Chapter 17
200 Years of Ricardian Theory: The Missing Dynamics

Esteban Rossi-Hansberg

Abstract In recent years, trade economists have started to incorporate dynamics in international trade models, using frameworks that are at their core Ricardian. Using a quantitative model to estimate the effect of dynamic knowledge innovation, I argue that reducing trade barriers leads to large gains from trade as a result of these dynamics. I illustrate these effects with a quantification of the impact of trade barrier reduction between Latin American countries. Productivity levels and their distribution in space are estimated to be much greater when including the dynamic effects that result from the trade liberalization.

I am not a classically trained trade economist. I studied at Chicago when there were really no trade economists there, so I studied macroeconomics and got interested initially in trade as a secondary topic, and so it is excellent (and somewhat surprising) to be here with all of you. When I think about Ricardian trade theory and the kind of work I have been interested in during the last few years, the key aspect that I think requires more attention is dynamics. So I will use my talk to make the case for that.

I came to trade theory because I was interested in the distribution of economic activity in space, and trade was just an example where the economic activity in space matters. I was also very interested in regional economics, and urban economics. In fact, since Eaton and Kortum's famous paper,[1] we have experienced the explosion of a set of frameworks that have at their core this Ricardian theory, but that can be used for international trade, but also for urban economics and regional economics, once you sprinkle in a little bit of agglomeration and congestion.

A group of us have been using these models, along with a lot of data, to try to think about general equilibrium counterfactuals in all these spatial dimensions.

Note: This chapter is based on a transcription of the presentation given at the Conference "Celebrating 200 Years of Ricardian Trade Theory" on May 12, 2017, at the University of Basel, Switzerland.

[1] Eaton and Kortum (2002).

E. Rossi-Hansberg (✉)
Department of Economics and Woodrow Wilson School, Princeton University, Princeton, NJ, USA
e-mail: erossi@princeton.edu

R.W. Jones, R. Weder (eds.), *200 Years of Ricardian Trade Theory*,
https://doi.org/10.1007/978-3-319-60606-4_17

Eaton and Kortum showed us how to do it for trade, and since then, we have expanded the set of economic situations in which we can use them to perform general equilibrium counterfactuals, as many of you have already mentioned today. Most of these counterfactuals are, of course, computed conditional on the local characteristics at the country level, the regional level or, maybe, the block level if we are thinking about a city. One of those characteristics is productivity. The conclusion from these models, keeping fixed these local characteristics, is that the gains from trade are in general small. Think about voters living in some region that has been completely changed over a decade. As a trade economist, you may say to those voters "if you shut down trade, you will have 2 percent lower consumption". They may say, "Well, I'll take it, I'll take my old town with 2 percent less consumption".

So the question is, do we believe these numbers, or do we think these numbers are missing important channels? I believe that we are missing some channels. Ralph [Ossa] mentioned one of these channels. Namely, that we should considers substitution across sectors with elasticities of substitution that are potentially a lot lower than the ones we use in some of these calculations. Costinot and Rodriguez-Clare have some estimations of the resulting gains if we do so[2] and Ralph has a paper on that, too.[3] There are two other channels that I would like to underscore here:

(1) Internal trade: That, is, the fact that there is a lot of trade interactions within countries. We should take into account how the internal distribution of economic activity varies with trade barriers.
(2) Dynamics: That is, the fact that productivity levels are not constant. We think that when we open up a market, productivity levels will be affected.

Let me focus on productivity dynamics. There is a good reason to think that there are important dynamics going on here. The basic argument is simply that if you are thinking about undertaking some costly innovative activity, you need to understand your market and the size of it in order to make that decision; understand whether it is profitable to invest or not. And so there is this very basic logic in economics that tells you that, inevitably, these dynamic effects have to be there.

