Integrating Transportation and Geography into Trade Analysis
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My topic today is the role of transportation costs and geography in patterns of international trade. One might think that this is an obsolete subject. We hear so much about globalization, international integration, the death of distance, the triumph over transport costs, the borderless world, and statements like, "Firms do business across the globe as easily as across town." It is not hard to see where all of this comes from. The trend toward increased integration and reduced costs of transportation and communication has been very strong for a long time. It consists of a number of parts. There's technological progress in transport itself. Perhaps, in the 20th century, the invention of the airplane would be the most dramatic example. And it's interesting that even though we think of ocean shipping first, a higher and higher percentage of U.S. trade goes by air than by sea. Currently, 31 percent of U.S. exports go by air, up from just 14 percent in 1970, and that increase is at the expense of the share that goes by sea, with land remaining pretty constant. So the share that goes by air is almost equal to the share that goes by sea, and that's not including services and other ways in which air transport matters. I think we have to consider all three modes of transportation.

Technology and Innovation Bring Down Transportation Costs

It's not just scientific or technological innovations that matter, but also innovations in transportation. I think one of the most important events of the post-war period was the invention of containerized cargo, which was just an idea by a guy named McLean—Malcolm McLean. It's sort of an interesting story. Apparently, initially the motivation wasn't just efficiency, but to cut down on pilfering by the people handling the cargo in the port. But containers are more efficient and have had a huge effect on reducing costs. For the share of trade that goes by sea, the average sea freight charge per short ton has fallen from $95 in 1920 (expressed in 1990 dollars) to $29 currently. In addition to innovation in the private sector, liberalization by governments, reductions in both tariffs and nontariff barriers have, of course, been very important in the post-war period. There is danger of overdoing this liberalization. The conventional wisdom, if you're not careful, is that borders don't matter at all anymore. Distance doesn't matter at all. Geography doesn't matter at all. As I said, a producer can do business across the planet as easily as across town. And just to read you one quote from *The Borderless World* by Kenichi Omae: "National borders have effectively disappeared." That's an exaggeration. We want to pay a lot of attention to the increased integration, the decreased costs associated with distance. But we don't want to get carried away and say that there is no role for geography at all.

Global Integration Far From Complete; Geography Still Matters

Let me mention five different ways in which geography still matters. First, a bit of macroeconomics. Last year (1998), the U.S. economy grew by 4 percent (third year in a row that the Council of Economic Advisors grossly underestimated the rate of growth of the U.S. economy). The rest of the world was in a slump, especially Asia, of course. If the world were really so perfectly integrated, you would think that the Asian slump would have had a huge effect on us. It did have some effect. It showed up in our trade deficit, and it created a drag on U.S.

growth of something like 1 percent. But that was relatively minor compared to how big and strong the domestic economy was, how much momentum it had. That is, at a crude level perhaps, an indication that maybe international integration is not quite as complete as we've gotten into the habit of saying.

The most common ready estimate of the degree of integration is the ratio of trade to GDP, which has certainly been increasing throughout the post-war period. The average of exports and imports of merchandise as a share of GDP in the United States is now at 9.1 percent, which is more than double what it was as recently as 1971. This is comparable to the trends in other countries. Japan and the EU, if you consider them as an aggregate, both have openness roughly in this neighborhood of about 9 percent, which is an important trend. But is international integration close to complete? I would argue far from it. Here are two other perspectives on that statistic. First, the ratio of trade to GDP was almost as high before World War I. It was 5.6 percent in 1989 and about 6 percent in 1913 just before World War I. So most of the technological innovation and liberalization that we have had during the post-war period has merely reversed what happened between World War I and World War II, especially in the 1930s when many tariff barriers went up and trade as a share of GDP in the U.S. and other countries fell very sharply. It took until the mid-1970's before we had re-attained the degree of openness that the world had experienced before World War I. So that's a little sobering.

Second, let's think what it would mean if it were literally true that a producer could deal with a customer around the globe as easily as across town. It would mean that there would be no necessary correlation between customers' producer relationships, on the one hand, and where you're located on the other. The U.S. economy is currently about 26 percent of gross world product. If geography didn't matter, an American consumer would buy from an American producer no more frequently than anybody elsewhere in the world would buy from an American producer. In other words, 26 percent of the time, 74 percent of our trade would be with other countries. Instead, it's only 9 percent. That means even though openness has doubled, it would have to increase another eight-fold before we'd be at this theoretical perfect world in which distance no longer mattered, geography no longer mattered; in which you traded with people around the globe as easily as across town. Maybe that's a "straw man," but given how often those quotes I mentioned come up and given the extent to which distance and geography have indeed been omitted from most analyses, I think it's important to make that point.

