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The Simple Analytics of Trade Creation and Diversion

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ABSTRACT

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This paper conducts analysis of a free trade agreement within a simple model of partial equilibrium, linear supply and demand, and circumstances such that trade flows are positive in all equilibria considered. The results illustrate the close connection, on the one hand, between trade creation and the benefit to the FTA-forming countries and to the world, and, on the other hand, the equally close connection between trade diversion and the harm to outside countries and potentially both the participating countries and the world. In addition, by considering a second case in which a country that already has one FTA adds another, we show that the new FTA causes trade to be diverted from its prior partner, an effect that we call trade reversion. It turns out that trade reversion causes neither harm nor benefit to the importing country, and when we look at world welfare, if trade reversion is equal to trade diversion their two effects cancel out, leading the effect on world welfare to be a simple function of the amount of trade creation and the size of the tariff.

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I. Introduction

In this paper we lay out a simple model of trade creation and trade diversion caused by a Free Trade Agreement (FTA). These concepts, introduced by Viner (1950) for a customs union, are most simply explained in terms of the cost of producing a good in a potential partner country compared either to the cost of producing it at home or producing it abroad, in a country from which imports continue to be subject to a tariff. However, market responses to FTAs will often, especially in the short run, cause costs to change and even become equal at the margin, as suppliers move up and down their supply curves. The analysis here allows for that, so that the welfare effects of trade creation and trade diversion cannot be easily inferred from marginal costs as they appear in equilibrium. These welfare effects are nonetheless quite easy to derive using the standard

*This paper began as the theoretical basis for Deardorff and Sharma (2018), in which we ask how the sectors that countries exempt from their FTAs are related to whether they would be subject to trade creation or trade diversion. Our development of the model was prompted in part by comments from Peter Neary on an early version of that paper. The current extension of the analysis to include a fourth country, and what we are calling trade reversion, was prompted by comments from a referee on that other paper.

tools of consumer and producer surplus, and they conform well with the expectations of Viner.

Viner's analysis was conceived at a time when FTAs and customs unions were not common. Today, there are hundreds of FTAs reported to the World Trade Organization, so that when two countries form a new FTA, it is likely that each has other trading partners with which it already trades freely under a separate FTA. Viner's concepts can be applied to such situations as well, but now a new FTA diverts trade not just from outside countries but also from inside countries – those with which the importing country trades freely under the separate FTA. While such trade may be viewed as literally being diverted, the welfare effects are not the same as trade diversion from an outside country, and we will give it the different name of "trade reversion."[1] Our thinking is that this is trade that had previously been diverted in the conventional sense when the prior FTA was formed, and the diversion due to the new FTA is really just reversing that earlier trade diversion.

In section II we lay out our market assumptions and the notation that we use throughout the paper. In section III we provide a graphical analysis of a simple 3-country case, in which one country forms an FTA with a second country, while keeping its tariff on the entire rest of the world unchanged. The essence of this graphical analysis is not new, adapting and building on WTO (2011). It shows clearly how the welfare effects of the FTA are related to trade creation and trade diversion, and how these concepts make sense even though costs in each country change with the formation of the FTA.

[1]A search for this term in prior literature also found it, with the same meaning, in Silva (1986) and Deardorff (2014).

Section IV provides the algebraic analysis of both the model of section III and of a 4-country model that includes a pre-existing FTA. The latter model is then examined graphically in section V. Each of sections III-V present steps in analysis that may be less than obvious without breaking them into smaller steps. These smaller steps are laid out in appendices.

II. Model Assumptions and Notation

Ours is a partial equilibrium, perfectly competitive analysis of a single product that is imported by a focus country, A, and that is exported to it by two or more other countries, B, C, and, in section V, D. Demands and supplies are linear, as are their differences, exports of countries B-D, and imports of country A:

$$\text{Exports:} \qquad X^i = b^i\left(p^i - a^i\right), \quad i = B, C, D, \ \ for \ \ p^i \geq a^i \tag{1}$$

$$\text{Imports:} \qquad M^A = b^A(a^A - p^A), \quad for \quad p^A \leq a^A \tag{2}$$

Here, $b^i > 0, \ i = A, B, C, D$, are the constant slopes of the excess supply and demand functions, and $a^i > 0, \ i = A, B, C, D$, are the autarky prices at which trade in this product would be zero. We will confine our attention to only cases in which all of the quantities traded are nonnegative, and thus[2]

$$p^i = a^i + X^i/b^i \,, \quad i = B, C, D \tag{3}$$

$$p^A = a^A - M^A/b^A \tag{4}$$

[2] We discuss the importance of this assumption, and how it might be dropped in section VI.

As the only country importing this good, country A levies specific tariffs, t^i, $i = B, C, D$, on its imports from the other three, any of which may be zero. In equilibrium

$$M^A = X^B + X^C + X^D \tag{5}$$

For any trade flow (since they are assumed positive), prices differ by the size of the tariff:

$$p^i = p^A - t^i, \quad i = B, C, D \tag{6}$$

The revenue of country A (the only country levying a tariff in this market) is

$$R^A = t^B X^B + t^C X^C + t^D X^D \tag{7}$$

Solution of the Model:

Substituting (1), (2), and (6) into (5):

$$b^A(a^A - p^A) = \sum_{i=B}^{D} \left[b^i \left(p^A - t^i - a^i \right) \right] \tag{8}$$

which rearranges to

$$\gamma + \sum_{i=B}^{D} b^i t^i = \beta p^A \tag{9}$$

where

$$\beta = b^A + b^B + b^C + b^D \tag{10}$$

$$\gamma = b^A a^A + b^B a^B + b^C a^C + b^D a^D \tag{11}$$

As will be seen below, under additional assumptions the b^i reflect country size, and therefore we define

$$\theta^i = b^i / \beta \tag{12}$$

which can then be interpreted as country i's size as a share of the world economy. From (9), the equilibrium price in country A is then

$$p^A = \frac{\gamma}{\beta} + \sum_{i=B}^{D} \theta^i t^i \tag{13}$$

Welfare

When price in a country changes, we will identify the welfare effect of the price change by the trade analogue of producer/consumer surplus. For the importing country, A, the change in welfare will also include any change in tariff revenue, plus the change in net surplus of the private sector (domestic suppliers and domestic demanders):

$$\Delta NS^A = -M_0^A \Delta p^A + \frac{1}{2} b^A (\Delta p^A)^2 \tag{14}$$

For the exporters

$$\Delta NS^i = X_0^i \Delta p^i + \frac{1}{2} b^i \left(\Delta p^i\right)^2, \quad i = B, C, D \tag{15}$$

Country Size

To deal with country size, we add the following assumption about the composition of industries in each country: Let the industry in each country $i = A, B, C, D$ be composed of a large number n^i of competitive suppliers, each with the same supply curve $\sigma\left(p^i - c^i\right)$. Thus the slope parameter of all firms in all countries is assumed to be the same, σ, and the firms differ across countries only in their cost intercept, c^i. The industry domestic supply curve in country i is therefore

$$S^i = n^i \sigma\left(p^i - c^i\right), \qquad p^i \geq c^i \tag{16}$$

Assume too that demanders in all countries i also share a single slope parameter, δ, and that they too differ across countries only in their intercepts, m^i. Assume finally that the number of demanders in each country is a common multiple, Γ, of the number of firms, n^i. Then the industry domestic demand curve is

$$D^i = \Gamma n^i \delta\left(m^i - p^i\right), \qquad p^i \leq m^i \tag{17}$$

With these assumptions, the autarky price in country i can be derived as

$$a^i = \frac{\sigma c^i + \Gamma \delta m^i}{\sigma + \Gamma \delta} \tag{18}$$

which is independent of the numbers of firms and demanders, and thus of industry/country size. The slope parameter of the export and import functions, however, does depend on country size. These functions can be derived as

$$X^i = n^i(\sigma + \Gamma\delta)\left(p^i - a^i\right), \quad i = B, C, D, \ p^i \geq a^i \tag{19}$$

$$M^A = n^A(\sigma + \Gamma\delta)(a^A - p^A), \qquad p^A \leq a^A \tag{20}$$

Thus the slope parameters are,

$$b^i = n^i(\sigma + \Gamma\delta), \quad i = A, B, C, D \tag{21}$$

and the b^i differ across countries only by country size. Let the units of measurement of goods, money, firms, and demanders be chosen so that $\sigma + \Gamma\delta = 1$. Then we can interpret $b^i = n^i$ as measuring the size of country *i*, and $\theta^i = b^i/\beta$ as the relative size of country *i* compared to all together. [3]

[3] The assumption above that numbers of demanders are proportional to numbers of firms may strain credulity even more than the other assumptions here, since one expects exporters to have more firms on average, relative to population, than importers. This error might be minimized if trade itself is small compared to domestic supply and demand, but even that is a stretch. This association of the *b*'s with country size is therefore only intended as a very rough heuristic, and even then is better for comparing exporters than comparing an exporter to the importer.

III. Analysis of a First FTA

In this section we apply the model of section II to the formation of a single FTA between country A and country B, with country C representing the entire rest of the world with which country A continues to have a common MFN tariff, t. We ignore country D, for which we assume $b^D, \theta^D = 0$. The analysis in this section is graphical, using the same assumptions of section II, with one additional assumption: that the two exporting countries, B and C, are identical. This assumption allows us to represent them with a common export supply curve. Its importance is minimal in the 3-country case, but it will be more important when we add a fourth country, as we will see later.

Figure 1 shows the equilibria before and after the formation of the FTA. On the left are the common export supply curves for countries B and C as functions of the price in country A, p^A, with the superscript f when they are not subject to a tariff by country A and the superscript t when they are subject to the common specific tariff t. The panel on the right shows the import demand curve of country A, M^A. Equilibrium is found by intersecting this with the horizontal sum of the two export supply curves.

Prior to the FTA, both exporters are subject to the same tariff, so this horizontal sum has the same intercept as the two with-tariff export supply curves, and half their slope. The equilibrium has price p_0^A in country A and quantity of imports M_0^A, which is split evenly between the two exporters.

With the FTA, country B's export supply curve is now the lower one, X^{Bf}, and it is able to export at prices below the autarky price of country C. The import supply curve on the right therefore is identical to country *B*'s export supply curve for prices below $a^C + t$. Only above that level are the two export supply curves added together, resulting in the kink shown at that price. Because we assume throughout this paper that all trade flows remain positive, we show the new equilibrium as above that kink, although it wouldn't have to be if the tariff were large enough.

Comparing the two equilibria, we see that country *A*'s total imports rise from M_0^A to M_1^A, while partner country *B*'s exports rise even more, from X_0^B to X_1^B. This happens because the exports of the outside country, *C*, fall, from X_0^C to X_1^C. This, of course, is the trade diversion that Viner taught us, though in this case it does not arise because of any *ex ante* difference between countries *B* and *C*, since we assumed them to be identical. We'll see shortly why this trade diversion is costly in spite of that.

Figure 1 labels the rise in imports of country *A* as trade creation, *TC*, and the fall in exports of country *C* as trade diversion, *TD*. The increase in exports of partner country *B* must of course be the sum of these two (as required by equation (5) since country *D* is absent), and it will be convenient therefore to show *TD* and *TC* also as making up the gap between X_0^B and X_1^B.

Now consider the welfare effects of this FTA. These are shown in Figure 2 for the importing country *A*, in Figure 3 for the both exporting countries, *B* and *C*, and in Figure 4 for the world. In Figure 2, Country *A* loses all of its previous tariff revenue from country *B*, and it also loses the tariff revenue on those imports from country *C* that no longer occur. On the other hand, country *A*'s domestic demanders of the good gain from its fall in price, and their gain exceeds the loss to domestic suppliers by the amount shown on the right of Figure 2. For expositional convenience, we will refer to this as the gain to country A's net demanders, and speak similarly of the welfare of the exporting countries' net suppliers.

Country A may therefore lose from the FTA if the loss of tariff revenue is greater than the gain to the domestic private sector. As indicated in Figure 2, the loss is associated with the amount of trade diversion and the gain with the amount of trade creation. The latter is true because not only the small triangle but also the much larger rectangle of gain depend in size on the amount of trade creation, since the price change and quantity change are related by the slope parameter, b^A. However, it is not the case that one can simply compare the two quantities of trade creation and trade diversion in order to infer whether the FTA is overall beneficial to country A. That depends also on the height of the areas in Figure 2 plus the amount of initial trade with country B, on which all tariff revenue is lost.

The welfare effects on the two exporting countries are shown in Figure 3 as very simply the areas to the left of the two export supply curves between their two prices, country B gaining and country C losing. As drawn, the former exceeds the latter, but that would no need to be the case if B and C were not identical. What matters for both is the size and direction of its change in exports, and the price changes that cause them. However, it is clear from the figure that the loss to country C depends directly, and almost solely, on the amount of trade diversion. The partner country B, on the other hand, gains from both trade creation and trade diversion.

Figure 4 includes all of the effects shown from Figures 2 and 3, with the loss of tariff revenue for country A superimposed on the gain of country B. It may not be obvious how these positive and negative effects net out, but the result (shown in several steps in Appendix A) is in Figure 5. This shows clearly that all of the gain for the world is due to trade creation (the green triangle), and all of the loss is due to trade diversion (the red rectangle). Again, however, one cannot simply compare the quantities of these two changes in trade to determine whether world welfare rises or falls, since the areas depend on their vertical dimensions as well as the horizontal. The vertical dimensions depend on the size of the tariff, but that matters for both the gain and the loss similarly. More important are the slopes of the curves, which we saw in the equations of section II to be related to the sizes of the countries. We will need the algebra to sort that out more fully, which we will do in section IV.

What the graphical analysis does allow us to do, however, is to see more clearly why trade creation and especially trade diversion have the welfare effects that they do. For trade creation, the green triangle in Figure 5 tells the familiar story: as trade expands, net demanders purchase units of the good that are worth more to them (the height of the demand curve) than their marginal cost of production abroad (the height of the supply curve).[4] The green triangle captures the integral of this difference, as the marginal benefit and marginal cost are moved together by new trade.

For trade diversion, we look more carefully at costs in the two exporting countries in Figure 6. Initially, because they face the same price, suppliers in the

[4]More fully, by "net demanders purchase" we mean domestic demanders increase their purchases of goods worth more to them than their cost from abroad at the same time that domestic suppliers reduce their sales of goods that cost them more to produce than they can be obtained from abroad.

two countries have the same marginal cost. But as trade diversion causes output to rise in the country B, its marginal cost goes up along B's supply curve, and at the same time output falls in country C, causing its marginal cost to fall. Thus after the first unit of trade diversion, which replaces one export with another at the same cost, all additional units of diverted trade replace units of exports with others at higher marginal cost. The two added trapezoids in Figure 6 integrate these cost changes, and their difference in area is equal to the small rectangle of world efficiency loss shown above them as the loss from trade diversion.

As this suggests, the efficiency cost per unit of trade diversion in this model with upward sloping supplies increases with its quantity. Indeed, like the deadweight loss in simple models of tariffs, it rises with the square of the quantity of trade diversion, since the more trade is diverted, the greater will be the marginal cost difference between the two suppliers.

IV. Model Solutions

We now apply the model of Section II to a situation in which country A initially has an FTA with only country D, then forms an FTA with country B as well. Thus we have an initial equilibrium with a common tariff, t, on both B and C but a zero tariff on D. The second equilibrium has the tariff set to zero on B as well as D, keeping the MFN tariff t on country C only. The solution is also valid for the case of a first FTA as well, by just setting θ^D, reflecting the size of country D, to zero.

From (13) we have the initial and final price in country A:

$$p_0^A = \frac{\gamma}{\beta} + \theta^B t^B + \theta^C t^C \qquad (22)$$

$$p_1^A = \frac{\gamma}{\beta} + \theta^C t^C \tag{23}$$

Therefore the price change in the importing country A, which is also the price change in countries C and D since their prices continue to equal $p^A - t$, is

$$\Delta p^A = \Delta p^C = \Delta p^D = -\theta^B t^B < 0 \tag{24}$$

Note from this that the drop in price in the importing country is larger the larger is the new partner country, both relative to the rest of world and relative to its existing partner, since θ^B reflects country B's share of the markets of all four countries combined.

Using (1), (2), and (24) it is straightforward to derive the changes in trade:

$$\Delta M^A = \theta^B b^A t > 0 \tag{25}$$

$$\Delta X^B = \theta^B (b^A + b^C + a^D) t > 0 \tag{26}$$

$$\Delta X^C = -\theta^B b^{\boldsymbol{C}} t < 0 \tag{27}$$

$$\Delta X^D = -\theta^B b^{\boldsymbol{D}} t < 0 \tag{28}$$

Thus the formation of an FTA between countries *A* and *B* causes trade between them to increase in (25-26), while reducing the exports in (27-28) from both the outside country *C* and the country *D* with which country *A* already had an FTA. These two declines in exports, since they are matched by an increase in exports by country *B*, might both be called trade diversion. However, because their welfare implications turn out to be different, we will call only the first trade diversion *TD* (from country *C*) and refer to the second as trade reversion *TR* (from country *D*). The reason for that name is that this can be viewed as a partial reversal of the trade diversion that had previously occurred when country *A* formed its FTA with country *D*, although we have not looked at that explicitly here.