There is also a question, of course, of how large these dynamic effects are. Now, writing models with dynamics that are quantitatively flexible, such as the Eaton-Kortum model and the follow-up models, is very hard. Part of the reason why it is so hard is that the state space includes the characteristics of all countries and regions. The set of state variables in the dynamic investment problem is extremely large. Therefore, there have been very few attempts to try to do this. And most of the papers that have attempted this have had to take some short-cuts. You can add dynamics in different ways and there is some literature, or some emerging literature, that has been trying to do this, but as you can see, all this literature is very recent (see Fig. 17.1).

[2]Costinot and Rodriguez-Clare (2014).
[3]Ossa (2015).

- Hard problem since dynamic investment problem has dynamic characteristics of all countries / regions as state variables

- Important, though, since trade frictions likely affect investment decisions as they affect profitability of investments
  - » Same with mobility frictions and more generally any spatial friction

- Dynamics can be the result of:
  - » Capital accumulation: Eaton, Kortum and Nieman (2016) and Anderson, Larch and Yotov (2015)
  - » Improvements in technology through innovation and diffusion: Desmet and Rossi-Hansberg (2015) and Desmet, Nagy and Rossi-Hansberg (2017)
  - » Transitional dynamics from mobility: Caliendo, Dvorkin and Parro (2015)

Fig. 17.1 Incorporating dynamics: a few attempts. Source: Illustration based on the presentation slide of the Conference

You can try to add dynamics to capital accumulation, to improvements in technology, or to diffusion—Jonathan [Eaton] talked a little bit about that and I'm going to talk more about it today—or you can think about transitional dynamics caused by mobility and the effect that workers moving to different regions is going to have over time, which Lorenzo Caliendo and Fernando Parro[4] have been working on.

I have been thinking about the effect of trade on technology and the fact that the investment decisions of firms are going to be affected by market size. When you think about technology and the fact that it is endogenous, you can think about diffusion, which is complicated. That does not mean that it is not present or not important, but it is complicated because it is so hard to measure and see. You can think about patents. However, when we talk about innovation, we talk about all improvements in technology, so you do not want to limit yourself to patents. We are also talking about small improvements in technology, better techniques, so thinking only about patents is going to miss a lot of the real effects.

In my view the more important economic mechanism here is market size. If a firm is thinking about innovating, its market size is going to determine whether it will do so or not. The key aspect of this is the replicability of technology: The fact that when I invent that one thing, I want to use it as many times as I can. What trade does, at the end of the day, is that it allows me to use that invention many times over. So the key implication from reducing trade frictions is that it allows producers to invent things and use them more often; exploit the replicability of technology.

[4]Caliendo, Dvorkin, and Parro (2015).

- In the aggregate, correlation between income per capita and population density increases with development.
  - » -0.11 in Africa but 0.5 in North America
  - » Also evident across U.S. counties and zip codes
- Suggests that innovation happens in places with larger market size.

Fig. 17.2 Dynamic Ricardian comparative advantage: market size. Source: Illustration based on the presentation slide of the Conference

There are some smoking guns that tell you that this is important: One is, for example, the fact that the correlation between income per capita and population density increases with development. So, in areas that are more developed, the correlation between income per capita and density is high, suggesting that some of this innovation may be happening at a local level. Something similar happens when you look at the data of firms in cities (Fig. 17.2).

It is very hard to pin down and be very precise about measuring this exactly, because these technologies are sometimes a little bit elusive, but when you try to organize the local data through these ideas, there seems to be something there.

Together with Klaus Desmet and Dávid Kristián Nagy,[5] I have tried to use one of these quantitative models to think about the effect of trade and migration on dynamic knowledge innovation, and whether reducing trade barriers will have a much greater impact if we incorporate some of these effects. We have measured it as well as we can, given the available data on growth, migration, production, etc. We try to do the best job possible in quantifying these models and although we're not going to test them, we're going to use all the data that we can to get the best number we can put on the table.

That number may be imperfect in all sorts of ways, but it is the best number that we can come up with. And let me say that this exercise passes one test. If I use all these data to quantify the model for the year 2000, then I can move backwards in time using the model to try to predict the past. When I run it backwards and see how the model does in terms of explaining population counts across regions in 1950, it does really well. The good fit gives us some confidence in the model.

