Chapter 7
Comments on the "The Main Contribution of the Ricardian Trade Theory" by Ronald W. Jones

M. Scott Taylor

Abstract The aim of this chapter is a critical assessment of the Ricardian model and its usefulness in research. It starts with explaining the analytical difficulties by which the two-by-two model is characterized in comparison to an endowment model. Further, it is examined why it is challenging to add further dimensions and extend the basic example to a three-by-three case. Three possible solutions of the challenges related to many-good and many-country cases are discussed. Firstly, understand the possible efficient outcomes of these cases based on Jones (1961). Secondly, introduce the many-good-continuum model of Dornbusch, Fischer and Samuelson (1977). Thirdly, find an empirical approach such as Eaton and Kortum (2002).

Thank you to Rolf for inviting me as it's an honor to discuss a paper by Ron Jones. I discussed one of his papers quite a while ago, when I was an assistant professor. It was also on comparative advantage and Paul Samuelson was in the room. At that time, I had to explain

M. Scott Taylor

Department of Economics

University of Calgary

e-mail: mstaylor@ucalgary.ca

NOTE: This chapter is based on a transcription of the presentation given at the Conference on May 12, 2017, at the University of Basel, Switzerland.

how comparative advantage works in front of Paul, and that was a little frightening. So today things are somewhat similar. Today I have Jonathan Eaton here, but I'm a little older and a little less worried now. So, what I'm going to do with these comments, is what I thought would be the most productive use of my time, and this is to provide a bridge between Ron's presentation and the later presentation of Jonathan. I'm going to start out being slightly contrarian about Ricardo and the usefulness of his model, but I should let you know that Ricardo is paying my mortgage, he is paying my kids' school tuition, and he has bought all my clothes. This is true because almost all of my papers in one way or another use or elaborate on the Ricardian model. So while I'm being slightly contrarian to start with, you should understand that it will turn around at the end.

Ron's presentation started with the two-by-two Ricardian model that we use to teach undergraduates. We use this model to explain comparative advantage to the uninitiated, and while it's a beautiful thing to behold, it's really not that useful as a tool. Frankly its not that useful either analytically or empirically.

It's tremendously insightful but it uses to be almost the end of the road for Ricardo. In some sense I feel like, if you had a graduate student bring the model to you with a two by two example, you'd go: "That's quite good, now can you go on and expand it to a whole bunch of countries or tell me what aspects of world trade this can explain that previous theories cannot?" The graduate student would have a hard time doing this I think, so lets review what these deficiencies are.

To start lets review Ron's example or at least part of it (see Fig. 7.1). He has the three-by-three case in his paper but started talking about the two-by-two case. And all I have done in the figure is to put his example into the formulation of the *A(z)* schedule, that Dornbusch-Fischer-Samuelson (1977) brought to Ricardian trade theory. Ignore for the moment cloth and ignore continental Europe to make this truly a two by two example. I've assumed home is North America and so it's ordered in terms of home country comparative advantage which is first linen and then corn. The exact numbers are Ron's. The equilibrium is then determined by demand conditions which pick out whether we are at A, B or C. So, if the demand for linen is really high, then both countries are going to be producing it at an equilibrium like A, and the US is going to have really high wages. Alternatively, they both could be specialized at B. Or they both could be diversified in corn at C. So that's pretty well the two-by-two case.