Thus these changes in trade give us formulas for trade creation, trade diversion, and trade reversion:

$$TC = \theta^B b^A t > 0 \tag{29}$$

$$TD = \theta^B b^{\boldsymbol{C}} t > 0 \tag{30}$$

$$TR = \theta^B b^{\boldsymbol{D}} t > 0 \tag{31}$$

Note that, while the increase in exports from country *B* does not have a name, it is equal to the sum of the other three:

$$\Delta X^B = TC + TD + TR > 0 \tag{32}$$

Welfare Effects

In country *A*, the government loses the entire tariff revenue on its prior imports from the new partner country *B*, and it also loses the tariff revenue on the trade that is diverted from country *C* to country *B* (*TD*). It does not lose anything from the decline in imports from the existing partner country *D*, since the tariff on it was already zero. Thus

$$\Delta R^A = -tX_0^B - tTD \tag{33}$$

On the other hand, country A gains from the fall in price, since it is a net importer, and its domestic demanders therefore gain more than its domestic suppliers. This gain in net surplus (ΔNS^A), can be calculated from the import demand curve as the following trapezoid:

$$\Delta NS^A = -\frac{M_1^A + M_0^A}{2} \Delta p^A \tag{34}$$

With some manipulation, shown in Appendix B, this can be transformed to the following,

$$\Delta NS^A = (M_0^A / b^A + \theta^B t/2) TC \tag{35}$$

which we combine with (33) to get the net effect on the welfare of country A:

$$\Delta W^A = (M_0^A/b^A + \theta^B t/2)TC - tTD - tX_0^B \tag{36}$$

Welfare of countries B, C, and D can be found similarly from their price changes and their export supply functions:

$$\Delta NS^i = \frac{X_1^i + X_0^i}{2}\Delta p^i = X_0^i \Delta p^i + \frac{b^i}{2}\left(\Delta p^i\right)^2, \;\; i = B, C, D \tag{37}$$

To apply this to country B we need its price change, which is a rise from $p_0^A - t$ to p_1^A:

$$\Delta p^B = p_1^A - (p_0^A - t) = \Delta p^A + t = (1 - \theta^B)t \tag{38}$$

from which (37) give us

$$\Delta NS^B = X_0^B(1 - \theta^B)t + \frac{b^B}{2}(1 - \theta^B)^2 t^2 \tag{39}$$

In Appendix B this is manipulated to get

$$\Delta W^B = \Delta NS^B = \left[X_0^B + \frac{1}{2}(TC + TD + TR)\right](1 - \theta^B)t \tag{40}$$

Countries C and D, with constant and zero tariffs respectively, experience the same price change as country A: $\Delta p^C = \Delta p^D = \Delta p^A$. Therefore a similar analysis, also detailed in Appendix B, leads to

$$\Delta W^C = \left[-X_0^C + \frac{TD}{2}\right]\theta^B t \tag{41}$$

$$\Delta W^D = \left[-X_0^D + \frac{TR}{2}\right]\theta^B t \tag{42}$$

Interestingly, while the facts of trade diversion and trade reversion are harmful to these countries, these reductions in their exports reduce their loss below what would have occurred from their price change alone had their exports not declined. This is analogous to the familiar result that the loss of producer surplus from a fall in price is smaller than the loss in revenue that would have occurred if suppliers were unable to reduce output. With a sloping supply curve, they limit that loss somewhat by ceasing to produce units of the good that would cost them more than the new lower price.

Finally, we ask how the FTA affects the welfare of all four countries combined. Adding (36), (40), (41), and (42) we get

$$\Delta W^W = \left(\frac{M_0^A}{b^A} + \frac{\theta^B t}{2}\right) TC - tTD - tX_0^B$$

$$+ \left[X_0^B + \frac{1}{2}(TC + TD + TR)\right](1 - \theta^B)t$$

$$+ \left[-X_0^C + \frac{TD}{2}\right]\theta^B t + \left[-X_0^D + \frac{TR}{2}\right]\theta^B t \qquad (43)$$

With more manipulation shown in Appendix B, this reduces to the following:

$$\Delta W^W = \frac{1}{2} TCt + \frac{1}{2}(TR - TD)t \qquad (44)$$

Thus, the world as a whole gains from trade creation and trade reversion, but loses from trade diversion.

V. Analysis of a Second FTA

We now turn to a graphical analysis of the 4-country model that includes trade reversion. The approach is exactly the same as in section III, but with three identical exporting countries instead of two. Figure 7 shows three equilibria in the right-hand panel, E_0, E_1, and E_2, for country A having FTAs with no country, with one country (D), and with two countries (B and D) respectively. Each is the intersection of import demand with export supplies, where the latter are the sums of the appropriate individual export supplies shown on the left. As in section II, countries B, C, and D are assumed to share the same export supply curve (as was <u>not</u> assumed in the math of section IV). The export supply as a function of the country-A price, P, is shown with the superscript f (for free trade) if there is no tariff on those exports, and with the superscript t if the exports face the tariff t for sales into country A.

Import supply curve $\sum X_0$ is the horizontal sum of those identical upper three supply curves. Curve $\sum X_1$ is what we take as our initial supply curve, with tariff on B and C, but not on D. It duplicates just country D's export supply curve up to the price at which the other two countries begin to export, beyond which it is flatter, parallel to $\sum X_0$. Curve $\sum X_2$ shows import supply when both countries B and D face a zero tariff, and it therefore has half the slope of $\sum X_1$ up to its kink. As before we have drawn the figure under the assumption that all three countries export in both equilibria.

The formation of an FTA between countries A and B in the presence of a prior FTA between A and D causes movement from equilibrium E_1 to E_2. Thus it causes imports of country A to expand by ΔM^A, exports of country B to expand by ΔX^B, and exports of countries C and D to fall by ΔX^C and ΔX^D respectively. Since these last two changes are movements along parallel supply curves responding to the same fall in price, they must be the same: $\Delta X^C = \Delta X^D$.

As before we identify ΔM^A as trade creation, TC. There are now two countries whose exports decline and are replaced by additional added exports from country B, so both might reasonably be named trade diversion. However, because we know (but have not shown) that country D must have been the beneficiary of earlier trade diversion when its own FTA with country A was formed, we name ΔX^D

trade reversion, TR, instead. Only the drop in exports of the still excluded country C gets the name trade diversion, TD. These labels are also shown in the figure.

In section III it was useful to note also that the change in exports of the partner country B could also be labeled with TC and TD. The same is true here for the new partner B, whose ΔX^B equals the sum of TC, TD, and TR. We show this as well in the figure, as it will be useful in our subsequent interpretation.

Figures 8-11 show the welfare effects of country A's new FTA with country B. Their construction parallels what was seen in Figures 2-4 sufficiently that no additional explanation should be needed. The main new feature is the loss of net surplus in country D due to trade reversion. Figure 12 then shows all four sets of effects together, to get the effect on the world.

The gains and losses shown in Figure 12 are not trivial to manipulate so as to find the net effect on the world, but it can be done in a number of steps shown in Appendix C. The result is the perhaps surprisingly simple Figure 13. The net of all the gains and losses shown in Figure 12 turns out to be an unambiguous gain, equal to a simple triangle the base of which is the tariff and the height of which (measured horizontally) is the amount of trade creation.

This surprising result – that the trade diversion and reversion of a second FTA do not hurt the world – is an artifact of an assumption that we made in order to simplify the diagrams: that countries C and D are identical. This assumption led to the quantities of trade diversion and trade reversion being the same. Looking back at equation (44), with $TD = TR$ it becomes

$$\Delta W^W = \frac{1}{2} TCt \tag{45}$$

which is precisely what is shown in Figure 13. Without that assumption, the second FTA would raise world welfare even more than in (45) and in Figure 13 if $TR > TD$. Alternatively, if $TR < TD$ – as of course it must be if there is no prior FTA – then world welfare will rise by less and may fall.

VI. Other Cases

Zero trade

We've assumed throughout that every country's exports are positive both before and after the FTA. With our linear export supplies, that may not be the case, as a price may start or end below the intercept of the export supply curve. The new partner country, B, may initially not export, but the FTA may allow it to. And countries C and D, from whom trade is diverted, may reduce their exports to zero.

We will not address any of these cases explicitly, except to note that when an FTA causes a price to cross a country's autarky price, the case can be broken into two parts, one part with that country supplying zero and therefore not included in the analysis, and a second part where it behaves as we have modeled the countries here. Since our analysis includes cases in which a country is absent (as was the case of country D in section III), the model easily accommodates such cases. Most of what we have found here will hold in such hybrid cases, with the obvious exception that once a country's exports are driven to zero, no further trade diversion or reversion is possible for it.

Non-identical exporters

We assumed identical supply functions for all exporters only in the graphical analysis of sections III and V, so the algebra of section IV allows arbitrary differences among them. However, our argument that the slope parameters b^i would reflect country size also required that the countries be identical. It remains true that, other things equal, a larger country will have a larger value of b^i, but many other things may matter for the b^i as well as country size.

Also, it is notable that the parameters a^i have played no role in our analysis, even though these would normally be thought to reflect comparative advantage and the cost differences that drive our normal understanding of the costs of trade diversion. The reason is again our assumption that all exports are positive both before and after the FTA. It follows that all effects are movements along the supply curves, so that only their slopes matter.

However, if it is the case that the exporting countries differ in their autarky prices a^i, then countries with lower values for this parameter will be exporting more at given prices even with the same b^i, so that again our association of b^i with country size will not be valid.

Other importers

We've also assumed only a single importer for the good. The rest of the world outside any FTA of country A can of course include other countries that import the good, since they will just be part of the domestic demand of country C. What will complicate things for us, however, is if country A is already in an FTA with another country that also imports the good. When country A lowers its tariff on country C and this reduces the price of the good in country A, that other importer will also benefit from the lower price even though it does not reduce its own tariff. That is a complication that is not covered by the analysis here.

Conclusion

This paper has conducted analysis of a free trade agreement within a simple model of partial equilibrium, linear supplies and demands, and circumstances such that trade flows are positive in all equilibria considered. The results illustrate the close connection between trade creation and the benefit to the FTA-forming countries and to the world, and the equally close connection between trade diversion and the harm to outside countries and potentially both the participating countries and the world. In addition, by considering a second case in which a country that already has one FTA adds another, we saw that the new FTA causes trade to be diverted from its prior partner, an effect that we called trade reversion. It turns out that trade reversion causes neither harm nor benefit to the importing country, and when we look at world welfare, in the special case where trade reversion is equal to trade diversion, their two effects cancel out, leading the effect on world welfare to be a simple function of the amount of trade creation and the size of the tariff. More generally, trade reversion will increase the world benefits from the new FTA if it is greater than trade diversion.

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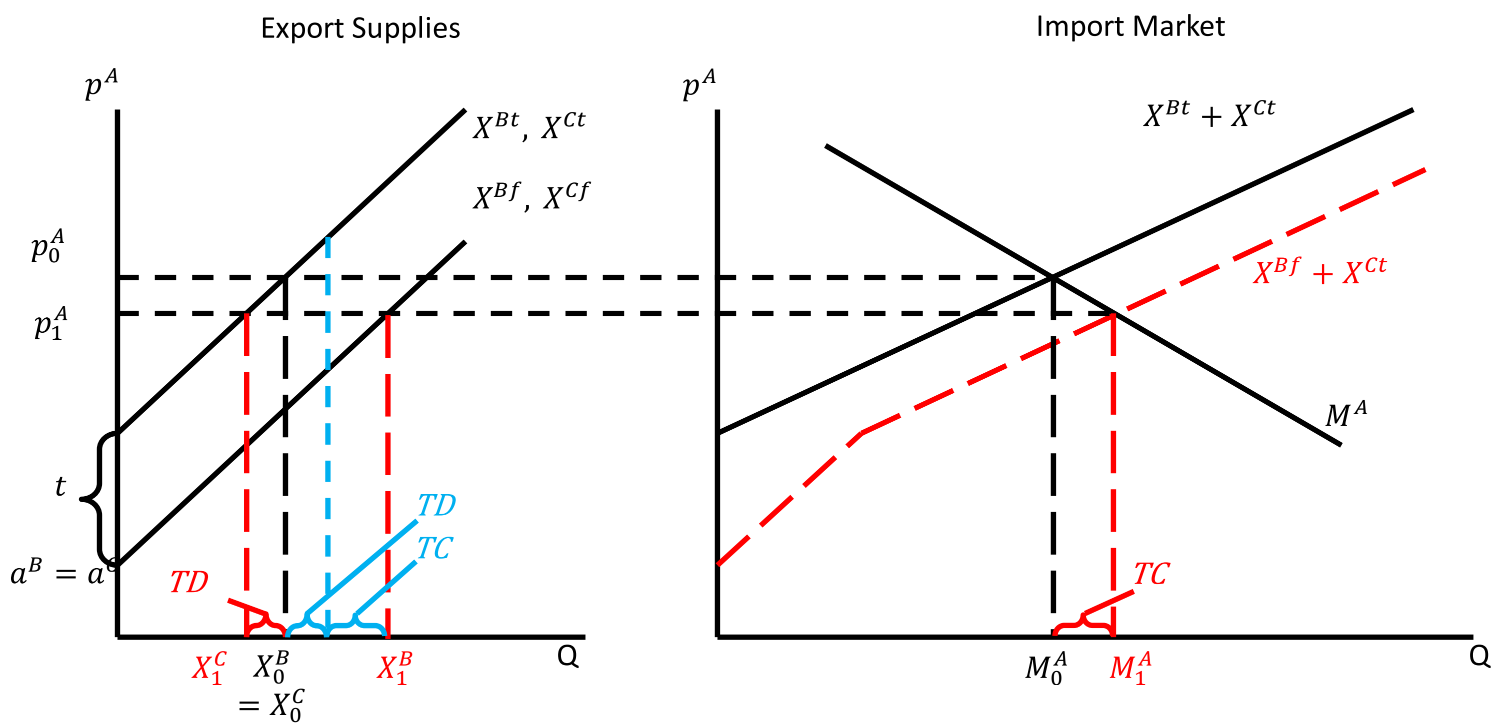
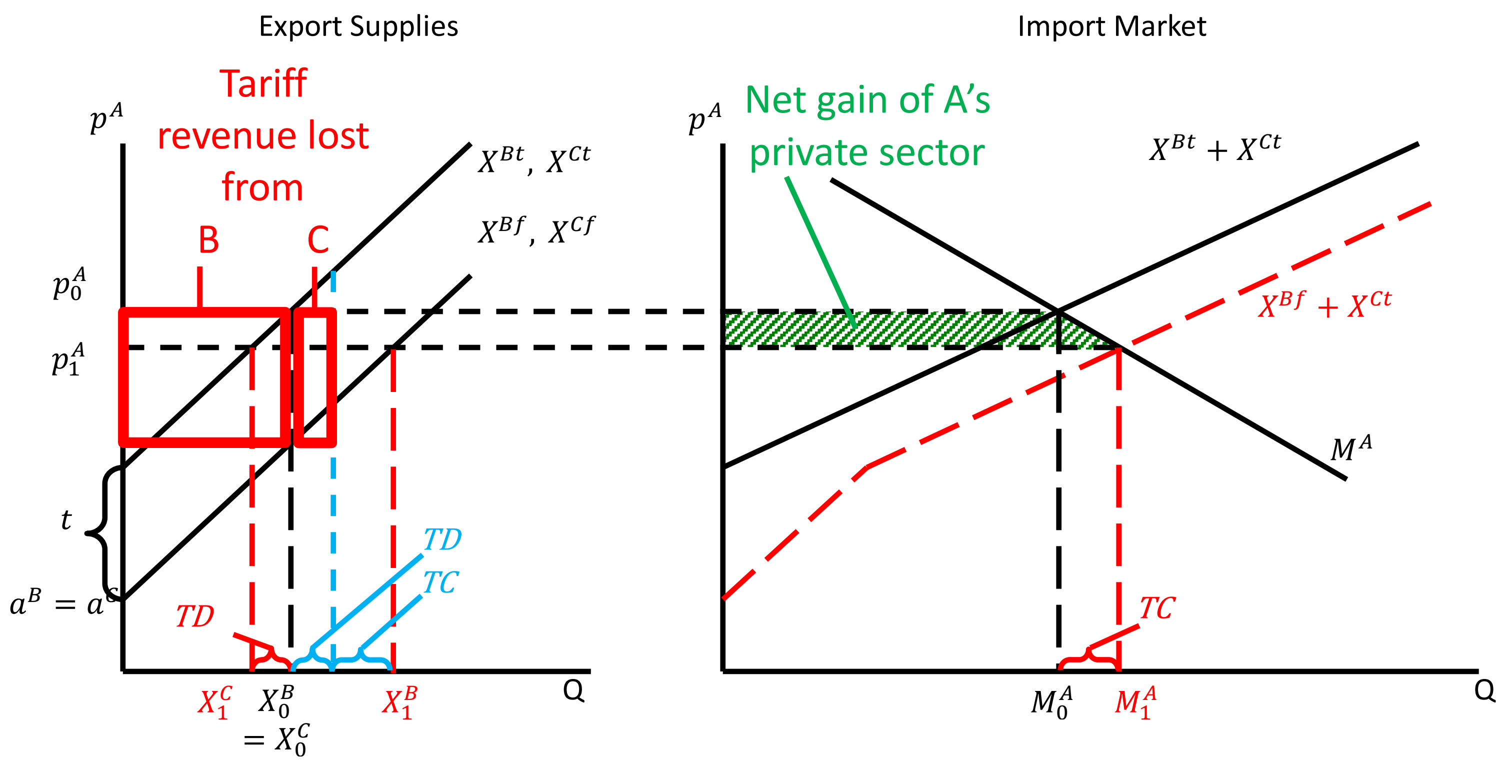


Figure 1

FTA with a Single Country



$$\Delta W^A = \left(a^A + \frac{b^B t}{2\beta} \right) TC - tTD - tX_0^B$$

Figure 2

Change in Welfare of Country *A* Due to FTA with a Single Country

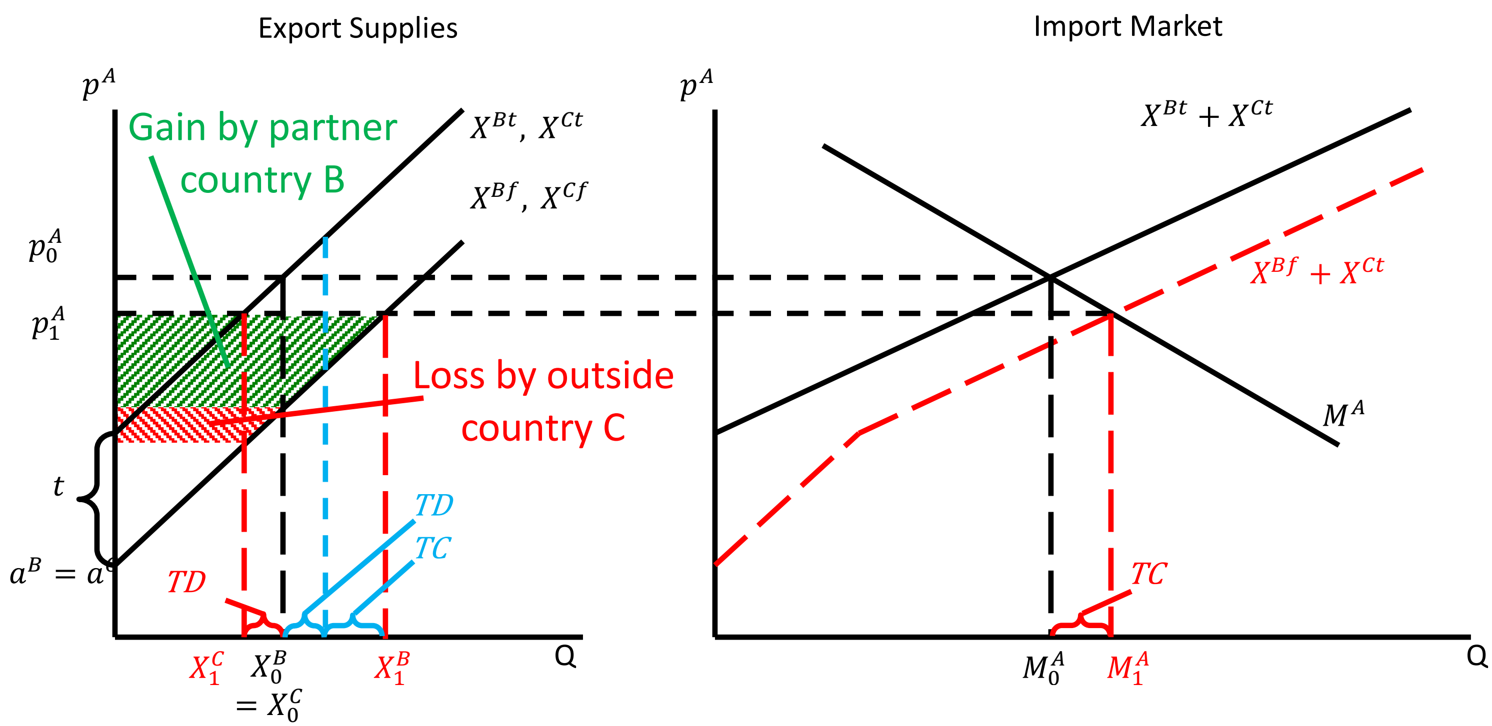


Figure 3

Change in Welfare of Countries *B* and *C* Due to *A*'s FTA with a Single Country