The implication of this model is that we have large gains from trade due to the dynamic effect on innovation. In particular, the elasticity of the present discounted value (PDV) of real GDP to trade costs is about 0.75. You can also think about gains from relaxing migration restrictions and those are also very large [elasticity of the PDV of real GDP to migration costs is 1.24] (Fig. 17.3).

[5]Desmet, Nagy, and Rossi-Hansberg (2017).

- In Desmet, Nagy and Rossi-Hansberg (2017) we incorporate this mechanism in a quantitative dynamic spatial framework
  - » Spatial resolution of 1x1 degrees for whole world
  - » Innovation due to market size, diffusion, costly trade, and costly migration
  - » Quantified using local population and output, trade, migration, wellbeing, and growth data

- Fairly successful in backcasting exercise from 2000
  - » Correlation between population in 1950 is 0.97 and in population changes is 0.74

- Leads to large *gains from trade* due to dynamic gains
  - » Elasticity of the PDV of real GDP to trade costs is 0.75

- Leads to large *gains from migration*
  - » Elasticity of the PDV of real GDP to migration costs is 1.24

Fig. 17.3 Are dynamic effects large? Source: Illustration based on the presentation slide of the Conference

17.1 A Free Trade Agreement for Latin America

Let me illustrate with one particular exercise. It gives me the opportunity to show you some nice maps with lots of colors as well as the level of heterogeneity that you can incorporate into these models. We quantify a model of the whole world economy at a 1×1 degree level; so each one of these squares is 1×1 degree. We have some data from [William D.] Nordhaus (G-Econ 4.0) at that level, so it has some internal trade and some international trade, of course.

Now imagine the following exercise. Assume that, perhaps motivated by Trump's election, Latin American countries sign a trade agreement between themselves. The countries in Latin America reduce trade costs between them by 35 percent. Internal country trade costs remain the same. We want to think about the technology implications of this reduction. What I have here [in Fig. 17.4] is the change in productivity at impact when you sign that agreement. It doesn't include the U.S., so, it's from Mexico southwards. This is, of course, a policy that has been under discussion many times in Latin America. You can see the productivity increases that come as a result of the policy. They are very varied across regions. Some regions gain a lot, in particular Argentina and some regions of Peru. Mexico gains very little, because it trades a lot with the U.S. already. These are the gains in productivity; but note that these numbers are really small. The largest number on this scale is 0.009 (9×10^{-3}). This means that the impact on those regions that

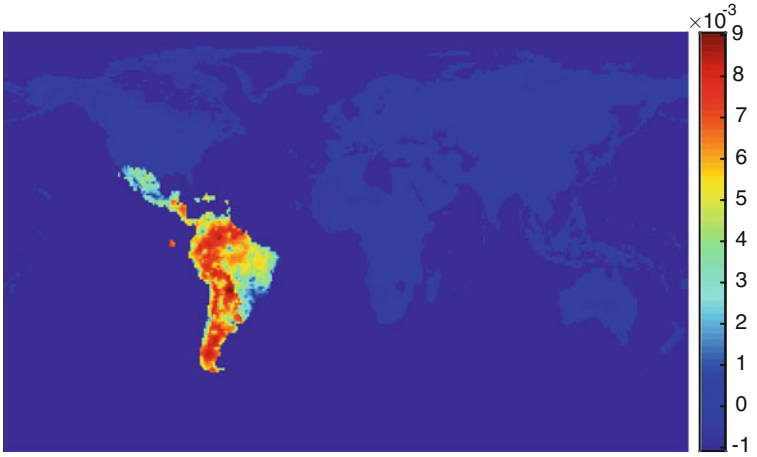

Fig. 17.4 Latin American trade agreement: productivity change at impact. Source: Illustration based on the presentation slide of the Conference