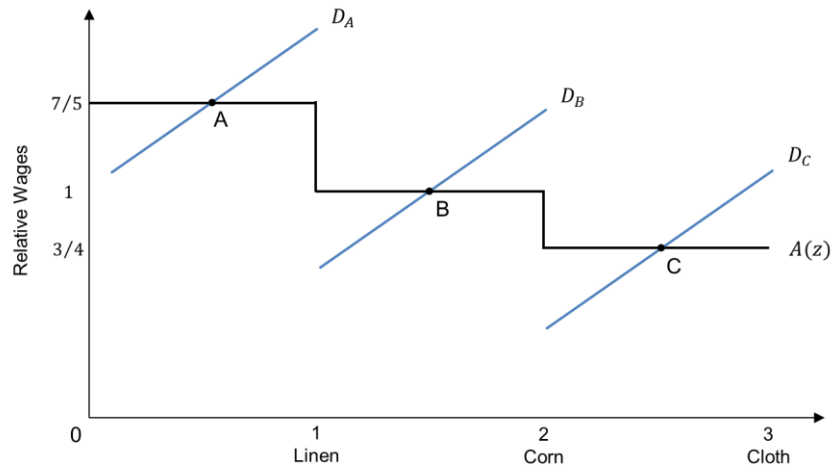

Fig. 7.1 Ron Jones's Numerical Example in Terms of Dornbusch-Fischer-Samuelson. Source: Own Figure

Now, what's the problem with this two-by-two case? Well in the specialization case at B, if you do local comparative statics, the model is identical to an endowment model. It really doesn't carry with it any more information than that. So why use a model with production anyway if we are at B? Although the Ricardian model is the simplest general equilibrium model with production, comparative statics around B don't exploit this feature. But what about points A and C? In these cases, one country operates just like an endowment economy, because it is specialized and the other one operates as if it was in autarky. And as you know, autarky isn't trade so the welfare properties of these equilibrium are somewhat strange since all the gains go to one country. Finally, at A or C where countries are diversified, local comparative statics either do very little and alter only the amount of one good produced, and or do too much by affecting the set of goods produced in each country in a discontinuous way. So analytically, the simple two by two is a difficult animal to deal with, much harder than say the endowment model is. It's great as an example, but if you want to do comparative statics to learn from it, it is probably not the model you want to use. So, what happens if you add more countries or more goods? Maybe these changes will solve the problem.

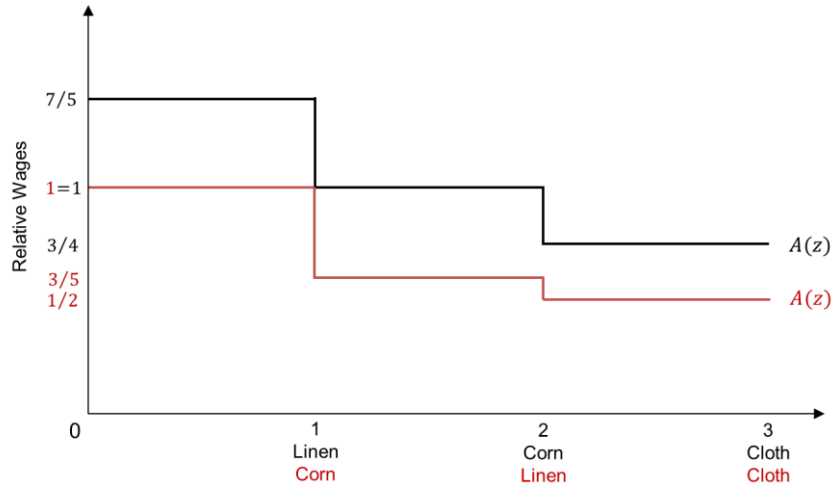

Fig. 7.2 Three Countries: Adding America versus Europe. Source: Own Figure

So what I have shown is Ron's second case (Fig. 7.2) where now I have added Continental Europe. And I have constructed an America vs. Europe *A(z)* schedule (red), and an America vs. Britain *A(z)* schedule (black). Relative wages now are a little bit confusing to think about because the vertical axis has to represent first an Amercia relative to Britain relative wage and then an America relative to Europe relative wage. But the purpose of the slide is to show how difficult it is to add more dimensions, so that's a goal rather than a flaw. Finally there is one more complication. Notice the ordering of comparative advantage has to be different: For the black schedule, America vs. Britain, the ordering is linen, corn and then cloth. And for the red schedule, American vs. Europe, it's corn first, linen second and then cloth. So, if you were to stick three countries and three goods together and used the same apparatus that I used in the previous slide and then extrapolate, you are going to be in trouble because the vertical axis has two different relative wages, and as we will see bilateral comparisons of comparative advantage can lead you astray.