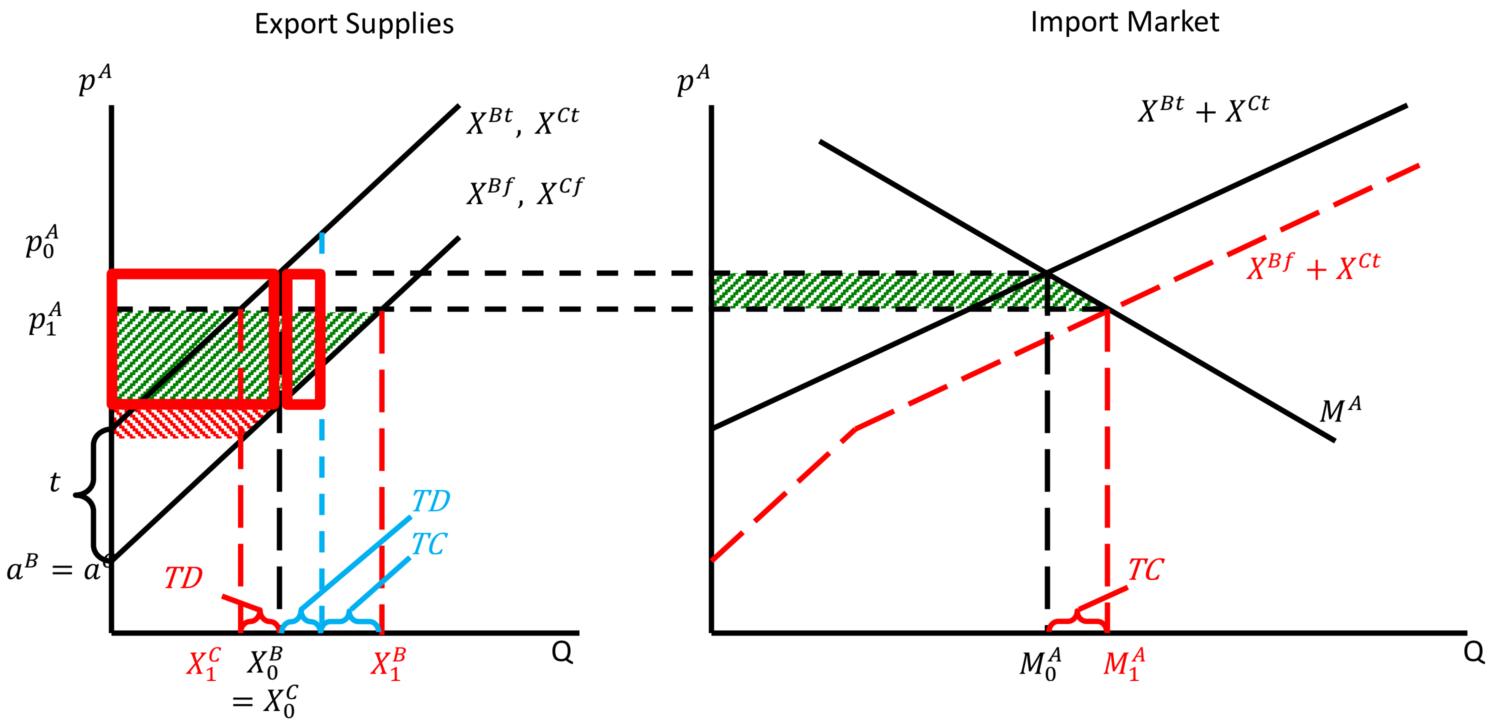


Figure 4

Change in Welfare of the World Due to *A*'s FTA with a Single Country

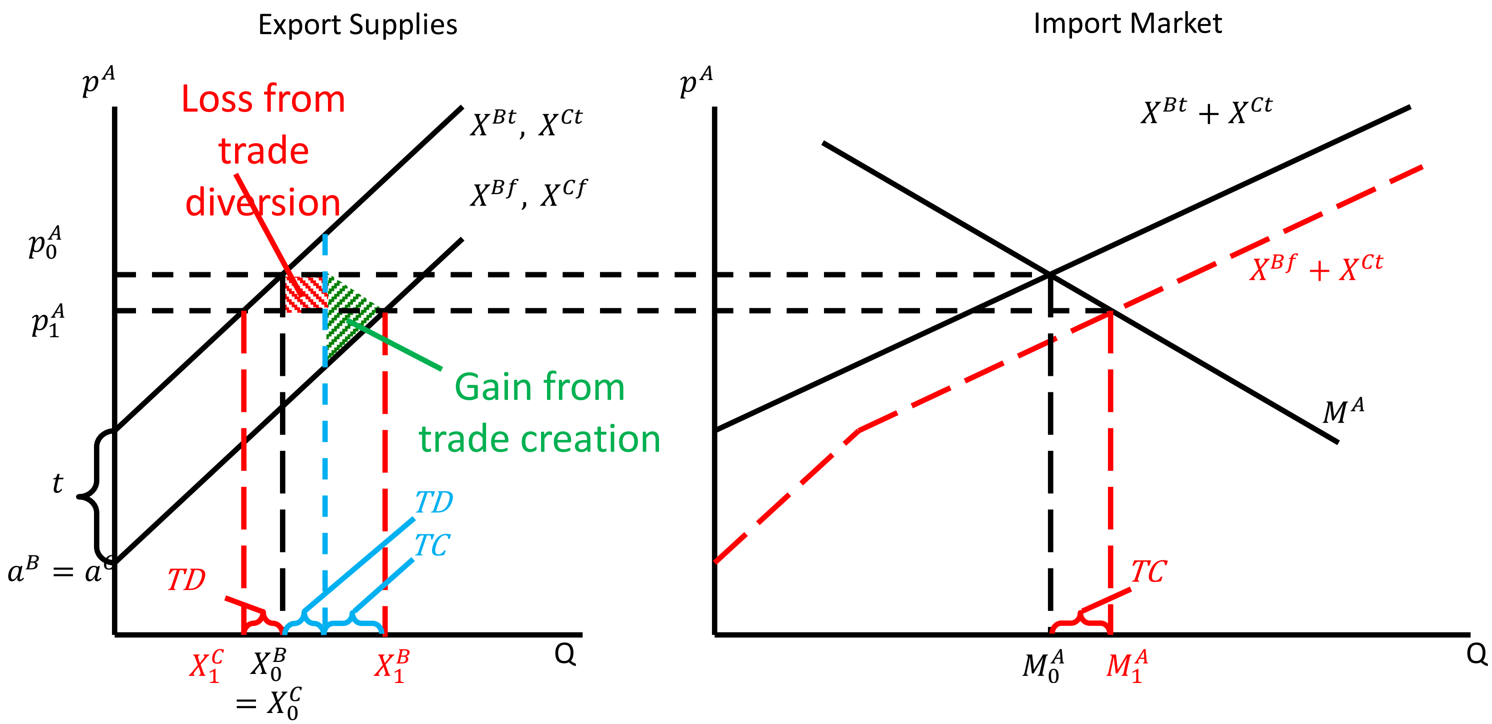


Figure 5

Change in Welfare of the World Due to *A*'s FTA with a Single Country

(after some cancellation of losses and gains)

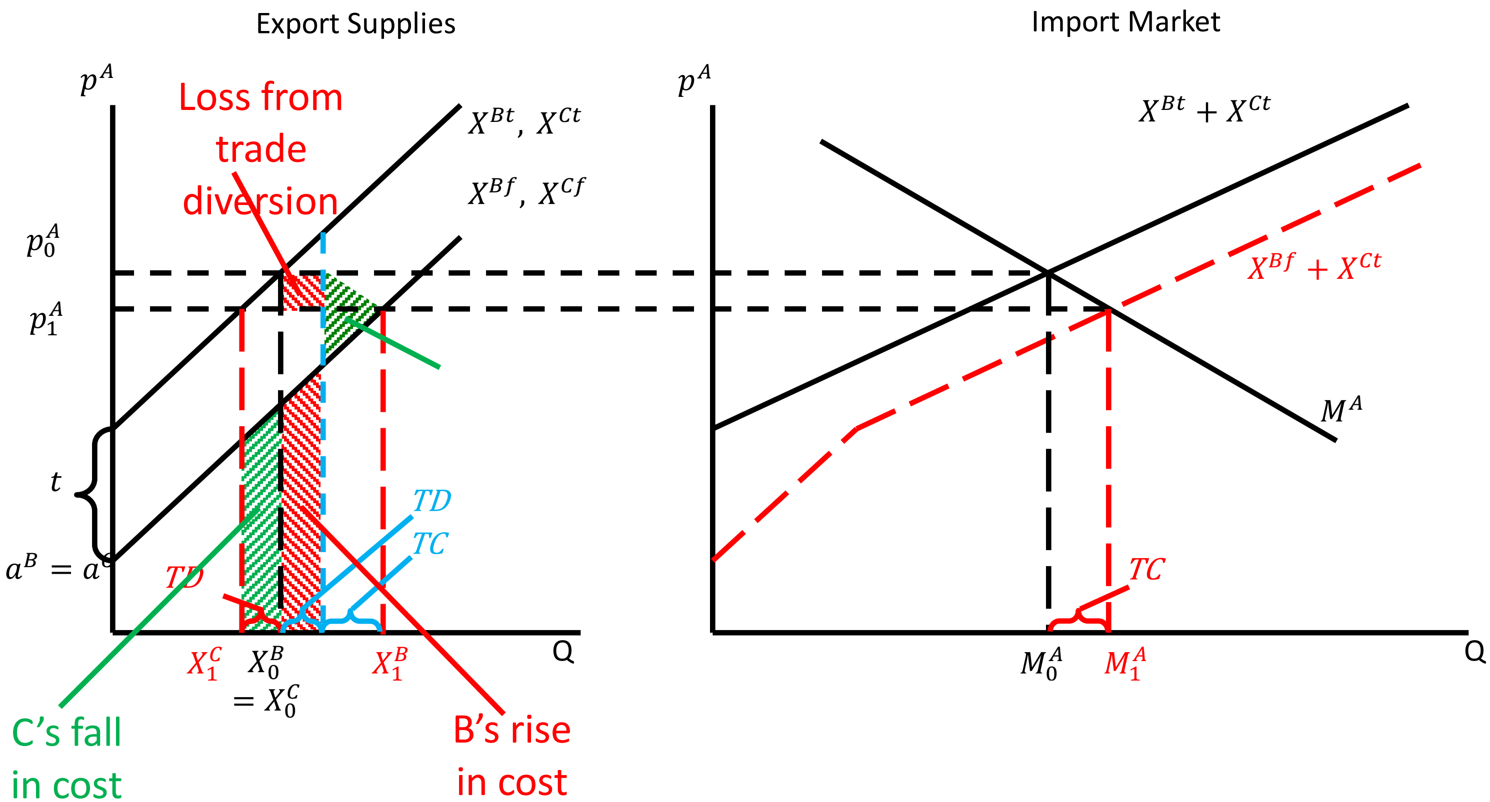


Figure 6

Why the Loss from Trade Diversion

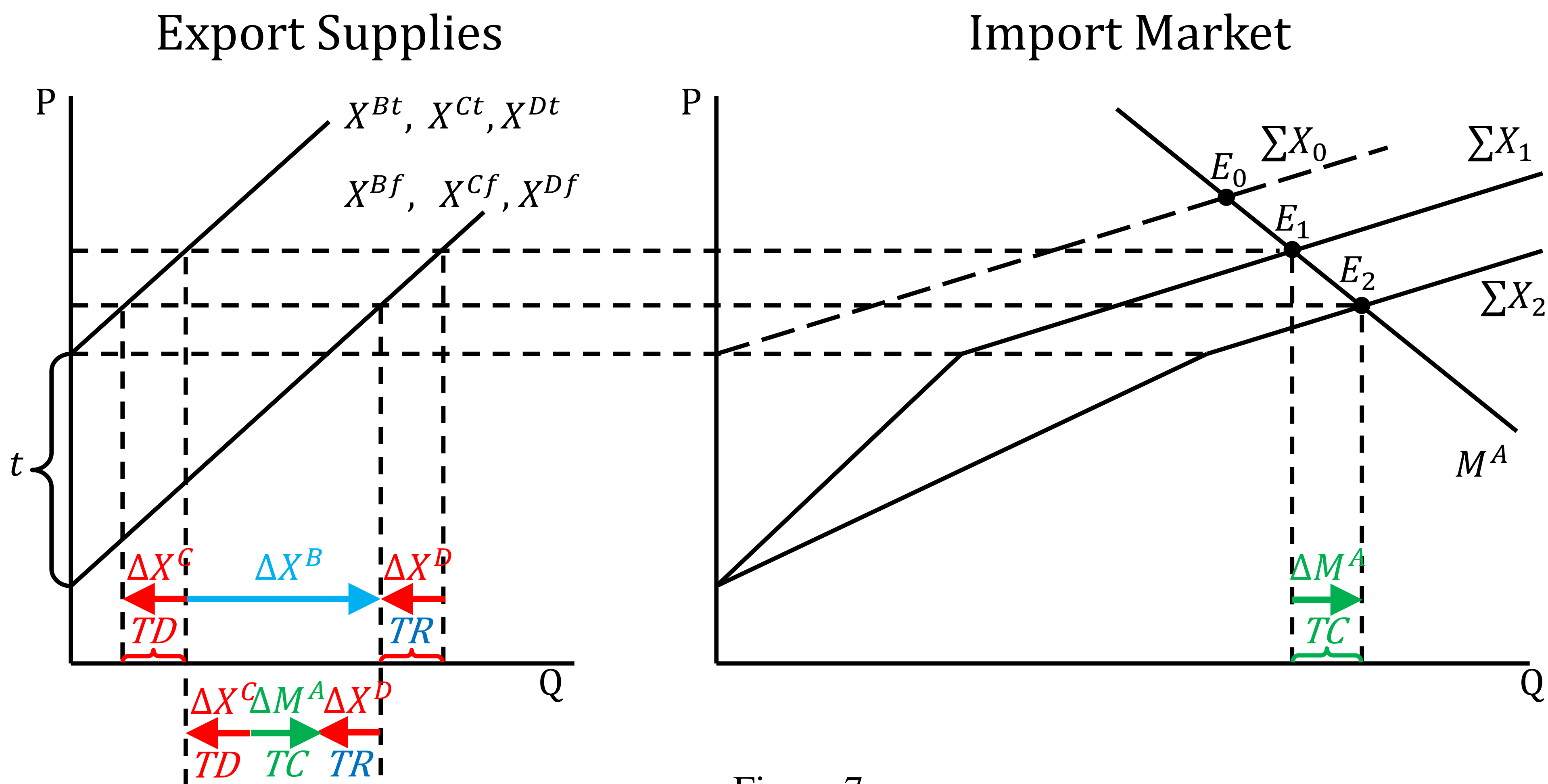


Figure 7
Adding a Second FTA
(By *A* with *B* after First FTA with *D*)

