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United States  
Department of  
Agriculture



Economic  
Research  
Service

Miscellaneous  
Publication  
Number 1566

# Technological Changes in the Transportation Sector – Effects on U.S. Food and Agricultural Trade

## A Proceedings

William Coyle  
Nicole Ballenger



**Technological Changes in the Transportation Sector—Effects on U.S. Food and Agricultural Trade: A Proceedings.** William Coyle and Nicole Ballenger, editors. U.S. Department of Agriculture, Economic Research Service, Market and Trade Economics Division. Miscellaneous Publication No. 1566.

## **Abstract**

ERS sponsored a workshop, *Technological and Structural Change in the Transportation Sector: Effects on U.S. Food and Agricultural Trade*, March 17-18, 1999, in Washington, DC. The program's objectives were to raise awareness within ERS about the role and importance of transportation in U.S. food and agricultural trade and to discuss the need of an agency research agenda in this area. More than 60 people attended. Bob Thompson of the World Bank and Jeffrey Frankel of the Brookings Institution led with discussions about the role of transportation in the global food system and the importance of integrating geography and transportation in analysis of international trade. Other panels dealt with transportation technology, past and future, the changing policy environment for ocean shipping, logistical and technological developments aiding exports of specific commodities, including the use of supply chain management. Representatives of the Agricultural Marketing Service discussed the availability of transportation cost data, and the availability of other shipping data was discussed by representatives of the PIERS database, a product of the *Journal of Commerce*. Two ERS research projects were summarized, one using GTAP and another applying the gravity model to estimate the extent to which distance is less of an inhibiting factor in exporting certain U.S. agricultural exports. The administrator of the Agricultural Marketing Service, the ERS associate administrator, and representatives of the Transportation Research Board, the USDA's World Board, and the Farm Foundation discussed potential ways ERS could include the transportation variable in its research. The program was cosponsored by the Farm Foundation and World Perspectives, Inc.

**Keywords:** Transportation, distance, technology, agricultural trade, United States.

## **Acknowledgments**

The authors thank Praveen Dixit and Kitty Smith for their support of the workshop from which this proceedings was developed. They also thank the Farm Foundation and World Perspectives, Inc., for their financial support, Bob Donegan and Florence Brandstetter for administrative support, RCI Sound Systems for taping the program, and EEI Communications for producing the transcript. Anne Kelleher and J.B. McCraw provided exceptional editorial assistance.

1800 M Street, NW  
Washington, DC 20036-5831

September 2000

## Foreword

Transportation has always been important in agricultural trade, as reflected in the *1940 Yearbook of Agriculture*: "Transportation, whether provided by commercial agencies or by the farmer himself, is a vital necessity to the economic functioning of agriculture."

Income growth overseas and accompanying changes in food preferences and diets are most often cited as drivers behind the unmistakable, more than decade-long shift in U.S. agricultural exports from bulk commodities (e.g., wheat and soybeans) to nonbulk items (e.g., meats and fruit). While income growth and some policy measures to liberalize trade are key determinants in the rise of perishable shipments, advances in transportation technology and logistics are equally important. For U.S. agriculture to benefit from growing overseas demand for, say, fresh fruits and vegetables, shippers must be able to deliver them to purchasers thousands of miles away with no substantial loss in freshness and quality.

Perishable agricultural products, many of which U.S. farmers could only have dreamed of selling abroad just 10 years ago, now account for about 20 percent – a growing share of total U.S. food and agricultural exports. Moreover, the cost of transporting perishable products is, in many cases, substantially more than for bulk commodities: 5 to 10 percent of the free on board (fob) value of grain versus over 30 percent for important horticultural products such as citrus and frozen potatoes. In part due to declining transportation costs and new technologies for handling and extending shelf life, perishable products are a rising component of trade in food and agricultural products.

The dynamic growth in perishable products trade and the role of technology in lowering the costs for shipping and handling time-sensitive products motivated the ERS-sponsored workshop, *Technological Changes in the Transportation Sector – Effects on U.S. Food and Agricultural Trade*, held March 17-18, 1999. More than 60 people attended the one-and-a-half day program. The presentations covered a variety of subjects, including the incorporation of transportation and geography into international trade analysis; innovations in technology, past and future; the impact of changing U.S. maritime policy; and technological and logistical developments in exporting New Zealand dairy products and Sunkist citrus.

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# **Technological and Structural Change in the Transportation Sector: Effects on U.S. Food and Agricultural Trade**

**U.S. Department of Agriculture, Economic Research Service**  
**Waugh Auditorium**  
1800 M St., NW  
Washington, DC

**March 17, 1999**

**Welcome:** Nicole Ballenger, Acting Director, Market and Trade Economics Division (MTED), ERS

**Context and Objectives:** Bill Coyle, ERS

**The Role of Transportation in the Global Food System:** Robert Thompson, The World Bank

## **SESSION 1: Integrating Transportation and Geography into Trade Analysis**

Introduction: Praveen Dixit, Chief, Asia-Western Hemisphere Branch, MTED

Jeffrey Frankel, Brookings Institution

## **SESSION 2: Innovations in Shipping Food Products, Past and Future**

Chair: Jim Caron, Agricultural Marketing Service (AMS)

Brian McGregor, AMS

Bill Hall, Seaport Consultants

Dick Parry, Agricultural Research Service (ARS)

## **SESSION 3: Policies in the Shipping Sector**

Chair: Shirley Pryor, ERS

Bob Blair, Federal Maritime Commission

## **SESSION 4: Technological and Logistical Developments in Shipping: Case Studies**

Chair: Robert Tse, Foreign Agricultural Service (FAS)

Beef, Bill Hahn, ERS

Citrus, Mike Wootton, Sunkist

Dairy Products, William Bailey, Massey University, Palmerston North, New Zealand

**March 18, 1999**

**SESSION 5: Data Issues and Preliminary ERS Research**

Chair: Bill Coyle, ERS

**Data Issues:**

Heidi Reichert, AMS

Fred Cannone, *Journal of Commerce*

**Preliminary Research:**

*Incorporating Transportation Costs into International Trade Models: Theory and Applications*,  
Mark Gehlhar and Madeleine Gauthier, ERS

*The Impact of Distance on U.S. Food and Agricultural Exports*, Zhi Wang, Mark Gehlhar, and  
Bill Coyle, ERS

**WRAP-UP SESSION**

**Panel: A Research Agenda for ERS**

Chair: Walter Armbruster, Farm Foundation

Kelley White, Associate Administrator, ERS

Enrique Figueroa, Administrator, AMS

Shayle Shagam, World Board, USDA

Joedy Cambridge, Transportation Research Board

# **The Role of Transportation in the Global Food System**

**Robert Thompson, World Bank**

## **Transportation and Geography Rediscovered**

I'm really delighted to see the general economics profession rediscovering the importance of transportation costs and geography in international trade considerations. The agricultural economics profession in the 1960's and into the 1970's did an awful lot of spatial equilibrium modeling. And, of course, the cost of transportation was one of the most fundamental variables in any spatial equilibrium model. Some of you may be familiar with a survey of world trade modeling I did that came out as an ERS bulletin in 1982 or 1983, which had a whole section on spatial equilibrium models and spatial models.

## **Transportation Costs Are Like Tariffs**

Let me just mention one important equation: *price in the exporting country multiplied by the exchange rate, plus the transportation cost times one, plus the tariff rate, equals price in the importing country*. In trade, we always talk about the possibility of having prohibitive tariffs and what an impediment the tariff wedge can be to international trade. But if you look at this equation, the transportation cost is just as significant as the import tariff so that high transportation costs can work against trade flows in exactly the same way as high tariffs. Anything that brings down transportation costs, whether it's technological change or structural change in the industry, can reduce the wedge between the price in the exporting country and the price in the importing country. Lowered transportation costs can have as positive an effect on promoting international trade as a reduction in tariffs negotiated over years and years in subsequent rounds of international trade negotiations in the GATT or the WTO.

The study of transportation and transportation costs was in vogue back in the 1960s and 1970s, but later we in the agricultural economics profession tended to forget about transportation and focus much more on trade policy. Trade policy was somehow sexier and more exciting. (Maybe because it's easier to get trips to Geneva if you're working on tariff rates than if you're working on transportation costs.) But transportation has always been an important variable and it's important that it is coming back into vogue. Transportation is also coming back into vogue in the international development community. Public works projects, particularly road construction, were important in foreign aid programs in the 1960s into the 1970s, but infrastructure projects also went out of vogue in the foreign aid business in the 1970s and only very recently have come back into vogue.

## **The World Bank's Interests in Infrastructure and Transportation**

I've been asked to make a few comments on what the World Bank is doing in this area right now. I can speak with the authority of eight months at the World Bank, but I think I have picked up some sense of the changes that Mr. Wolfensohn is bringing since he came to the Bank. One of the important things that he has caused the Bank to do is carefully review the appropriate role of government in the process of development. And, also, how we might change the public/private



balance in investments in developing countries, particularly investments in things that once were the domain of the public sector.

In particular, Mr. Wolfensohn has focused our attention on making poverty reduction the most important mission of the World Bank. Poverty reduction is front and center in the bank's current mission statement. Around the world today, about 1.2 billion people live on incomes of less than \$1 per day per capita. About 70 percent of these people live in rural areas that are generally not integrated into either their national economies or into the international economy. And, as Wolfensohn has focused our attention on the poor and where they are, it's drawing into bold perspective the importance of investments, both public and private, in facilitating economic development in those rural areas.

### **Public and Private Roles in Investing in Infrastructure and Human Capital**

As we've gone through the process of redefining the Bank's role, one of the things that Mr. Wolfensohn has asked us to focus very carefully on is being sure that the Bank is not supporting activities that could be much more efficiently undertaken by the private sector. In particular, we need to focus on creating jobs and income streams, which are the fundamental forces for reducing poverty in low-income countries, both through public investments and by creating an environment conducive to successful economic development.

And as we've focused on those important public investments, two areas that jump to the forefront are infrastructure and human capital formation. Infrastructure includes roads, ports, telecommunications, and rural electrification. Obviously, some infrastructure can be built by the private sector, but some will have to remain the responsibility of the public sector. In urban areas in developing countries, significant progress has been made in the last 20 years in inducing the private sector to participate in infrastructure investments programs, such as build-operate-transfer (BOT) systems. Another example is collecting tolls to pay for interstate highways or expressways around cities. But the further you get from cities into areas where the population density is smaller and where the density of economic activity is lower, much larger inducements will be required from the public sector to get the private sector involved.

Historically, most rural roads have been a public sector responsibility. But in rural electrification and telecommunications, obviously, the private sector plays an important role. Of course, there too, it may take some public sector inducement to get the private sector involved. So we're looking for creative ways to induce the private sector to invest in rural roads and in telecommunications, as well as in electrification. Investments in rural roads are key, because we've got to get transportation costs down in rural areas.

We're finding that in many parts of the world, in Africa in particular but not only in Africa, there are much better agricultural technologies available than have been adopted. These technologies haven't been adopted because they don't pay off for farmers. The cost of transporting fertilizer to farms is prohibitively high. The cost of moving products from the farm to the cities is prohibitively high, and there is simply no net profit left for a farmer who adopts new technology. These farmers need improved transportation to bring down costs before they can adopt improved technologies

and before rural economies can be integrated into national economies. Then, not only will these rural communities begin contributing to the GDP, but they will also enjoy lower rates of poverty.

In addition to infrastructure investments, public sector investments are needed in schools, in health care, and in safe drinking water to improve human capital.

And, finally, the third role of government is to provide the enabling public policy environment, including:

- ❑ A commercial code that defines the rules of the road for a functioning market economy.
- ❑ A legal structure that defines property rights, particularly in land and intellectual property, and that permits those property rights to be registered, transferred, or pledged as collateral.
- ❑ Honest weights and measures.
- ❑ The other public policies needed for a functioning market economy.

After securing the necessary infrastructure, human capital, and public policy, the best thing for the government to do is get out of the way and let the private sector function. That is generally the philosophy that Mr. Wolfensohn is promoting within the Bank.

### **Decentralizing the Bank's Operations**

Mr. Wolfensohn is also working to decentralize the bank's operations and move more of its human and financial resources out to the countries where we work. The Bank should then be able to play a more effective catalytic role than it has historically when it lent to governments substantially in support of public sector activities that could have been much more efficiently carried out by the private sector. In a nutshell, that's the changing perspective at the World Bank.

We're putting a lot higher priority on investments in world infrastructure, both directly through governments as well as in public/private partnerships to get the private sector to do as much as possible. The governments of developing countries certainly don't have the resources to build all the necessary infrastructure or to build it as fast as it's needed. Once you've induced the private sector to do as much as possible, the public sector can fill in.

### **Pacific Food Outlook: Emphasis on Infrastructure**

Finally, I would like to mention a project that Bill Coyle and I are involved in together, along with Carole Brookins, CEO of World Perspectives, Inc., one of our sponsors today. It's the *Pacific Food Outlook*, which is an activity of the Pacific Economic Cooperation Council (PECC). For the first two issues of this publication, I've had the privilege of chairing the forecaster's group, which has brought together forecasters from all 21 or so of the Pacific Rim countries that are members of APEC. I'm pretty proud of the job the forecasters have done in putting together this document.

But more importantly, I want to point out the emphasis this project is placing on infrastructure. In the 1998-99 issue, there was an introductory section on the importance of rural infrastructure to

the functioning of the global food system. This year's *Pacific Food Outlook*, which will be released this fall in Auckland at the time of the APEC heads-of-state meeting, includes a more explicit, fuller treatment of infrastructure and the extent to which it either impedes or facilitates the functioning of the Pacific food system. This is not just production agriculture, but the whole food system from production through processing to the consumer, whether that consumer is within the country or in other parts of the Pacific Rim. I think it's going to make a major contribution to the literature. We're going to be meeting in Tokyo with the authors of this year's *Pacific Food Outlook* in about three weeks and then through the summer the report will be finalized and come out in the fall. So look forward to the release of the 1999-2000 *Pacific Food Outlook*.

Again, thanks a lot for inviting me to open this session and make some prefatory comments.

# **Integrating Transportation and Geography into Trade Analysis**

**Jeffrey Frankel, The Brookings Institution**

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. Notwithstanding 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 than

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 remarshal, 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.

## **Innovations in Shipping Food Products, Past and Future**

**Brian McGregor, Agricultural Marketing Service**

Wherever we are transporting product, we want to deliver it in good condition. And the principles for doing that have been around for decades: maintain temperature using the latest packaging and other recommendations to get the product from one point to another in good condition. Of course, the overriding objectives are to maintain quality, reduce handling, reduce time in transit, increase utilization of the refrigerated transport equipment because of the high capital costs, and keep overall costs to a minimum. If we did all these things, we'd probably put a lot of farmers out of business, as well as some people in other parts of the cold chain. So we know that this perfect world could never be, but it's still a goal that should be worked toward. Things can go wrong at many stages in the cold chain. Here's what was happening in Tokyo back in 1987: the containers were opened right on the dock and exposed to the elements while the inspectors looked over the citrus. Now, this is done in a controlled refrigerated environment.

You can go to any market in the United States or any other part of the world and see high-quality products brought in and then subjected to temperature abuse or you can see poor-quality products that have had the added expense of transportation and packaging, and you wonder why the product was shipped that way and why is it being presented that way. And the fact is, with economics, you can work on the margins. It's certainly not a goal. Every perishable product, whether it's a fruit, vegetable or meat, ice cream, or whatever has a recommended temperature and a practical storage life. The goal is to get the product to the correct temperature as soon as possible after it is harvested or produced and maintain it there.

With all the recent food safety scares, I maintain that food has become a relatively low-risk product. One potential benefit from all this focus on food safety may be big improvements in the cold chain. This is certainly happening in Europe. Another long-term goal has been reducing the number and sizes of boxes. This is something ARS worked on back in the 1970's with fresh fruits and vegetables and there is still a lot of work to be done. Another area with a lot of problems is transport equipment quality and maintenance. You can go anywhere and find poorly maintained, poorly sanitized equipment. This may change with the increased emphasis on food safety. When making decisions about the cold chain, as I learned from my first boss at USDA, you've got to consider the whole system, not just the transport vehicle or the package or the product, but all the things that make it possible to get a product safely from one point to another.

An essential issue in shipping is proper documentation. A lot of products are destroyed due to delays in documentation or improper documentation, so we have a lot of challenges. We do a lot of field packing, a lot of shed packing, and of course, good packing requires good training and good technology to reduce the number of times a product is handled. One extreme example is the company Del Agro in Bogotá, Colombia, which was way ahead of the food safety curve back in 1990 using hospital conditions for packing raspberries. And they took enormous care harvesting the raspberries under plastic. These people were serious. Of course berries are very susceptible to microorganisms, Guatemala suffered a lot with this, and Del Agro wanted to do everything possible to protect their market in Europe and make sure the berries arrived in good condition.

While all packaging is subject to abuse, poorly designed packaging suffers the most. We still have lots of problems where the packaging doesn't match the pallet size, and you quickly lose the strength of the box. Also, when you cross-stack you lose strength. These are mistakes that continue to be made every day throughout the world. Hopefully, with digital imaging cameras, we'll be able to get more feedback through the Internet about how an exported product looks to receivers and buyers when it reaches the other end.

We still have to take individual products and mix them together, and there's a whole science concerning what products can be put together without causing damage. Here's another instance where we could benefit from reducing the number of different packaging sizes and trying to come to some standardization. Then we have the consumer pack issue, which has really undergone a revolution, especially with the advent of fresh-cut salads. The plastics and other materials create an internal atmosphere that gives the product a longer shelf life.

When I was in Japan in 1987, cherries were transported by sea on an experimental basis. But to my knowledge, the majority of cherries still go by air. So even though things are technically feasible, other factors are involved, such as the back-haul capacity of air freighters or the fact that the shipper and receiver are comfortable paying the extra air transport costs to receive the cherries quickly. Of course the packaging has to be designed for the product, such as using a special machine to inject broccoli with ice. Wax, of course, is on the way out because of the concern about recycling and is being replaced by plastic coatings. There's also a package design called iceless broccoli, where a plastic film is put inside the fiberboard to provide a controlled or modified atmosphere. Then maintaining the proper temperature becomes paramount. Broccoli gives off a lot of heat and needs a high-humidity environment, otherwise the product can be damaged and lose shelf life rapidly. And a lot of frozen product is moved. For example, slipsheets of frozen french fries are transported by rail.