In fact, figuring out the set of possible outcomes in trade is very difficult if not impossible, using our previous method unless you could put really strong assumptions on how those two *A(z)*-schedules relate to each other. The ordering of goods is now different than before, so it's hard to know how to proceed and you are tempted to use the two schedules in sequence to find a set of efficient outcomes in free trade, but at this point this is more of a hope rather than a plan – hoping that it worked before so maybe it will work again, which is exactly what Ron did earlier in his presentation. It looks good for efficiency if America is in linen, Britain is in

corn and Europe is in cloth, because you can think sequentially and use the two schedules to say: "Well, what should America be in relative to Britain? It should be in linen according to the black schedule! And what could Britain be in? It could be in corn or in cloth. But then what does Europe have to be in? It looks as if it has to be in cloth because if America is in Linen then this is the right choice for Europe from the red schedule." And by this form of deduction, you end up rationalizing the specialization pattern you started with, but this specialization pattern is not efficient as Ron showed in his 1961 paper.

So how did the profession resolve these problems? There are three things we did. First, we generalized to the extent we could to understand the set of possible efficient outcomes in the many-countries and many-goods case. Second, we introduced techniques to smooth out the two-good model's comparative static properties, primarily by the introduction of the many-good-continuum model of Dornbusch, Fischer and Samuelson (1977). And finally we waited for somebody to solve the many-good many-country problem in a tractable, empirically useful and elegant way.

7.1 Solution One

Solution one is something that Ron provided in 1961 (Jones 1961) and he revisited that result in his paper here today. To understand today's paper I re-read the original 1961 paper – actually I am not sure if I had read it before. The paper is quite dense, and the proof to the main result is beautiful and fantastic but it's still somewhat mysterious to me. The paper begins with the two by two example, and Ron notes that all efficient allocations are situated along the world PPF respectively comparative advantage. We saw that in one of the figures. Then he notes that all such points are also convex combinations of possible specialization allocations which is something I did not realize until I read the paper. Using this he shows you that if the ordering is done respecting comparative advantage, then the product of the unit labor requirements are minimized in any efficient allocation. This seems reasonable in the two by two case, which was clearly his purpose. Next, Ron introduces the third country and the third good and shows you – what Ron said earlier [in his talk] – that respecting bilateral comparative advantage isn't going to be enough, as I tried to show in my example. But then using a mathematical theorem from input-output analysis, he finds there is a way to calculate what efficiency requires in the many-good many-countries case. And that is again the minimum product of

the unit labor requirements. And furthermore, in that paper – and I think in this paper today – Ron suggests that if we had more countries and more goods, theory would impose more constraints on what represents an efficient division of production worldwide. It looked actually really promising when I read it, as this would really narrow down the number of possibilities for efficiency, but in a world with geography, where you add in source and destination specific based transport costs, then it gets a little harder for theory to impose that strong a set of restrictions. Nevertheless, it's a really beautiful paper, just in the way it is constructed: Starting with the two good example, then going to the three, and carrying the reader through the same logical argument. It's all beautifully straightforward until Ron's ingenious proof of the general result using this Hawkins-Simon condition that comes right out of the left field to save the day. So, Ron's 1961 paper is the solution to our first problem, and this is about as far as we could go with the many-good many-country framework by providing this result on efficiency.