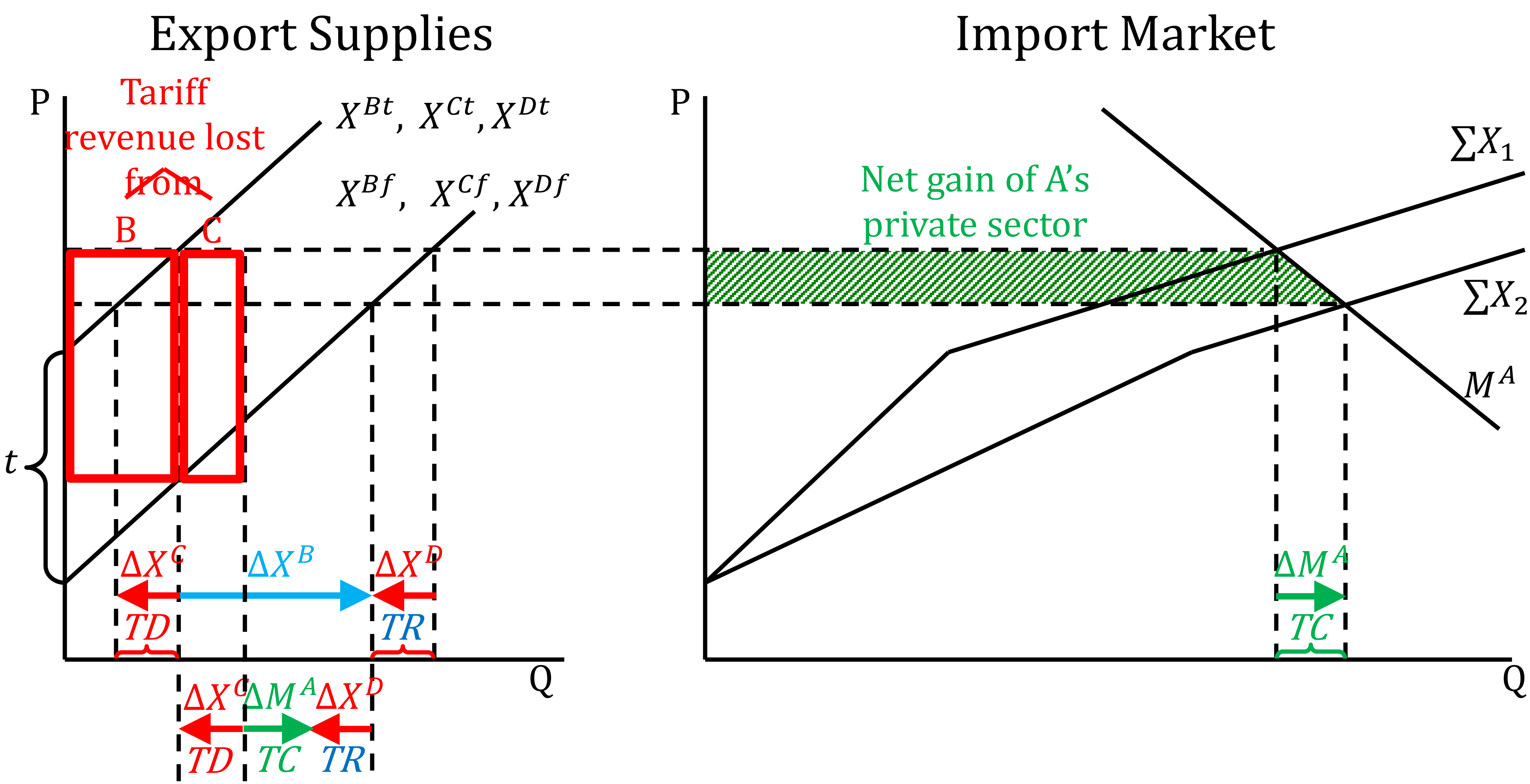


Figure 8
Welfare Effects on *A* of Adding a Second FTA

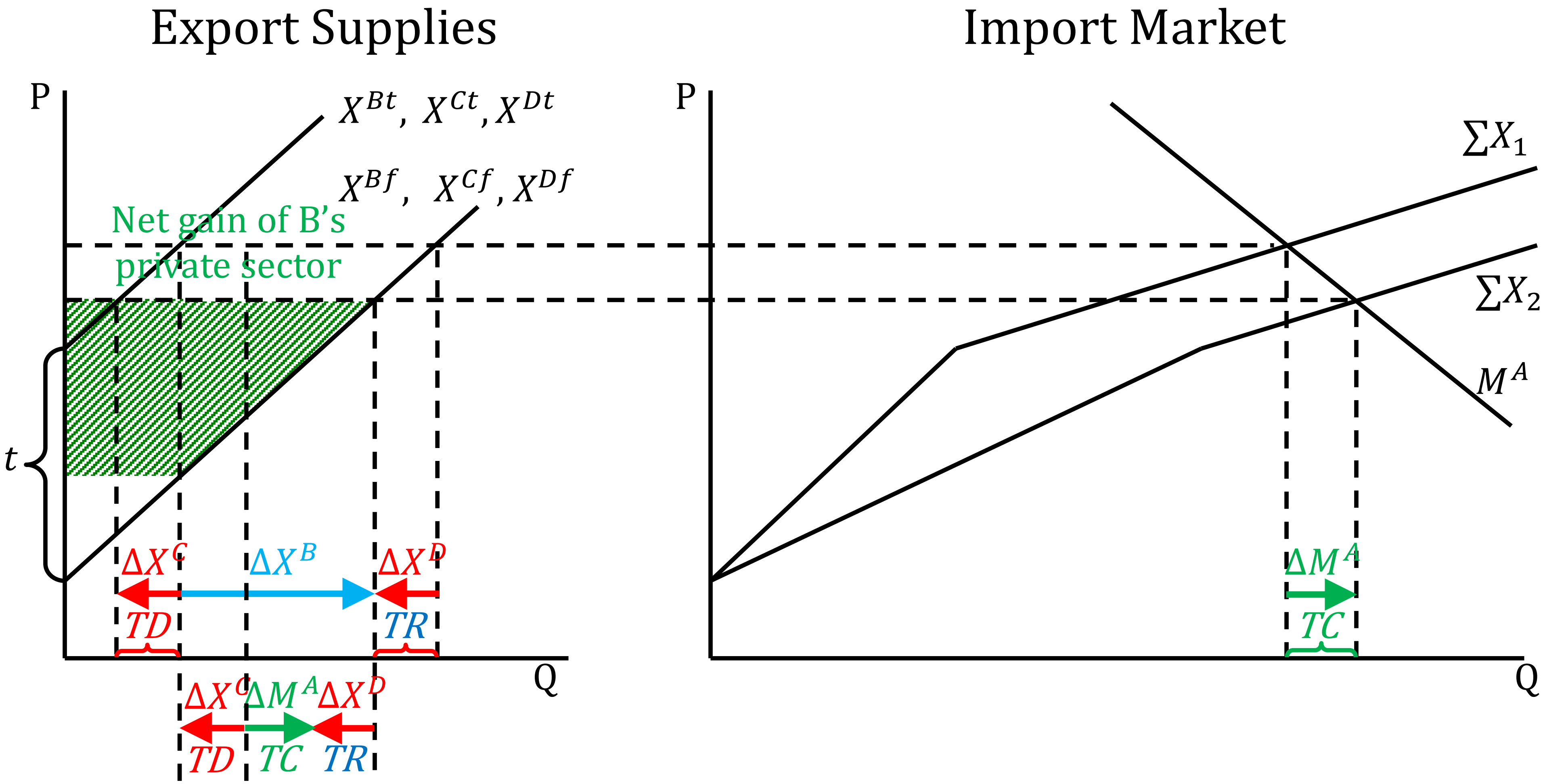


Figure 9

Welfare Effects on *B* of Adding a Second FTA

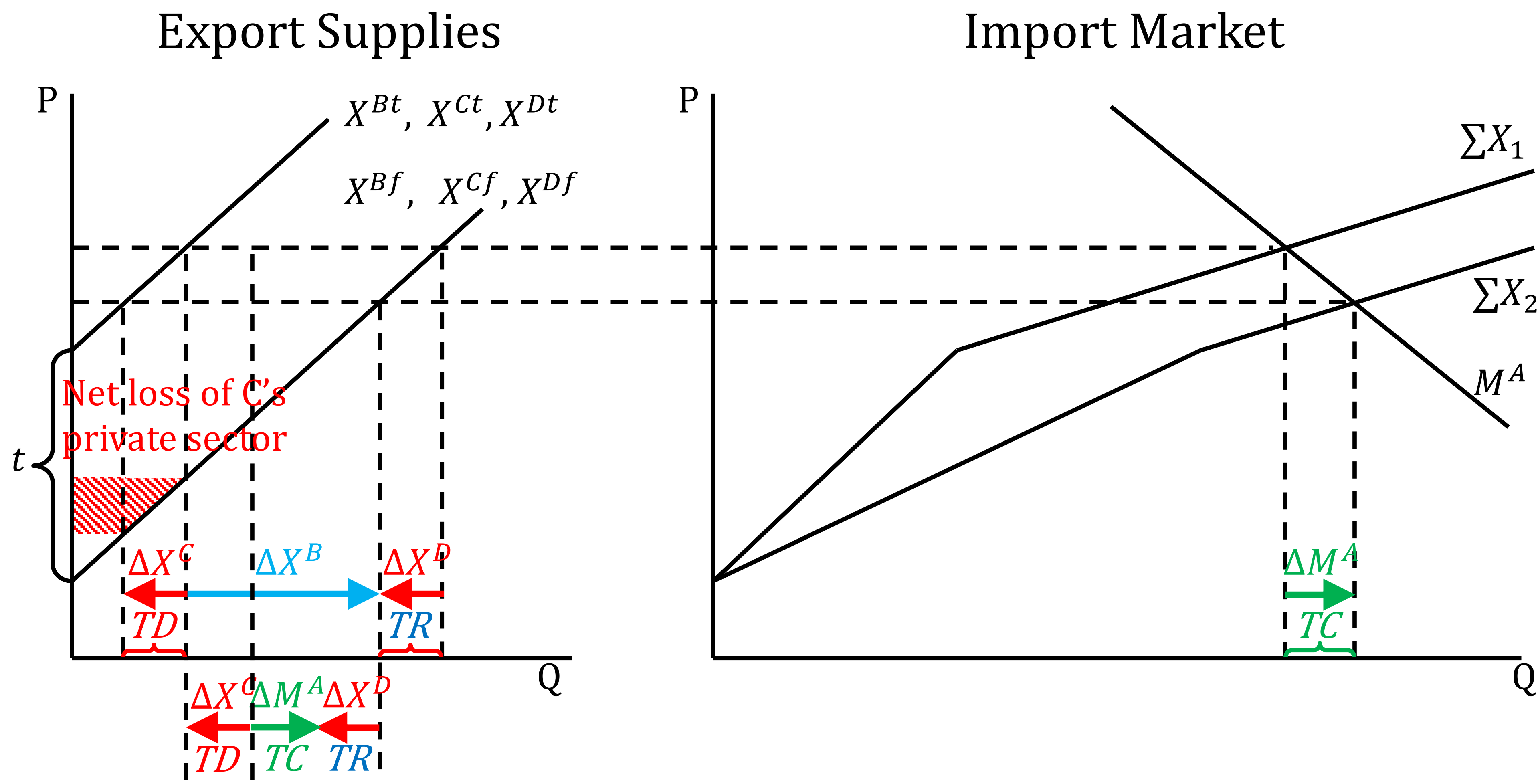


Figure 10
Welfare Effects on *C* of Adding a Second FTA

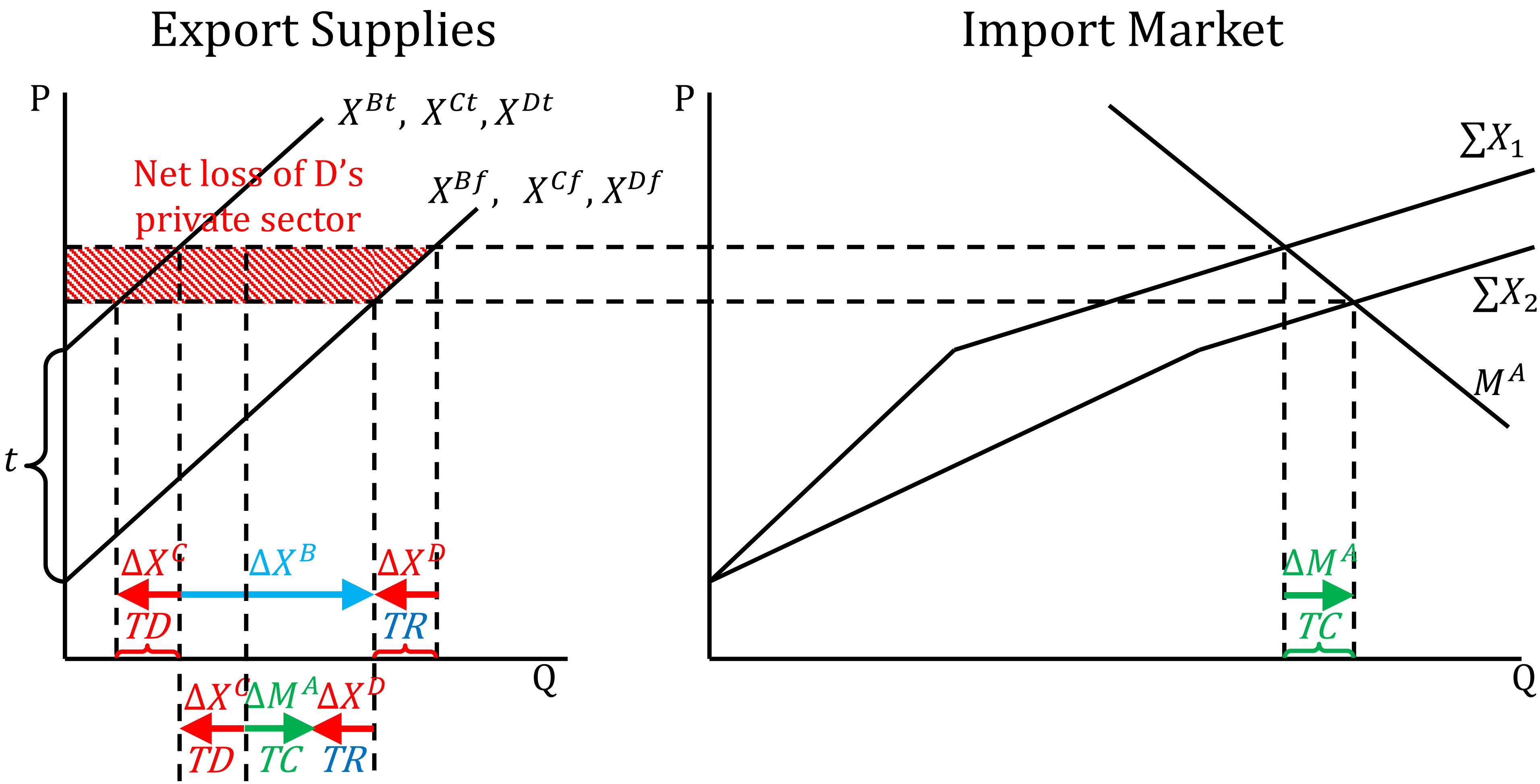


Figure 11

Welfare Effects on *D* of Adding a Second FTA

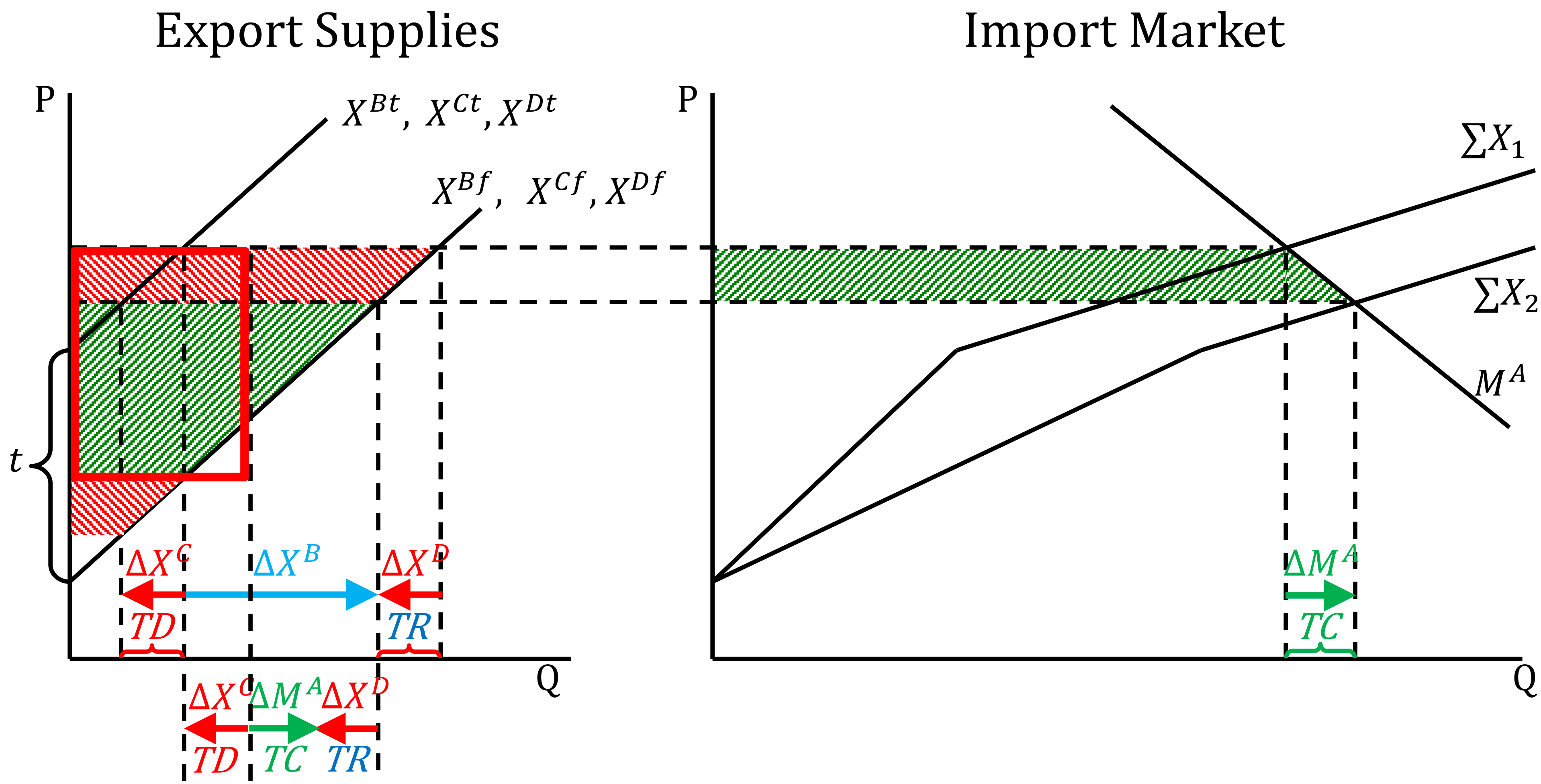


Figure 12
Welfare Effects on World of Adding a Second FTA

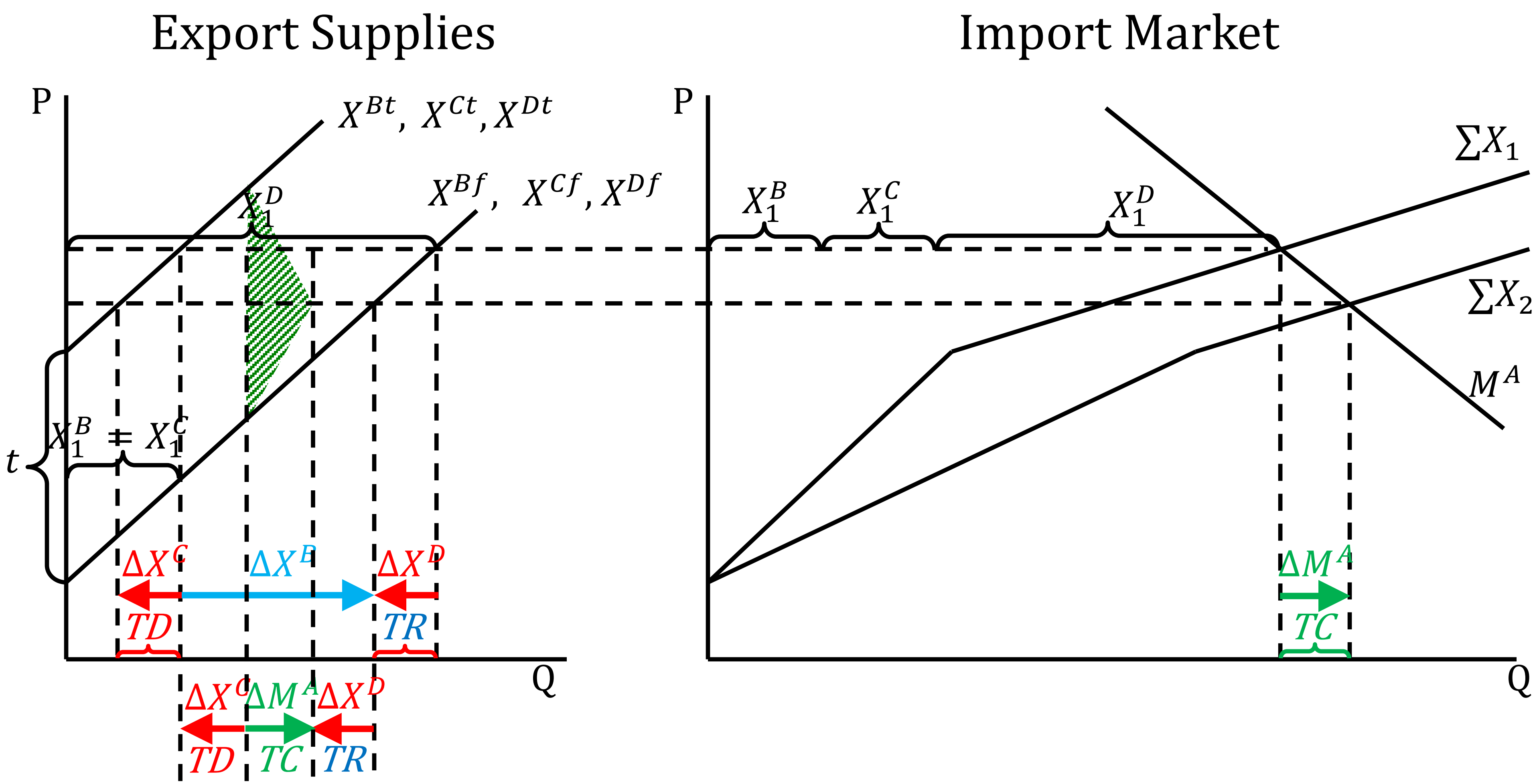


Figure 13
Welfare Effects on World of Adding a Second FTA
(after cancellations)