Slipsheets are a technology that never took off, however, because of the need for specialized handling equipment at both origin and destination. Although large-volume shippers have the necessary equipment, slipsheets never cut into the wood pallet market very much. Without the necessary equipment, you had to take the load apart box by box and put it on the pallet. And each product has an ideal method of cooling after harvest.

Another example of new technology is vacuum-cooling lettuce. It's still hard for me to understand that after you put the lettuce in the machine and the water boils off the lettuce isn't cooked. It's because lettuce, like most produce, has a very high moisture content. Hardy products that may not need to be cooled as fast are room-cooled. And that's another cost that's factored in. But my experience is that a lot of people take shortcuts in cooling and never get the product to the recommended temperature. Therefore, the product is loaded into a vehicle at a warmer-than-ideal temperature and most refrigerated transport vehicles are not designed to bring down temperature, just to maintain it.

ARS and the National Bureau of Standards helped the trucking industry come up with a system of testing trucks for insulation and refrigeration capacity. That takes us into the 1960's when the container revolution occurred, and then Sea-Land Service. Malcolm McLean, the so-called father

of containerization, and his employees worked with the ARS on the recommended temperatures for ocean transport. ARS had been doing research for decades on recommended temperatures for various products.

In the United States, trucking is still one of the weak links in the transportation system because it's a fragmented industry. Truckers are forced to hire people to help unload the trucks. They are forced to wait with little or no compensation for unloading. The ideal, of course, is the palletized system of handling, with theoretically less damage to the product. And, of course, there are jokes about how containerization of trucking has minimized pilferage. In many countries today, whole containers or trailers are hijacked. This is a big problem in Mexico where two-and-a-half trailers a day are stolen. Some of the hijackings are inside jobs; some are done by criminal syndicates. So the industry in Mexico is having to make a big investment in background checks of employees and in various technical devices to keep track of its containers and trailers.

Modified atmosphere for strawberries, for example, is another packing innovation. Bags are wrapped around the pallets and a higher level of carbon dioxide is put in. Keeping the product away from the walls where they can absorb heat is another recommended loading practice, using either vinyl or kraft air bags. Highway trailers generally have a top air-delivery system so you need good air circulation around the load. In ocean shipping, air is typically delivered from below. So in a maritime application, you want to cover all the remaining floor space to try to force the air up through the load.

The modified/controlled atmosphere work was done in the 1950's and I'm sure ARS was involved. Whirlpool Corporation held some of the patents on the modified/controlled atmosphere. They were looking at higher tech refrigerators. That's one interesting thing about the technology that is becoming popular today: the research was done decades ago. Basically, ocean shipping is now dominated by refrigerated containers with the built-in unit on top powered by electricity and sometimes with built-in fuel tanks and generator sets. Alternatively, palletized units are loaded as many as four to eight pallets at a time into a refrigerated vessel, or a clip-on refrigeration system is used in which the containers have two large holes in the top and bottom where they plug into the ship's air supply. On land, the containers need a complete refrigeration and generator set bolted on for land travel whereas the refrigerated containers only need to bolt on a generator set or put it underneath the chassis to provide the electricity for refrigeration. And the problem you'll find in port areas, including the United States, is the attitude: "We're pretty close to a destination. We're not going to fool with a gen set." And the insulation on these containers is not that good, especially during summer or the cold of winter. So that's a problem that needs to be managed.

Container operators have invested quite a bit in new technology. Of course, Sea-Land was the leader and they provided a great labor pool for the other shipping lines, like American President Lines. But in the United States, Sea-Land and American President Lines used ARS data to develop their own booklets and guidelines about how to load their equipment. They invested in test shipments. They provided a lot of funds toward research at the University of California at Davis to develop better equipment and come up with better recommendations.

Most containers today are capable of providing a controlled atmosphere. The Transfresh system is basically a little computer that is inserted above the fan and helps adjust the air composition inside the container during transit. A vent allows air exchange because some products give off ethylene, which, if not vented, can cause premature ripening or excessive ripening of the product in transit.

Sea-Land now has a container that adds humidity. While we've known for years, that most products would benefit from constant humidity levels of between 90-98 percent, in reality, refrigeration withdraws humidity from the air, just like a home air conditioning system. So Sea-Land and others have introduced a water source in their systems to increase humidity levels.

I don't know what's happened with rail. Having worked with a railroad company, I'm always saddened that the railroads more or less haven't aggressively pursued getting back market share from the trucking companies. Probably because they feel it's a hassle and not worth it. The same could be said for a lot of the airlines. So we have a dwindling supply of box cars. Most were built in the 1970's and only Tropicana, which has a closed system for shipping juices and concentrates, has invested in new cars. Union Pacific has an experimental fleet of 50 cars and Burlington Northern (BN) has also experimented with a few cars. But basically, they've allowed the number of cars to go from about 12,000 in the late 1970's to about 5,000 or 6,000 cars today. Box cars are primarily used for frozen food, hardy products like apples, some citrus, and potatoes. Without the proper equipment, cars have to be unloaded box by box, and you end up with some damage.

It was Sea-Land and APL, not the railroads, that really pushed double-stacked containers. Railroads were too conservative, so ocean shipping companies invested in flat cars. They more or less rented the use of the locomotives and the track. That has really taken off, but not refrigeration. That's been a disappointment, because we could sure use the extra highway capacity if more products could move by rail. But there's still a breakdown in service with the railroads. You still hear horror stories such as a boxcar of potatoes ending up in Florida when it's supposed to be in Chicago. So even though the railroads have been deregulated and consolidated, it seems their attitude towards customer service has not changed.

It's important throughout the whole transport process to keep good temperature records. And of course, I'm hoping the food safety scares encourage people to think more about proper cooling to the recommended temperature and maintaining that temperature. The larger companies, without government regulation, already require this because of their own concerns about customer satisfaction and, more importantly, liability. So I think we will see an increase in good temperature control and more control by electronic means versus intrusive means.

Time and temperature indicators have been around for 20 years, but the science of interpreting how much temperature abuse has occurred and how the product quality and safety have been impaired still needs to be developed. Of course we're not going to be able to keep each product at its ideal temperature throughout the wholesale/retail chain, so we have to compromise and at all times make sure that different products are compatible when they are stored together. For a short period, maybe a day or so, you don't have to be as concerned. But some products are sensitive to being too cold and can be just as easily damaged as if they were too hot.

In Europe, they actually regulate the temperatures of meat, poultry, fish, seafood, and frozen products during transport. There's been talk of doing this in the United States, but I just don't see it happening. What we may see in the States is regulation requiring proof of sanitation of the refrigerated vehicle. A law was passed in 1990 in reaction to back-hauling of trash, but no regulations have ever been developed for that.

Asparagus is a good example of the importance of transportation. The number of marketing days you get with asparagus depends on how close you get to the recommended temperature during transport: the range is from 4 to 17 days. It's amazing how often this is violated. If you go into Safeway or Giant or go to Jessup Wholesale Market here in Maryland, you'll see constant temperature abuse. Again, the manner in which the product is loaded and temperature control are key.

You have the same problems in air cargo. Most air cargo moves without refrigeration. Ideally, the product is cold when it gets to the airport and is kept in a small cold room at the terminal and quickly put into refrigeration afterwards. There are gel packs and other types of refrigeration, such as dry ice, but most product goes without refrigeration. In Europe, because of the greater food safety concerns there, they've done a lot with air shipping perishables to make sure the proper facilities are at the origin and destination.

Another big issue, of course, is recycling. Although we have sufficient landfill space in the United States, people don't like landfills, though they are probably one of the safer places to put things. Concern about landfills has led to a reduction in the amount of packaging used. That's still the key. We're doing a great job of recycling, but from an economic point of view, it's better to reduce the amount of packaging. Yet you still need to protect the product because inadequately protected product results in an environmental cost. There's a big debate now in the United States about whether to use plastic returnable crates, which of course have to be cleaned and sanitized and transported back. The effect on market share of using returnable plastic crates will be interesting. And, of course, with the plastic crates, you're going to lose the nice graphics. The debate is, who really sees the nice graphics? So we are slowly moving toward fewer pallets and less packaging.

The plastic crate picked by the industry is 600 millimeters by 400 millimeters. The size of the crate has to be standard for it to work. The same with the pallet. Fortunately, even though we've never adopted the metric system in the United States and probably never will, the 48- by 40-inch pallet that's widely used in the United States pretty much matches the 1,200- by 1,000-millimeter one used in Europe. The Europeans also like a smaller one (1,200 mm by 800 mm) for their smaller cold chain operations.

Some U.S. inspections now offer digital imaging services to the interested parties. As people get better feedback about what's happening to their product at the destination, it should push responsibility for the poor quality back down the chain.

We have a number of publications. Heidi Reichert has put two of our newer ones on the Internet: our *Agricultural Export Transportation Handbook* and also our *Freight Forwarder Directory*



(see [www.ams.usda.gov](http://www.ams.usda.gov)). *The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks* is the so-called bible of the USDA. This book has been put out for many decades by ARS, with recommended temperatures and handling for a variety of products. *Protecting Perishable Foods During Transport by Truck* is our popular trucking handbook. It 's now brown or purple in color. ThermoKing and Carrier use it to train their employees. A lot of trucking companies order copies of it. All of our handbooks have similar information written in different formats for slightly different audiences. Thank you.

### **William Hall, Seaport Consultants**

I would like to talk about the structure of the ocean shipping industry, the broad impact of technology on the industry in the past 30 years, and how future changes may affect U.S. shippers and ports. Also, since we are looking at ways of analyzing transportation activity in this seminar, I would like to share some personal experiences about how these structural changes in ocean shipping are affecting our ability to analyze the industry. The changes present a challenge to institutions such as USDA that want to analyze ocean shipping and its impact on U.S. producers and their foreign competitors.

Containers, for those who may be unfamiliar with them, are based on internationally standardized modules. They come in two sizes, basically, 8 feet by 8 feet by 20 feet and 8 feet by 8 feet by 40 feet. There's some variation, especially in U.S. domestic service, but for international service these two sizes predominate. Containers can be handled equally well on ships, road vehicles, and rail cars. They can be stacked one atop the other. The idea was to create a simple, rugged, standardized unit that expedites vehicle loading and unloading, one that can be transferred quickly from one mode of transportation to another, and one that permits high-density storage of cargo.

The standard unit of capacity measurement is a 20-foot module, the 8- by 8- by 20-foot module, which is known as a TEU, or a Twenty-foot Equivalent Unit. In the maritime press and elsewhere, you 'll see references to ship capacity in numbers of TEU. Ship capacities have been increasing steadily since the 1950's, starting at about 150 TEU and going up to 2,000- 3,000 TEU by about 1980. Today we're up to somewhere between 6,000 and 8,000 TEU, with really no end in sight.

The first impact of containerization and intermodal technology was to radically increase the speed and reliability of ocean service and thus to drastically increase the effective capacity of general cargo vessels. Imagine an old freighter--an old-style Marlon Brando *On The Waterfront* kind of ship--stuffed with barrels and boxes and crates and everything put together in a hold and extracted manually at the port of destination. That 's a system of transportation that 's like a moving van, something that we all have a lot of experience with in our lives. The moving van shows up in front of your house in the morning and you spend five hours loading it. You have to make sure that everything is secured and that the floor lamps don't fall over and that one thing doesn't crash into another. You put a great deal of time and energy into very carefully arranging items in a logical way.

So you spend five hours in the morning packing the van and then you spend about half an hour driving across town to your new house and another five hours in the afternoon unloading the

moving van. In a similar way, a conventional ship, an old-style break-bulk ship, would spend about a third of its operational life in a port, loading and unloading.

The first impact of containerization was to radically reduce the time spent working cargo on each end of the voyage. With standardized containers, it was simple to develop a system in which ships could be rapidly loaded and unloaded by large cranes. Since containers could be stacked and could easily fit on a truck chassis or rail car, loading and unloading became much more efficient. A vessel now spent about a tenth, rather than a third, of its operational life in port. Which means in practice that cargo moves between A and B much more reliably and quickly, despite the fact that the vessel isn't traveling any faster than its ancestor.

In fact, it might even be going slower. In the 1950's and 1960's, when you couldn't do very much about the technology on either end, the focus was on the speed of the transoceanic passage. Shippers would try to squeeze another extra two or three knots out of the vessel perhaps with a sophisticated, expensive turbine power plant. After containerization, the speed of the vessels became much less critical, since so much time was being saved in the ports, as well as in newly efficient inland connections. During the fuel crisis of the 1970's, container ships actually slowed down a little bit and today are frequently slower than the vessels of 20 or 30 years ago. But cargo moves across the ocean at much faster and more reliable transit times.

The versatility of the container, the fact that it can go from a ship to being towed behind a truck or to being loaded on a specialized rail car, has totally transformed the ways in which these firms see themselves. The industry progressed from one that focused solely on moving things by water to becoming an industry that focuses on the reliable movement of boxes around the world by any one of several modes. The industry is less about ocean shipping per se and more about being global movers of containers.

The invention of containerization coincided with the massive postwar expansion of Western economies, culminating with the Asian boom of the 1980's. This upsurge in activity allowed container companies to integrate into other complementary forms of transportation. Electronics from East Asia moving to a chain store in the U.S. Midwest, for example, could be tracked from the production line to the display shelf. All of this was made possible by the introduction of new electronic tracking and inventory management systems. Today, these firms have progressed one more step--not only do they consider themselves global movers of containers by various modes, but they also see themselves as inventory schedulers and managers, as extensions of the global production lines of their major customers.

Vessels keep getting larger. As they do, some interesting things may start to happen among ports and their associated trade routes. The largest container ships afloat now have a capacity of about 8,000 TEU, or the equivalent of 8,000 20-foot boxes. Naval architects are now seriously talking about even larger vessels. If this happens in a major way, some ports in North America would be clear winners and others would lose.

For example, a *megaship*, that is to say, a vessel of 12,000 to 15,000 TEU, now in the conceptual design stages, would draw about 50 feet of water. Suppose for the moment that these vessels

eventually become standard in the major U.S. trade lanes. Many ports in America simply couldn't accommodate such vessels, except at great expense. And ports are differently endowed through the vagaries of geography or geology. Gulfport, Mississippi, for example, has about 36 feet of draft. New Orleans has about 40 feet, with all that sediment coming down the Mississippi. The Seattle approach channel, on the other hand, was glacier-carved; it averages 175 feet. Halifax, Nova Scotia, averages about 60 feet, Baltimore and Hampton Roads average about 50 feet, while New York/New Jersey presently averages 40 to 45 feet.

Thus, some U.S. ports will have an easier time of it when accommodating megaships, with the consequent potential for some reshuffling of rank among various North American ports. This would be very similar to another change that happened 40 years ago during the advent of containerization. Some people could make it--some people couldn't make it. San Francisco decided it didn't have the room to pursue containerization. It became a tourist waterfront and gave all of its cargo up to Oakland. Manhattan decided that it couldn't do it and gave it all to New Jersey.

I hasten to add that *megaships* face quite a few hurdles. There is the enormous cost of modifying infrastructure--everything from piers to cranes and the inland infrastructure to handle the massive increases in road and rail traffic. Dredging a harbor, especially when contaminated sediment is present, is an enormously costly undertaking. So the widespread adoption of *megaships* may be a decade or two away. But, taking the longer view, the increase in vehicle size seems inexorable; it has been progressing on the ocean since the invention of steam navigation and shows little sign of reversing.

Container shipping also has a way of bringing new kinds of cargo into its orbit. In large part, it is due to the increases in vessel size and the need to keep them full in both directions. Remember that containers were originally designed to transport manufactured goods--Sony TV sets packed in cardboard boxes all moving in a steel container from Yokohama to Sears in Chicago. What can they carry back to Yokohama?

The answer is that cargoes that used to go by break-bulk ships or even specialty product tankers now increasingly travel by container. When I worked for Burlington Northern in the 1980's, we had quite a healthy trade in containerized auto parts from Japan going to the newly established Japanese assembly plants in places like Smyrna, Tennessee, and in Ohio, and so forth. And we would get trains of empty containers coming back. That lasted for about six months to a year. Then the containers going back to Japan started passing through Seattle full. They contained several commodities, but primarily eastern hardwood going back to Japan to be transformed into Yamaha pianos or furniture. Traditionally, such a commodity would have gone by rail or truck perhaps to Savannah or Charleston, and then have been put on a conventional ship that would have gone around the Gulf of Mexico and through the Panama Canal and out across the Pacific. Instead, because the Japanese established an assembly plant for automobiles in Tennessee, containerized Midwest hardwood started going through Seattle.

New container trade, in this case, auto parts, often will create commercial opportunities in its wake, like a new trade route for export hardwood, that are subtle and can be very difficult to

predict, but which are quite important. This movement of new commodities in container ships has some implications for U.S. agricultural trade. We have done vessel cost and container forecasts for various ports within the Pacific Basin and have also looked at the possible cargoes that could be carried in larger container ships--the *megaships*, if you will. These exercises have been very interesting. Once you get up past around 11,000 or 12,000 TEU, or about 25 to 30 percent larger than the largest ships afloat today, you can start moving grain in them, at least in some trades.

This is a very interesting development. Bear in mind that we are predicting the commercial behavior of ships that have not been fully designed in the theoretical trading environment of the future. But there's obviously something in the wind here that has potential implications for U.S. shippers and may indicate eventual new patterns of movement within the United States.

This ability of containers to attract new cargoes has implications for all sorts of trades--not only those capable of supporting megaships. In the developing world, where efficient conventional grain-handling infrastructure often doesn't exist, but where a reasonably efficient container terminal may be present, containerized intermodal movements may open up numerous possibilities.