7.2. Solution Two

The second solution was to introduce a method to make comparative statics easier and more useful while retaining a Ricardian structure. And this was done in a paper written by Dornbusch, Fischer, Samuelson in the mid 1970ies. They retained the two country assumption, with one factor; and they introduced a continuum of goods z – that's why I introduced the *A(z)*-schedule earlier – except that now *A(z)* is going to be smooth (see Fig. 7.3) and is assumed to be continuous – and differentiable. These assumptions ensure that no good will be produced by two countries at the same time. Then they also introduce iceberg transportation costs and revenue raising trade barriers. The transportation costs were especially innovative at that time, because it allowed a set of non-traded goods to be determined endogenously, where previously we used to just assume for example "Good *z* is non-traded and the others two are traded." Importantly, it allowed the set of non-traded goods to change with comparative statics. That was very nice. And tastes were assumed to be Cobb-Douglas.

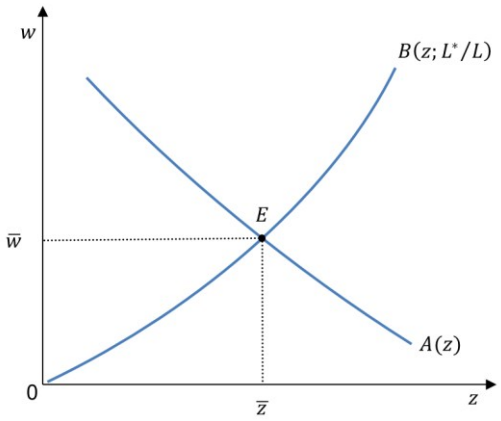

Fig. 7.3 The Ricardian Model until 2002. Source: Dornbusch, Fischer and Samuelson (1977)

So, what this model looks like now, is that we have home relative wages on the vertical axis and we have the goods ranked along the *A(z)*'s schedule in terms of declining home country comparative advantage. This is just a smooth continuum version of the graph with flats I showed a few slides ago. And then the *B(z)* schedule reflects demand for home vs. foreign labor conditional on the set of goods produced. *B(z)* takes into account the potentially differing budget shares consumer's have across all goods and it also reflects relative country size as captured by labor force sizes.

Until 2002 – and there were many elaborations of this – this was the Ricardian model that was taught in graduate schools everywhere. And this was because the model provided a very productive setting to examine many questions. While the model has been used in many different ways, I'll give you just three examples of papers using this framework. The three I chose represent the three most cited papers (google scholar citations) that employ and extend the DFS model. Fortunately all three are quite different as well.

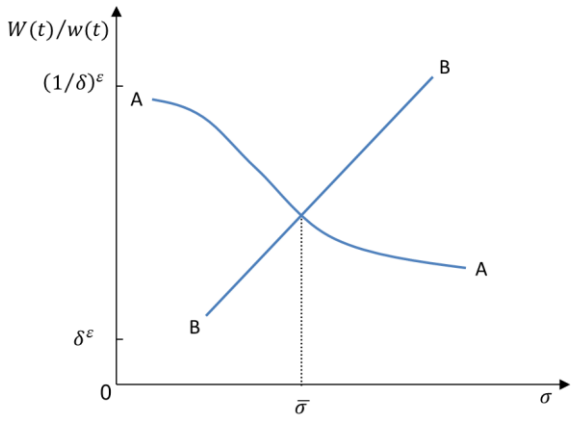

Fig. 7.4 Narrow Moving Band, Dutch Disease and Competiveness Consequences**.** Source: Krugman (1987)

The first example is Paul Krugman's (1987) paper 'The narrow moving band, the Dutch disease and the competitive consequences of Mrs. Thatcher', published in the Journal of Development Economics. It's a very interesting paper to read. It's kind of amazing to see, how much Paul got away with in this paper. It's a big think paper with a lot of missing details, none of which I will talk about today. The basic idea can be conveyed by (Fig. 7.4), where along the horizontal axis, it's not z anymore, but it's the share of spending falling on home produced goods and along the vertical axis it's again relative wages. What happens in this model is that when you produce more of a good, you accumulate knowledge capital. This knowledge capital is external to the firm, it accumulates and of course the more knowledge capital you have the more productive you and every other firm are in producing that good. This knowledge spills across borders, and the extent of these international spillovers is determined by the parameter δ. So, if δ was one, everything that I know, somebody else living in another country learns too and vice and versa. Spillovers are completely international. If δ is less than one, then Rolf gets part of my knowledge capital from production but doesn't benefit from it completely. And in the steady state this parameter is going to bound wages because it's going to determine ultimate productivity differentials between the two trading countries in any steady state. Paul Krugman used this as a means to talk about three things that people had talked about in trade theory but didn't have a way to model. And the first one was the effects of temporary protection on long run outcomes. He suggested that if a country was to refuse to import one of the goods exported by the partner country, it may in fact become more competi-