Appendix A

Derivation of Figure 5 from Figure 4

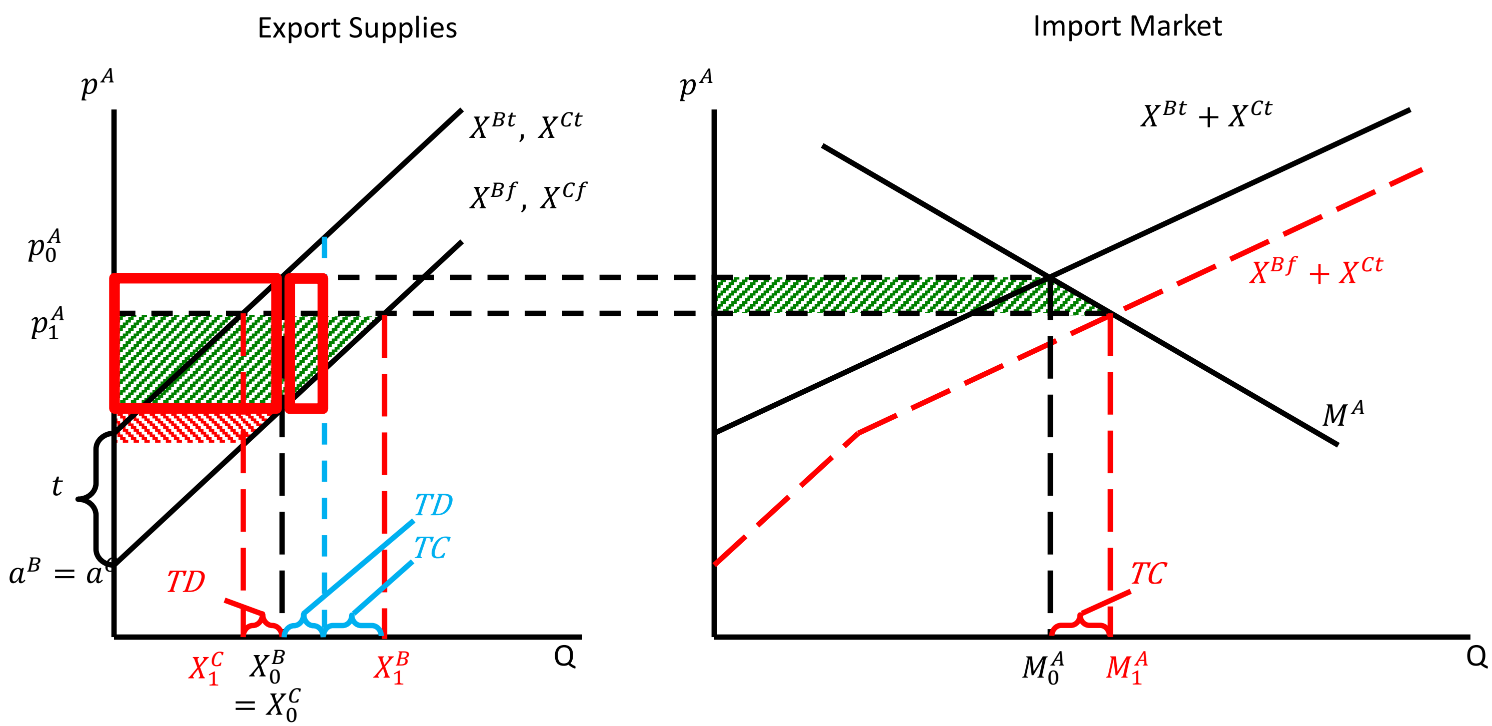


Figure 4
Change in Welfare of the World Due to *A*'s FTA with a Single Country

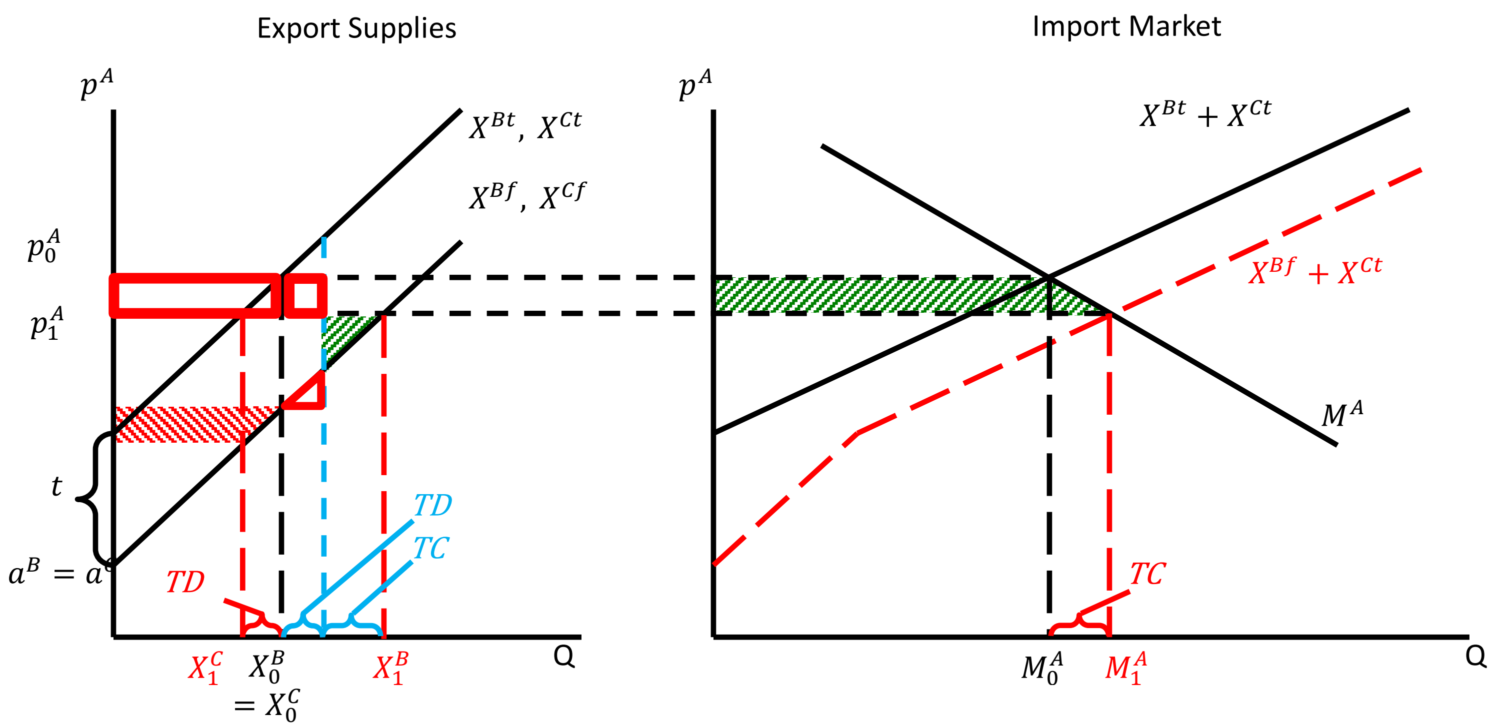


Figure 4.1
Cancel overlap of lost tariff revenue with supplier gain to County *B*