Let me explain this latter point in more detail. Containerization allows ports throughout the developing world to leapfrog past a stage of older technology--rather like cell phones in the telecommunications market. Go to someplace like Jakarta and every other person has a cell phone growing out of his ear. Well, you see the same kind of thing in the ports of the developing world. Oftentimes a nation will have a small colonial port in one portion of the harbor, rather ramshackle, with antiquated technology and very low productivity. But on the other side of the harbor is a bustling container terminal that is bursting at the seams. This has considerable significance for how U.S. producers may move small consignments or food aid, for example, in the future. Again, going back to a port like Dar Es Salaam and looking at the total costs, would I automatically bring food aid to East Africa on pallets or in bags in a single large shipment aboard a break-bulk ship, with all of the attendant difficulties of storage and inland distribution? The alternative might be to bring it in containers on a scheduled service and deliver the aid directly to the point of consumption in much smaller shipments over a longer period of time. Ten years ago, before that container terminal existed, there would have been only one answer. Today, well, the answer is not quite so clear cut.

We have seen that ocean shipping technology has changed radically over the past 30 years. Cargo handling is more efficient, transit times are lower and more reliable, and there is a greater emphasis on managing the entire transport chain. Ports have changed, grown or fallen behind, trade patterns will continue to develop in new ways as a result of the new technology, and there are various implications for the developing world.

In addition, there have been and will continue to be fundamental institutional changes that have equally important effects. I am speaking of a continued tendency toward consolidation, rationalization of services, and oligopoly. This trend has a long history. When steamships were first introduced in the 19th century, suddenly you could predict how long it would take you to get between Southhampton and New York. And you knew what your annual capacity would be, in a

way that you didn't know in the days of sail. As steamship technology progressed, the danger of excess capacity grew. The introduction of compound steam engines in the mid-19th century meant that marine power plants could become smaller--in other words, that the cargo capacity of a given vessel could increase by perhaps 25 percent. And advances in metallurgy and engineering meant that hulls were getting larger all the time.

And all of this capacity was very capital intensive. And capacity, once created, is very difficult to reduce. Before World War I, the problem for the new steamship industry was how to control losses in a downturn and how to control the effects of predatory pricing by a player seeking a temporary advantage. The next logical step was to form shipping cartels to regulate capacity and to fix prices. These cartels existed from the advent of steam, through World War II, and beyond.

When containers were first adopted worldwide, one school of thought, especially in Britain, maintained that cartels would become more powerful than ever. Containerization would bring a new round of inevitable and massive capital commitments, creating high barriers to entry and vastly increased capacity that would lead to a repetition of the situation existing before World War I.

In fact, in the 1970's and 1980's, the traditional shipping cartels more or less fell apart. They are no longer very powerful at all for several reasons. The first thing that conventional wisdom overlooked was the rise of the Asian economies; the traditional European and other operators were undercut by low-cost Asian carriers in the 1970's and 1980's, and by the Russians and East Europeans with their highly subsidized shipping companies. These firms--because of cost structures or subsidies--could stand outside the cartel structure and still survive. The second thing that helped to break up the ocean cartels was deregulation of transport in the United States, which meant that much of the cartels' price-fixing activity became illegal in U.S. trade. Now, more than two decades later, we have a very different picture. I would argue, unlike what was said before, that despite the influence of national governments, which continues, and protectionist policies, which also continue, cartels don't amount to very much today.

I suppose the larger question is whether the earlier assessment was simply premature. You might say that the Asian boom of the 1970's and 1980's simply stalled the inevitable by injecting new entrants into the system. In reality, all of the fundamental factors that people worried about in the late 1950's and early 1960's are still with us--huge capital investments, high barriers to entry, and large capacity increases, with all of the consequent tendencies to ally, rationalize, and merge. Since the entry of the East Asians, it is not immediately clear who else is poised to create a large merchant fleet that could shake the system up once again. In fact, it is a closed club.

So today we see an incipient oligopoly in container shipping. The conventional wisdom is that, in a few years' time, the world will have maybe two European carriers, two Japanese carriers, one or two Chinese, perhaps a Korean, and a Taiwanese. And that's basically it. It will be rather like oil, or airline alliances--a small group of very large, global players.

One interesting thing about this list is that it doesn't have any Americans on it.

Sea-Land, a U.S. company founded by the inventor of containerization, Malcolm McLean, is still a presence, but we don't know what's going to happen to this company. It may fold into Maersk, a Danish firm with which it is tightly allied, in the way that American President Lines has folded into Neptune Orient, a Singaporean company. But in any event, it seems there will be no Americans on the list in a few years time (Maersk Line acquired the global shipping operation of Sea-Land Service, Inc. in July 1999).

All this raises many currently unanswerable questions about the effects of concentrated market power and the lack of American participation. How effective will the United States be in regulating a global industry in which it primarily participates only as a very large customer? This would seem to differ from the airline industry in which, Airbus notwithstanding, U.S. industry builds the vehicles, its businesses are among the major users of the vehicles, and where the U.S. government is the major regulator of industry activity. Other national and international aviation agencies follow its lead, especially in certain technical areas related to aircraft inspections and airworthiness, for example. In ocean container shipping, the structure of the industry is fundamentally different.

What happens to the smaller shipping lines, especially those created by developing nations? Do they become niche players? Or do they become subsidiaries in the way that today's commuter airlines are subsidiaries serving the hubs of major air carriers?

If a few seaports turn into hubs for *megacarriers* and their megaships, in the way that Atlanta and Dallas-Ft. Worth are airline hubs, what happens to the other, smaller ports? Do we reallocate public resources to build some ports at the expense of others? How will we decide how this is to be done?

In a deregulated oligopoly environment--again, think of the airlines--how will the smaller shipper fare? The one who has no corporate volume travel discount?

In summary, we have seen a continued tendency, stretching back over a century, for ocean shipping companies to collude in matters of pricing and capacity regulation. This collusion was spurred initially by the risk inherent in such heavy capital investment and by the excess capacity caused by technological advances in the early era of steam navigation. It has persisted for over a century, even though the old cartels weakened with the entry of the Asian newcomers in the 1980's. Given that entry costs are now so high, capacity so great, and consolidations and alliances seemingly will continue, what happens next?

There is another aspect we should mention, something subtle and less quantifiable, but important in the context of a workshop such as this. When a domestic industry loses a critical mass of talent and when decisionmakers congregate in other parts of the world, you have to work all that much harder to stay current when you want to analyze the industry.

The kind of analytical work that we do in the U.S. maritime consulting community, and to some extent in government, is now the kind of analysis done by a culture that's the passive recipient of the shipping services of others. How deeply should we dredge this channel? Does our port build

the Koreans a new terminal over here or over there? It's an infrastructure-oriented, consulting engineer's way of analyzing shipping. And we are rather good at it.

But U.S. consultants, as an industry, are not so good at other kinds of questions, questions that I think you folks would be very interested in answering, especially given that American agriculture faces some new competitive challenges overseas. Here are some examples of these kinds of questions: Will rates for soybeans between Brazil and Malaysia rise or fall next year? How will capacity increases in Chinese shipyards affect the secondhand price of grain ships and, consequently, impact future grain rates? These kinds of questions presuppose a different body of knowledge on the part of the person answering them--a greater knowledge of the industry itself, as opposed to knowledge of the physical aspects of the technology. And I would argue that this sort of public knowledge is becoming somewhat more difficult to come by as a result of the industry consolidating overseas.

As an aside, I want to relate some experiences I had in 1997 in East Africa that illustrate something about our collective position as a nation in this matter. I was doing a mining logistics job, looking at getting copper out of Central Africa. One of the ports that I had to study was Dar es Salaam and I ended up going to a steamship industry party. We were outside, in the middle of the rainy season, all sitting around in suits under a blue-and-white-striped party tent at the end of a warehouse in a sea of mud. And the conversation was very interesting. The group was largely Scandinavian, with some British, and a South African or two. The Danish guy told me about how his dad had worked for the same company, and how his grandfather had signed on back in the days of sail. And you had people from different companies who had spent their lives abroad and who had crossed paths elsewhere in the world. You know, "Remember when we were both in Chile back in the 1980's?" In that tent, I realized that this kind of pragmatic knowledge, that depth of global experience, combined with a training in which ocean transportation is still a subject of extensive academic analysis, is something that we as a culture no longer possess. When I go to the Propeller Club dinner in Seattle, the conversation is not the same as it was in that tent in Dar es Salaam.

Now, don't misunderstand me - there are some exceptionally bright people in the private sector in this country as well as in the government spending their lives analyzing the maritime business. At issue is more the climate in which this analysis is conducted. In the United States, ocean transportation analysis tends to be highly proprietary and narrowly focused--in the petroleum, agribusiness, or mining sectors, for example. In contrast, in the UK and elsewhere in Europe, they design and build the ships, finance the ships, insure them, and manage them. The industry is centered there, in other words, and there is a wider and deeper pool of publicly available maritime knowledge coupled with strong academic traditions in transportation economics and maritime business management. And its product is the bright fellows sitting in the tent in Dar es Salaam. So in the face of a consolidating industry that has largely left the United States, I would argue that any government institution, such as USDA, wanting to study ocean shipping must focus its analytical talent overseas. And this would seem doubly important in a climate of increased competition from foreign agricultural producers. You will somehow have to introduce yourself into the global nerve centers of the industry, perhaps stationing transport attachés in places like London and Tokyo and Singapore. That is another consequence of this fundamental industry

change.

The upshot is that we're seeing a massive consolidation of the industry. There will be larger, fewer players with their fingers in many pies, active in complementary modes of transportation, all over the globe. This is an industry that is very capital-intensive and where the barriers to entry seem to be getting higher; there are no new entrants in this game. And none of the players, the conventional wisdom goes, will be American in the next few years. And all of these things are probably of some importance.

Thanks very much for your time.

**Richard Parry, Agricultural Research Service**

It's a pleasure indeed for me to be with you today, especially as a biologist invited to speak with all of these noted economists. I would like to present an overview about the ARS research program and its impact on transportation technologies of the past, present, and the challenges of the future. The ARS has developed a very diverse research program with its \$8 million annual budget. Our customers include growers, processors, shippers, and several action agencies of the Federal Government, all of which identify specific problems requiring innovative solutions.

American agriculture has a long history of rapidly adapting to technology. The ARS technology that has been mentioned already by Brian McGregor is an indication of the ARS accomplishments that have significantly improved transportation efficiency. ARS does not identify transportation research as a separate program; there is no budget cross-cut specifically identifying this sector. However, many projects within the program portfolio affect the transportation industry. Measuring the economic impact of these improvements has not been successful.

The innovations in refrigeration engineering that occurred in the 1950's, 1960's, and 1970's have had a major impact on commodities traded today. This work led to the creation of the frozen foods industry. The flash freezing of meat and poultry products has significantly extended shelf life and enhanced food safety, making our products some of the safest in the world. Foam-mat drying of processed milk, fruits, and vegetables is another example, which has created new opportunities for the food industry and new challenges for movement of products nationally and internationally.

Controlling that process of ripening of fruits and vegetables extends shelf life and methods to limit food pathogens have increased the diversity and availability of products in retail markets. Also, controlled atmosphere storage and shipment of commodities such as Washington apples have expanded markets and created new technical challenges for the transportation industry. New technologies have also allowed the transportation unit to become part of the commodity quarantine treatments for citrus, and opened markets overseas for U.S. producers.

ARS research programs that will affect the transportation industry in the near term include:



- ❑ *Gene expression.* Extending the shelf life of commodities through control of gene expression will be possible as soon as the basic information about gene location and function is known. The mapping of the plant genome, once viewed as a long-term objective, is now on the horizon. The primitive plant *Arabidopsis* will be first, probably in 2000, followed soon thereafter by rice and other species. This information will rapidly be applied to fresh fruits and vegetables and would make it possible to turn genes that produce ethylene on and off. Changing ripening properties will result in major changes for product shipping standards.
- ❑ *Edible food films.* Using thin films to reduce spoilage and dehydration of fresh fruits and vegetables has become a common way of extending shelf life. Edible films will be the next advance in commodity treatments. Films are currently made from a variety of natural materials such as pectin and starches. Protein polymers are being developed to extend this practice, which may change shipping parameters for these commodities.
- ❑ *Food irradiation.* Research done over several decades may soon make irradiation an acceptable practice for reducing foodborne pathogens. Irradiation may be the method of choice for the fresh fruit and vegetable market, where pre-harvest contamination from the use of animal manure for fertilizer may occur. Maintaining food safety is absolutely essential to maintaining consumer confidence.
- ❑ *Product defect detection.* Using a variety of different biosensors in processing plants has been proven to be effective in reducing contaminants and enhancing quality, which reduces transportation losses. Also, using sensory panels to identify product quality characteristics in a variety of different commodities has enhanced the ARS variety development programs.
- ❑ *Contaminant sampling and testing.* Improved methods for sampling and testing for contaminants have permitted export of commodities to overseas markets with product quality requirements. Rapid testing for mycotoxins, pesticides, and other environmental contaminants are extremely important to meet international quality standards.

ARS is developing methods to eliminate food pathogens in production as well as post-harvest for meat and poultry products. Bulk commodity shipments are expected to continue to decrease while processed or partially processed food shipments are expected to increase.

Biotechnology is introducing a new era of crops designed for specific end uses, such as wheat products and animal feed from corn. One example is a new variety of feed designed to significantly reduce phosphorus in animal waste. Such improved varieties will only have market value when product identity is preserved, which changes bulk commodity transportation operations. Other genetically improved crops will also need to preserve product identity throughout the production, processing, and marketing channels. These new grains may lead to significant changes in the way grain is handled within the United States and when exported.

Transportation is an important factor within the agricultural system. The impacts of all the new technologies I have mentioned cannot be measured in aggregate economic transportation models. New technology has played and will continue to play an important role in diversifying agricultural

production and enhancing production efficiency. There is a need to measure this economic impact as an indicator of the public good that has come from this research effort.

## **Policies in the Shipping Sector**

### **Bob Blair, The Federal Maritime Commission**

The bulk of my comments today are going to be about international ocean shipping: industry organization--the cartels that Bill Hall talked a bit about and the emerging oligopolistic conditions--and the new legislative provisions of the Ocean Shipping Reform Act (OSRA). But before that, I'd like to make a couple of other points about shipping that might fit in with the economic research interests of this group.

First is the Jones Act. The Jones Act Coalition does have a wonderful website, and it is worth a visit. The man heading the coalition is a former FMC commissioner named Rob Quartel, for whom I used to write speeches. He's a very good speaker and he likes controversy. If you invite him to come talk about the Jones Act, I'm sure he'd be happy to.

The other topic is the national task force under the Department of Transportation that is currently assessing the capability of U.S. maritime transportation. I think it's looking mainly at seaports and at rail and road infrastructure, and how the infrastructures tie together. That is probably something of interest to all shippers, including agricultural shippers. You might want to see if you can get someone from the task force to come and talk about what they're looking at.

Now, on to international liner shipping.

What we're talking about, essentially, is regularly scheduled shipping service. The service tends to be weekly. As Bill Hall mentioned earlier, liner shipping is mainly the shipping of containers. Not only do these liners no longer see themselves in the "movement of goods" business, these days they also go beyond the "movement of containers" business to the "we provide transportation solutions" business. As Bill noted, the lines are involved with rail, involved with trucking, and at least the major carriers provide additional value-added services.

A point of terminology: "carriers" means the companies running the ships, and "shippers" means the firms that have cargo moving on the ships.

The carriers who have so far survived the winnowing-out process as their industry becomes increasingly concentrated see the movement of containers from port to port, or even from inland point to inland point, as almost a commodity business. From the shipper's perspective, one ship or one container is pretty much the same as the next. If the carrier is going to make any real money, it's got to provide additional benefits beyond simple transportation. And that's an important part of where international shipping is going.

The other important part, as Bill mentioned, is the cartels. Since the late-1800's, international liner shipping has been cartelized. That's what makes it a particularly interesting industry for economists. There are so few cartels operating in the United States that have antitrust immunity to collectively set prices. But the government allows cartels in liner shipping and has since 1916. When I talk about OSRA, I'll stress the point that, even under deregulation, the government

continues to grant antitrust immunity. So, the economic consequences of allowing carrier cartels is still a live policy issue.

When preparing my notes for this workshop, I asked myself, "If I were an agricultural economist, what would I want to know about international shipping (if anything)?"

First: I'd want to know about shipping cartels and their present incarnation. The traditional cartels are rapidly dying out. By "traditional" I mean the groups of carriers that formerly sold themselves as offering a premium level of service and jointly priced their services. In recent years, these groups have tended to have a collective market share of about 50 percent, but sometimes higher, in the U.S. trades in which they operate. They agree on the individual rates they offer and maintain a joint tariff listing the rates they are supposed to be charging. However, these traditional cartels are now passing from the scene. I don't expect the few that are still around to continue to operate beyond the next year or two. But there is a new creation, a new form of cartel, which I'll discuss in a few moments.

Second, as an agricultural economist, I'd want to know about key economic and technological trends--because this industry is strongly driven by technology and by economic conditions.

And, finally, I'd want to know about the recent policy changes in the Ocean Shipping Reform Act. OSRA officially goes into effect on May 1, 1999. But, as economists, you know that when people have information about future events, they begin acting on it well before these events occur. So, it's not incorrect to say that OSRA has been having an effect for well over a year now and perhaps longer than that in some respects.

Since I can't really present any of these topics in great depth in 30 minutes, I've decided as an alternative to present a brief outline of how cartels have changed over the last 20 years in relation to changes in public policy and technology. And I have broken that history into three eras to make it easier to comprehend.

From 1961 to 1984 (the year the first deregulatory act was passed), I'll call the Era of Red Tape. From 1984 to around 1997, I'll call the Era of Declining Cartels--because traditional cartels proved not to work well. And from 1997 onwards, I'll call the Service Contract Era. Obviously, it's hard to predict the essence of an era when you can't even predict how long it's going to last, but it is clear that the key element is going to be service contracting under the new contracting provisions of OSRA.