tive in this industry over time. In this sense temporary protection could work to generate longer run comparative advantage which is often at the heart of infant industry arguments for protection. So, if you are the home country here, if you refuse to import one of the goods you are currently importing [any good to the right from the intersection], then what would happen is, if you are large enough, you would be gaining more experience in that good because of your relatively large domestic production, than would the foreign country with relative small domestic production. Over time, this will affect the *A(z)* schedule and may turn it in your favor.

For example, in this model with learning by doing, the *A(z)* schedule to the left of the intersection moves up because only Home is producing these goods and they are getting relatively more productive at doing so. Conversely, everything to the right of the intersection moves down, so the limiting *A(z)* schedule looks something like a step function with a vertical section at the intersection point. The narrow moving band of the title is just suggestive of the possibility of a country selectively protecting a group of industries near the intersection so that over time this step function moves rightwards. In essence, it's an argument about the importance of hysteresis since temporary protection can have long run consequences for trade patterns. At the time this was– I think – pretty novel to international trade. The details were left for others to work out.

The second example of Paul's involved the Dutch disease and to model this he used what we already knew about the impact of international transfers. In fact, the element of the transfer problem he used, Ron worked on quite a bit.[1] A resource boom was modeled as delivering a flow of offshore income coming into the country. To get these resource transfer payments to affect the competitive margin, and hence long run comparative advantage, Paul probably read one of Ron's earlier papers and recognized that, with identical homothetic tastes, transfers are going to do nothing. World demand is unaffected by income distribution in that case, so what did he do? Paul introduces non-traded goods, and this gets him around the problem. With non-traded goods in the mix, the BB schedule shifts up when the home country receives a transfer because a greater share of world income is then spent on home produced goods. The transfer of these resource rents consequently affects the economy's competitive margin and over time

[1] See, for example, Jones (1975).

it can make this country less competitive in these industries. If the transfers continue for long enough, then when resource rents are gone the economy moves back to a world where it has lost comparative advantage in a set of other industries. Again, a temporary change in the competitive margin has long run effects because of learning by doing. A similar result can follow from overly tight monetary policy that likewise affects the set of goods produced, and this was the paper's last example and the genesis for the "Mrs. Thatcher" in the title.

This application of the Dornbusch, Fischer and Samuelson (DFS) 1977 paper stimulated a large literature by many academics. The Ricardian structure was simple enough so that we could sensibly add the complications of learning by doing, and the efficient pattern of production was also simple to track given our understanding of comparative advantage. The paper led to a large industry of followers who picked up all the pieces and filled in all the missing details having to do with whether temporary protection matters for welfare, about the permanence of resource boom impacts and, I think, even about the long run competitiveness consequences of tight monetary policy. Paul's paper was in some sense completely Ricardian since only one factor earned income and this factor's productivity alone determined trading patterns. The next two applications of DFS moved a little bit away but still retained a strong Ricardian flavor.