I promised you five reasons why geography still matters, why integration is not perfect. The third one uses price data rather than quantity data. If distance didn't matter, and transportation costs were zero, we'd have perfect arbitrage. Agricultural products are generally a good area to test this because there is relatively greater homogeneity, relatively greater reason to think that a bushel of wheat in one country is a good substitute for a bushel of wheat in another, although even in this case it may not literally be true. The so-called law of one price which says, adjusting for currency, prices should be equalized is a very important part of theory, but it just doesn't hold all that well in practice. There is a huge volume of empirical literature on this, but I cite one paper that I find really striking by Froot, Kim, and Rogoff. They obtained data going back to 1273–that's not a misprint, every time you put that in a paper, the editor thinks it's a misprint–
so they got over 700 years of data on prices in England and Holland for eight commodities:

barley, butter, cheese, eggs, oats, peas, wheat, and silver. Seven out of the eight happen to be agricultural commodities, and they look at the price differential and see how it has moved over time and the speed at which a deviation from the law of one price is corrected and the role of currencies. But the most striking thing is that the average price deviation between Holland and Britain is no smaller today in most of these commodities than it was seven centuries ago. I consider that astounding. Presumably, transportation costs were prohibitive for butter and eggs then and they were high for some of the others. We know that those transportation costs have fallen a lot, and yet the law of one price doesn't hold any closer today and the speed with which deviations are corrected is no higher today than it was 600 or 700 years ago. What's going on is that we've got serious government trade barriers in the form of the common agricultural policy in Europe. We've got volatile exchange rates, which even for agricultural products create deviations from the law of one price. And those factors have increased over time by enough to offset declining transport costs.

Another fascinating piece of research I want to cite is by Charles Engel and John Rogers. They looked at consumer prices in categories of goods not quite as narrowly defined as butter and such, but 12 categories of goods among a sample of 23 cities spread throughout Canada and the United States. They looked at the price differentials and how they were affected by geographical considerations. They found that distance has a statistically significant effect on relative price variability. The average city-pair, average pair of cities in North America, has a standard deviation that is one-fifth higher than it would be if those two cities were right next to each other, say Minneapolis-St. Paul. Raising the distance to the average within the continent raises the variability in relative prices by about one-fifth. I'm going to come back to that work a little bit later.

The fourth reason why we know integration has not gone quite as far as we sometimes think is the literature on the increasing gap between wages paid to skilled workers and unskilled workers. We seem to be reversing this a bit now, but since the early 1970's, the gap between wages paid to skilled and unskilled workers has increased rather sharply. There is a debate about whether this is due to trade, as a lot of people think, or other causes. Without going into the methodologies, most people find that a relatively small fraction of the gap is due to trade and more is due to technological change and the increasing importance of education and skills. Most of these studies conclude that trade is just not that large a share of the U.S. economy, contrary to all the globalization talk.

Finally, financial markets. One would think transport costs are essentially zero and that integration would be complete, and my compatriots in the field of international finance generally assume that. But, in fact, there are all kinds of ways in which, even in the realm of finance, integration is not complete–failures of arbitrage, so-called home-country bias in holdings of securities, and so on.

In the rest of my time, I'm going to run through three categories of costs in which distance does make a difference. Then I will talk about why we should care about transportation costs, and geography more generally, in trade theory. And then about the famous gravity model-- what it is, some empirical conclusions one can derive from it, and maybe a few policy implications as well. The first of the three different kinds of costs of doing business at a distance is what you think of automatically, namely physical shipping costs. It is hard to get a comprehensive measure. I

suppose the easiest one is the gap between the cif price, which includes insurance and freight, and the pre-export price, as a percentage of the total. I'll call that the cif margin. That average is about 4 percent for U.S. trade, starting at about 2 percent for trade with Mexico (and about as low for Canada) and going higher for trade with partners that are farther away. The maximum in my data sample is 26 percent for Guinea in West Africa–that is, 26 percent of the value of the trade is accounted for by the insurance and freight margins. Obviously, this varies across commodities. In the categories I've got data on, the lowest margin is for pearls at 0.7 percent. Obviously pearls are not perishable and have a high ratio of monetary value to weight. So transport costs are negligible for trade in pearls. At the other end, the cif margin for fruits and nuts is 19.3 percent, quite a bit higher margin. If you look at cif margins worldwide, they've been falling throughout the post-war period, from roughly 10 percent in 1950 to roughly 6 percent now. That underestimates the effect that declining transport costs have had. I want to warn against using the cif numbers as a measure of transport costs, because of composition effects. Composition with regard to trading partners and with regard to commodities, in part precisely because transport costs are falling. Regarding composition of trading partners, I've seen a calculation by Michael Ferrantino that the distance of trading partners weighted by how much trade we undertake with trading partners has increased over time. We trade at a greater distance on average now than we did in the past. Regarding the composition of commodities, in the 1950's no one would have dreamed of trading certain products. Some specific examples in the agricultural area would be fresh strawberries or cut flowers. But now they are traded. Declining transport costs allow you to trade at a greater distance in different commodities. The cif margin reflects declining transport costs, but it also is going to reflect a shift in composition toward trading partners that are farther away and toward commodities that previously would have been more expensive to trade in. So, the first way in which doing business at a distance costs money is the obvious one: physical transport costs, whether the goods go by sea, land, or air.

The second factor that raises the cost of doing business at a distance is the time elapsed in transportation. Transportation time has three components: interest rate charges, perishability, and the loss from adapting to changing conditions. We've all heard about the importance of just-in-time inventory methods, which have had a huge effect on the level of inventories that firms have to hold. Inventories of raw materials, intermediate products, and final products have all hit historic lows in recent years because of an innovation copied from Japan and some good use of information technology. But the just-in-time method depends on a pretty short lag. If you have to wait three months for product to be shipped across the ocean, then you can't do just-in-time inventory management.