In 1961, Congress split the two major maritime functions, regulation and subsidization, between the Federal Maritime Commission, which got regulatory responsibility for overseeing the cartels, and the Maritime Administration, first a part of the Department of Commerce and later the Department of Transportation. Originally the two functions were in an organization called the Maritime Board, and you had the schizophrenic situation of trying to regulate an industry that you were also handing out subsidies to on the side. Maybe that's a familiar situation in agriculture, I'm not sure. But it didn't work for shipping. So the FMC became the regulatory body, and the Maritime Administration became the U.S.-flag promotional body.

The 1960's, for those of us who are old enough to remember it, was the "big is bad" era of regulation. And the Federal Maritime Commission, when it was set free to be the regulator, was encouraged by Congress to be an *active* regulator. In the 1960's and onward, when agreements to form cartels--and operational agreements, but I'll be talking strictly about cartel agreements--were filed with the FMC there was no deadline by which the FMC had to approve the agreement. In fact, the people setting up a cartel, or changing an already existing cartel, had to show there was a public necessity to do so. And then, of course, their carrier rivals and the shippers who would be most affected could come to the FMC and protest, demand public hearings and additional information. These agreement approval proceedings could run as long as two years.

Now, if it's going to take up to two years to get permission to do something, is it worth pursuing? That became a problem for the carriers beginning in 1966, because that's when containerization was introduced into the international trades. Containerization expanded through the late 1960's and into the mid-1970's. Bill talked earlier about how that affected the industry. Once you moved to a containerized system for cargo, the process was faster and more efficient. There was less damage to cargo, to go back to one of Brian McGregor's points, because there was less handling. You moved the full box directly onto the ship and onto the train. And there was less port labor needed to move boxes through a port rather than to load and unload individual pallets of goods.

Two things happened with the expansion of containerization: first, the per-unit cost to move goods was reduced. Second, the absolute cost for the new technologies, new ships, specialized equipment, port technologies, distribution technologies that went along with containerization went way up. So the capital costs of running a shipping line went up, but the lines could then offer the customer cheaper rates.

By the time you hit the mid-1970's, containerization was pretty much complete in the main East-West U.S. trades. But then the next feature of the 1970's appeared and Bill alluded to this, too, with the introduction of new shipping lines by Asian nations like Korea, Taiwan, and Singapore. These countries began new containerized shipping services. And it is important to understand the difference between the Asian view of international shipping and today's American view. The Asians consider shipping a strategic industry. Perhaps that's because many Asian nations have traditionally been more heavily export-oriented than we have, so their industries and their national economies are more dependent on liner shipping. The point is that many Asian nations view international shipping as a strategic industry and their national lines as a strategic asset to be supported. So when the new Asian carrier services entered the U.S. trades in the 1970's, they had governmental support. Sometimes they were owned or controlled by their governments. These new Asian lines introduced a whole new element of competition from the mid-to late-1970's onward.

So what was the state of the conference system at this point? Another point of terminology: "conference" is ocean shipping jargon for "cartel." I don't mind referring to them as cartels. Some cartels don't mind calling themselves cartels. But the traditional jargon, a nice euphemism, is conferences. The state of the system was somewhat chaotic, in part because there were so many

cartels operating in a given region. In the Pacific, for example, there were at least a dozen and possibly more individual cartels in the Pacific trades. There would be one from the West Coast to Korea, another from the West Coast to Taiwan, yet another from the Atlantic and Gulf Coasts-- via the Panama Canal--to Korea. And so forth.

The cartels were also experiencing trouble adjusting because of the inflexibility that existed under the then-current regulatory scheme. If the cartel wanted to make adjustments to its agreement, particularly with respect to intermodal shipping, it found that change was nearly impossible.

With the development and expansion of containerization, the ability to amend agreements to fit new business situations--especially when intermodal transportation ( the linkage of sea and land transportation) was involved--became increasingly important. Cartel members had traditionally priced together on the port-to-port movement of goods, but with containerization the game changed. The business was no longer port-to-port, but from one inland point (in Asia, for example) to an inland destination point (say, Chicago in the U.S. Midwest). If cartels were going to continue to function effectively, collective pricing was going to have to cover more than the ocean movement. It was going to have to cover the through service from one inland point to the other.

Not only were the lines having difficulty with the red tape of the regulatory process, but the Department of Justice was also beginning to raise the question of whether point-to-point collective pricing was an area requiring intervention by its Antitrust Division, and not simply an FMC issue.

That combination of inflexible regulation, potential Department of Justice intervention, and the increased competition from the new Asian lines--most of which declined to join the cartels-- created a difficult environment for the cartel lines. The carriers' solution was to go to Congress and propose new legislation that would modernize the regulatory scheme and give the cartels clear authority to collectively price the inland leg of their cargo shipments.

They began in 1978, and it took them until about mid-1983 to get the new legislation passed. Along the way, they had to do a lot of compromising with shipper interests to achieve their goals.

What the carriers got out of it was: (1) the end of the red tape in the agreement approval process, and (2) clear intermodal pricing authority. The new agreements establishing cartels were to be reviewed by the commission within 45 days, after which they went into effect automatically, or else the commission had to take the parties to court to show that the agreements were so egregious they should be halted. In any court case, the burden would be on the FMC to establish that the proposed cartel would have horrendous future economic consequences for the trade. The new shipping act also made clear that agreements with intermodal pricing authority were outside the scope of DOJ Antitrust Division oversight.

What did the carriers give up in the compromise leading to the Shipping Act of 1984? Two things. First, the act introduced contracting, in a limited way, as a new pricing process in ocean shipping. It may seem a little strange, but before 1984 there was no contracting between carriers and

shippers. Individual commodity rates were published in public tariffs, and even giant shippers like DuPont could not contract with their preferred carriers.

Along with contracting, the new act introduced (and here's another piece of jargon) "independent action" or IA on tariff rates. Independent action meant that a particular cartel member could, after a ten-day waiting period, offer a rate other than the previously agreed-upon rate published in the cartel's joint tariff--without the other cartel members having authority to take any adverse action against the member who took "independent action." Basically, members were allowed to cheat on their previous rate decisions, but they had to do so publicly. This introduced an element of potential internal competition among cartel members.

What happened to cartels when the Shipping Act of 1984 went into effect? Structurally, the number of cartels decreased, and the new cartels had vastly expanded geographic scope. Where there had been 12 or more cartels operating in the outbound Pacific trades before 1984, consolidation created a single cartel--the Transpacific Westbound Rate Agreement, or TWRA--covering movements from all points in the United States to all points in Asia. You've probably heard of this cartel because it affected U.S. agricultural exports to Asia. However, I don't expect it to exist much longer.

The new contracting provisions turned out to be relatively popular with shippers. For the first couple of years that the act was in effect, contracting was a bit of a trial-and-error learning experience. The carriers in TWRA, for example, signed a lot of contracts initially--many of them containing what were called "Crazy Eddie" clauses (which said, basically, that if the carrier offered anyone else moving that commodity a lower rate, the contracting shipper was entitled to the same lower rate). After a couple of years of this, TWRA members simply collectively agreed to stop offering contracts. And not until 1995 did TWRA lines offer much beyond two or three contracts to special shippers.

In most other trades, contracts were regulated rather than eliminated (TWRA was a unique case), and 50 to 60 percent of the volume moving in key trades moved under service contracts.

However, most of the new Asian carriers still did not join the cartels. Initially, there were two markets--a *premium market* for shippers with goods that needed especially high-quality, dependable, frequent service, and a *discount market* where the shippers' main concern was low price. The cartel carriers offered a dependable, well-established quality of service and tended to attract the premium-market customers. The Asian independent lines, which tended to price 10 to 15 percent below the cartel rate, could compete effectively in the discount market.

Over time the Asian lines improved. They adopted more modern technologies, their level of experience increased, and the transportation service that they offered became every bit as good as those offered by the premium lines. With this difference: the Asian lines tended to maintain the original 10 to 15 percent price differential. So, by the late 1980's and early 1990's, the cartel carriers discovered that they were losing market share to the Asian independent lines.

That loss of market share was a serious problem. There was now a single market and a standard

level of service, but the cartels commanded only about 50 percent market share in the various trades. With only half the market cartelized and half competing on price, it didn't take long to see that the cartels were becoming less and less effective.

At the same time, capital costs were increasing as the technologies became more sophisticated (and expensive), as carriers expanded their service networks to call on more ports, and as electronic tracking of goods became possible. And the industry concentration that began with containerization continued to grow. We'll talk more in a moment about where that's headed.

From an economist's point of view, the 1984 act had some very interesting features. One being that it mandated a 5-year study of changes in the industry. The FMC was to do the study, with a review of the results by the Department of Justice, Department of Transportation, and the Federal Trade Commission. After that, a Presidential Commission was to be formed, which would have a year to conduct public hearings on the issue of how the new act was working out and whether it needed any changes. Not a bad idea.

From the shippers' point of view, this was seen as a second chance to eliminate the carriers' antitrust immunity altogether, or failing that, at least an opportunity to expand the new contracting provision and remove contracting authority from the control of the cartels. Cartels, as the TWRA example I gave shows, had the authority to regulate their members' contracts.

In 1989, the FMC published its final report on the 5-year study. The report has lots of good data on rates and other contract-related issues. So if you get involved in researching, that study is worth looking at, especially if you like crunching numbers. The figures--originally covering the period from 1976 through 1988--have been updated to 1990, and are available on diskette from our office.

During 1991, the Advisory Commission on Conferences in Ocean Shipping, or ACCOS, held hearings and collected lots of additional information. They issued a report in April 1992, and for my money, that is the best single document that exists on shipping in the U.S. trades. The advisory committee got input from big shippers and carriers. FMC economists (but not me) and DOJ economists were involved in putting it together, and it contains their different perspectives. The final report contains all the industry and government body views, covers all the key issues, and provides a short but useful history of modern liner shipping. Whenever I run into someone who's new to the liner shipping industry, say a reporter who's been assigned to cover it, I give them a copy of the advisory commission report and say "If you want to learn about this industry quickly, start by reading this." Unfortunately, I've given away my last copy--but I'd certainly advise any new researcher studying this industry to begin with that report.

What shippers wanted to see, but ACCOS did not produce, were recommendations for changing the 1984 act. And that was pretty much a foregone conclusion since one-third of the advisory commission was carrier representatives, one-third was shipper representatives, and one-third was congressmen--a recipe for gridlock. But, from the carriers' perspective, the absence of any recommendations for legislative reform of the act was a major plus. The status quo was the best the carriers believed that they could achieve, and that's what they got. Shippers, however, were



very unhappy with the results.

Not only did ACCOS ' s early 1992 report offer no prospect for change, but the winter of 1992-93 saw the formation of a new liner conference that demonstrated real market power. The traditional conference carriers in the North Atlantic brought several formerly independent lines into the new conference--called the Trans-Atlantic Agreement, or TAA--by setting up a double-tiered rate system, high market share was achieved. And by establishing internal solidarity and a good information exchange process, after two years of very severe competitive discounting of rates, the new conference achieved a remarkable pricing turnaround. The first act of the new conference was to radically raise rates--and made the increase stick! That demonstration of effective collective pricing, following by only 9 months the disappointing ACCOS report, got groups like the National Industrial Transportation League working hard on a political effort to change the regulatory system.

Skipping ahead a bit, in mid-1997 a second really effective cartel was created. This new agreement was different from the traditional conference-style cartel. Like TAA, the new transpacific cartel--called the Transpacific Stabilization Agreement, or TSA--brought in several formerly independent lines. TSA set up an excellent internal information exchange process and got the members ' CEOs to exercise tighter control over their marketing divisions as they sold vessel space. Competitive discounting among TSA members was brought to a halt. So, by the end of 1997, there were two examples of very effective, nontraditional cartels--TAA and TSA.

Where are we today? OSRA has passed. It was the best deal that shippers were able to negotiate. Like the carriers in the years before 1984, shippers sought new legislation to get the changes they wanted in the 1984 act, but ended up having to compromise with the carriers, with U.S. ports, and with maritime labor. What the shippers got out of the bargain was a reduction in the cartels ' control over their members ' contracts. The cartels no longer have the authority to regulate their members ' contracts; the members can--and most are expected to--offer their customers individual contracts.

The shippers also got legal authority for confidential contracts, and contract rates are no longer publicly available. There are pluses and minuses to confidential contracting, which I ' ll discuss if we have time. However, the shippers who pressed for confidential contracting think that the new flexibility it introduces will allow them to form partnerships with their preferred carriers--breaking those carriers ' connections with the other cartel members. The shippers hope to be able to get customized service, to be able to exchange proprietary business information, and to develop real commercial partnerships. And that is a real possibility. I don ' t want to play that down.

But there is also a potentially anticompetitive side to the new legislation. It was, after all, a compromise. The carriers retained their antitrust immunity to agree on rates and on capacity levels--if they can. OSRA also allows carriers to establish what are called confidential "voluntary service contract guidelines." These guidelines have no mandatory requirements--cartels can ' t do anything to a member who doesn ' t want to abide by the voluntary guidelines--but carriers will have the opportunity to voluntarily agree, for example, to restrict the confidentiality of their contracts. They could, for example, agree that all member lines will adopt a common

confidentiality clause in their individual contracts that allows them to protect contract information from other shippers, but share rate information among themselves. That would allow them to prevent the general shipping public from knowing the rates being negotiated, but still exchange that information within the cartel so that they can continue to agree on, and support, collective pricing actions.

Carriers now have a model for effective cartels under OSRACTSA-style agreements. Known as "discussion agreements," or "stabilization agreements," this new form of cartel appears to be the wave of the future. These discussion agreements are specific to particular geographic regions. They agree on the common aggregate price increase they'll implement rather than on thousands of specific individual commodity rates--say an annual increase of \$300, or even \$1,000 per container. And some recent rumblings have suggested that some carrier groups are considering using their antitrust immunity to establish collective capacity management processes.

Such capacity management schemes could work in two ways: by actually removing vessels during periods in which the carriers judge that there is likely to be excess capacity, or by regulating the entry of new vessels into a trade. Capacity regulation could be achieved by the cartel members agreeing to share forecasts on future demand and information on each company's plans to bring additional capacity into the trade. If it looked like new capacity would exceed expected demand, individual member lines could agree to delay new entry in exchange for the allocation of additional space on another member's vessels. Instead of its members bringing in new ships right away, in anticipation of higher future demand, the cartel could encourage its members to allocate their available current capacity in a way that satisfied each carrier's short-term need for space. That would allow the group to slow the introduction of additional vessels--reducing the scope of any short-term excess capacity--or even to remove vessels if the demand for current capacity was judged to be insufficient. The possibility of that kind of collective rationalization of capacity exists under OSRA.

There's one other element of the current scene that is worth briefly mentioning because it may have a significant impact on liner shipping--the existence of multiple national regulatory authorities. Liner shipping is an international business. The Federal Maritime Commission is the regulatory authority for the United States. The European Union has its own competition authority--DG IV--that oversees the European trades, including the U.S.-to-Europe trades. And most interestingly, China is now in the process of establishing a national regulatory authority for the China-based trades.

Each of these organizations has its own separate perspective and style. DG IV, for example, tends to be relatively narrow and legalistic in its perspective and adopts a fairly confrontational style in its dealings with carrier cartels. Instead of viewing cartel operations as an economic or commercial issue, DG IV often seems to take the approach that clear legal limits exist with respect to cartel operations, and those legal limits are decisive (regardless of any arguments about economic efficiencies that may exist). DG IV seems to be trying to use a narrow interpretation of EU law to constrain cartel activities to the point that the sheer inflexibility will render liner cartels nearly useless to their members.

The FMC, in enforcing the 1984 act and now OSRA, has tended to favor flexibility in its interpretations of legitimate cartel authority--based on what the economic consequences of the cartels' activities may be. This approach seems to be to allow significant operational latitude, but balance that liberality with close monitoring (and attendant requirements for information on cartel activities) and occasional intimations of possible legal action to limit potential abuse.

China appears to be setting up a system--based, in part at least, on the old 1984 act model--under which carriers publish binding tariffs, and terms of service contracts are publicly available. It's as if China were saying: "We like the way that the FMC was operating before OSRA went into effect, and we're going to create a similar system of our own for the China trades."

How these various, and potentially discordant, regulatory approaches will interact is one of the questions that make these such interesting times to be engaged in research on liner shipping. Given the growing oligopoly effect, the development of new cartel structures, the introduction of more flexible contracting, and China's new regulatory ambitions, the next few years should prove fascinating. And given that possible complexity, liner shipping research may have to be conducted largely on a trade lane by trade lane basis.

That's a brief overview of where things stand today, and how we got here. If there are any questions, I'll try to answer them--always with the caveat that the answers will still be my own opinions, not the official views of the Federal Maritime Commission.

MS. BALLENGER: What can you tell us about the availability of shipping data?

MR. BLAIR: Getting good information has always been difficult. When the FMC undertook its 5-year study, the fact that Congress had mandated the study, and was looking at the possibility of changing the act, helped us get cooperation from both carriers and shippers. The rate study had to deal with a lot of technical problems. For example, there were many different publicly available rates for a given commodity. So it was difficult to know under which rates most of the cargo was moving. You could assume, and we did for awhile, that the majority of a given commodity moved under the lowest rate. But when you got to post-1983 period, the problem of service contracts arose. There would be a number of contracts in existence, and it was hard to know how much moved under each one. We needed a way to weigh the various contract rates to get an average rate for a commodity. We established various advisory groups to help us--a carrier group, a shipper group, a port authority group, etc. The advisory groups allowed us to get the information needed to work out the approximate average rates for the commodities and trades we were researching. But once the study was finished, and the advisory groups disbanded, the insider perspective was gone--and doing accurate rate studies became very difficult.

Today you'd have to go to the shippers to get the necessary information. A version of that approach was tried in the Ferguson study--but was not very well done in my opinion. With confidential contracting under OSRA, rate studies will be harder than ever. The confidential contracts are filed with the FMC, so we could do rate studies if there was an interest. The tariffs will still be out there, and many will now be individual lines' tariffs. But the expectation in the industry is that, after a year or two of transition, 90 percent of the cargo will be moving under

service contracts.