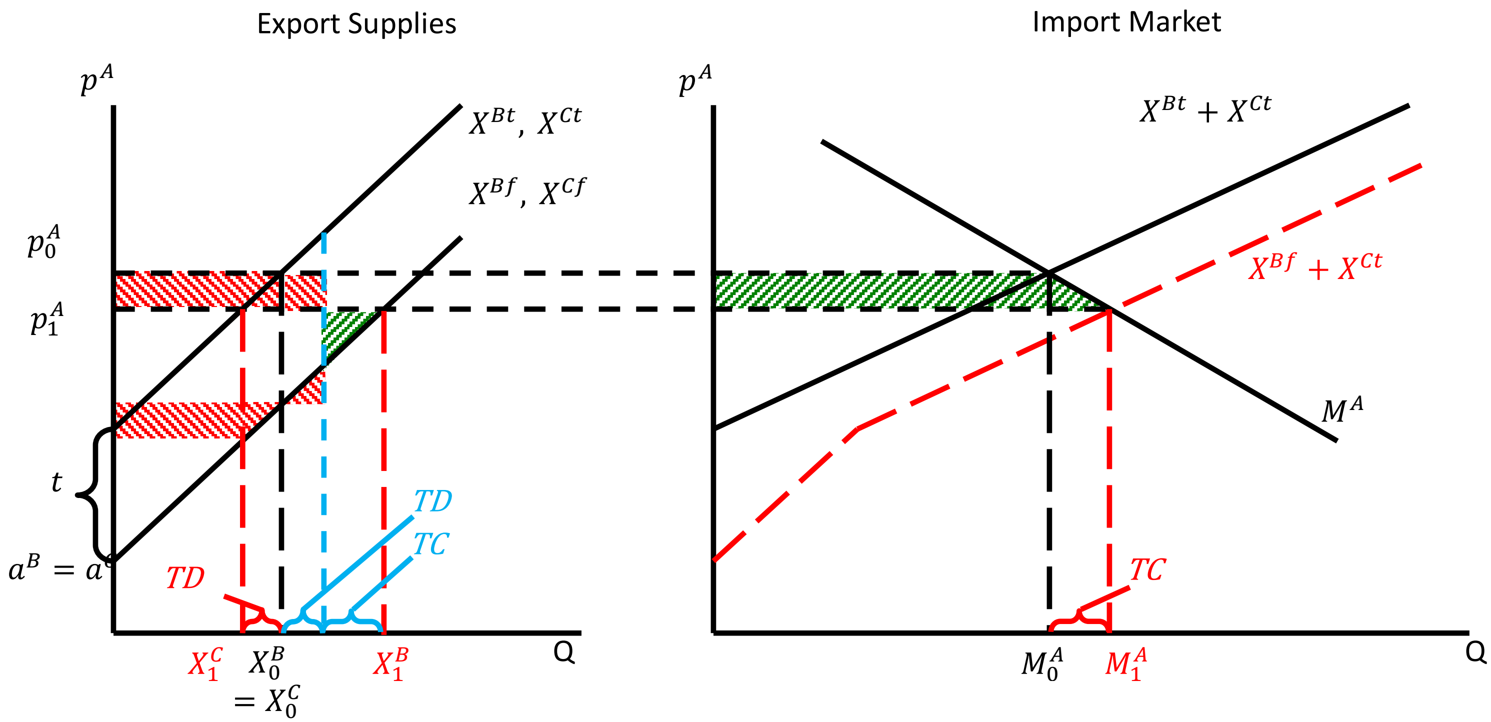


Figure 4.2
Re-shade remaining lost tariff revenue

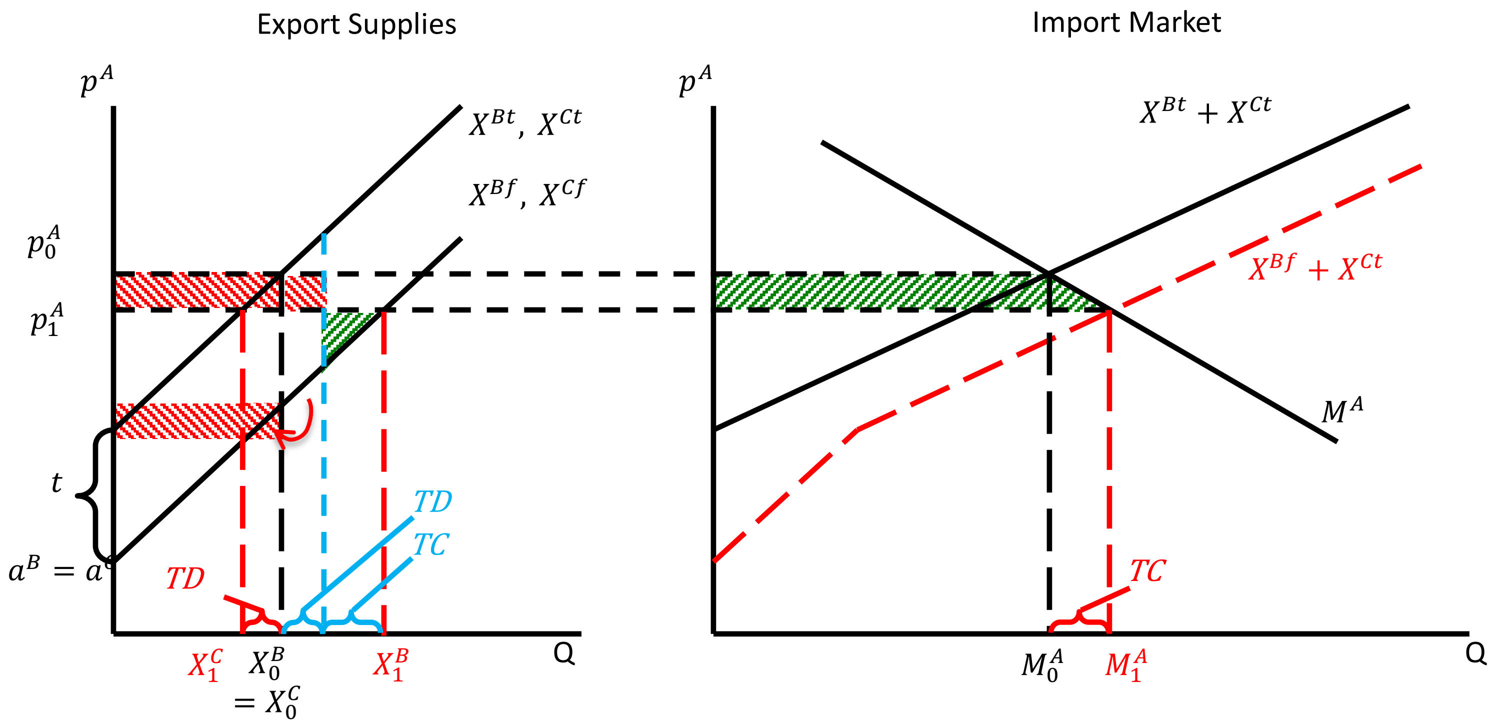


Figure 4.3
Move small red triangle to complete red rectangle

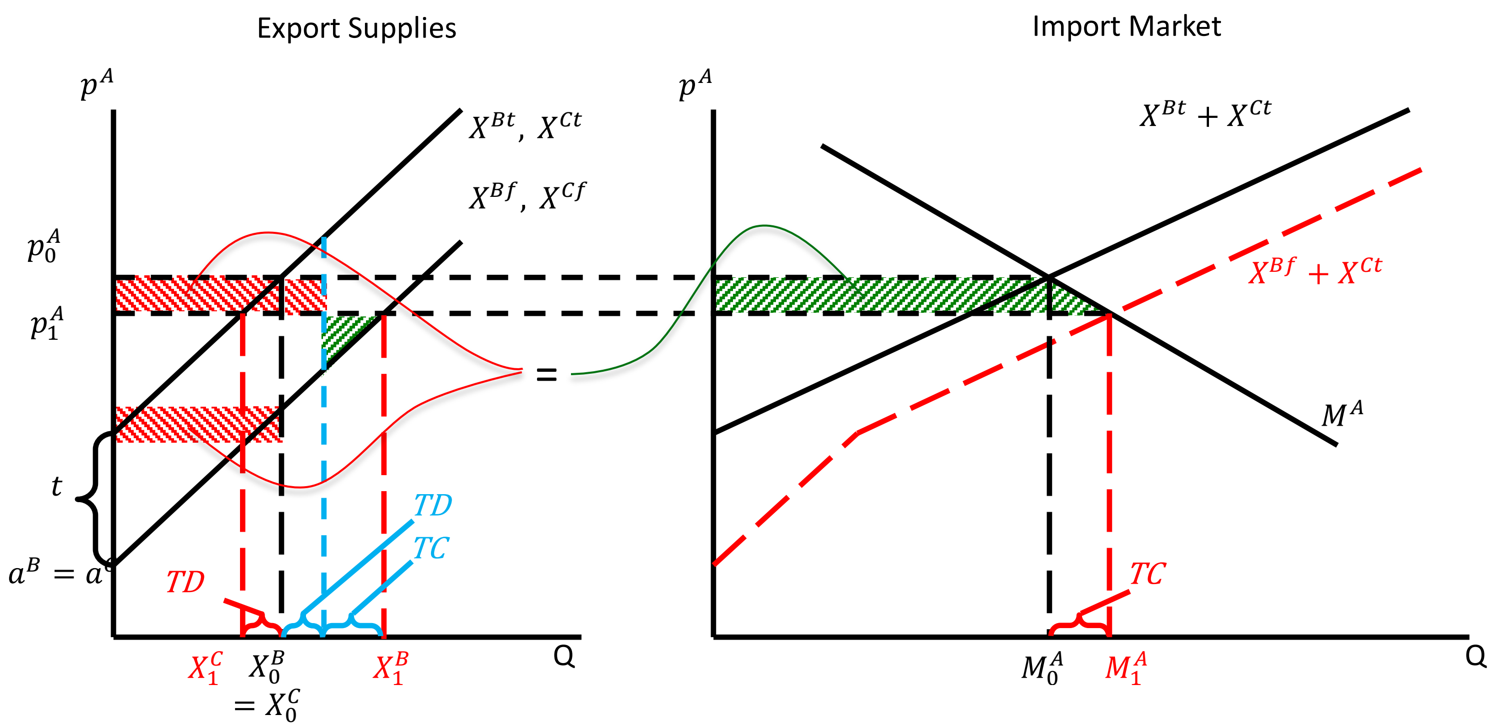


Figure 4.4

Note that green rectangle on right is the sum of two red rectangles on left,

since $M_0^A = X_0^B + X_0^C$

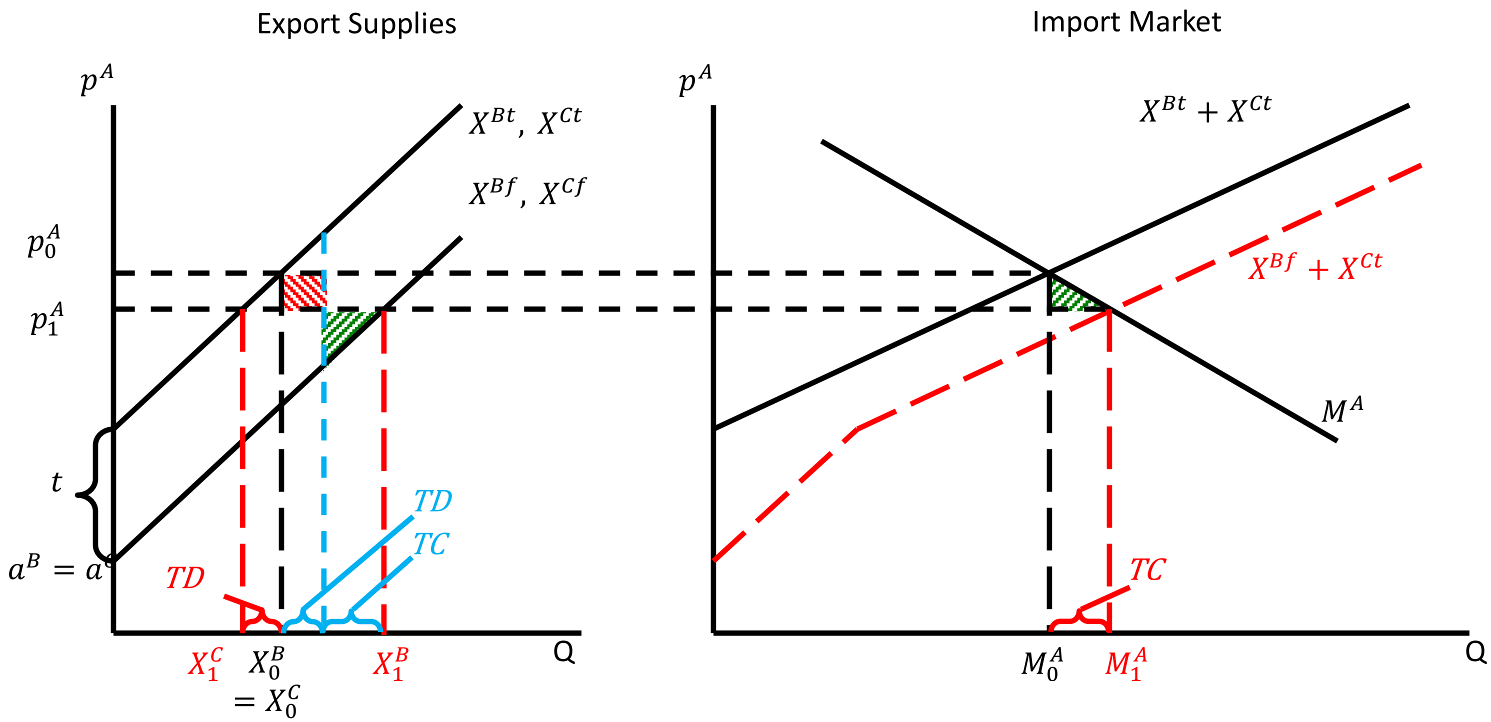


Figure 4.5
Cancel red and green rectangles

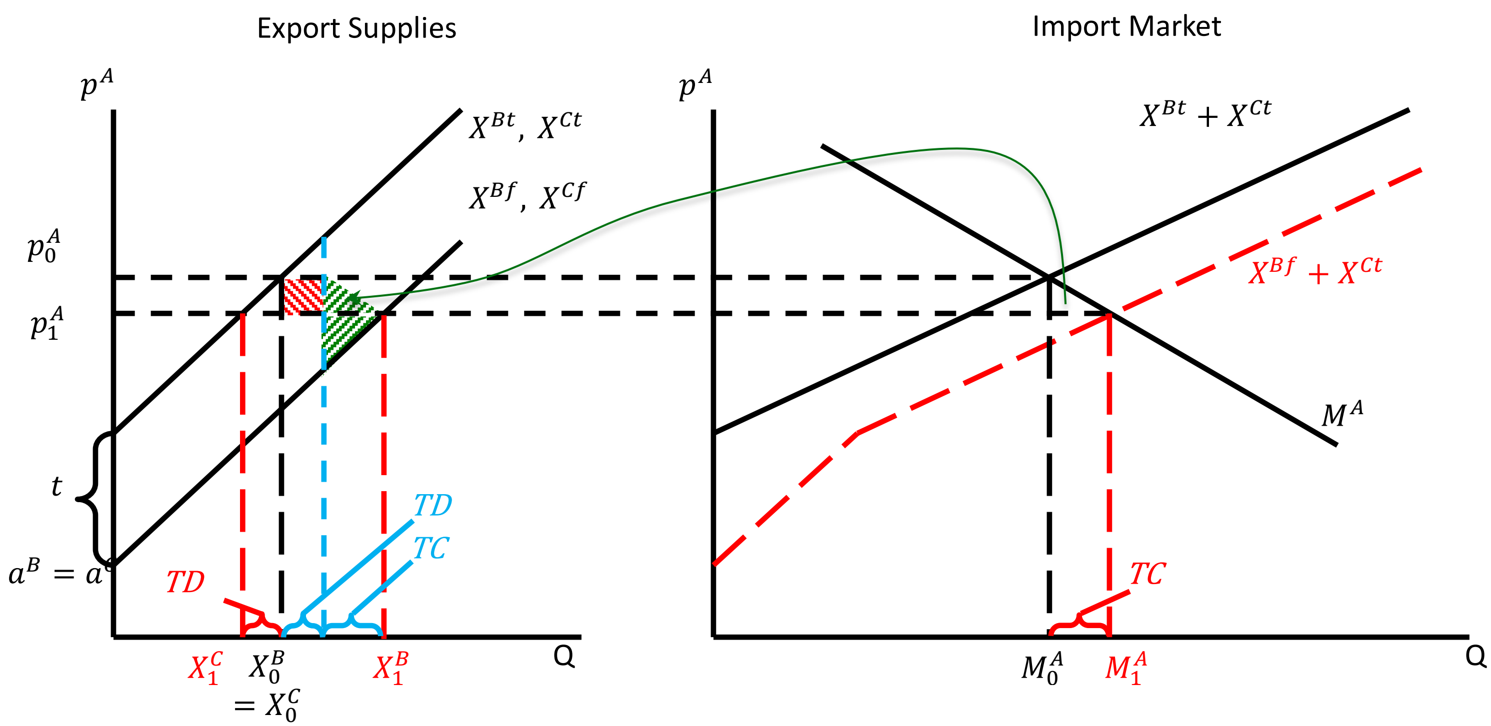


Figure 4.6
Move small green triangle to left

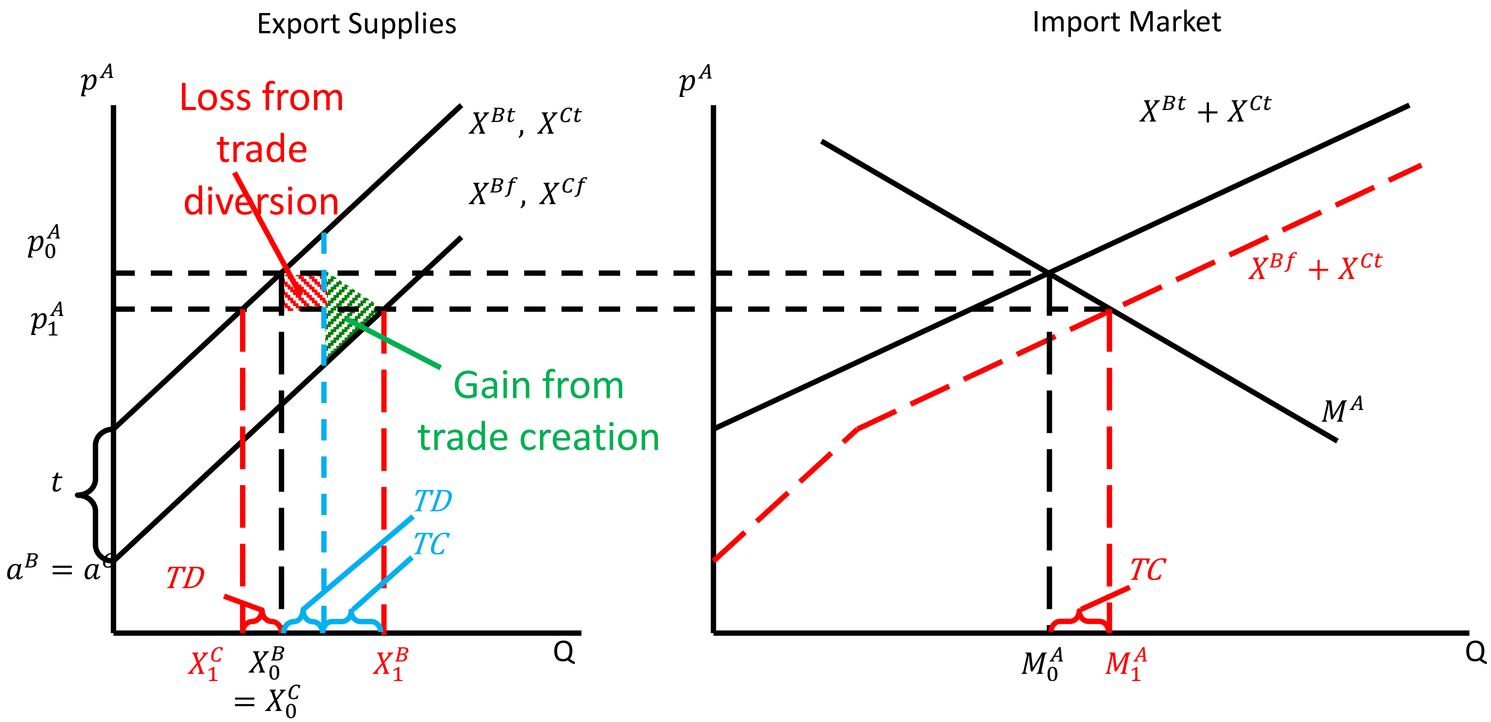


Figure 5

Change in Welfare of the World Due to *A*'s FTA with a Single Country

(After cancelations)

Appendix B: Steps deriving welfare changes in Section IV

Derivation of (35) from (34):

$$
\begin{aligned}
\Delta NS^A &= -\frac{M_1^A+M_0^A}{2}\Delta p^A && (34)\\
&= -\frac{b^A(a^A-p_1^A)+b^A(a^A-p_0^A)}{2}\Delta p^A && \text{from (2)}\\
&= -\frac{b^A(a^A-p_1^A+p_0^A-p_0^A)+b^A(a^A-p_0^A)}{2}\Delta p^A \\
&= -b^A(a^A-p_0^A)\Delta p^A + \frac{b^A(\Delta p^A)^2}{2} \\
&= b^A(a^A-p_0^A)\theta^B t + \frac{b^A}{2}(\theta^B t)^2 && \text{from (24)}\\
&= (a^A-p_0^A)b^A\theta^B t + \frac{\theta^B t}{2}b^A\theta^B t \\
&= (M_0^A/b^A)TC + \frac{\theta^B t}{2}TC && \text{from (2) \& (29)}\\
&= (M_0^A/b^A + \theta^B t/2)TC && (35)
\end{aligned}
$$

Derivation of (40) from (39):

$$
\begin{aligned}
\Delta NS^B &= X_0^B(1-\theta^B)t + \frac{b^B}{2}(1-\theta^B)^2t^2 && (39)\\
&= \left[X_0^B + \frac{b^B}{2}(1-\theta^B)t\right](1-\theta^B)t \\
&= \left[X_0^B + \frac{b^B}{2}t - \frac{b^B}{2}\theta^B t\right](1-\theta^B)t \\
&= \left[X_0^B + \frac{b^B}{2}t - \frac{\beta-b^A-b^C-b^D}{2}\theta^B t\right](1-\theta^B)t && \text{from (10)}\\
&= \left[X_0^B + \frac{b^B}{2}t - \frac{\beta}{2}\theta^B t + \frac{b^A\theta^B t+b^C\theta^B t+b^D\theta^B t}{2}\right](1-\theta^B)t \\
&= \left[X_0^B + \frac{b^B}{2}t - \frac{b^B}{2}t + \frac{TC+TD+TR}{2}\right](1-\theta^B)t && \text{from (29-31)}\\
&= \left[X_0^B + \frac{b^B}{2}t - \frac{b^B}{2}t + \frac{TC+TD+TR}{2}\right](1-\theta^B)t && \text{from (12)}\\
\Delta W^B = \Delta NS^B &= \left[X_0^B + \frac{1}{2}(TC+TD+TR)\right](1-\theta^B)t && (40)
\end{aligned}
$$

Derivation of (41-42) from (37):

For $i = C, D$:

$$
\begin{aligned}
\Delta NS^i &= X_0^i\Delta p^i + \frac{b^i}{2}\left(\Delta p^i\right)^2 && (37)\\
&= -X_0^i\theta^B t^B + \frac{b^i}{2}(\theta^B t^B)^2 && \text{from (24)}\\
&= \left[-X_0^i + \frac{b^i}{2}\theta^B t^B\right]\theta^B t^B \\
\Delta NS^C &= \left[-X_0^C + \frac{b^C\theta^B t^B}{2}\right]\theta^B t^B \\
&= \left[-X_0^C + \frac{TD}{2}\right]\theta^B t^B && \text{from (30)}
\end{aligned}
$$

$$\Delta W^C = \Delta NS^C = \left[-X_0^C + \frac{TD}{2}\right]\theta^B t^B \tag{41}$$

$$\Delta NS^D = \left[-X_0^D + \frac{b^D\theta^B t^B}{2}\right]\theta^B t^B$$

$$= \left[-X_0^D + \frac{TR}{2}\right]\theta^B t^B \quad \text{from (31)}$$

$$\Delta W^D = \Delta NS^D = \left[-X_0^D + \frac{TD}{2}\right]\theta^B t^B \tag{42}$$

Derivation of (44) from (43):

$$\begin{aligned}
\Delta W^W &= \left(\frac{M_0^A}{b^A} + \frac{\theta^B t}{2}\right) TC - tTD - tX_0^B \\
&\quad + \left[X_0^B + \frac{1}{2}(TC + TD + TR)\right](1-\theta^B)t \\
&\quad + \left[-X_0^C + \frac{TD}{2}\right]\theta^B t + \left[-X_0^D + \frac{TR}{2}\right]\theta^B t && (43)\\
&= \frac{M_0^A}{b^A} TC + \frac{\theta^B t}{2} TC - tTD - tX_0^B \\
&\quad + X_0^B + \frac{1}{2}(TC + TD + TR)t \\
&\quad - X_0^B\theta^B t - \frac{\theta^B t}{2} TC - \frac{\theta^B t}{2} TD - \frac{\theta^B t}{2} TR \\
&\quad - X_0^C\theta^B t + \frac{TD}{2}\theta^B t - X_0^D\theta^B t + \frac{TR}{2}\theta^B t \\
&= \frac{M_0^A}{b^A} TC - tTD + \frac{1}{2}(TC + TD + TR)t \\
&\quad - X_0^B\theta^B t - X_0^C\theta^B t - X_0^D\theta^B t \\
&= \frac{M_0^A}{b^A} TC - tTD + \frac{1}{2}(TC + TD + TR)t \\
&\quad - (X_0^B + X_0^C + X_0^D)\theta^B t \\
&= \frac{M_0^A}{b^A} TC - tTD + \frac{1}{2}(TC + TD + TR)t - M_0^A\theta^B t && \text{from (5)}\\
&= \frac{M_0^A}{b^A}(TC - b^A\theta^B t) + \frac{1}{2}TCt + \frac{1}{2}TRt - \frac{1}{2}TDt \\
&= \frac{1}{2}TCt + \frac{1}{2}TRt - \frac{1}{2}TDt && \text{from (29)}\\
\Delta W^W &= \frac{1}{2}TCt + \frac{1}{2}(TR - TD)t && (44)
\end{aligned}$$