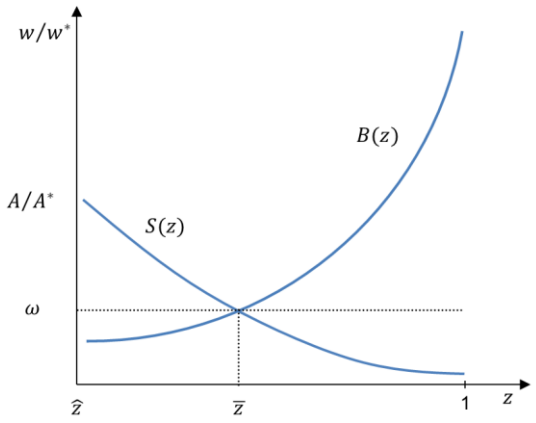

Fig. 7.5 North-South Trade. Source: Copeland and Taylor (1994)

This second application of Ricardian trade theory is actually a paper of mine (Copeland and Taylor, 1994). It is very Ricardian in the sense that industries are ordered by their pollution intensity, and ordering these industries in terms of their pollution intensity plays a key role in

determining trade patterns. Everyone worldwide has the same technology, but if the North imposes a higher pollution tax than does the South, then the costs of producing pollution intensive goods are relatively higher in the North than they are in the South. And that's what this *S(z)*-schedule reflects here (see Fig. 7.5), and it is the analog to the earlier *A(z)*. The North is the country with the higher pollution tax and the *S(z)*-schedule shows declining Northern comparative advantage as the goods become dirtier and dirtier moving to higher and higher *z* goods.

It's still Ricardian although with another intermediate step determining comparative advantage, but it would not have been published had I stopped at the exogenous pollution tax case. Another Ricardian component creeps in when we allow for endogenous pollution taxes. The North is the North for a reason, and we assume the two countries differ in absolute advantage. We model this difference by giving the North greater human capital per person, so that the North is much richer than the South. The North, because it's richer, has a higher marginal damage from pollution, so it imposes endogenously higher pollution taxes. And so the fixed pollution taxes which gave you comparative advantage à la Ricardo become endogenous pollution taxes that also give you the same pattern, as long as the North is sufficiently richer than the South. The model replicated the trade pattern Larry Summers wrote about in his 1993 memo that got him into a lot of trouble. The rich North gave up production of dirty goods that were in turn produced by the poor South. It gave the first formal proof or demonstration that the pollution haven hypothesis could in fact work in a general-equilibrium context. Apart from this contribution, the paper decomposed the changes in pollution created by trade or economic growth into the now common mantra of Scale, Composition and Technique effects, and showed how income gains created by international trade had a fundamentally different effect on environmental outcomes than did say economic growth. Just like Paul's earlier paper, we also considered transfers but in this case to examine the impact of foreign aid on environmental outcomes.

This paper also stimulated a large literature that extended the analysis to allow for additional factors, to consider strategic policy choices across countries, and to empirical work examining the strength of trade-related changes in the environment. As such, it was again a very successful application of Ricardo's basic ideas to important and timely present day questions.

The final example of Ricardo's continuing legacy that I was going to discuss was an important paper by Feenstra and Hanson published in 1995. Their paper is even further a field from a typical Ricardian model because there is another factor endowment and this factor is in inelastic supply, but Feenstra and Hanson employed the DFS trick to order all of their continuum of intermediates according to their skill intensity much like Copeland and Taylor did in terms of pollution intensity. The continuum again divides up the intermediate good production across countries, and shifts in the additional endowment – capital – which alters the competitive margin. A increase in foreign direct investment to Mexico or additional capital accumulation in Mexico stimulated by the prospects of NAFTA would then increase the demand for skill in both countries. It did so because Mexico took over a set of industries on the margin of their competitiveness, and these were the most skill intensive relative to Mexico's existing production. This raises the relative demand for skill in Mexico. The US in turn loses the least skill intensive of its industries, so this raises the relative demand for skill in the US. The model has a factor endowments flavor, but the prospect of trade liberalization – if it induces changes in capital stocks – ensures that both countries post-liberalization could see a rise in the relative return to skill. This was the paper's key result, and it follows from the ranking of sectors, the continuum assumption made popular by DFS, and by the movement of capital with trade. This paper provided a very nice explanation for why the skill premium in both Mexico and the United States could rise with trade, and stimulated a large literature examining the labor market effects of trade liberalization that continues today.