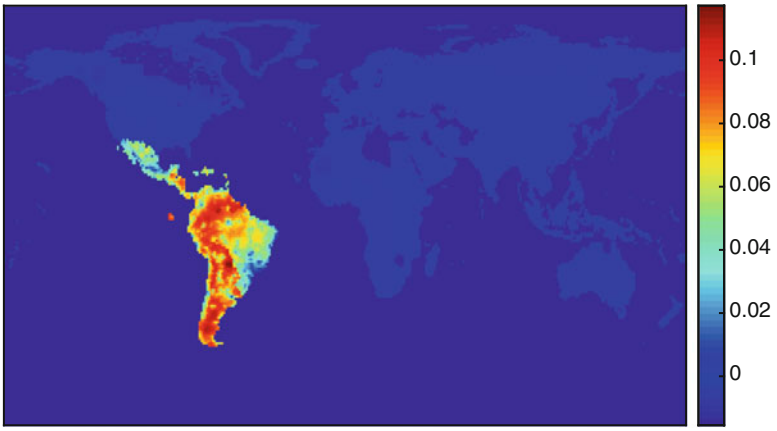

Fig. 17.5 Latin American trade agreement: productivity change after 50 years. Source: Illustration based on the presentation slide of the Conference

gained the most is close to 1% and a lot of the other regions gained essentially nothing in terms of productivity. Furthermore, if you are outside of Latin America, this is a policy that essentially does not affect you.

Now I'm going to move forward in time. Fifty years later, what do these gains in productivity look like? The numbers in Fig. 17.5 are no longer multiplied by 10^{-3}. They tell me that the regions gaining the most are now improving their productivity

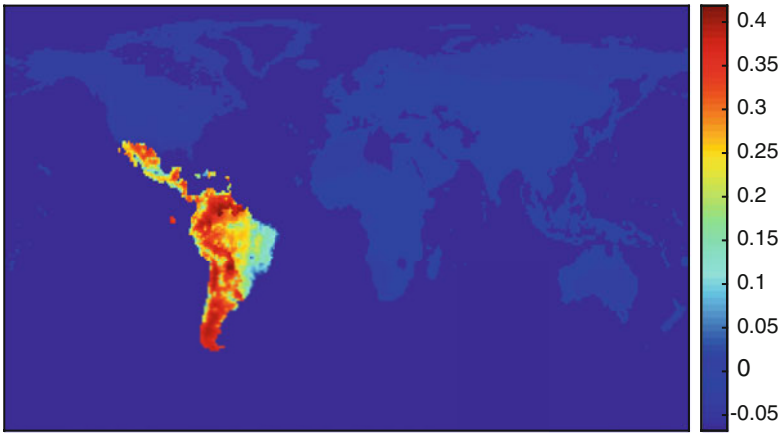

Fig. 17.6 Latin American trade agreement: productivity change in balanced growth path. Source: Illustration based on the presentation slide of the Conference

by about 10% as a result of the free trade agreement that was signed. The color pattern is very similar, though, which means that the relative effects do not change that much. Mexico still looks as if it does not gain that much, whereas Peru and Argentina are seen to gain more.

In the model the distribution of economic activity will converge eventually to a balanced growth path. Figure 17.6 shows the spatial productivity distribution in the balanced growth path. The highest numbers are now in the region of 40%. Countries are now saying "so we signed this free trade agreement and productivity started to improve, and now these are serious numbers". These incentives to innovate created an improvement in productivity over time. But more importantly, look at the North of Mexico. Eventually, the North of Mexico became the connection between the United States and the block of countries in the free trade area. So productivity started to increase there. Of course, in a model where there are no dynamics, we are going to completely miss this type of effect. And so the question is, how much of the gains from trade are coming from these dynamic productivity changes.