How confidential those contracts will be remains a key question. The term "confidential" wasn't defined in the legislation. Some shippers, if they have the power of a 3-M or DuPont, may be able to say to carriers, "If you want to carry my cargo in the multiple trade lanes I move goods in, you will share contract information with nobody--including your cartel partners." That might work for the biggest shippers. On the other hand, it's quite possible that the cartels will work out a system under which they will protect the contract information in Shipper X's contract from his competitor Shipper Y, but still share it with the other carriers. If so, the members of the cartel will know what rates are being charged by the other members for each commodity-type to each port or inland point, while the shippers with whom they negotiate would *not* have the same sort of information. And such asymmetry of information is likely to have economic consequences.

I don't expect that the lines will offer any of this rate information to outsiders interested in doing rate studies. Although I tend not to get involved in rate studies myself, there are some people in our bureau who do. So if you decide that's an area you want to pursue, please feel free to get in touch with us and we'll see if we can work out an arrangement that would be consistent with OSRA's confidentiality requirements on service contracts. As a personal opinion, it seems to me that access to the filed contract rates may be the only way to do an accurate rate survey without the assistance of the lines themselves.

Finally, I'd say that if this group is interested in studying the effect of liner shipping on agricultural exports, the most important element is going out and talking with the shippers, going out and talking with the carriers, going out and talking with those guys in Dar Es Salaam that Bill was talking about. That face-to-face contact with the players is the best way to find out what's going on in this industry. Reading the *Journal of Commerce* helps. And there are a couple of excellent monthly magazines. *Containerization International* is the best, and *American Shipper* is the next best, for keeping up with industry news. I recommend both of them. But nothing beats going out and talking to the people involved.

MS. PRYOR: What is the future of Sea-Land, the remaining U.S. shipping line?

MR. BLAIR: That may be a special case. I think everyone will be waiting with bated breath to see if the separation of Sea-Land Service into three parts--the very lucrative U.S.-flag-oriented Jones Act trade, the terminal business (which I hear is also a lucrative part of Sea-Land's operation), and Sea-Land, the international ocean carrier, is a prelude to the sale of the international carrier's assets.

APL, the other major U.S.-flag line, is now owned by Neptune Orient Lines of Singapore. And one of the very few other American lines, Lykes, was picked up by a Canadian carrier. It seems to me that the possibility exists--and I don't have any inside information on this, just the speculation I read in the paper--the possibility exists that Sea-Land's stand alone international carrier business could be bought by someone. Best guess is Sea-Land's alliance partner, Maersk.

Which raises a very interesting question. If there comes a time where there are no major U.S.

carriers left, would that change the general perspective on how international shipping policy is evaluated? From the maritime unions' point of view, perhaps not. But from other interested parties' institutional perspectives, maybe so.

## **Technological and Logistical Developments in Shipping: Case Studies—Shipping U.S. Beef to Japan**

**Bill Hahn, ERS**

One of the reasons that I've been asked to talk about beef today is that beef has been one of our agricultural export success stories. We've had substantial growth in both the volume and value of beef exports since the early 1980's. In the past couple of years, the value of beef exports has not grown and has even shrunk while the volume has kept going up. We've had some lower beef prices in the past several years, and that is an important reason why our beef export value has not grown while the beef export volume has. Another is that we have had more growth in our low-price markets, like Mexico, than we have had in our higher priced markets.

Focusing specifically on Japan, rather than on beef exports in general, is not a bad idea because the Japanese beef export situation is very similar to our overall beef situation. Japan is by far our largest customer. In the mid- to late-1980's, Japan was our most important beef customer, accounting for over 70 percent of both our value and our volume. Since the early 1990's Japan's export share has fluctuated and is now around 60 percent. Japan is one of our higher priced markets; its share of the dollar value of U.S. beef exports is a bit higher than its share of the tonnage.

The general focus of this conference has been innovations in technology, or specifically, in transportation technology. And so the question is what have these innovations done for our exports of beef to Japan? To get to the bottom line in my story, the available technology for shipping beef overseas from the United States really hasn't changed much since 1988. Some minor improvements were discussed earlier, but our technology overall hasn't changed very much. The exporters have, over time, selected a different mix of transportation methods. I can't be very specific about what was done in the 1980's because there are no solid, reliable numbers. But impressionistically, in the 1980's most of the beef we shipped was frozen and went via ocean freight in the container systems that others discussed earlier. Also, there was some chilled beef sent to Japan via airfreight.

One of the curious things about the beef situation in Japan before 1988 is that they had a very limiting quota. And there was such a huge gap between the value of beef in the United States and the value of beef once it got to Japan, that you could ship beef by almost any feasible transportation method and still make money. As is often the case, Japan's beef quota had a loophole: live cattle imports did not count. Beef in Japan was so expensive that they would buy live cattle in the United States, air freight them to Japan, let them sit in a quarantined facility for 30, 40 days, and then slaughter them, and still make scads of money. I can't imagine a less efficient way of getting beef from the United States to Japan, but it worked.

Today, we're still shipping beef to Japan via ocean freight. Much of it is frozen. But we are now also sending significant amounts of fresh chilled beef to Japan via ocean liner in refrigerated containers. In the past few years, the Japanese have begun to keep statistics on chilled versus frozen imports, and their statistics show that the chilled beef volume is rapidly approaching the

frozen beef volume. Since shipping chilled beef is more expensive than shipping frozen beef, what is really driving this shift is not transportation cost-effectiveness but Japanese preferences. They prefer chilled beef over frozen beef.

I telephoned a salesman for one of the shipping companies and asked him if there was much difference between shipping chilled beef and frozen beef. I was surprised to find out that there is a huge difference. To get chilled beef to Japan, the carrier will deliver a container to the packing plant. The packing plant fills the container, hitches the container to the truck, and ships it to the dock where it is loaded on the ship. The frozen procedure is quite a bit different: a freezer boxcar full of frozen beef is shipped to the cold storage at the dock, then the boxcar is offloaded and put in a freezer container, which is then loaded onto the ship. All this extra handling should make the frozen procedure a lot more expensive, but the savings in shipping costs for frozen beef more than offset the costs of the extra handling.

The big disadvantage in shipping chilled beef is the more complex temperature control requirements. With frozen beef, temperature control is not that critical. You want to keep frozen foods around 20 degrees below zero, 10 degrees colder or warmer is okay, too. With chilled beef, you have much tighter specs on temperature control. You're only going to get really good shelf life if you can keep it just above freezing. The other disadvantage to this chilled shipping system is the cost of getting that container from the dock back to the plant. I'm not sure what kind of back-haul chances they've got with this technology. In some cases, the packers ship the containers from the dock to the plant using their own trucks. Since packers are not shipping companies, their back-haul opportunities might be more limited.

In any case, it turns out that it's much more expensive to do the chilled procedure than to do the frozen procedure. As other people have said, transportation costs are hard to compare. In this case, when you buy shipping services for chilled beef, you are buying a plant-to-destination service. When you buy frozen beef transportation services, one vendor handles the plant-to-dock shipment and another the dock-to-destination. It turns out that the total cost (plant to destination) is higher for chilled. It also appears that each leg is higher for chilled as well. The salesman I spoke to could not give me a breakdown on the cost of each part of the chilled beef shipment process. I would assume that someone at the shipping company knows that. Either they don't tell the salesmen or the salesmen aren't willing to share with the agricultural economist. But the salesmen that I talked to figured that the ocean part of shipping chilled beef was about 80 percent higher than the ocean part of shipping frozen beef. Based on what he told me, and if I understand him correctly, that works out to be \$.04 or \$.05 per pound to ship frozen beef from major West Coast ports to major Japanese ports, and about \$.09 or so to ship chilled beef from the same ports in the United States to those same ports in Japan. There's also the complicating factor that whenever you read anything on these shipping rates you always see at the bottom of the paragraph, "quantity discounts available as well."

The most important factor in expanding beef markets for the United States has been policy reform. Policy reform for Japanese markets started in 1988. Before then, as I've said, Japan had a very strict beef quota. In 1988, Japan negotiated the Beef/Citrus Agreement with the United States, which opened up the Japanese market to all beef-exporting countries, or to be more

specific, all beef-exporting countries that don't have foot-and-mouth disease or other health problems. Also in 1988, Japan started to gradually phase out its quota. From 1988 to 1990, Japan set a higher quota level and in 1991 replaced the quota with a tariff. Even though Japan's 1991 tariff was 70 percent, it still amounted to a liberalization of the beef market. The tariff was reduced 10 percent per year until it reached 50 percent in 1993, where it was supposed to stay. But because of the Uruguay Round in 1995, Japan agreed to further phased-in reductions. Japan will hit its floor rate, or target in April 2000 when it drops to 38.5 percent. I think policy reform in Japan has been the big factor driving expansion of our exports there. In fact, policy reform around the world has been a big help to our beef exports.

Another factor has more to do with shipping. It's not actually a shipping innovation per se, but it's been the problem of improving shelf life. In 1990's when the Japanese were in the early stages of trade liberalization--and while we at ERS were getting geared up to do some analysis of the Uruguay Round of GATT, I was one of the authors of a report called, "The World Beef Market--Government Intervention and Multilateral Policy Reform." I said some things in that report that may not have been accurate. One potential inaccuracy was that I reported that Australians were able to ship their beef to Japan and achieve 100-day-plus shelf life after landing it in the port and that American beef, once it hit the Japanese port, had a 30- to 40-day shelf life. Later, someone in the meat industry, told me that that was a lie being spread by the Australians; that the U.S. really had much better shelf life than that. In any case, our packers did get to work on this problem and made a lot of improvements. There were also some problems with the quality of our boxes. The boxes used for shipping beef around the United States are not sturdy enough to handle ocean transport. The beef would arrive in Japan and be just a pile of smashed boxes once the container was unloaded. So they started using stronger and smaller boxes. The industry also moved to thicker films and higher vacuum levels on the vacuum bags the meat cuts are put into before they are boxed. All these small improvements have helped to extend shelf life. Also, just in the domestic market, we've had many food safety problems, or food safety challenges, and we've introduced a lot of innovations in beef packing and meat packing generically to improve control of food pathogens in the United States, which have also improved shelf life. The pathogen controls have helped our marketing efforts as well, since improved food safety is a selling point.

Another thing that's helped increase beef exports to Japan has been a reduction in that third type of distance that Professor Frankel mentioned this morning: cultural difference. The experience of shipping beef to Japan has improved communication between U.S. exporters and Japanese buyers.

Some structural changes in Japanese beef institutions also has allowed Japan to take better advantage of the overseas suppliers. Before the Beef/Citrus Agreement, the Livestock Industry Promotion Council (LIPC) of Japan had monopoly control over beef imports and was using some of the money earned from beef imports to subsidize programs for Japanese beef production. The Beef-Citrus agreement eliminated the LIPC's monopoly on beef imports and allows more direct contact between U.S. sellers and Japanese beef buyers, which is helping to bridge some of the cultural or perceived differences. Also, I said some things in the report I mentioned earlier that are probably unfair. I said that the Japanese food distribution system was arcane and inefficient, which is probably not entirely fair. The problem is that the Japanese distribution system is designed to solve a specific Japanese problem, which is that most of the stores are very small with limited



resources. Things that would be done in-house in the larger scale American stores have to be done out-of-house or contracted out because the smaller scale stores don't have the resources to do all the things that our stores do. And it's the Japanese wholesalers who get stuck doing all those things that would normally be done in American retail stores. Consequently, Japan needs a fairly complex distribution system because more of the work is being done within the distribution system and less is being done at the point of sale. The Japanese government has had a policy of protecting these small scale stores by making it very difficult to construct larger scale stores. They've reformed that law; now it's merely difficult instead of impossible to put up a Wal-Mart or the Japanese equivalent. Because of this, Japan has seen some rationalization in the retail sector. They've closed a lot of small scale stores, combined them to make medium scale stores, and they're opening more large scale stores. This change has provided more opportunity for direct contact. U.S. exporters are able to deal with people closer to the final consumer. These reductions in the cultural and institutional barriers have expanded our beef sales to Japan.

My bottom line conclusion is that rather than shipping technology adopting innovations to meet the needs of the beef trade, the beef trade has adapted to the shipping technology that exists. So more of the innovations have come in on the pre- and post-shipment handling phases rather than in the shipment phase of beef transport.

## **The Sunkist Experience**

### **Michael Wootton, Sunkist Growers**

I have been asked to speak about Sunkist's experience as a world marketer of perishable commodities--specifically citrus fruit—and how the evolution of transportation technologies has affected our ability to deliver that fruit to market.

In addressing this, I'd like first to talk about the experience of our early growers, the impact of rail transportation, then trucking, and, finally, ocean shipping on our major markets around the world and conclude by talking a little bit about some dramatic changes we see in the immediate future and the effects of deregulation on ocean shipping.

I should preface my remarks with a little bit about who Sunkist is. I assume most of you are familiar with our brand name, which is found on a number of citrus products: fresh oranges, lemons, grapefruit, clementines, tangerines, pummelos, orange drink, orange juice, lemon juice, and a range of other licensed products around the world from fruit roll-ups to vitamin C tablets to, most recently, fresh-cut flowers found in such retail outlets as Safeway and Giant.

But, Sunkist is not a big corporation. We are a nonprofit, farmer-owned marketing cooperative that is owned by and serves some 6,500 citrus farmers in California and Arizona. Much to everybody's surprise, we do not yet have packing houses and operations in Florida, although that probably will come within the next year or so.

Sunkist growers produce about 65 percent of the citrus fruit produced in the western United States, and 30 percent of our fruit is exported to some 33 countries around the world. The export value of our fruit constitutes about 65 percent of our total return to our growers, so export markets are indeed a very high-value market for us, critically important to our economic well-being.

Now, for a little historical perspective: the California citrus industry, where we originated in southern California, greatly expanded between 1860 and the turn of the century. With the increased population that flocked to the state during the Gold Rush, there was increased consumer demand for citrus fruit to ward off scurvy in the gold mines and silver mines and timbering operations. Initially, the market for citrus fruit was pretty much limited to the perishable distance it could be transported by wagon, but the advent of the East-West Railroad changed everything. So the railroad was the first transportation development that really changed our marketing opportunities.

By 1887, with the advent of the ventilated freight car, upwards of about 2 million cartons of oranges were shipped east from California to Chicago, New York, and Philadelphia and the eastern seaboard states. The technology further improved with the development of the ice bunker car. Then, in April 1883, 1,000 cartons of oranges were shipped by rail to New York and then by steamer ship to Liverpool, England, with one box even being delivered to Queen Victoria. We have a letter from Queen Victoria in our headquarters in Sherman Oaks thanking us for the oranges. This was our company's and our industry's first export.

During the latter half of the 19th century, a number of mechanical cooling devices and systems were applied to ocean shipping. Much new technology was devised by the Europeans--things like ammonia cooling machines and the Coleman cold-air machine, which uses CO<sub>2</sub> technology. Thanks to advances in refrigeration techniques and increases in sailing speeds, exports of perishable commodities like citrus fruit, and bananas, and meat products to different consumer markets from production areas in the United States and Argentina, Brazil, and Australia became more common after 1900, and those products were regularly found on the meal tables of many European households.

After 1925, forced-air cooling found widespread application in shipping, and thereafter fruit transport increased exponentially. By the mid-1960's, reefer ships used automation with temperature recording devices to monitor cargo-hold temperatures, which assured greater reliability in transport. By 1972, refrigerated containers were being used for some perishable commodities aboard ships.

The use of controlled atmosphere has further enhanced the ability to preserve perishable fruit, both in storage and during transport. Depending on the product, this involves increasing the carbon dioxide and reducing oxygen. Because of this change in the gas composition of the atmosphere, the respiration rate of the fruit is greatly reduced, slowing the maturation and decomposition process. So, in effect, when we store or transport fruit, we basically put it to sleep.

The combination, therefore, of faster transport, shortened delivery times, and refrigeration and preservative technologies created a marketing environment for perishable food products that would have been unimaginable just a few decades before. It should be noted, however, that these changes have taken place over a span of 100 years. The change has been evolutionary, incrementally affecting our ability to expand our markets. Nevertheless, today only 7 percent of the world's fruit production is traded internationally in the form of fresh produce.

Over the past two decades, international trade has increased considerably as a result of growth in consumer demand for fresh fruit year round. No longer do seasons limit consumer options. Thanks to improvements in transportation and preservative technologies, producers are able to meet the demand year round. World imports of fresh fruit have grown in total value to well over \$23 billion annually. In the last 5 years, importation of produce into the U.S. market from abroad has tripled. Much to the chagrin of the folks at APHIS at USDA, who are overwhelmed with inspections, and as a result of the import growth, we suffered 26 fruit-fly infestations in California last year.

EU fruit imports amount to more than \$12 billion, half of which is intra-EU trade. For the major fruit producers; North America has an export share of 32 percent, Europe 31 percent, South America 23 percent, and Asia 13 percent. Exports of the principal fruit products are valued at more than \$13 billion, with citrus the main product group at \$3.8 billion; bananas \$3.1 billion; and apples about \$3.5 billion.

After Brazil, the United States is the world's largest producer of fruit. While the vast majority of U.S.-grown fruit is destined for the domestic market and exports account only for 7 percent of

total production, the United States is still the biggest exporter of fruit.

Until the early 1970's, our biggest overseas market for citrus fruit was Europe. Then, because of increased transportation costs and the EU's imposition of a discriminatory tariff of about 20 percent on our citrus fruit versus an 80 percent discount for citrus from Mediterranean countries, such as Israel, Algeria, Morocco, and then the inclusion of major citrus producers, Spain and Portugal, into the EU, we lost out on that market. The transportation cost for delivery of fruit there combined with the additional duty made us noncompetitive. Today, transportation costs for us to deliver a carton of oranges or a carton of lemons from California to Europe, dock to dock, is upwards of about \$8 a carton. On the other hand, to move fruit from California to Hong Kong is less than \$2 and to Japan is a little over \$3. So, it's clear where our market has to be, at least with the current transportation cost parameters and tariffs. Even though we see significantly higher tariffs in the Asian markets, it still is a better market for us than Europe. The other factor driving that distinction is that European buyers, particularly the French, are low-cost produce purchasers. The British and the Germans typically will pay more than the French but not as much as the Asians, who will pay a premium for high quality.