The third factor that raises the cost of doing business at a distance is a little more general; it is cultural unfamiliarity. It makes a big difference if you are doing business with a culture that you understand and are close to. That is in turn correlated with past immigration between the countries and whether you speak a common language. And it is correlated with distance. I'm taking these three categories from Linnemann who wrote in the 1960's. He called this third category, psychic distance. Drysdale and Garnaut in Australia call it subjective resistance to trade as opposed to objective resistance, which are the physical costs.
These are the ways in which distance comes in and has an effect.

Transportation Neglected by International Trade Economists

Why do we care about this? Why should geography be part of trade? It is quite remarkable that most textbooks and most models have almost completely neglected the role of transport costs, distance, and geography. Generally, I imagine when I tell somebody outside of economics that I study international trade, they think that geography must be an important part of that. But it isn't. (Actually, it's even more striking for people who study geography and have a hard time explaining to their families that their work doesn't actually involve knowing where countries are located.) I think it should be. The role of geography has been especially absent from international trade theory since theorists weren't trying to explain bilateral trade: who trades, how much, or with what other country. The big questions that trade theorists have tried to explain for 200 years are: what is the commodity composition of our exports, what is the commodity composition of our imports? How much do we trade, not who do we trade with. That's true of Ricardo and comparative advantage. It's true of the Heckscher-Ohlin-Samuelson model of factor content.

The idea is the product you're producing is a perfect substitute for everything else that's in that category, regardless of whether you are producing the good or not. You may want to think of trade in terms of countries or empirical models, but the idea was there's a world rice market and all rice is the same. If you produce rice and export rice, you dump it into the world pool of rice. And if you buy rice, import rice, you take some rice out and you don't look to see whether this grain of rice came from the United States, from California, or Thailand, or anywhere else. It's all the same. So if you're not trying to explain the bilateral pattern of trade, then I guess it is understandable that you wouldn't look at the role of geography. But I think it is of theoretical interest and certainly when you get to the empirical models it is of interest. Not withstanding some work over the years on this side, the majority of empirical work also has left out geography. Countries are disembodied entities that have no actual location and physical space.

It's interesting to ask why this has been happened. Paul Krugman has an explanation; it's the old phenomenon of looking for your lost quarter under the lamppost because that's where the light is bright, even though you lost the quarter the next block over. We didn't really have the tools until recently to model bilateral trade. The most relevant model is trade with imperfect substitutes and increasing returns to scale in order to get a determinate and interesting solution. And I think that probably is part of it. On the empirical side, computers that made it possible to run regressions on large data sets are another reason why this has become more popular.

By the way, just parenthetically, the imperfect substitutes assumption, according to the conventional wisdom, is only applicable to trade in manufactured products among industrialized countries and, supposedly, is less relevant to trade in agriculture and to trade with developing countries. That is the conventional wisdom, though I am not sure I buy it. In fact, California rice is an imperfect substitute for Thai rice, as any Japanese consumer will tell you. Similarly, for wheat and a lot of other products, you do not have perfect substitutes. Empirical evidence suggests that the model is as relevant for developing countries as it is for industrialized countries.

Let me give you five reasons why we should care about geography, why we should put distance and other geographical characteristics into our models and why we should care about the bilateral

pattern of trade at all. Let me first mention a false reason, which is not on my list. That is bilateral trade balances. In Washington, we have no choice but to talk about this a lot because people, and Congress talk about it a lot. What is the bilateral U.S. surplus or deficit with Japan or Mexico or anybody else, in particular products? I am sure you are all familiar with the economists' argument that, for most purposes, it is not wise to focus on bilateral balances. People who focus on bilateral balances implicitly assume that they should be balanced somehow. This neglects the principle of comparative advantage, that you want to run a surplus with certain trade partners and in certain products that you're good at producing. The money you earn from those products allows you to run a bilateral deficit with other trading partners or in other commodities. There is no reason why the bilateral balances should balance.

Here are four reasons why we should care about the geographical pattern of trade, one each for policymakers, producers, theorists, and econometricians. Why should policymakers care? Notwithstanding what I just said about bilateral trade imbalances, thinking of the trade policy questions that I've worked on in my two-and-a-half years at CEA, although some of them are multilateral–WTO, GATT issues–I would say more than half are not. More than half of the issues are in some way bilateral or regional, particularly regional trading arrangements (RTAs). RTAs experienced a revival that is correlated with the revival of geography and distance in bilateral trade that started in the 1960's. The same thing happened with regional trading arrangements, free trade areas, and other preferential trading arrangements. They were tried in the 1960's and didn't work that well for the most part, with the single exception of the European Economic Community, and then they were revived in the 1980's and especially the early 1990's. That's how I got into this subject, the geographical dimension, analyzing for regional trading blocks.

Why should producers care? I think that is pretty clear. Producers would have a hard time understanding or believing that economists ever neglected this dimension. If you're a producer, you want to know where your markets are, what markets are going to be expanding in the future, and, in particular, where you should invest your energies in developing a market. Just to give one example, after the fall of the Berlin Wall, we had a number of countries going from near autarky to a state of being just like other countries–transitioning to full integration with the West. If you'd wanted to plan ahead 10 years in 1990, how much was Czechoslovakia going to be trading with the West? How much was Russia going to be trading with the West? You needed some model of bilateral trade and geography to answer that, to predict what would be the normal level of trade for those countries.