Figure 17.7 shows the level and growth effects. The growth effects disappear over time, but it takes a long time for that to happen. Why is this? Well, how much you want to invest depends on what others have invested in the past, so that creates the sequentiality that leads to very protracted effects from these trade agreements. Importantly, the numbers showing the increases in the present discounted value of real GDP and welfare are of an order of magnitude greater than what you would get in a model without any dynamics. Thus, a lot of the gains are further in the future. They are much larger, because now you are impacting the growth rate, and so the effects on technology and output accumulate over time. As I mentioned before, there are a lot of issues with these numbers, and we can question them in all sorts of

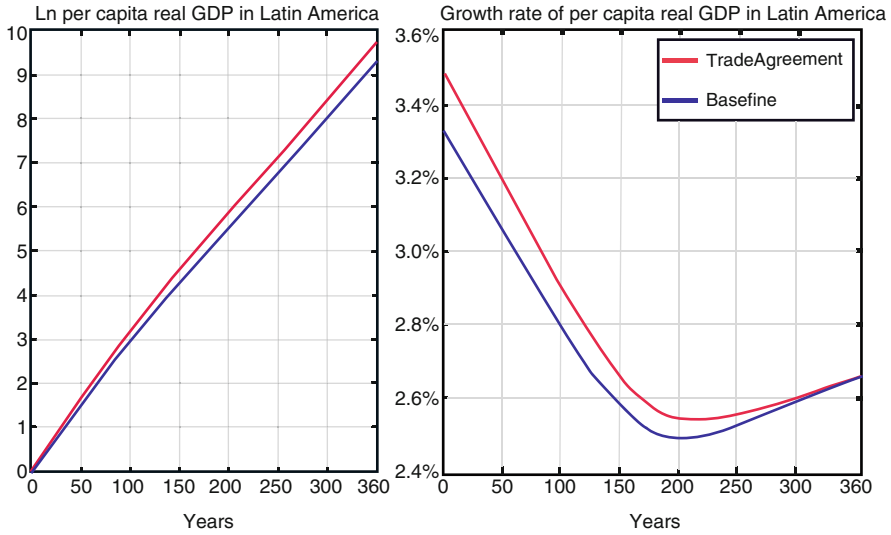

Fig. 17.7 Latin American trade agreement: real GDP percentage growth. Source: Illustration based on the presentation slide of the Conference

ways, but it is some indication that focusing more on some of these dynamics is a good idea.

17.2 Conclusion

To conclude, we need more work on establishing more exactly this link between market size and innovation, and to measure in a better way the parameters that govern this relationship. We need more models that have dynamics and that allow us to introduce capital, through consumption and savings decisions, together with these innovation decisions. There is a lot to develop here and I think this is one of the areas in which we can push these Ricardian theories quite a bit further. There are a lot of smoking guns around that show us that this is important. One of those smoking guns can be found next to Bill Gates, when he said, "I wish for a week that we could shut down trade and then, you know, Boeing, Microsoft, Hollywood, pharma would resize their R&D departments for a couple of weeks for fun. And then two weeks later people would go 'Holy smokes, that was not a very good deal'."[6]

[6]Financial Times, April 18, 2016.

References

Anderson, J. E., Larch, M., & Yotov, Y. V. (2015). *Growth and trade with frictions: A structural estimation framework*. NBER: National Bureau of Economic Research, No. w21377.

Caliendo, L., Dvorkin, M., & Parro, F. (2015). *Trade and labor market dynamics*. RIETI Discussion Paper Series, 16-E-050.

Costinot, A., & Rodriguez-Clare, A. (2014). Trade theory with numbers: Quantifying the consequences of globalization. In G. Gopinath, E. Helpman, & K. Rogoff (Eds.), *Handbook of international economics* (Vol. 4). Amsterdam: Elsevier.

Desmet, K., Nagy, D. K., & Rossi-Hansberg, E. (2017). The geography of development. *Journal of Political Economy* (forthcoming).

Desmet, K., & Rossi-Hansberg, E. (2015). On the spatial economic impact of global warming. *Journal of Urban Economics, 88*, 16–37.

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

Eaton, J., Kortum, S., & Neiman, B. (2016). Obstfeld and Rogoff's international macro puzzles: A quantitative assessment. *Journal of Economic Dynamics and Control, 72*, 5–23.

Ossa, R. (2015). Why trade matters after all. *Journal of International Economics, 97*(2), 266–277.