Appendix C: Derivation of Figure 13 from Figure 12

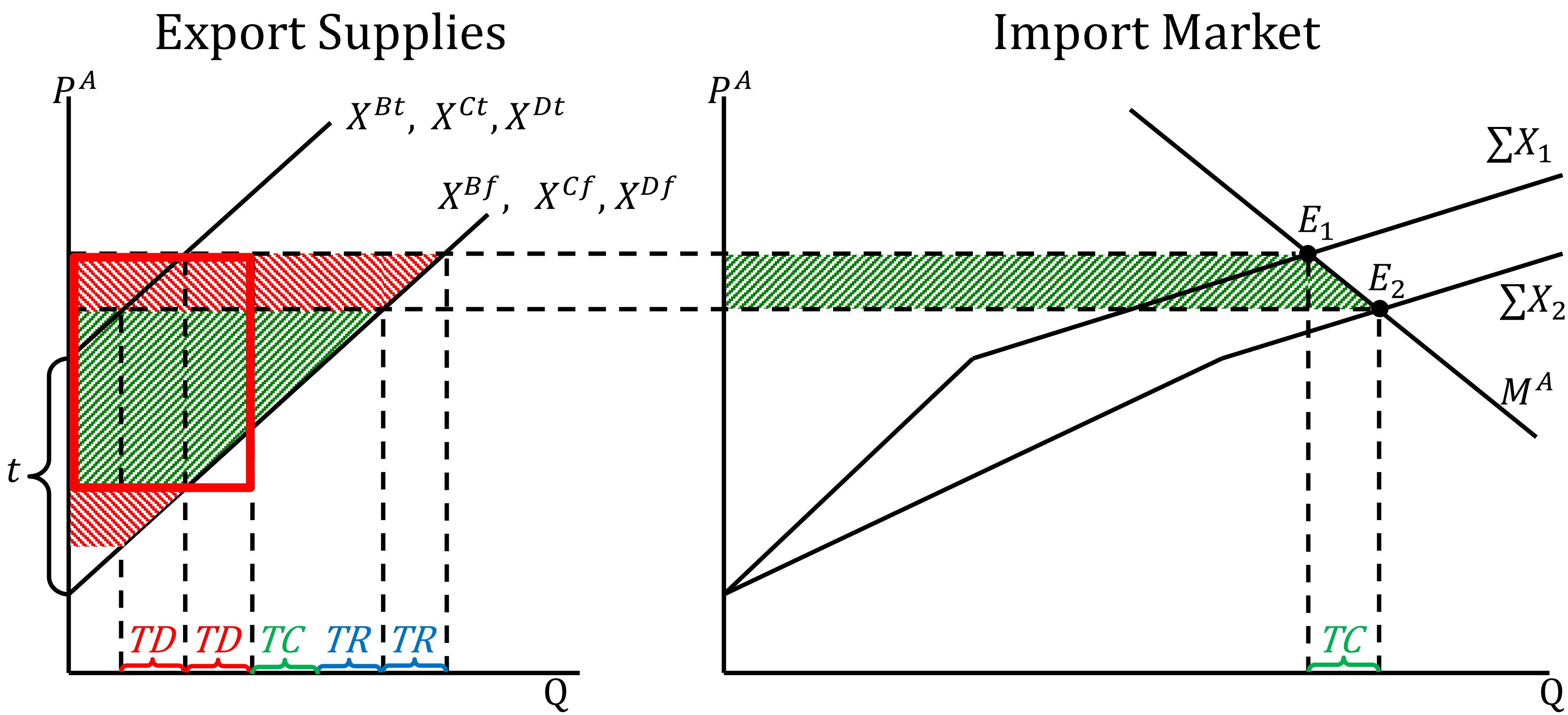


Figure 12
Welfare Effects on World of Adding a Second FTA

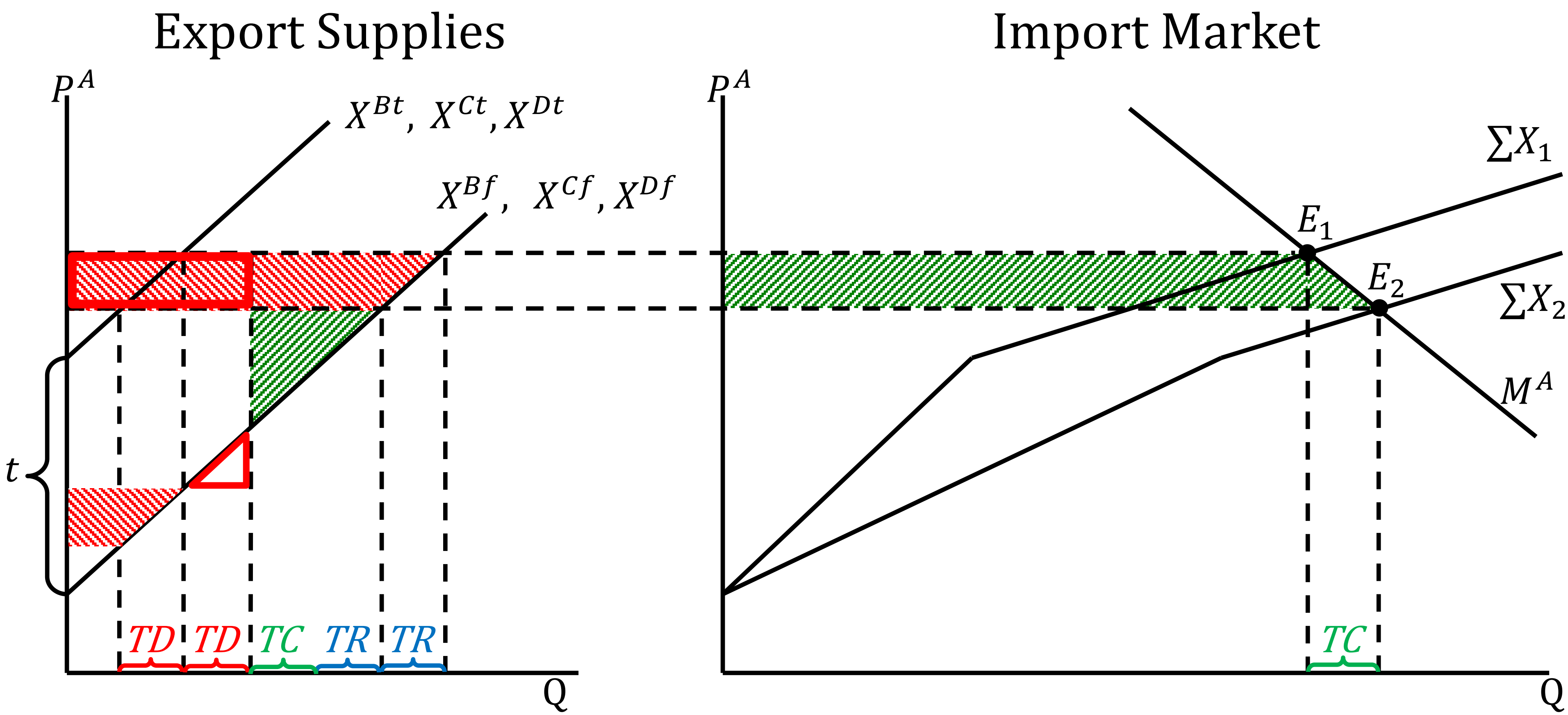


Figure 12.1
Cancel overlap of lost tariff revenue with supplier gain to County B.

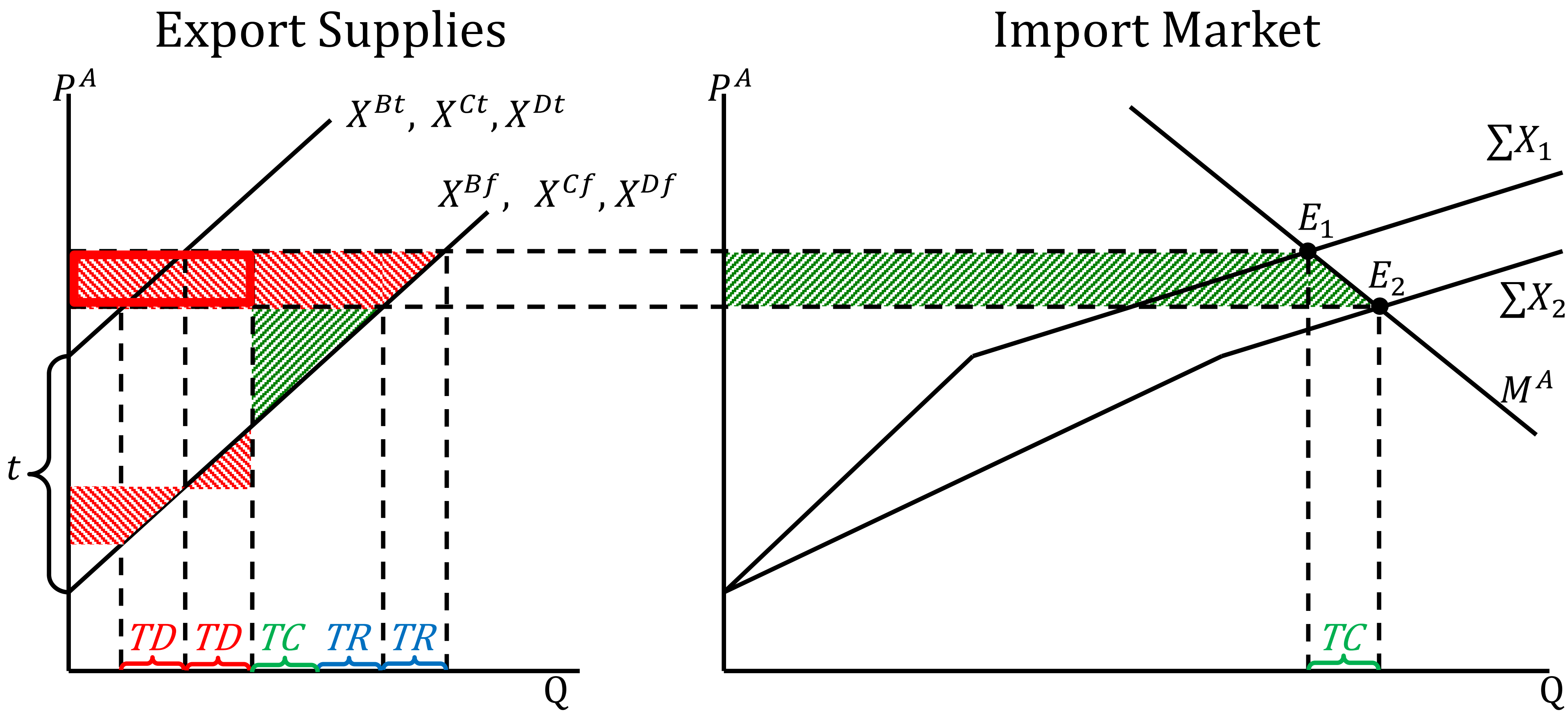


Figure 12,2
Re-shade triangle of remaining lost tariff revenue.

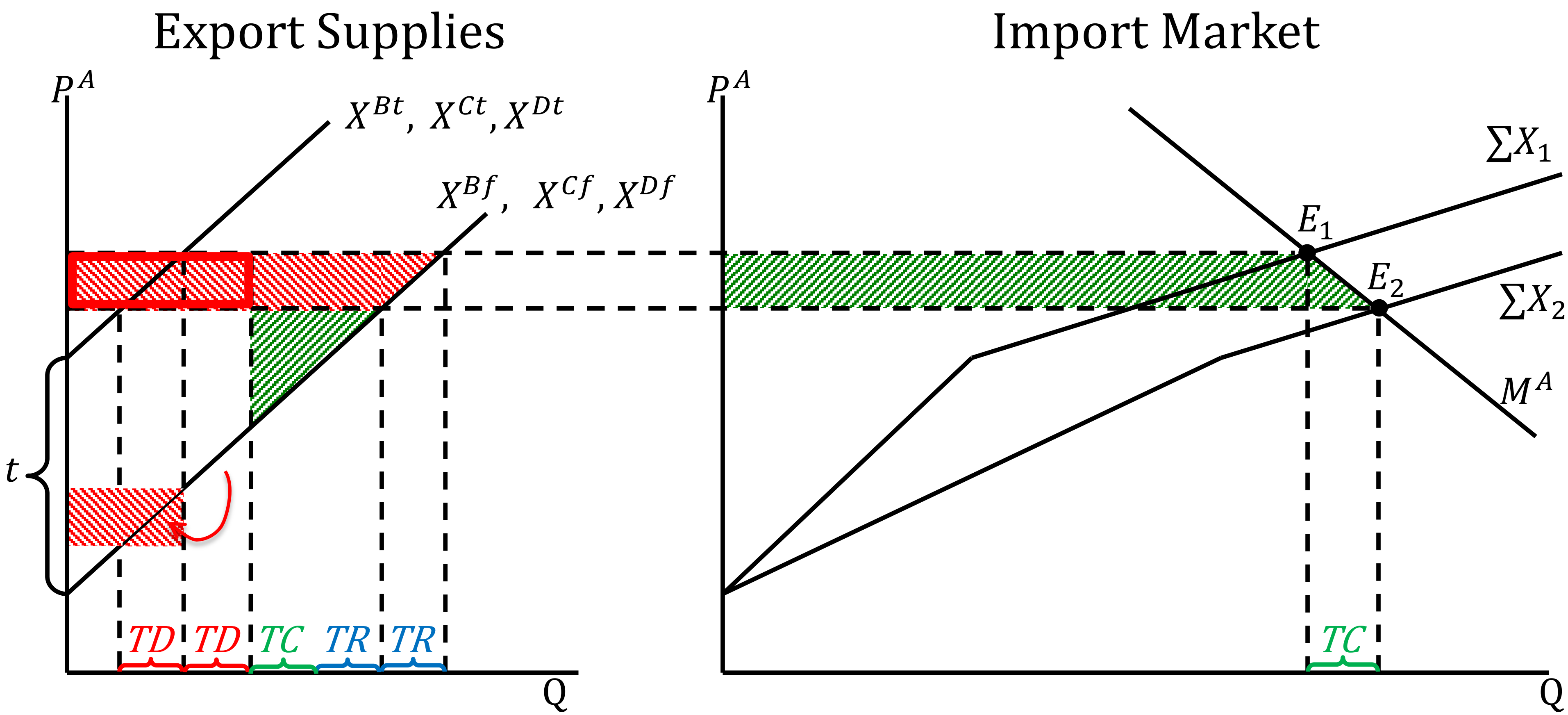


Figure 12.3
Move small red triangle to complete red rectangle.

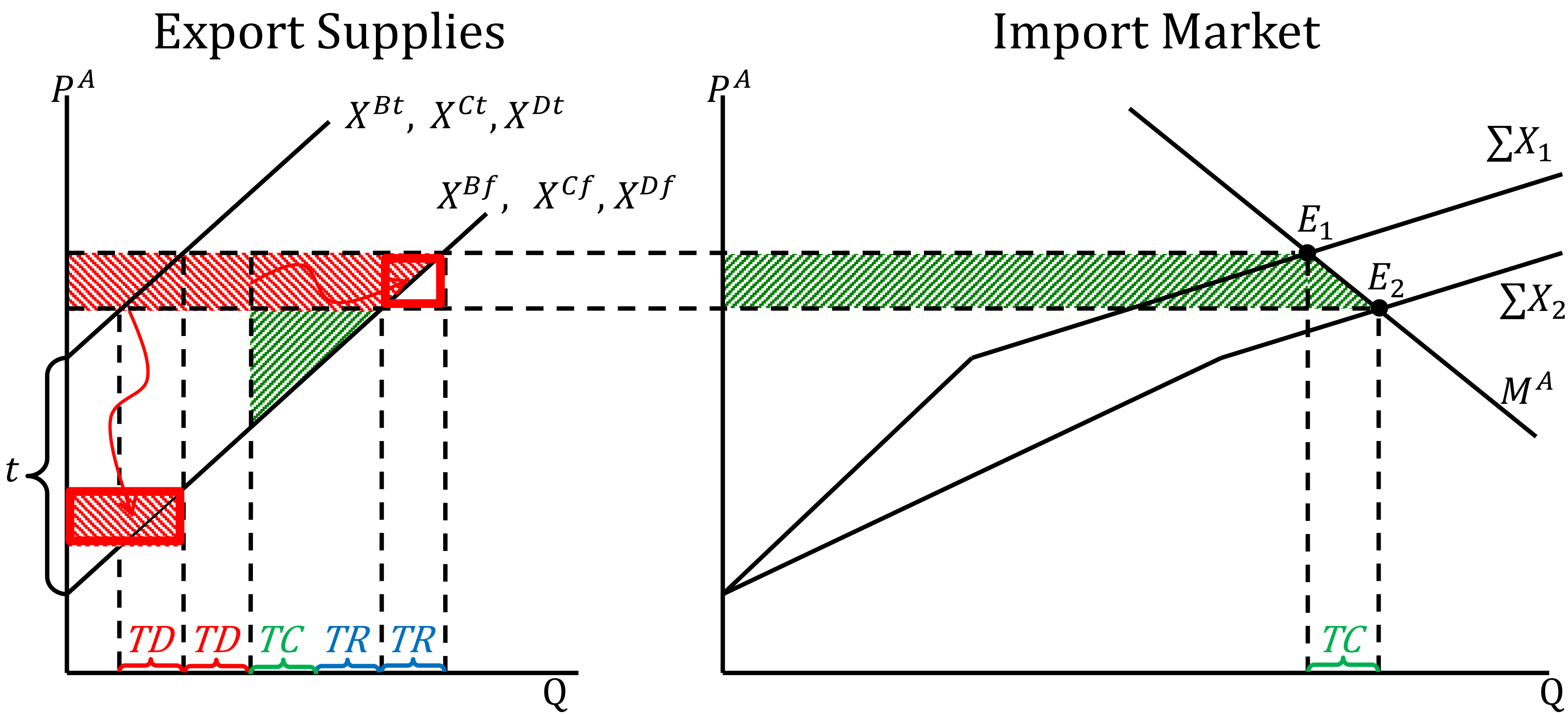


Figure 12.4
Split and move red-bordered rectangle.

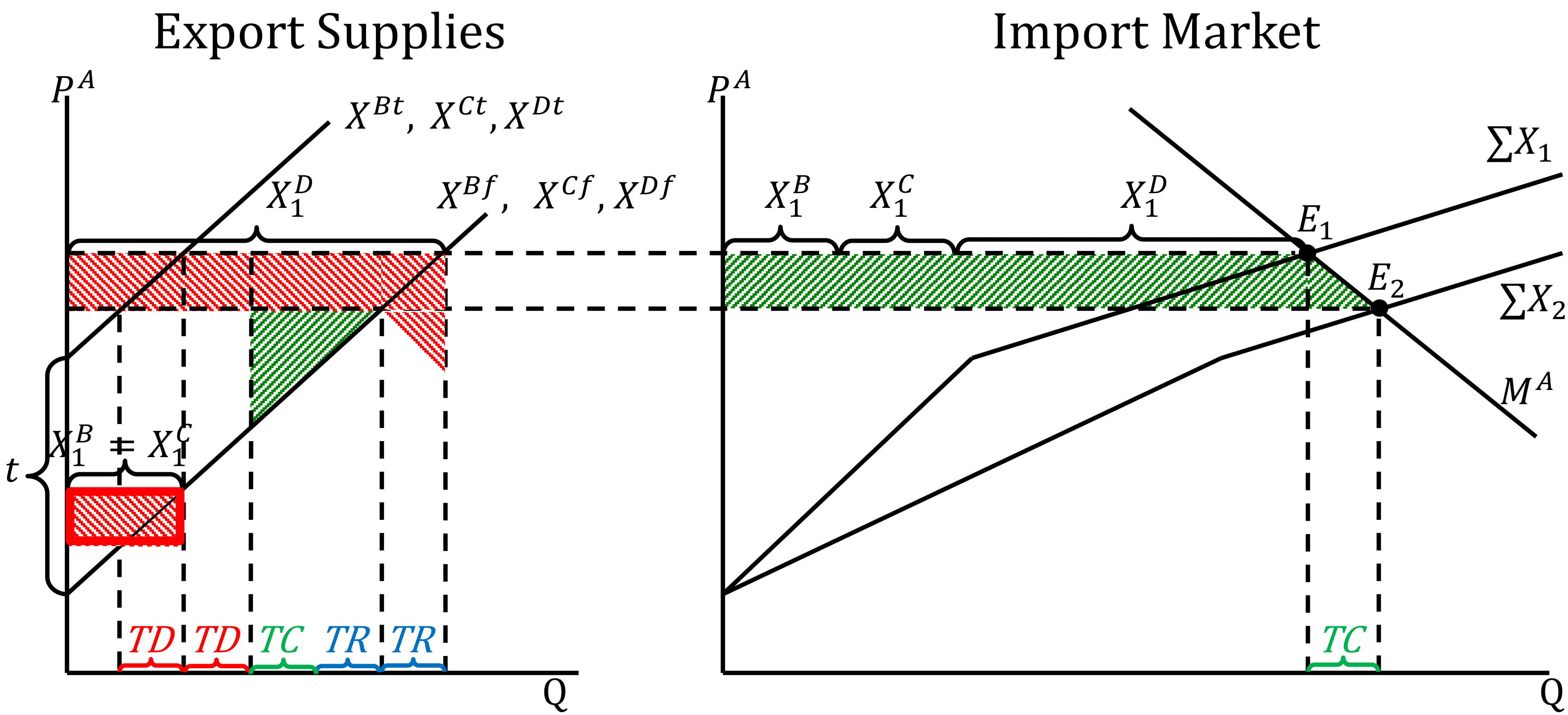


Figure 12.5

Replace small red-bordered rectangle with shaded triangle of equal size.