Why should geography be of interest to theorists and historians? One reason it should be of interest to theorists is that doing business at a distance creates a cost that helps explain a phenomenon that is pretty dominant in the world: agglomeration. Without increasing returns to scale, producers should be spread evenly if they want to be close to their consumers. But what we observe is that producers cluster in many fields. Famous examples are Silicon Valley and other electronics and high-tech clusters. Financial clusters are interesting because in financial markets, we think of transport costs as being zero, and yet face-to-face contact is important enough that you have big financial centers in New York, London, and Hong Kong, for example. To examine agglomeration, you need transport costs.

I mentioned historians; why should historians be interested? You have transport costs explaining agglomeration, and you have agglomeration explaining what we now call path-dependence. The fact that history matters. An example that Porter and Krugman use is the first carpet manufacturer in, I think, Dalton, Georgia. Or the beginnings of the high-tech firms in Silicon Valley. Initially, agglomeration is historical chance—one firm locates in a place, then a second firm chooses to locate there because the first firm is there because there are spillovers and benefits to being close by. Then time passes and you get a whole industry, a whole carpet industry in Dalton, Georgia, or a whole semiconductor industry in Silicon Valley.

Why should geography be of interest to econometricians? It is rare that we have enough data to answer a question reliably. Usually, standard errors are bigger than we want and significance levels are lower than we want. A bilateral data set offers a lot of data. If you have 100 countries, that's just 100 points. But if you look at bilateral data, that's 100 times 99 − 9,900. That's a huge number of observations, which provide answers to some questions with much greater confidence and accuracy than would be the case with a smaller data set. Certainly, you're going to be interested if you have to take into account geography or if you're interested in the question of the role of distance in transport costs. But even if you are interested in some other question—such as, "Is Japan abnormally closed?" or "What is the effect of a free trade area?" or "What is the normal level of trade between Czechoslovakia and the West?"—you are going to want to hold constant for distance and for other geographic factors. This is leading to the gravity model.

Applying the Gravity Model

To give the originators of the gravity model their due is a bit tricky. There is important work by Tinbergen and Linnemann in the early 1960's that, in some sense, is the modern foundation of the gravity model. But it goes back farther than that and I've found references in the urban and regional geographic literature going back to 1946. I've gotten into the habit of saying there's always going to be somebody earlier. So let's take Sir Isaac Newton as the original citation for the gravity model.

We are trying to explain bilateral trade. How much would we expect Country I and Country J to trade? The analogy to Newton's gravitation is a good one. Newton's theory of gravitation is that the attraction between two heavenly bodies is proportionate to the product of the mass and is inversely related to the distance between them. Analogously, the gravity model of trade says that trade between Country I and Country J is proportionate to some measure of the product of the size of the two countries and is inversely related to some measure of the distance between them. In the case of size, that is where you need the models of imperfect substitutes. Or you don't need them--actually Alan Deardorf has shown that you can also do it in a Heckscher-Ohlin model. But we didn't really feel comfortable with theoretical foundations for the gravity model until we had gotten them naturally from model-traded imperfect substitutes. To put it very simply, the question is how much does the United States trade with Belgium versus Great Britain. Great Britain is twice as big as Belgium: it produces more varieties of goods and consumers everywhere have taste for variety. They care not just about the quantity of the good consumed, but the number of different varieties that they consume. You are going to trade more with a country that produces

more varieties, all other things being equal. So that predicts that you will trade more with a larger country than with a smaller country. Now regardless of what you think about that particular set of theoretical foundations, this is a very strong empirical irregularity. And as soon as you stop and think about it, it just has to be true.

If you sit down and write a model to try to predict trade with Luxembourg versus trade with Japan and you don't have size in there, if you do it solely based on factor content, you are going to get a pretty foolish result. You are not going to predict that trade with Japan is much bigger than trade with Luxembourg. And the case for the gravity model all along, by the way, has been that it does fit the data very well. The empirical case was there before the theoretical case.

There are three different possible measures of size. One is GDP, another is population, and another is land area. They all matter.

The other set of variables concerns distance. We've already discussed how distance creates costs for doing business. Not just the physical shipping costs, but the other ones that I mentioned. The effect of cost is immediate. It is like a tariff–it raises the price. Of course, it's going to reduce consumption and that's easy to model. If people hadn't put distance in before, it's only because they hadn't tried. It wasn't that there was anything difficult about it. The results I am going to refer to, unless I say otherwise, measure distance in kilometers between the capitals of the two countries. There are other measures of "distance" as well. Recall what I said about psychic distance or cultural unfamiliarity. You'd also want to include other geographic measures and also social and political measures: the extent of links between Country I and Country J, such as a common language. The results I'm going to cite are mainly from the work I've done with Shang-Jin Wei that's summarized in *Regional Trading Blocks* on a sample of 64 countries, which works out to 1,953 pairs of countries. I'm also going to draw on work by other people using the gravity model, because a lot of people out there are doing interesting things.