Sunkist's market niche is that upper 5 percent in terms of quality and price. We cannot compete with low-cost producers like Brazil, Argentina, and South Africa.

This kind of successful world market would not be possible, obviously, without the kinds of technologies that have made it possible to deliver fruit—or for that matter, any perishable commodity—to consumer markets far from production areas around the world. Today, southern hemisphere summer production is meeting northern hemisphere winter consumer demands. Chilean fruit is a good example of a country that has been able to enjoy significant increased volumes into the U.S. marketplace.

Let me talk briefly here about deregulation. In addition to the technological changes that have improved transportation and preservation of perishable commodities, the increased economic efficiency of transportation has played a significant part in market expansion for American agriculture. With governmental deregulation of rail and trucking, shipping rates have become much more competitive. With deregulation, the railroads had to take a hard look at their costs. Instead of prices set by rate bureaus, which meant monthly examining the docket and setting rules and rates, predicated on the most inefficient player, deregulation took away the railroad's antitrust protection for setting these rates.

To give you an example of California-based transportation, deregulation meant that Santa Fe and Southern Pacific, lines with parallel track systems, found themselves competing rather than cooperatively conspiring in a rate bureau to set the charges. Almost overnight, expensive networks of railroad sales offices around the country disappeared after being identified as extraneous expense items. Instead of winning over shipping clients by hosting lunches and dinners and golf outings, since the rates were all predetermined and equal, railroads had to win clients by beating their competitors with better rates and service, differential pricing to reflect potential loss, lower shipping rates for easier-to-handle cargo and increased rates for more risky cargo, like perishables. Railroads stopped fussing about claims and cleaned up and simplified the claims

process. Armies of railroad claims adjusters were replaced by contracts limiting railroads' liability.

Railroads began sitting down with shippers and working out creative cargo contracts: offering rebates if shippers met certain volume targets by year's end, devising customized contracts, and committing to equipment purchases in exchange for volume guarantees by shippers. The prevailing principle then, as now, is that the big guy gets a better deal than the small guy. Fortunately for us, Sunkist is the big guy. We're the biggest fresh-fruit, citrus-brand marketer in the world.

Today, domestically we ship by truck—refrigerated truck. We do not ship by rail anymore. The trucking industry went through the same kind of transformation after its deregulation. But, rail delivery for us from West Coast markets to East Coast markets became very unpredictable. Time for delivery varied from 12 to 16 days. For a perishable commodity, that means significantly reduced shelf life. It costs more for us to ship by truck, but it means absolutely guaranteed delivery in not more than 4 days. The reliability factor just far outweighs the added cost. So, we have dramatically shifted. We ship virtually nothing by rail anymore.

It should also be mentioned that since deregulation, trucking has become all nonunion now. You don't see teamsters driving trucks anywhere in the country. They're virtually out of that except for UPS or something like that. But, virtually all of the produce that's shipped around the country goes by nonunion trucking.

Talking about ocean shipping moves us into the export market. In May of this year, ocean shipping will be deregulated for the first time. We believe this will result in dramatic changes in the way business is done in ocean shipping trades. We're expecting to see major cost-cutting, greater competitiveness, and market-based rates. We anticipate that ocean shipping by common carriers, such as APL and Sea-Land, will change in some of the same ways that rail shipping did after deregulation.

Up to now, common carriers in ocean shipping trades have operated with the same kind of antitrust immunity previously enjoyed by the railroads. Like the old railroad rate bureaus, ocean shipping firms held conferences where they set prices and terms. Terms and rates were published and publicly available for all to see through the Federal Maritime Commission. These common carriers were nondiscriminatory and noncompetitive, offering the same rates to all shippers large or small.

For the first time, shippers and common carriers will be free to negotiate contracts without having to make public their essential terms. This confidentiality will enable shippers to keep strategic information from industry rivals. Carriers will be free to form alliances that make their operations more efficient and competitive. The rates set by the conference were mandatory. In fact, we are the only country left with a public tariff regulatory system and that is about to change. Shippers from other countries already enjoy the ability to negotiate freely confidential contracts with carriers allowing goods competing with U.S. products to be sold on a CIF-delivered basis. This has given foreign shippers considerable flexibility and competitive advantage in pricing practices that has worked to the disadvantage of many U.S. firms.

On May 1, as I said, all of this changes. Conferences will break up; carriers can enter into confidential contracts with shippers; and judging by what happened with trucking and rail, rates will come down and shippers will have more options. At least that's what we look forward to. One-on-one negotiations will be a prerogative, along with the ability to enter into long-term contractual relationships that are custom-designed, capitalizing on carrier expertise and shippers' specific needs. Alliances will supplant conferences as the dominant forum for rationalizing services. There is the potential for partnership not only between carriers, but also between carriers and a host of other players, such as shippers, intermediaries, ports, possibly even labor unions. Large carriers will likely cannibalize small, less-efficient rivals, and a few culturally compatible large carriers will probably emerge. Some experts predict that liner shipping will soon consolidate into three or four major alliances. Common carriage will yield to customized contracts with the most favorable terms reserved for the larger shippers.

The infrastructure of U.S. ports will also be affected. As ocean carriers work to contain their costs and remain competitive, the ships themselves will come under scrutiny. With fixed costs, the same carriers will look to build bigger, more economical and efficient ships. Increased ship size and draft will limit the number of ports capable of handling them.

Also, the ability to quickly load and unload the vessel will be critical to port competitiveness. Ports will be played off one another by the big shipping firms. There will be a scramble to land the big contracts. Ports able to meet these demands may be further away from shippers, imposing added overland transportation costs.

Port improvement costs will be passed on to shippers and, in turn, to their clients. So, pressure on prices will operate, really, both ways. Downward pressure will be exerted by cost containment and rate reductions made for competitive purposes; at the same time, infrastructure changes will result in passed-through costs that will push prices upward.

The importance of quick turnaround time in the port that a previous speaker talked about is illustrated in another deregulated industry by the success of Southwest Airlines. Today, Southwest is the country's most profitable airline because it has the fastest fleet turnaround time at an average of 20 minutes versus 90 minutes for the rest of the industry. They enjoy other economies and efficiencies from flying only one type of plane, the 737. All their pilots can fly all their planes, eliminating a lot of cross-training. Employees also serve multiple functions. If you've ever flown Southwest, the people that sold you the ticket also unload the luggage and clean up the airplane and serve the snacks and all the rest. These same realities are likely to confront the shipping industry. Ships won't be able to afford to sit in port. They'll need to be on the water generating revenue.

Union labor at ports will also be affected significantly, we suspect. Current work rules and pay scales are very noncompetitive, resulting in high handling costs. It will become necessary to confront this problem and to rationalize work rules.

Before deregulation, the unions and the carriers used to be able to sit down, cut a deal in

conference, and then go to the government regulating body--in this case, the Federal Maritime Commission--with their proposal, arguing that while they're in agreement, there is no way to meet the higher costs other than raising shipping rates. With deregulation, that is going to change.

Let me note also, from the point of view of a shipper like Sunkist, technological improvements in transportation are of limited value if the destination of the export doesn't have handling facilities. I think the previous speaker talked a little bit about that in terms of having the chain in place to be able to accommodate these products. We learned that the hard way at Sunkist a few years ago when we were approached by Russia when it was still the Soviet Union--they wanted to buy three shiploads of third-grade lemons, which we had an abundance of at that time. The shipments were to go into what was then Leningrad and is now St. Petersburg.

The first shipment went fine and on the second shipment a few months later in addition to the third-grade lemons we put 1,000 cartons of top-grade Sunkist lemons in the hold to test the consumer market in Russia. When it came time for the third shipment, the Russians came to us and said, We want to be sure that you don't put those Sunkist lemons in the hold this time. We thought that was kind of strange since we had just given them 1,000 cartons worth about \$40 a carton, so we asked why and they replied: When we transported all that stuff down to markets in Moscow, the Sunkist grade lemons were the only ones that people wanted to buy.

From that we discovered that there is a consumer market in Moscow for our lemons if we could find people there with the money to buy them. We have not shipped to Russia since then, though, because in the third shipment we ran into real difficulties, and this gets to the infrastructure question. On that third trip, when our ship reached Leningrad the port was all backed up, and we had to pay a demurrage fee of \$10,000 a day as we sat there for two weeks, which took the fun out of doing business with the Russians real fast. Until they get their act together and have more resources, we're not likely to get back into that market. We just don't take those kinds of risks anymore. We sell, typically, all of our export produce fob our dockside.

In conclusion, let me just suggest that given the fact that there is going to be this dramatic change in ocean shipping with deregulation, I think it would be of value if ERS were interested in undertaking an analysis of the economic conditions that exist under a regulated environment and the kind of transition that's likely to take place, possibly reaching some conclusions here in a year or two as to where things are after deregulation. It would be educational and I think it would also benefit public policy to have an understanding of the effects of deregulation in a business environment.

If there are any questions, I'll be happy to try to answer them.

MR. BAILEY: Bill Bailey from Massey University, New Zealand. You talked in the beginning about Sunkist going into fresh-cuts, fresh flowers?

MR. WOOTTON: Fresh-cut flowers.

MR. BAILEY: Fresh-cut flowers.

MR. WOOTTON: It's a licensing arrangement.

MR. BAILEY: Okay. I was going to ask, is this driven by your distribution structure, or could you talk about it?

MR. WOOTTON: It's driven primarily by the brand name--having such a positive consumer response to that brand. So, capitalizing upon the brand identity.

MR. MCGREGOR: Brian McGregor with Agricultural Marketing Service. How much of the Sunkist export business goes freight bulk and how much container?

MR. WOOTTON: It's getting to be more and more container. It used to be very little container; it used to be mostly into the holds on pallets, cartons on pallets into the holds of reefer ships. But now we find that some ports like, for example, Singapore, we will go by container. But we still do both. It's probably 60 percent container/40 percent pallet.



## Supply Chain Management in New Zealand's Dairy Industry

William Bailey, Massey University, New Zealand

I will talk about how seaports and the New Zealand dairy industry have reacted to technological and structural changes in their respective industries. I wish to review the role of supply chain management in adjusting to those changes. My comments will be not just about transportation, but also about supply chain management. The Dairy Board views supply chain management, and not price, as *key* to their worldwide competitiveness. First, I'd like to spend just a couple of minutes describing the dairy industry in New Zealand.

When most people think of New Zealand agriculture, they think of the Dairy Board and have a knee-jerk reaction to it as a single-seller, a monopoly, a bad thing with huge government subsidies involved. Well, there are no subsidies involved. It's simply a single-desk seller. Anybody can export dairy products from New Zealand. The Dairy Board has to give them permission to do that. I think there are around 20 different companies exporting dairy products. But, by and large, for the products we're going to talk about, the Dairy Board is the single-seller. The Dairy Board is a cooperative and as such has a structure with significant implications for its ability to manage the supply chain. All the milk that is processed is processed by cooperatives just as all of the milk exported is exported through the cooperatively managed Dairy Board.

Dairy exports constitute 25 percent of the value of the country's exports. In a country like New Zealand, the level of milk production is national news. If there is an outbreak of some type of disease in the dairy industry, it is on the national television news that night. Not necessarily ahead of rugby, but nevertheless, it's national news. If you talk with dairy farmers, they are very clued in about what's going on internationally. They know the exchange rates, they know all the ins and outs of the dairy trade internationally. The production formula is low cost, high volume. Production has increased 45 percent since 1990. While production has increased, the number of cooperatives has declined. A few years ago there were 15 cooperatives. There are now, at least there were when I left, nine cooperatives in New Zealand. We have experienced this increase in milk production and decrease in the number of cooperatives processing the milk. As a consequence, economies of scale have really begun to drive the industry. Combined with these factors is the seasonal nature of milk production. There's a huge variation in production over the course of the year. Deliveries range from zero during parts of the year to over 4 million gallons in a single day. Plants have been built to accommodate this huge shift in volume. So, we have seasonality combined with huge production increases and fewer processing cooperatives. All of these factors are driving the industry to embrace economies of scale.

Now, just a quick look at the dairy situation in New Zealand. The country is divided into the North Island and South Island. Most of the milk is produced on the North Island and moved to a number of facilities. Kiwi, for instance, has trucks moving milk from the west side of the North Island to its major plant on the east side, a distance of about 400 kilometers one way. Some South Island milk also feeds into the North Island plants. As I said, during the flush production period, as much as 4 million gallons of milk per day is delivered to one facility. That's a lot of milk. In order to move this, Kiwi uses milk trains. Milk is collected at a number of farms, taken to a rail facility, put into a milk silo, honest, a milk silo, and then pumped into a milk train. Trains operate

back and forth from one side of the North Island to the other during the peak season. Each train carries around 800,000 gallons of milk. Again, this volume of milk is required to feed the plant at Hawera. This is an example of the economies of scale used in the industry.

And what makes all of this a challenge is the export focus of the industry.

There was a question this morning in reference to deregulation in the ocean shipping industry about what happens when a shipping cartel is done away with. At one time, there was a very tight cartel between New Zealand and Australia for ocean shipping. But about 5 years ago that cartel was opened. As a result, ocean-freight rates have come down over 50 percent during the past few years.

While Australia remains an important destination for dairy exports, the majority of exports are moving a long way—to Europe, Russia, and South America. Exports of nonfat dry milk don't go quite as far—to Malaysia, The Philippines, Indonesia, Japan, and Thailand, but these destinations are still 9-10 days by boat away from New Zealand.

The situation faced by the New Zealand dairy industry includes these givens: 1) it is export driven; 2) it depends on volume and the volume of milk arriving at plants fluctuates enormously over the course of a year; 3) the milk must be moved a long distance—either to processing facilities or to export markets.

In addition to the above, the external environment is changing in ways that the Dairy Board has no ability to influence. Most of these changes we've talked about previously. Shipping lines have rationalized their services. Today's larger ships and larger containers require larger volumes. As a consequence, we're seeing hubbing; that is, scheduled carriers are servicing a reduced number of ports in New Zealand. When the carriers do arrive, they have big boats. They want attention. They want to arrive on fixed days. They want guaranteed facilities. They want fast turnaround of their vessels. Those are demands that the Dairy Board must respond to.

The major ports in New Zealand are Auckland on the North Island and Christchurch on the South Island. Altogether, there are 13 commercial ports throughout the country. But this hubbing is creating considerable competitive pressure on the smaller ports. The question is how can these ports survive, and how can the dairy industry work in concert with the ports to remain competitive?

The ports can't change their location. I mean, where they are is where they are. And so what are they doing to remain competitive? The ports no longer offer just a facility, just some place for a boat to stop. They are expanding their range of services so that they can monitor products all the way through the system. They will work with shippers to make sure that the products are delivered on time to the various ports and that they have sufficient facilities for a quick turnaround on the boats that arrive.

A good example is the port of Auckland, which is New Zealand's biggest and busiest port. This is where the America's Cup is going to be held, for those of you who are sailors. Don't know how

long the Cup will need to be in New Zealand before it's called New Zealand's Cup, but this is a big deal for Auckland. It's creating some problems in Auckland because as the large container ships arrive, the 12-meter yachts are running back and forth. The port itself is in downtown Auckland, which creates some intermodal and environmental problems. Unloading empty containers at 3:30 in the morning makes a lot of noise just as trucks moving containers to and from the port during rush hour creates some issues. Nevertheless, 52 percent of all products brought into New Zealand by sea come through Auckland.

Now, what is the Port of Auckland doing to become the main competitor, the main hub, in New Zealand? They've improved turnaround times. A boat that arrived during 1989 required 39 hours for containers to be offloaded and new containers onloaded. As a result, in part, of improved technology, turnaround time has been reduced to 14.9 hours. I don't think it's unique to New Zealand, but when a vessel arrives, the people at the port of Auckland know exactly where the containers are in the vessel. This means that when a boat arrives the cargo is quickly moved off, stacked at the appropriate place, and new cargo positioned for export is loaded onto the vessel. The intention is to minimize the movement of containers that don't generate revenue. As a consequence of the new technology, the vessel can be turned around more quickly, and more importantly, the liner companies can be kept happy. The improved handling procedures have resulted in a 30 percent increase in container traffic in 4 years and a reduction in the number of employees.

The major port or hub for the South Island is Lyttleton near Christchurch. One of the important operational things Lyttleton has been working on is truck turnaround time. When a truck arrives at the port with a container, the container is offloaded and the truck is out of there in 11 minutes. The focus of the port is on the paperwork. Lyttleton uses technology to make sure documentation is handled as quickly and efficiently as possible. Lyttleton sees the use of technology to speed and improve documentation as their competitive advantage.

How has the Dairy Board responded to these controllable and uncontrollable events? For dairy products exported from New Zealand, ocean shipping is 30 percent of the total marketing bill, so any opportunity to reduce the cost of ocean freight will significantly benefit the industry. What can the Dairy Board do so that it can return more money to the dairy farmers of New Zealand? In the past, the response has been to go out and sell more cheese, or more butter, or more nonfat dry milk, to increase sales. But over the past year or two, the industry seems to have changed its attitude. While increasing sales is still good, it doesn't necessarily mean increasing profits. Furthermore, while ocean freight is an important cost component, if the industry focuses just on the cost of shipping, that won't be enough. What happens, for example, if the cost of shipping is reduced considerably but the products don't arrive on time, or they're damaged, or there's some delay in the handling of documents? The industry has significantly improved documentation. Each exported container of dairy product requires approximately 10 documents. During the past 3 years, there's been an 80 percent increase in the number of containers exported. At the same time, the Dairy Board has reduced by 50 percent the number of employees working on documentation. We cut costs, but it may not help at all.