While all of this is great stuff and important work, all of these papers were about two countries or regions. And although they stimulated empirical work, none of them really provided a tight test of the the theories that they put forth. They were suggestive and illuminating, but none of them provided guidance for structural estimation. Adding more than two countries to a many good analysis remained difficult without very strong assumptions and extreme patterns of specialization remained in all of them. And without a better way to map theory into empirics, this branch of trade theory was destined to dwindle and be eclipsed first by a reanaissance of the empirical Heckscher-Ohnlin-Vanek (HOV) tradition and then later by a surge of interest in models of monopolistic competition stressing firm level behavoir. What the Ricardian model desperately needed was a way to take Ricardo's key insights seriously, move

them to a world with many countries and goods, and then allow for a rigorous empirical evaluation of their merits.

7.3 Solution Three

The solution to problem three, that I alluded to above, has been provided by (Eaton and Kortum, 2002) and their subsequent work, but Jonathan is going to talk about this later today so there is no need for me to talk about it here. Suffice to say, their work provides a brilliant solution to this last key problem, and it has reinvigorated interest in the Ricardian model.

7.4 Conclusion

In closing, what are the nagging questions and the missing-in-action components I have ignored in this fly-by review of Ron's paper and Ricardian trade theory? First of all I ignored all applications of the two-good model, for which there are many, many great ones. Actually, I think, my favorite is Bill Ethier's "Decreasing Costs in International Trade and Frank Graham's Argument for Protection" (Ethier, 1982). There were many other applications. John McLaren's Judge Bowker's argument against free trade (McLaren, 1997) being another. And I ignored all those. So, the Ricardian model played a big role – even the two-good Ricardian model– in allowing trade theorists to go into new areas and bring them into the fold of trade theory.

A second omission, is that I did not ask how far can Ricardo go in explaining the world pattern of production and trade? What fraction of world trade is left to be explained by increasing returns or by models stressing factor endowment differences? Do we really think that increasing returns and factor endowment differences are no longer important for explaining world trade, or should we think of this new reinvigorated Ricardian approach to trade theory as providing us with a far better, but still only partial, guide to reality?

References

Copeland, B. R., & Taylor, M. S. (1994). North-South trade and the environment. *The quarterly journal of Economics*, 109(3), 755-787.

Dornbusch, R., Fischer, S., & Samuelson, P. A. (1977). Comparative advantage, trade, and payments in a Ricardian model with a continuum of goods. *The American Economic Review*, 67(5), 823-839.

Eaton, J., & Kortum, S. (2002). Technology, geography, and trade. *Econometrica*, 70(5), 1741-1779.

Ethier, W. J. (1982). Decreasing costs in international trade and Frank Graham's argument for protection. *Econometrica: Journal of the Econometric Society*, 1243-1268.

Ethier, W., Helpman, E., & Neary, J. P. (1993). *Theory, policy and dynamics in international trade*. Cambridge University Press.

Feenstra, R. C. & Gordon, H. H. (1995). Foreign investment, outsourcing and relative wages: Evidence from Mexico's Maquiladoras. *Journal of International Economics*, 42, 371-393

Jones, R. W. (1961). Comparative advantage and the theory of tariffs: A multi-country, multi-commodity model. *The Review of Economic Studies*, 28(3), 161-175.

Jones, R.W. (1975), "Presumption and the transfer problem, Journal of International Economics, 5, 3, 263-277.

Krugman, P. (1987). The narrow moving band, the Dutch disease, and the competitive consequences of Mrs. Thatcher: Notes on trade in the presence of dynamic scale economies. *Journal of development Economics*, 27(1-2), 41-55.

McLaren, J. (1997). Size, sunk costs, and Judge Bowker's objection to free trade. *The American Economic Review*, 400-420.