In a moment, I'll give you the results for the coefficient on distance, which is relatively robust across different data sets and different authors. We found that putting distance in log form seems to be the best simple functional form. And it is consistent, by the way, with something we found when we looked at the cif margins and tried to relate them to distance. There is a relationship between a cif margin and distance. Not as tight as you might think, but there is a relationship and it seems to be less than proportionate. That is not too surprising. There is a certain cost just to loading the goods onto the ship. Then once they are on the ship, the additional cost for going a greater distance is not fully proportionate. So maybe that is part of the reason why the log seems to do better than the actual level of distance.

The coefficient on the log of distance, to explain the log of bilateral trade, is around -0.75**.** That says if you increase the distance between Country I and Country J by 1 percent, then trade between them falls by 0.75 percent. That is, if you don't have a common border. One of the variables that has turned out to be the most important and that I always try to put in is a dummy variable representing when two countries are adjacent, when they share a common border. It is always very significant statistically. The effect is estimated at 82 percent; two countries that share a common border, even holding constant for distance, trade 82 percent more with each other then

they would otherwise. So Canada and the U.S. trade a lot with each other as compared with, let's say, The Netherlands and France, or France and the UK, or Korea and Japan, which are close together geographically, but don't share a common border. If you hold constant for that, then the effect of distance falls a little. Instead of -0.75, it's roughly -0.6. If you increase the distance between two countries by 1 percent, trade between them falls by about six-tenths of a percent.

I've tried putting in a dummy variable for whether a country is landlocked. It tends to reduce trade with all its partners by about one-third. Some people have tried measures for island countries as well.

There are a number of reasons to think that the distance measure is not capturing just physical transport costs, but also some other factors I mentioned as well. In particular, there are reasons for thinking the distance measure doesn't just cover ocean shipping costs. First, there are a few papers by Wang and Winters, who have separated out distance by land from distance by sea. When they calculate distance by sea, they actually figure out the route from one port to another, going around the Cape of Good Hope or Cape Horn, and, also, they add on the land distance from the center of the country to the port. I'm very glad that they did that. It turns out not to make much difference. There is not that much difference between land and sea costs per mile and it doesn't change the coefficient very much on overall distance or other results. That is one hint that we are not just talking about sea distance. Second, there was an interesting experiment—in 1967 the Suez Canal was closed for eight years. Not as an experiment for econometricians, but for political reasons. It had a major effect on trade, in that ships had to go the long way around. So it's a nice experiment. A paper by Bikker examines what effect that had on trade during that period within the gravity model. He found that it did have a significant effect. Two countries that previously would have most naturally traded through the Suez Canal now saw a reduction in trade. But the effect was only about one-fifth of what one would have expected based on the additional distance for going around Africa. That illustrates a couple of things, one of which is that not all trade goes by ocean, by ship.

Parenthetically, another reason why this experiment was significant is that it gave rise to an innovation in transportation: the land bridge idea. Goods from East Asia shipping from Singapore to New York or even to Europe, previously would have gone through the Suez Canal. With the Canal closed, some of them went across the United States in containers transferred by rail from the West Coast to the East Coast for their final destination, transferring again to ocean shipping to Europe. This worked out to be quite speedy and has become a permanent innovation that has been tried in other parts of the world. Maybe that's part of the reason why closing the Suez Canal didn't have quite as much effect on trade as you might have expected. But the other reason, I think, is that the cost of doing business at a distance is not just the physical shipping costs, it includes the other cultural familiarity factors that I mentioned before.

Let me turn briefly to disaggregated data. Most of what I've done with the gravity model, and most of what other people have done, is trade in all commodities aggregated. But I have tried breaking it down into agricultural commodities versus other raw materials versus manufactures, and there are other people who have carried that further. The statistic is that now 8 percent of goods trade is agricultural, which is one-fifth the level of 100 years ago. A finding that might surprise you is that when you do this disaggregation, the results are pretty similar, but the distance coefficient is actually higher for manufactured than for agricultural products. I think I would have guessed that transportation costs are more important for agricultural products because they are bulkier. And that may be true, but the coefficient on the longer distance is, if anything, higher for manufactured than for agricultural products. I'll say a bit more about that in a minute.

A related paradox is the fourth on my list of reasons that show we're not just talking about physical transport costs. Even more surprising is that the coefficient on distance does not decline over time. I think before I started doing this, I would have thought that we would see very tangible evidence of technological progress and innovation in the transportation industry showing up as the coefficient distance becoming less and less important over time. But it's not the case at all. My data set runs from 1965 through the mid-1990's. There is no tendency at all for the coefficient on distance to decline during that period. Other people have gone back to the 1950's. The coefficient is no higher in the 1950's than it is now. There are some papers in the 1920's and 1930's. Barry Eichengreen has done it; the distance coefficient is again about the same. One fellow has done a gravity model in the 1860's and the coefficient was again no higher than it is now. What's the explanation for this? Of course, it's true that transport costs have been declining, but they've been declining at every distance. The costs of transporting to Mexico have been declining at the same time that the cost of transporting to Pakistan has been declining, maybe for different reasons–trucking in one case and air and ocean shipping in the other case. But the transportation costs have declined at every distance. The cross-country coefficient on the distance in my gravity model is simply the effect of an increase in distance. What is the additional effect of going from Mexico? If you used to be trading with Mexico and now you're going to start trading with Pakistan, the question is what effect that increase in distance has, not the absolute level. So I think that is the explanation for why the coefficient on distance doesn't decline over time. It sounds like a technical point, but there is some real significance there. It says that geography is as important as it ever was. The difference between trading with Mexico and trading with Pakistan is as significant today as it was 30 years ago.