True story: I was flying from Auckland to Singapore to meet Bill Coyle and some of his friends. As I got on the airplane in Auckland and sat down way back in steerage, the airline brought on

board a large styrofoam container and put it down in the seat next to me and strapped it in. Naturally I was curious and I asked what it was. It's some chocolate, I was told. There is a company in New Zealand that makes fine chocolate and this was a very large block of chocolate carved into an intricate design. It was going somewhere to become part of a big celebration. So, we have this exquisite chocolate, carved up in I don't what sort of design, sitting next to me on the airplane. We arrive in Bali and it was a 100+ degrees, 110 percent humidity. This box of fine chocolate, which was sitting next to me very calmly all the way up, then disappeared. I don't know what happened to it, but I had visions of someone taking the box off the plane and putting it on the tarmac next to the airplane to wait for someone else to come pick it up. I imagined that it sat there in the sun and heat and humidity for maybe four or five hours, and that the finely crafted, carved piece of chocolate turned back into a block of chocolate. And it wasn't because it wasn't well handled between Auckland and Bali. Something happened in the supply chain. And that's why the Dairy Board says if we just look at the cost, it doesn't mean we're going to become more competitive. Instead it said, let's improve the whole supply chain. If we reduce the total cost of delivering a product from our factories to the end-user overseas, the money saved goes straight to the bottom line. It's not like sales where you have to take some out for cost of goods sold, some out for marketing, some out for overhead. These savings go straight to the bottom line. The first six months that the Dairy Board focused on improving the supply chain, it saved millions of dollars. Those savings went straight to the farmers' pockets, which made the Dairy Board very popular.

Improvements in the supply chain put money directly into farmers' pockets. In addition, the improvements will increase the ability of the Dairy Board to compete, not on price but on service. Because the Dairy Board can deliver products at guaranteed times to specific places and at specific quality standards. The challenge of improving the supply chain is that it requires participation by everybody in the chain. We've talked about ocean shippers, we've talked about ports, we've talked about a number of things today that affect the New Zealand dairy industry. The Dairy Board says we can't look at those in isolation. For the chain to improve, all parts of the chain must improve.

Now, let us turn to some conclusions. The New Zealand Dairy Board is a single-seller organization. I don't know if having a single seller is necessary in order to have an efficient supply chain in agriculture. But I do know that the single-seller status of the Dairy Board enhances its ability to be competitive by improving the supply chain. While exports drive the industry, domestic movement of milk remains critical and very costly. Product movement is high-volume, low-value. While such a relationship is great for ships, it's tough with trucks. As competition between the seaports increases, as the drive for hubbing increases, and as scale requirements increase, the demand for movement of huge product volumes through ports will increase. The industry has responded to these challenges. The industry has embraced innovative ways to pick milk up at the farm, it uses global satellite positioning on the trucks that go to the individual dairy farms; it uses milk trains that carry nothing but milk from outlying areas to processing facilities. The Dairy Board looks at all the links in the chain, not just at facilities or at a particular mode of transportation, but at the whole chain. While distribution costs may go up, overall revenue will increase as overall costs go down. In my view, however, the most important improvement is information technology. We can get the straddle carriers to drive faster around the ports and pick

two containers up at a time instead of one, but if the documents aren't there, it doesn't do any good. If we've lost a container, if potatoes go to Albany, Georgia, instead of Albany, New York, we have problems. Information technology permits us to keep track of the containers--makes sure that we have maximum container loads. We know how much is required, how much we have available in various inventories to assure maximum payloads for the containers. Information technology makes sure the necessary documents precede the containers so that those documents are there when the containers arrive. Product flows throughout the system are much better managed, and the time in port for the containers and the ships is reduced dramatically.

So, that is how the Dairy Board looks to technology to become more competitive in the world marketplace. It doesn't look just at the transportation costs, but at the whole chain. As you do your research, I think that's something you have to keep in mind. Simply reducing your transportation costs does not mean that service will increase, that market share will increase, or that customers will be happy. The Dairy Board has said the supply chain is where the action is and it is developing that supply chain to meet consumer needs.

Thank you very much. If anybody has any questions or suggestions, I'll be more than happy to entertain them.

MR. ARMBRUSTER: Walt Armbruster, Farm Foundation. Could you give us a couple of examples of exactly how the New Zealand Dairy Board has dealt with the supply chain phenomena?

MR. BAILEY: For example, the Dairy Board was working with maybe 60 different companies that provide packaging. It said, "60 companies, come on, that's too many, how complicated is a cardboard box?" And part of the Board said, "Now, hold it. If we want the lowest possible prices, we have to have this bid-and-offer system. We have to have a situation where companies compete against each other to give us the lowest possible price for cardboard boxes." Fair enough. The other half, the supply chain management people said, "It's not the price, it's the service. If we get the service right, if we get the products right, if we get the containers right, if we get the packages right, it will reduce our overall costs." So, the board went from working with 60 packaging people to two and, as a result, forged a much closer linkage between the packaging people and the processing plant so that the packages are designed and delivered when they're needed. It's reduced the inventory costs of both the suppliers and the processors, reducing total cost in the chain.

Another example is working with containers. What do you do with a container? I mean with these packaging/processing plants in the middle of New Zealand there aren't any back hauls. I guarantee you, going to Harewa, there are very few back-haul opportunities. So, what do you do with the containers? Well, maybe, if the containers were pre-positioned at the ports, shipments could be consolidated at the ports rather than at the factory and maybe you could save some money instead of moving around empty containers. When working with the supply chain, you probably won't find one place that saves \$1 million, but you'll find a lot of places where \$1 can be saved. The key is having everybody talk and having the information flow back and forth. Any other questions?

MR. SPINELLI: I'm Phil Spinelli at GPSA (Grain Inspection, Packers and Stockyards Administration). I was wondering if you see the same kinds of structural changes that you identified in the dairy industry in other big export commodities from New Zealand, like beef?

MR. BAILEY: There are marketing boards for several commodities--apples, kiwi fruit--and these industries are moving quickly toward the supply chain management approach. When we look at the beef side, that's not necessarily true. The beef industry is fragmented. It doesn't take as full advantage of supply chain management as these vertically integrated industries do. Now, from a research perspective, do you have to have that vertical integration? Does it have to be a cooperative? Can these linkages take place strictly because it benefits everybody? It's a lot more difficult that way. It's great in theory, but the implementation is very difficult. So, the boards are doing well in the supply chain area, but the beef industry is not doing well at all.

MR. [INAUDIBLE]: Do you see the success of the New Zealand Dairy Board as a single-desk seller acting as a role model for other entities in New Zealand? I mean, is this the wave of the future? Is it going to be more moving backward toward other more broken up or disaggregated industries?

MR. BAILEY: Someone will provide the services provided by the Dairy Board. That is Marketing 101. The middleman adds value in some way. And so the services provided by the Dairy Board will be provided by someone even if the Dairy Board disappears tomorrow. But, the Dairy Board remains a model for other industries in New Zealand, because it's doing a good job. It's selling the products and taking care of the markets; it's looking at the whole chain and returning good value to the farmer. The farmer controls the product all the way through. The Dairy Board may change its name, but I think the idea of a single seller will remain in New Zealand for a number of years, at least for dairy products.

MR. [INAUDIBLE]: My question was: Can you see other industries emulating the Dairy Board?

MR. BAILEY: The success of the Dairy Board is due in part to the statutory basis for its existence. If a company wants to export a product, it goes to the Dairy Board for permission. I do not see the beef industry doing that. I don't see other industries in New Zealand requiring that permission. And so, while people look with envious eyes at the Dairy Board, I don't see that its statutory powers will be extended to any other industry in New Zealand.

MR. [INAUDIBLE]: Doesn't the New Zealand Dairy Board have established subsidiaries in several countries?

MR. BAILEY: That's a good question. The Dairy Board has maybe 50 subsidiaries in a 100 or so countries around the world. The challenge with supply chain management is that it takes communication. If the Dairy Board has 50 subsidiaries around the world, it has to be communicating with them. An offshoot of this has been that the Dairy Board had to bring responsibility and authority back into New Zealand and away from the subsidiaries, and that is creating some tensions. This is a little bit counter to some of the theory we read about in the *Harvard Business Review* where you want to move authority down with responsibility at the

lowest level. The responsibility will remain with the subsidiaries, but the authority is coming back to Wellington, New Zealand.

## **Incorporating Transportation Costs into International Trade Models: Theory and Application**

**Mark Gehlhar, ERS**

Is transportation a relevant variable? That's probably not a relevant question for this audience, but certainly if you've taken a number of theory courses, like I have, you'll recall that transportation didn't come up very often. I recall in one of my early courses as an undergraduate, the professor, as usual, assumed zero transportation cost. A student asked how could that be true and what was meant by that. The professor replied that he meant exactly what he said, transportation costs are assumed to be zero. The student got up and walked out of the classroom and was never heard from again. We can sometimes get away by assuming transportation costs do not exist, but it depends on the context in which we make the assumption. Although I've spent a lot of time on transportation data for modeling purposes, because I think it's important, if I were to go back to the classroom and teach trade, I don't think I would dwell too much on transportation costs. It's not necessary when trying to teach the essence of comparative advantage in trade. In fact, it can unnecessarily complicate things. In the classroom, we can teach a lot of good trade theory without real world complications regarding international transactions cost. Of course transportation is important; that's why we are here today. The problem is that some teachers assume too often students will recognize why it's not important in some circumstances but important in others.

Various trade models are used to explain or predict trade. When it comes to applied trade models, transportation can be an important variable. But I would say that just taking into account transportation costs in a model will not necessarily enable us to better predict evolving trade patterns. I'm not completely convinced that transport costs add much in explaining overall trade pattern changes, which can be very complex. But where I think the transportation variable is important is in policy simulation models, and that's how we use a lot of our trade models in ERS. This year we have a large modeling project working on upcoming WTO issues. For these models, we take trade as a given without having to explain why it occurs. We then simulate outcomes by changing policy variables, such as tariffs or other policy variables. Now, if we introduce the transportation variable, we can get different outcomes than if it were excluded. Transport costs affect how prices are transmitted between countries. So the transportation variable, I think, is important in that type of application.

This afternoon Zhi Wang and I are giving a briefing at the International Trade Commission. Not all of their staff are trained as economists, and they ask different questions than might be asked in a university seminar. They're going to be grilling us on the model for a project we are working on for the Commission. If we're asked about transportation costs we can look them in the eye and say, "Yes, we've taken into account transportation costs in this model." For some this is important and makes a model more realistic. Having realistic assumptions and detailed data raises the confidence level for people who are the end consumers of model results. Sometimes what comes across as an unimportant detail to modelers is of great importance to someone else.



Let's start by defining how we measure transportation costs. For any transaction involving transport cost, there's obviously a quantity or physical unit of trade. Then we have an exporter's price valued at fob prices, and an importer's price valued at cif prices. The difference between the two prices is the unit transport cost. Another measure of transportation costs is the transportation margin. A transport margin is the share of transport cost in the total cost of the good. So the two cost measures do not measure the same thing. The change in the margin across time can be confusing because if the cost of the good falls relative to the unit transport cost, the margin increases even while the transportation cost falls. We can observe changes in the margin over time but they do not directly reflect transport cost changes.

Next I'll try to walk you through some theory as painlessly as possible. In a spatial equilibrium model, we can represent two regions and clearly see that there's a higher price in region B than in A (figure 1). In the diagram, we see that the excess supply from region A and the excess demand from region B determine an equilibrium price and quantity in the world market. So, if there are transportation costs, clearly there's going to be less trade. Transportation costs act like a tariff.

Now that we see how transport cost fits into the world market, I'm going to derive the demand for shipping services. If you're good with geometry, you can see graphically that there's a relationship between transport costs and the quantity shipped in the world market. If the shipper or carrier decides to raise the transportation costs above a certain level, they can at some point choke off world trade. If they want to provide a free service, then trade expands out to the maximum equilibrium level of trade, the intersection of the excess supply and excess demand curve. The derived demand for services relates volume of traded goods with the price of the shipping service. It is an inverse relationship like all demand curves (fig. 2).

We can now link the derived demand for shipping services with the market for shipping services. Now to illustrate some things we've been talking about in the workshop, like technological change, I want to perform some experiments using this framework. A technological change in the shipping services industry is represented by a shift to the right in the supply curve for services (fig. 3). In other words, a higher level of services is supplied at the same unit cost. How might that occur? Well just as Bill Hall was describing, you now have faster turnaround times in ports. This is what I was thinking when he was talking about that. Lower rates and higher volumes of trade are the result. We see here this will increase world trade, decrease cif prices and increase fob prices. Unit transport costs fall and the margin falls. As shown here, if the fob price increases but the transport costs fall, then unequivocally we can say that the transportation margin falls.

We can do another experiment. Let's say if we liberalize trade, the excess demand curve shifts to the right as consumers in the protected region increase the quantity demanded, but at the same time, the demand for services increases, which then bids up unit transport costs (figure 4). Both unit transportation costs and fob prices increase. In that case, the change in the margin is ambiguous. The change in the margin depends on the supply response of services. We don't really know very much about the supply of services. We can't estimate it very easily. Perhaps if we had some detailed data we might be able to do so. In the model, a simple assumption is just to use a fixed margin. That's what has been done in the model I'm currently working with.

Madeleine is going to talk about a single-commodity model, and I'm going to talk about the transport services in an economy-wide CGE (Computable General Equilibrium) model. In the single-commodity model, unit transport costs are determined outside the model. In the CGE model, there is a price in the model representing transportation services.

The model I'm referring to here is known as GTAP, which stands for Global Trade Analysis Project. It's a project that I became actively involved with at Purdue University and that is now being used throughout the world for performing trade policy simulations and other applications.

In this model, we have a shipping industry where there's both a supply and demand for shipping services and what is assumed is that goods and transport services are in fixed proportion when trade occurs. You have to have a fixed quantity of services for each unit of traded goods. We can see from the equation that if there's a zero transport margin, a given percentage change in the cif price will give you exactly the same percentage change in the fob price. The higher the margin, the less of a percent change in the cif-fob price differential. This is why the relative size of the margin is important in a simulation.

Transport margins in the model vary by partner and by sector. So next we'll look at some estimates of margins. There's no complete source for global transport margins. Some of them have to be estimated. One thing I've taken into account is a problem associated with aggregation bias that I avoid by using very detailed margin data before aggregating to the sector level.

You might think the margins would increase with greater distances. Well, here are some margins from the GTAP model for an aggregate sector (table 1). The transportation margin for shipping from Mexico to the United States is higher than the margin for shipping from India to the United States. For this particular aggregate--fruits, vegetables, and nuts--the shipping margin is very low. The reason for this can only be understood after examining the detailed data and noting what the United States is actually importing from India. The trade consists primarily of cashew nuts, which have less than a 4 percent transportation margin, whereas fresh fruit has a margin of closer to 25 percent. When I was doing some econometric work, I would get frustrated working with aggregate data because many times the margins are not positively related to distance. It is common to find low margins on long-distance routes because of compositional shifts in the trade. It becomes prohibitively expensive to ship certain fresh products long distances. Having detailed data is important in this area of work.

If we look at U.S. trade with the same partners shipping to and from the United States, you'll notice that the margins are different. Margins for imports from Central America are higher than for exports to these countries. The distance is exactly the same and possibly the same ports are being used, so why are the margins different? Again, the answer lies in the type of product being shipped. Exports to these countries consist primarily of dried goods such as beans and legumes, whereas imports are fresh products requiring high per unit transport costs.

This next figure (table 2), which shows trade in fresh tomatoes, gives you an idea how unit costs and transportation margins vary. Comparing Mexico with Canada, we see that there is a higher margin for Mexican imports. But it's partly because higher-priced tomatoes are being imported

from Canada not because it costs more to ship to Canada than Mexico. So, there's not always a positive correlation between the high unit transport cost and the transport margin for the same product. This illustrates the importance of the unit cost of goods and how it varies by trading partner.

Something now being explored for this model is incorporating different types of shipping services. The market for transportation is becoming more fragmented by type of service. Basically there are three modes of transportation--ocean, ground, and air. The next figure (figure 5) shows the share of fresh fruits and vegetables shipped by air. Tomatoes are coming by air from the Netherlands and this share is rising. A greater share of fresh stone fruits are flown from Chile. So, we are seeing growth in air shipments for fresh produce.

So far, we have examined transportation margins in the model. In the next experiment, I ask what the impact is if these margins were reduced as a result of technical change in the shipping industry. In this case specifically, I'm asking what would happen if we had a 20 percent reduction in all transport margins. It turns out that this would have an effect nearly equivalent to complete trade liberalization in world trade. In other words, reducing barriers to trade would provide welfare gains of the same magnitude as reducing transport costs by 20 percent. The question came up yesterday, "How should we allocate our resources: to reducing transportation costs or to reducing levels of protection?" Well, if you can get a 20 percent reduction in transport costs, it is equivalent to complete worldwide trade liberalization and U.S. households would be better off by about \$9 billion (tables 3 and 4). However, I'm not sure if anyone knows exactly how we might achieve this kind of transport cost reduction. We know how to support and negotiate trade agreements, but as economists we are less sure about how to achieve a 20 percent reduction in transportation margins. This is at least one way to put trade barriers, which include transport costs, into broader perspective.

It turns out that because U.S. food imports have a higher margin than exports, imports would grow more than exports from a reduction in transport costs. The margins are actually higher for U.S. imports than U.S. exports. The reverse is true, by removing tariff barriers, food exports would increase more than imports since the United States is a relatively more open market than the rest of the world.

In summary, both producer and consumer welfare need to be considered when it comes to the problem of transportation costs. U.S. consumers stand to gain from cost reducing technologies. Cost reduction is not important solely for the benefit of exporters.

## Transaction Costs in Applied Trade Models

Madeleine Gauthier, ERS

To add to Mark Gehlhar's presentation on the role and importance of transportation costs in economy-wide models, I would like to briefly illustrate how to incorporate transportation costs into an applied trade model. I have recently looked at trade patterns in the market for fresh apples, so this will be the subject of my illustration.

Theory suggests that price differences between trading regions cannot exceed transport costs, but much empirical evidence shows that this theory is too constraining. Trade patterns can very rarely be explained by price competition alone. Applied trade analysts are increasingly looking at other factors to explain the direction and volume of trade between regions. These factors include formal and informal regional trade agreements, similarities in demand preferences and in business practices (what O. North refers to as *cultural homogeneity*), and a whole array of transaction costs. Transaction costs include not only transportation costs, as measured by freight rates, but also many other costs such as those associated with obtaining information about trading partners and foreign regulations and for coordinating and monitoring contractual arrangements. It is costly to do business with a country with a different legal system, to verify the credibility of new trading partners, and to ensure yourself against so-called sovereign risk, since property rights cannot be easily enforced in the international arena.