Note sizes of rectangles.

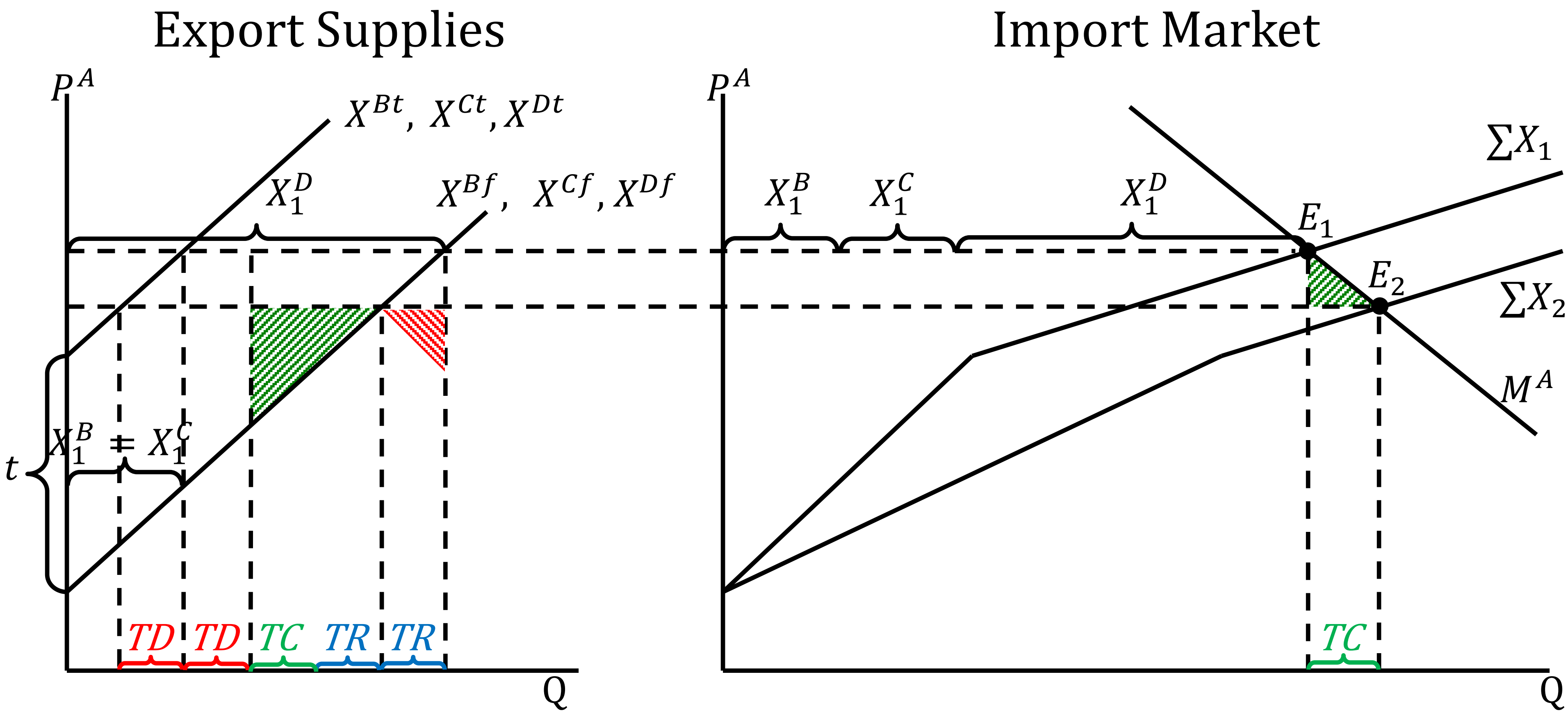


Figure 12.6
Cancel equal rectangles.

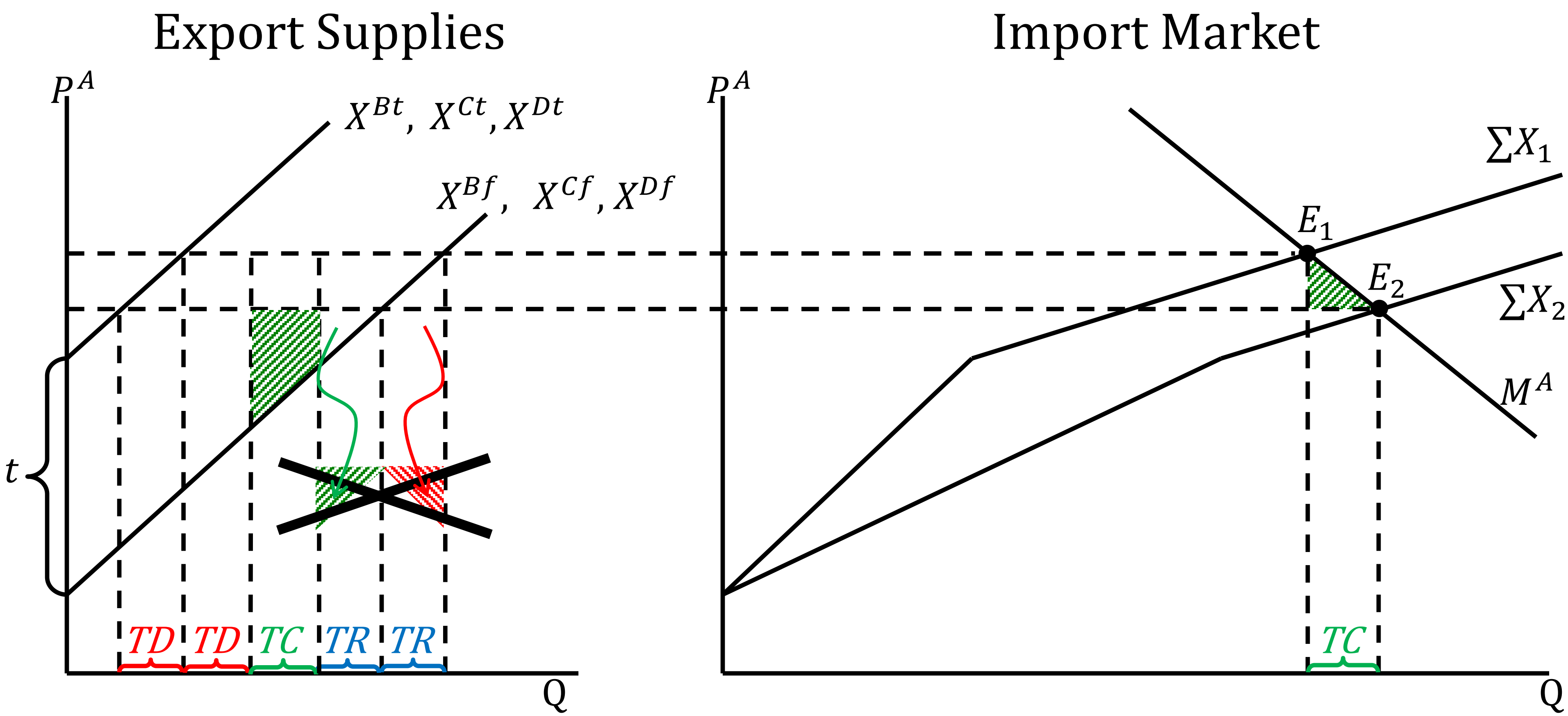


Figure 12.7
Remove size of red triangle from green triangle

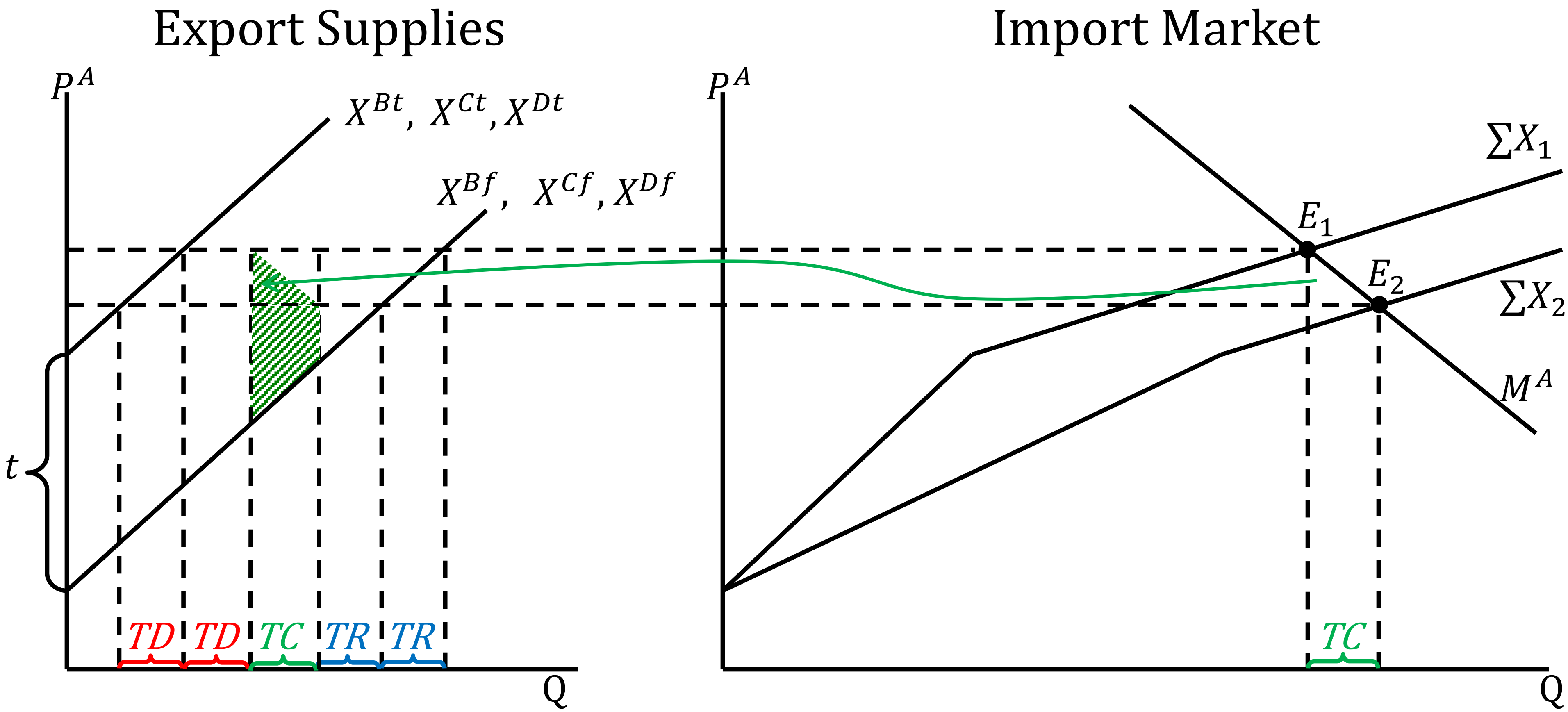


Figure 12.8
Move small green triangle right to left.

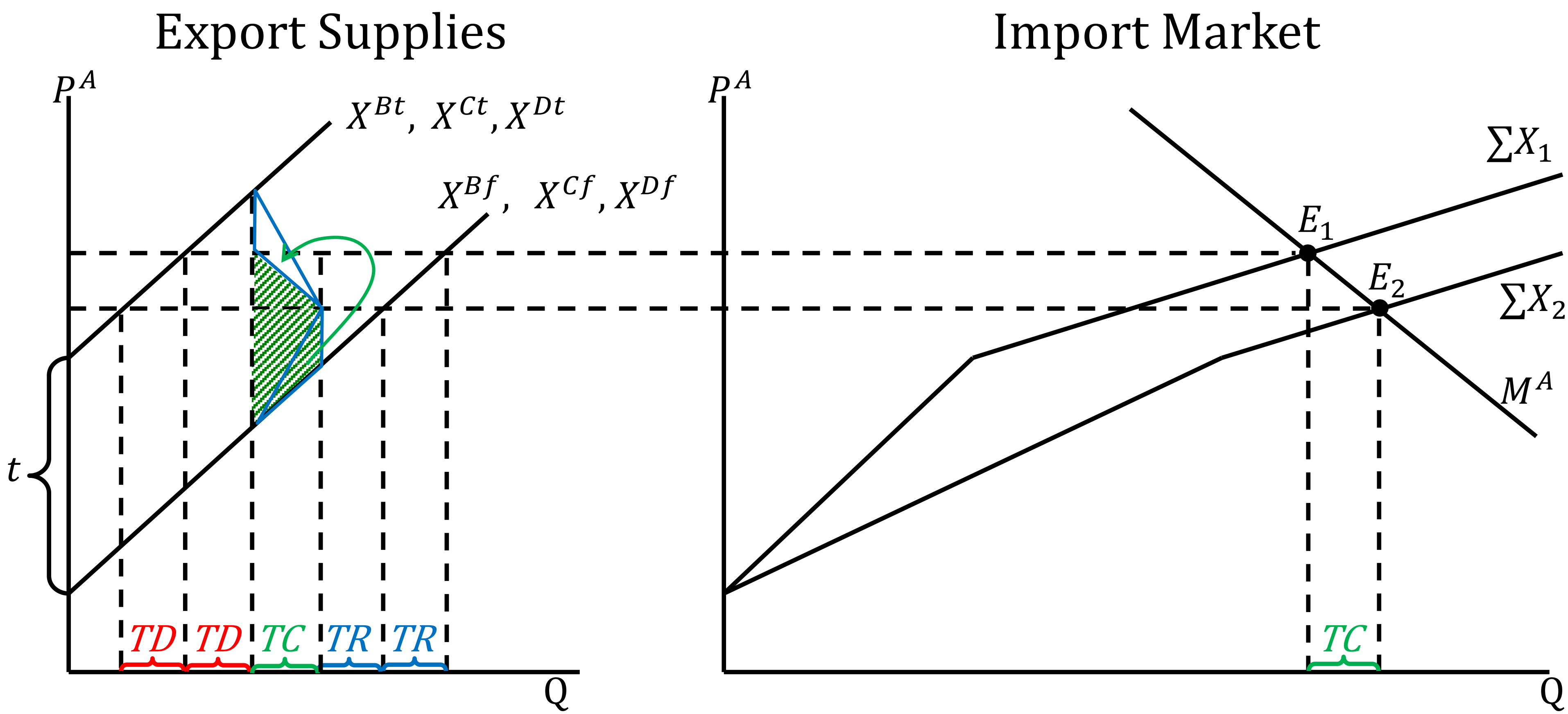


Figure 12.9
Convert trapezoid to triangle by moving a triangle up.

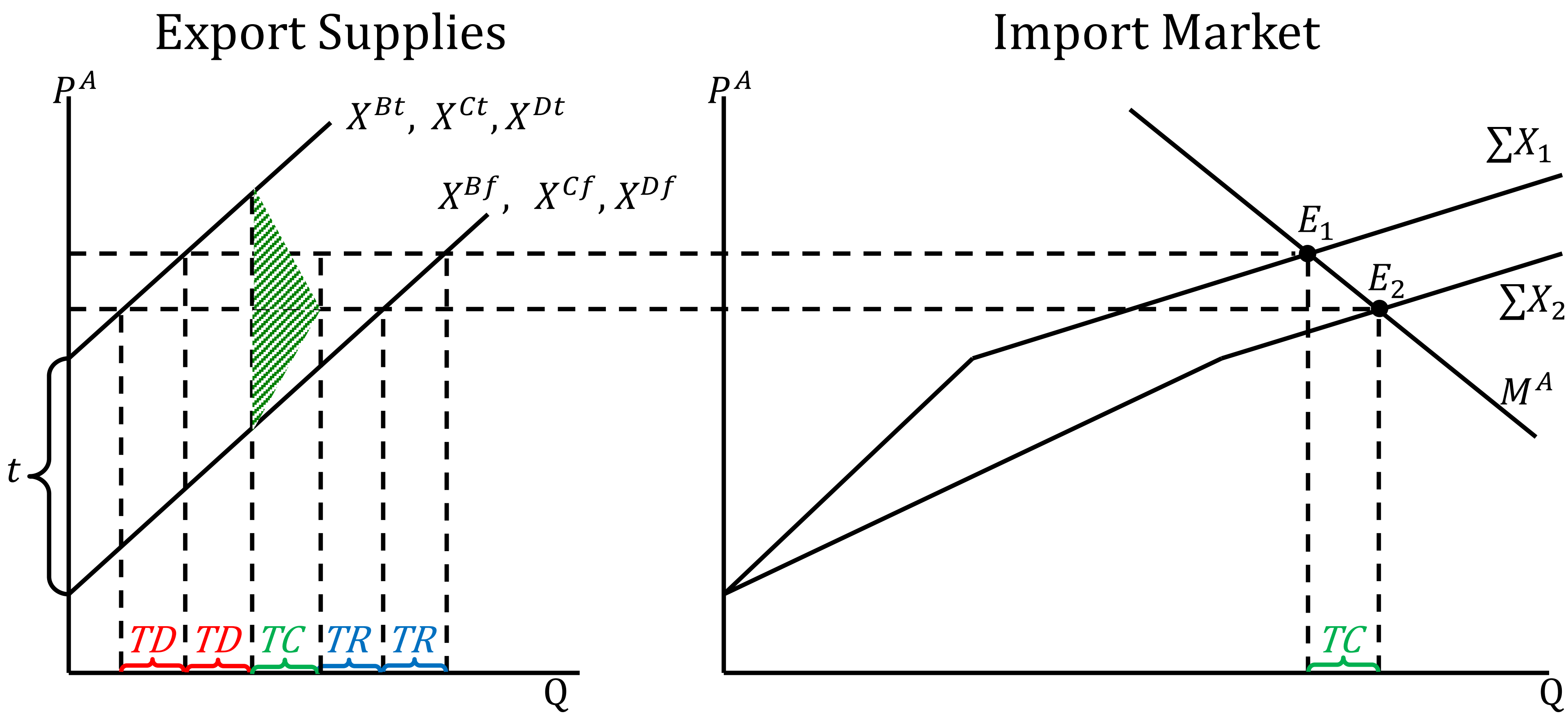


Figure 13
Welfare Effects on World of Adding a Second FTA
(after cancelations)