This is particularly relevant for regional trading arrangements and the concept that it may be natural to form a free trade area with your neighbors, with countries that you trade with naturally, because of low physical transport costs, rather than trading with them because of tariff preferences themselves. This is an issue of trade diversion versus trade creation, which are handy terms, but often hard to quantify and parameterize. The notion of natural trading blocks holds that a country that is in geographic proximity to you is a natural partner. Forming a free trade area with it is relatively more likely to be trade-creating than trade-diverting.

The last of the variables I want to talk about is the effect of the social and political links, getting at this idea of cultural familiarity. We tried a dummy variable representing when Country I and

Country J speak the same language or had colonial links in the past. There is a very high correlation between those two variables, so we just put them together–linguistic links or a history of colonial links. The effect on trade is about a half. Two countries that speak the same language trade about 50 percent more with each other, again holding constant for size and distance and borders and all the rest of it, compared with another pair. That tends not to vary much across languages.

The colonial links are interesting. Here's a trivia question. What is the Congo's biggest trading partner? If size were important, you'd think it would be the United States. Size is important and the United States is pretty high on the list, but it is not number one. If distance were important, which it is, you'd think that it would be Zambia or Rwanda or a neighboring country, but it's not. It is Belgium, showing how long-lived the relationship with the colonial powers is. One gravity study by a fellow named Kleiman found that colonial links in 1960, just on the eve of independence for most of these countries, resulted in trade being two to four times greater. It has declined since then, but as of 1960, France and a French colony, for example, would trade two to four times more than France and a British colony located side by side in Africa.

What about the effects of regional trading arrangements? That varies. We found that the formation of the EC raised trade among European countries by about 65 percent. Other estimates you'll see are much higher, but that is because they tend not to hold constant for the distance and the common border and common languages. Once you hold constant for all those things, you only get up to about 65 percent and even that doesn't really kick in until the 1970's. Some other free trade areas, customs unions, have bigger effects. Mercosur and the Andean Pact, which carved up South America, have quite large effects. They promote trade by a factor of about two-and-a-half among their partners.

Let's talk about even tighter links. What about a political union? How much difference does it make if two provinces form a federation if they are literally a member of the same country, as opposed to being provinces, as opposed to being two different countries. It makes quite a difference and there are different ways of seeing this. It is hard to get the data set, but for Canada, there are data on provincial trade. Some papers by Helliwell and McCallum look at trade among Canadian provinces and between Canadian provinces and U.S. states. Correcting for proximity, distance, and the rest of it, two Canadian provinces trade 20 times more with each other than they do with a U.S. state. That is astounding, considering that we think that if there is any border in the world that has essentially vanished, it is the border between Canada and the United States–common language, common culture. This was before the free trade era. NAFTA has brought this number down some, but it is still pretty high. It is also reminiscent of a finding of Engel and Rogers. I mentioned that Engels and Rogers were the ones who had the data set on price differentials between pairs of cities in Canada and the United States and showed that if you increase the distance between two cities, the variability of relative prices goes up because arbitrage holds less well. The law of one price holds less well. They also asked the question: how much difference does it make if you have two Canadian cities trading with each other, versus a Canadian city and a U.S. city, holding constant for distance? They found that it makes a huge difference to cross the border.

Does anybody want to make a guess how many miles, in effect, it adds to the transport costs to cross the border? They conducted a poll, and people way underestimated it. The answer is 2,500 miles. If you have a pair of cities–Windsor, Ontario, and Detroit–they trade as much with each other as Windsor and Vancouver, assuming that that distance is 2,500 miles. So that's a huge effect. It implies there are all kinds of factors that we don't talk about. The common legal system, common system of communications, of advertising networks, whether people can take their health plans with them when they move. And if you think about it, when you go to Canada, there are many brand names there that aren't here. Even with our closest neighbor, there is a tendency to do business within the country, rather than across the border. One factor that is clearly relevant is the exchange rate between the Canadian dollar and the U.S. dollar, which has long been variable and contributes to deviations from the law of one price.

Another way of getting at the effect of political union is to take historical examples where federations break up into separate units or come together. Sometimes there are data on this. As I said, there isn't data in general for trade among U.S. states or French provinces. But we looked at the case of the Austro-Hungarian Empire before and after its breakup. It looks like the existence of the Austro-Hungarian Empire increased trade by roughly eight-fold among the members while it existed. At the other end is German reunification. When I did this, I only had data through 1994, only four years after the fall of the Berlin Wall. But already in that span, trade between East Germany and West Germany was promoted by a factor of four. These are high numbers. Being in a common political union has more effect than a customs union or most of the other kind of factors that I mentioned. This is quite relevant for predicting, for example, what is going to happen to intra-European trade if the EU indeed progresses from customs union to full political union.

A final way of getting at this point–and again, getting at the point that we don't live in a borderless world–is simply to look at the ratio of trade to GDP, the statistic I mentioned at the outset, which has reached 9 percent for the United States. Look at that for a lot of different countries and ask, "Why is it that countries tend to trade with themselves more than with each other?" It is true for every country. A paper by Shang-Jin Wei finds that if the producer and the consumer are located in the same national political unit, it increases trade by a factor up to 10. If you then hold lots of things constant, including adjacency and common language, it still has the effect of doubling trade. The lesson is the same as the lesson I started with, that geography is still very important. We're still very far from a borderless world. Even though the trend has clearly been in the direction of integration, we still have a long way to go.

Conclusion

Let me conclude with one thought on policy, and I hope then we have a couple of minutes for questions. I've been speaking as if transport costs are exogenous. And in most of my econometrics, I treat them that way. But the point I want to make is one that Bob Thompson makes: they are not always exogenous. It is not just the state of technology that determines transport costs, it's also whether the transportation industry is organized competitively. It happens that the shipping industry, ocean shipping especially, but also air and to some extent trucking, is one of the least competitive sectors around: more highly regulated, more highly

protected than your average good or service. My recommendation is that this should be a priority for policymakers. This means investing in infrastructure and also trying to increase competition and deregulating some of these highly cartelized sectors. In the case of air, the Clinton administration has a number of open skies agreements to its credit that reduce the cost of air transport between countries. But nobody has been able to make much progress or as much progress on shipping, though we have made a little progress on port services in Japan.

The point is that there is a double payoff. Where any sector is as cartelized, as imperfectly competitive, as protected as shipping is, there is a high return to trying to liberalize that sector. But in these sectors, liberalization has a double payoff because in addition to reducing costs in the sector itself, transportation is an input into international trade. And we all know that there are big gains from international trade. So you have a double payoff; one by saving expenses in that sector per se and the other by promoting trade, making it possible for countries to specialize and do what they do best and reaping the full gains from trade.

MR. ARMBRUSTER: What effect will increasing transnational ownership have on Chrysler, for example? I saw something yesterday saying that a lot fewer U.S. citizens own Chryslers. That could be explained by a lot of institutional factors, but with the increasing ownership across borders and the increasing flow of information via the Internet, how much will that reduce cultural unfamiliarity and will it make a difference in how we negotiate trade?

MR. FRANKEL: The role of the multinational corporation is tremendously important. We hear about conflicting cultures and that makes it more difficult to integrate different firms. It is as important here as elsewhere not to overestimate the extent to which this has happened. Most companies are still based in a given country and when there are these international alliances or takeovers, it's far from a frictionless thing and you can tell the difference in cultures. Nevertheless, it's a very major phenomenon. A huge fraction of trade internationally is from an affiliate of one firm to another. It is a way of reducing transaction costs and this is an important component of the general phenomenon of integration if we reduce transport costs. Particularly in what is sometimes called slicing up the value-added chain. A huge amount of trade, particularly within Asia, for example, consists of intermediate products at various stages of production going back and forth. You produce a raw material in one country, you ship it to another country for processing, you ship it to a third country for some more value added and maybe back to the original one. And so by the time the final product arrives in the hands of the consumers, it has had contributions of value added from lots of countries and a lot of that takes place within firms that probably would not be happening if multinational companies did not exist to reduce transaction costs.

MR. PICK: As a person who put forth a proposal to use gravity models in agriculture, I opened myself to much criticism on the theoretical foundation of the gravity model. How do you handle that?

MR. FRANKEL: Now or at some particular date in the past?

MR. PICK: No, a proposal to the NRI grants. Hopefully, we plan on doing it in the near future.

MR. FRANKEL: When I started working on this, which was about 1991, I had to spend a lot of time (in print or in seminars) apologizing for using the gravity model. Saying, "Yes, I know, it doesn't have very good theoretical foundations, but the defense is that it holds up well empirically." I don't feel I have to do that anymore, in part because it now has good theoretical foundations. My view was that, in the past, nobody had even tried to model bilateral trade. As Alan Deardorf now says, as soon as you sit down and try to model bilateral trade between countries, you're going to end up with something like the gravity model. Fortunately, people have now done it. So I hope the gravity model can now hold its head up proudly and that it doesn't have to apologize for its existence.

MS. DIAO: Okay, so what we learned today is distance still matters in international trade. But in the meantime, you mentioned that the coefficient for distance has been pretty constant over 30, 40, even 50 years. However, trade has grown more rapidly than GDP in the last 20 to 30 years and, hence, the trade share of GDP has increased. I'd like to know how you explain this growth in trade by distance, or how we can use the gravity model to explain the dynamics of trade?

MR. FRANKEL: Looking for evidence of reduced transport costs in the coefficient on distance declining over time is the wrong place to look. Initially, I thought that would be the place to look. Once you think about it more, you realize that's not where it belongs; it belongs in the constant term. We've got this data set of 1,953 pairs of countries and if you want to look at the declining effect of transport costs over time, it's that the constant term in that equation in the 1990's is higher than it was in the 1980's, which is higher than it was in the 1970's. Trade has been increasing over time. Now, unfortunately, you can't separate out how much of that effect is declining transport costs versus declining trade barriers. Presumably, it's both. I indicated before that in the inter-war period, you presumably had technological progress continuity. But you had such a big increase in trade barriers that the constant term fell, the ratio of trade to GDP in every country decreased. In the post-war period we had the two working together again; separating out the two is sort of difficult. I suppose you could get direct measures of tariffs, but the problem is so much of the action has been with nontariff barriers that it is hard to capture.

MR. VOLLRATH: Recently, I took a look at what Linnemann had done and he has three versions of the gravity model: the basic model and the more complete models. And the one that he clearly prefers has a variable related to the commodity composition of trade. I was wondering why you hadn't included that variable in your models, especially in view of the fact, as you pointed out, transportation costs vary so widely across commodities. I also was wondering, how, in your view, the gravity model might be more completely, more fully specified in other ways.

MR. FRANKEL: So what is the commodity composition variable? Remind me, you're not just talking about doing it on the disaggregated data?

MR. VOLLRATH: He has a series of what countries export and what they import, and then he looks at the vector or correlation, basically, between what an exporter exports and what an importer imports.

MR. FRANKEL: The gravity model as I've done it, and as most other people have done it, in a sense goes to the opposite extreme from traditional trade theory by not disaggregating. Traditional trade models look only at trying to predict what goods you import and export and not at all who you trade with. Most of my work has been aggregated and so you don't look at all at what the commodity composition is, you look only at who one trades with. Obviously, the complete general equilibrium model would include both. That is beyond my model and capabilities, but is probably something I would encourage others to do. The gravity model is very stylized. You could start relaxing some of the assumptions of how shares enter. It is quite striking. I've made attempts to disaggregate a bit or to put in factor endowment to try to capture the Heckscher-Ohlin effects. (You would think two countries having very different capital endowment labor ratios should trade more. Doing the bilateral version of that theory is tricky, but the intuition seems to be pretty clear.) The results are very uneven. I've tried putting in relative price terms as well. It didn't work well and that's what most other people have found. So I encourage people to try to do the more disaggregated and more complete version, but it's tough going. It's something you want to do when you're trying to answer a question that requires that level of disaggregation.

MR. WANG: You mentioned that the distance elasticity estimation has not changed much over this century. Is it possible to provide another explanation? For example, most of the information is in the aggregate level. And, as you say, you have a variable transport cost because the transportation costs can vary very significantly across sectors. For example, for the computer chip, basically you see the transportation cost is a very small percent of the product value. But for some perishable goods, for example fresh fruits, ocean transportation costs may be 30 percent or 40 percent of the product value. So, basically, for the computer chip, there is no effect. But perhaps there is an effect for other products. In ERS, we are conducting a study in which we disaggregated food and agricultural products into 110 groups. With our aggregate data, we also found that the distance elasticity doesn't change. But, when it is broken down into more specific categories and products, we found some evidence that the elasticity declined over time.

MR. FRANKEL: My answer to the previous question was incomplete. Theoretically, these coefficients differ across commodities. Clearly the distance coefficient differs across commodities and maybe some of the others do as well. Theoretically, the correct thing to do is to estimate on a disaggregated basis. If the coefficients do differ across commodities and you mistakenly estimate in aggregate form, then you'll get the wrong answers. I should have said that right off. My own personal view as an econometrician is there are some benefits from aggregation, some of the measurement error washes out. It's heresy to say it, but sometimes I think I have more faith in the aggregated estimates than the disaggregated ones. But you have to be aware of aggregation bias. And it is certainly desirable to disaggregate, not just because you're interested in the individual commodities, but also to get a better estimate, provided you don't put too much emphasis on individual estimates that may be exposed to estimation error.

MR. ZAHNISER: I work here at ERS, too. Given the importance of distance and all its manifestations as an obstacle to international trade, to what extent do you think that public resources should be diverted from reducing certain barriers to trade like tariffs and quotas and nontariff barriers? Diverting them from those efforts to reducing other sorts of distance-related

barriers to trade.

MR.FRANKEL: How do you see those as substitutes? Why is it one or the other?

MR. ZAHNISER: Well, I don't see them as one or the other, but as a budgeting question, if you have a finite set of resources that can be put in this effort or that effort or that effort. And if distance is perhaps more important than people have been thinking previously, then people should remarshall, redirect resources from one effort to another.

MR. FRANKEL: One of the reasons why I concluded with a pitch for liberalizing the shipping sector is that unlike infrastructure, which costs real money, this saves money. Governments currently protect their shipping cartels, their shipping lines. From an economic viewpoint, liberalization would actually save money if they had the political will to do it. Now, if I were still in the administration, I couldn't say what I have already said, I suppose. Political forces, such as the merchant marine, are fairly irresistible in any administration. But as economists, we have to recognize the costs. So I would think that it would be good to have that as a priority.

MR. ZAHNISER: So you wouldn't see any sort of need to reallocate resources. Sort of just focus on this one issue, but leave the other set of commitments the same?

MR. FRANKEL: I'd have to hear that question raised in a more specific context, maybe we can talk afterwards. Let me just say, I'm very pleased to hear how many of you are working on the role of transport costs already. Obviously, that's the point of the conference. But I do encourage you and I think that the gravity model and other aspects of geography are now fully respectable. I've tried to do my part to make it so. In any case, there's a tremendous amount of information there, a lot to be learned. That's the justification, and I'm glad you're doing it.