In the market for fruits and vegetables in particular, transaction costs include costs associated with complying with phytosanitary procedures, such as treatment, inspection, or storage costs during quarantine. Food safety and environmental regulations in general also add costs to bringing a product from the point of production to the point of consumption.

The data available, as other presenters have shown us, is rarely detailed enough to allow a breakdown of the different types of costs. Also difficult to figure out from available data, but crucial in policy analysis, is who bears these costs, that is, how are costs distributed between agents along the trading route.

Let me turn to my study of U.S. imports of fresh apples by country of origin to illustrate my point. Thanks to Mark's careful work, I was able to compare unit value at customs (the *fob* value) and at the port of entry (the *cif* value) for the same shipment. The difference between the two can thus be attributed to transaction costs. This information is presented in the following graph and table (figure 6 and table 5).

We note first that although the United States is one of the world's top producers and exporters of fresh apples, it does not import many apples and there are very few foreign suppliers to the U.S. market. Secondly, the value of shipments to the United States can vary a lot from year to year and the selection of 1995 is arbitrary.

The graph shows large differences in both the value of the shipments and the margin between *fob* and *cif* prices. The case of Canada stands out. Both the product value and the transport margins are quite low compared with other suppliers. Most imports from Canada come from Quebec and

Ontario and are shipped to New York and Michigan for processing, which typically commands a much lower price than apples destined for the fresh market. Canadian producers are so close to U.S. processors that apples can be shipped rapidly and economically. The low value of processing apples would not warrant long-distance shipping and high transport costs.

Japan is known for its high-value, high-quality apples. This is reflected on the graph where shipments from Japan show the highest fob value. Transport costs, however, are about equal to the world average. Supplies from South American producers, conversely, have average values but high transport costs.

From this empirical example, we can see that there is no simple relationship between distance and transport costs. In applied trade models, where the aim is to analyze trade patterns and policies, it may be crucial to look at trade flows and to explicitly model transaction costs. One approach to analyzing trade flows is to construct an Armington-type model, which is an import demand model where the traded good (like fresh apples) is differentiated by country of origin. That means, for example, that apples imported to the U.S. market from Japan are not treated as perfect substitutes for apples imported from New Zealand and price differences can occur. Here is a simple illustration of this modeling approach (figure 7).

In conclusion, I would like to add that transaction costs are likely to impact the time dimension of trade flows as much as they impact the spatial dimension. For instance, transaction costs may act as barriers to trade through asymmetric information on new trading partners.

# **The Impact of Distance on U.S. Agricultural Exports: An Econometric Analysis**

**Zhi Wang, William T. Coyle, Mark Gehlhar, Tom Vollrath**

*(Note: This paper is an edited, expanded version of the paper presented at the workshop by Zhi Wang.)*

## **Introduction**

Overcoming distance has always been an important issue in marketing agricultural products. Agricultural economists have examined the role of distance intermittently (Thompson, 1981). International trade economists have long ignored distance until recently as described by Paul Krugman:

[T]he analysis of international trade makes virtually no use of insights from economic geography or location theory. We normally model countries as dimensionless points within which factors of production can be instantly and costlessly moved from one activity to another, and even trade among countries is usually given a sort of spaceless representation in which transport costs are zero for all goods that can be traded.  
(Paul Krugman, *Geography of Trade*, 1996)

There are three types of costs in shipping agricultural products: physical shipping costs, time-related costs, and the costs of unfamiliarity (Linnemann, 1966). Collectively, these costs represent a natural tariff that limits trade. The removal or reduction of these costs would have an impact on trade similar to the impact of the removal or reduction of a tariff.

While income growth and trade liberalization around the world are generally believed to be key determinants in the expansion of global food and agricultural trade, advances in technology that have lowered transportation and communication costs have also contributed to this expansion.

One way of measuring the trade effects of distance is the distance elasticity, which describes the change in trade with respect to a change in distance. The expectation is the greater the distance, the more inhibiting effect it has on trade, all other variables constant. A larger elasticity implies that distance has a greater impact on the trade of a particular item than would be the case with a smaller elasticity. A declining distance elasticity over time implies that distance is having less impact on trade with the passage of time. According to the literature, however, the estimated trade effects of distance, a proxy for transportation costs, are not diminishing over time. Using a gravity model, Leamer (1993) estimated a distance elasticity in 1985 not dramatically smaller than one estimated for 1970. Boisso and Ferrantino (1997) generated similar findings for their year-by-year estimates between 1950 and 1988. Eichengreen and Irwin (1997) showed that the effects of distance on trade did not diminish during the inter-war period, nor in 1949, 1954, and 1964. Frankel (1997) concluded from a survey of gravity model results that there was no statistical evidence of a decline in the distance elasticity for trade in the past century.

Most of the above results, however, were obtained from aggregated data, often total bilateral trade among trading countries, not based on specific commodities such as detailed food and

agricultural products. Recent developments in transportation and communication technology may have played an important role in reducing shipping costs, particularly for perishable products and possibly for other food products. We believe it is, therefore, important to let the empirical analysis inform us about the impact that distance has had on specific agricultural goods.

A key distinguishing characteristic of many food and agricultural products is perishability, which requires refrigeration and prompt delivery to the consumer to assure quality. Marketing prime-quality perishable products abroad was either prohibitively expensive or simply not feasible until 30 years ago. The adoption of modern technologies has facilitated trade of many high-value agricultural products in recent years. Examples of such technologies include:

- ❑ Improved communication systems allowing for better monitoring of quality, tracking of shipments, and coordinating of steps through the marketing chain of time-sensitive food products.
- ❑ Greater use of intermodal systems and the reefer box, a mobile refrigerated warehouse, from the point of production to the point of consumption combined with modern container terminals, allowing for quicker turnaround in ports and faster delivery of product over greater distances.
- ❑ Developments in refrigeration, controlled atmosphere (CA) and humidity control that reduce spoilage and allow the substitution of cheaper ocean shipping for air transport for some of the more perishable items.
- ❑ Packaging innovations, fruit and vegetable coatings, bioengineering, and other techniques that reduce deterioration of food products and help shippers extend the marketing reach of U.S. perishable products.
- ❑ Development of infrastructure linkages for making ocean shipping of perishable products not only technologically feasible but also profitable for all players. Providing sufficient crane capacity, adequate storage space, and ready access to highway and rail connections. Developing efficient inspection and customs services by government agencies, as well as port-to-market distribution systems, critical for fresh produce that often must arrive quickly on store shelves.

To assess the role of distance on the performance of exports of U.S. food and agricultural products and evaluate how that role has changed over time with new transportation technologies and logistical systems, we use a simple gravity model to estimate distance elasticities and their time trends for both aggregate categories and specific food and agricultural products, using pooled cross-section and time-series data for more than 100 destinations over 30 years. The results for the aggregate categories were similar to previous research. But we often found statistical evidence of a declining effect of distance when disaggregated data were used. Examples include most meats, eggs, and certain processed foods.

### **Distance and U.S. Food and Agricultural Exports**

To benefit from growing overseas demand, U.S. agriculture has had to meet the challenge of delivering food products to purchasers thousands of miles away with no substantial loss in freshness and quality. Two of the largest U.S. markets, Japan and the European Union, are thousands of miles beyond the shores of the United States (figure 8).

It is evident from the trade data that U.S. food and agricultural products are traveling greater and greater distances. East Asia, which surpassed the EU in the 1980's as the most important regional market for U.S. food and agricultural products, is about 50 percent further away than the EU (from Chicago, Tokyo is 10,200 kilometers and The Netherlands is 6,660 kilometers) (figure 9). Until recently, East Asia was even larger than the combined nearby markets of Canada and Mexico. It is also evident that non-bulk and perishable products are coming to dominate U.S. agricultural exports in recent years.

Over time, the mean distance traveled by many commodities has risen. U.S. bulk exports traveled an average of 8,000 kilometers in 1962 to 1964; roughly the distance from the United States to Brazil. This distance rose to 8,700 kilometers in 1993 to 1995, an increase of 9 percent. In the case of U.S. horticultural exports the rise was greater, from 4,400 kilometers in 1962 to 1964 to 6,300 in 1993-95, an increase of more than 40 percent (figure 10). This occurred despite relatively high transportation costs, accounting for 30 to 40 percent of fob values for a variety of horticultural products (figure 11).

U.S. meat exports, with the exception of poultry meat (whose production is not bound the way beef and pork are to space and land resources), are also traveling greater distances now compared with 1979 to 1981. U.S. beef exports, for example, averaged 8,200 kilometers in 1993 to 1995, compared with 7,500 kilometers in 1979-81, thanks to market-opening measures in East Asia and advances in logistics and transportation technology. A larger share of Japanese beef imports is chilled rather than frozen, reflecting greater sophistication in shipping technology and handling techniques. Meats are one of the fastest growing components of U.S. food and agricultural exports, traveling as far or further than more storable products like corn.

What are the underlying reasons for such differential growth in trade for U.S. bulk versus perishable food products?

Part of the explanation is attributable to the unevenness in technological innovation as it applies to specific food and agricultural commodities. For example, transport costs may have declined more rapidly for meats than for feed grains with the advent of and increased sophistication and speed of containerized versus bulk shipping.

Another reason is that more significant cuts in protection may have taken place for perishable products than for bulk commodities in the last 10 to 15 years. In Japan, for example, liberalization of meats has been far more dramatic in recent decades than for feed grain, which has been relatively freely traded for some time.

Finally, unbalanced economic growth across countries may be an explanation. The economic and income growth in far away countries was faster than in neighboring countries. The so-called shift



of gravity to East Asia, Japan, Korea, Taiwan, and Hong Kong, may account for a larger share of our meat and horticultural exports traveling a longer distance than before.

Since there are several possible explanations, we need an analytical model to determine the relative importance of transportation costs as one possible factor in explaining the bulk-to-perishable shift in U.S. agricultural exports.

### Model Specification and Data Sources

The gravity model is a commonly used empirical tool to assess the role of distance (a proxy for transportation costs) in international trade that has gained growing theoretical acceptance in recent years (Hummels and Levisohn, 1995, and Deardorff, 1995). In this study, we apply a simple double logarithmic version of the gravity equation as follows:

$$\begin{aligned} \ln X_{isrt} = & \alpha_{isr} + (\beta_{0i} + \gamma_i T) \ln DIS_{sr} + \beta_{1i} \ln GDP_{st} + \beta_{2i} \ln GDP_{rt} + \beta_{3i} \ln \frac{GNP_{st}}{POP_{st}} + \beta_{4i} \ln \frac{GNP_{rt}}{POP_{rt}} \\ & + \beta_{5i} \ln LAN_r + \beta_{6i} \ln AGLAND_{rt} + \beta_{7i} \ln RCA_{rt} + \beta_{8i} \ln EXC_{rt} + \beta_{9i} ADJ_r + \mu_{irst} \end{aligned}$$

Where  $X_{irst}$  is the value of exports of commodity  $i$  from country  $s$  (the United States) to country  $r$  at time  $t$ , measured at country  $r$ 's cif price.  $GDP_{st}$  and  $GDP_{rt}$  stand for real GDP (in 1987 U.S. dollars) of the United States and the importing country, respectively, and measures the size effect of the two economies. The next two items in the equation are per capita real GNP for the United States and for the importing country, respectively. Importer per capita income gauges the income effect on imports. The variable  $LAN_r$  is an index ranging from 0 to 10,000, which measures the percentage of people that speak English in both the United States and the importing country.  $AGLAND_{rt}$  and  $RCA_{rt}$  are arable land and Balassa's Revealed Comparative Advantage index (Balassa, 1965), respectively.  $EXC_{rt}$  is a real exchange rate variable measured by the units of the importing country's home currency per U.S. dollar. The variable  $ADJ_r$  is an adjacent dummy variable equal to one when the importing country shares a common border with the United States and zero when it does not.  $T_t$  is a time trend variable,  $\mu_{irst}$  represents the error terms (their structure will be discussed later), and  $\alpha_{isr}$  and  $\beta_{0i} - \beta_{9i}$  are parameters that need to be estimated.

Since only exports from the United States to its trading partners are considered in this study, the coefficient of U.S. real GDP acts as a time-varying shift parameter measuring the impact of economic growth in the United States on its agricultural exports. This is expected to be positive because the United States has a strong comparative advantage in agriculture. Since growth in U.S. food demand generally is slower than growth in demand for other products and services, the export market for agricultural products becomes relatively more important over time. The coefficient of real GDP for the importing country reflects the size effects and is expected to have a positive effect on U.S. agricultural exports. The coefficient of per capita real GNP is an income elasticity for the importing country: its sign depends on whether the commodity is a necessity or luxury. By using real GDP variables, we have taken aggregate price changes over time into

account. Since data on real, effective exchange rates are not available for all countries and years in our sample, the price-level-deflated exchange rate is used, which is the yearly average market exchange rate deflated by the CPI in the importing country. An increase in the dollar value of an importing country's currency implies an appreciation of the U.S. dollar and is expected to have a negative impact on U.S. agricultural exports. The coefficient of the exchange variable  $\beta_{6i}$ , therefore, should have a negative sign. The distance variable (DIS) is a proxy for the transportation cost and expects to be negatively correlated with U.S. exports.

There are a number of theoretical justifications for the above specification. Bergstrand (1989), for example, derives a similar specification from a microeconomic model of differentiated products, incorporating factor endowment variables of the Heckscher-Ohlin type and nonhomothetic tastes along the lines of Linder (1961). In his derivation, the importing countries' per capita GDP enters directly while the exporting countries' per capita GDP is a proxy for the exporting countries' capital-labor ratio. In such an explanation, the coefficient of U.S. per capita GDP measures the impact of capital intensity in the United States on U.S. agricultural exports.

The physical distance measure used in this study is the great-circle route measured in kilometers between Chicago and the most populous cities in the importing countries as calculated in Fitzpatrick and Modlin (1986). It does not change with time and therefore only varies across export destinations. Because of the progressive decline in international transportation and communication costs due to advances in technology, we expect the effect of distance on U.S. exports to decline over time. To formally test this hypothesis statistically, a linear time trend is used to capture the change in the distance elasticity over the sample period. Since the elasticity of distance is expected to be negative, a positive  $\gamma$  indicates a declining trend in the effect of distance on U.S. agricultural exports.

The measure of linguistic similarity we use was generated by Boisso and Ferrantino (1997). They first calculated the percentage of people in each country who speak each individual language as their preferred language and then constructed a linguistic similarity index for the two trading countries by multiplying together their language shares. The index has a maximum value of 10,000 when everyone in the two countries speaks the same language and zero when the native languages are totally dissimilar. It is superior to the linguistic dummies typically used. The language similarity index takes into account linguistic diversity within countries. In theory, as more and more people in the importing country speak the same language as in the exporting country, communication costs decline, thus facilitating trade. A positive coefficient is expected for this variable.

The gravity model specified in the equation is estimated by pooling time series and cross-sectional data. We use U.S. agricultural export data for more than 100 trading partners over 30 years (1966 to 1995). The export data are taken from United Nations Commodity Trade Statistics database and are based on cif prices. We first aggregate agricultural trade data into five broad categories: 1) bulk commodities; 2) intermediate processed goods; 3) horticultural products; 4) consumer-ready processed goods; and 5) other agricultural products.<sup>1</sup> The first four categories add up to

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<sup>1</sup> Bulk commodities are unpackaged products which include grains, oilseeds, plant-based fibers such as

the official USDA definition for total agriculture (FATUS). The fifth category includes distilled spirits, fish and marine products, and forestry products. In order to assess the role of distance on specific agricultural products and more narrowly grouped commodities, the data were further disaggregated into more detailed commodities based on the International Bilateral Agricultural Trade (IBAT) classification, an international classification scheme designed by ERS specifically for agricultural trade. The IBAT classification condenses over 250 SITC four-digit commodities into 110 commodity groups. The data for real GDP, real GNP, and population are from the World Development Indicators 1998 CD-ROM (The World Bank, 1998), while the nominal exchange rates and CPI are from the IMF International Financial Statistical online database.

Since we estimate the gravity model at a very disaggregated level, there may be a fairly strong Coals to Newcastle effect.<sup>2</sup> This effect biases upward the distance parameters. It occurs when region's exports of commodity i to region r are negatively correlated with region r's comparative advantage in commodity i, because of geographical clustering of comparative advantages. For example, a gravity model of Saudi Arabia's export in oil would find that it does not export much to other nearby Persian Gulf countries because their neighboring countries also export oil. To circumvent the possible bias from a geographic clustering of comparative advantage, we introduce arable land area and Balassa's RCA index<sup>3</sup> as an alternative explanatory variables into our gravity equation specification focusing on U.S. exports of agricultural goods. The Balassa index captures not only the comparative advantage associated with land but also other factors. We expect the coefficient estimates for both of these two variables to have a negative sign, the more arable land the importing country has (or the stronger the comparative advantage they have), the less its demand for U.S. agricultural exports. The data on arable land was downloaded from the FAO

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cotton, raw rubber and unmanufactured tobacco. These commodities are usually directly linked with extensive use of arable land for production. Processed intermediate goods are derived from bulk commodities and need further processing for human consumption, such as flour, feed, live animals, and animal fats and oils. Horticultural products are consumer-ready, unprocessed fresh commodities such as fresh fruit, vegetables, and flowers. They often require special handling such as containerization and refrigeration. Consumer-ready processed products are commodities that have been significantly transformed such as prepared and preserved vegetables, fruits and nuts, chilled and frozen meats, eggs, dairy products, processed meats and beverages.

<sup>2</sup> We are very grateful to Michael Ferrantino for his comments in this regard and his suggestion to use Balassa's RCA index as a repressor.

<sup>3</sup> RCA is the share of each commodity group in an economy's total exports divided by that commodity group's share of world exports (See Balassa, 1965). If the economy's export specialization has not been distorted by government policies, the ranking of RCA values indicates comparative advantage relative to the rest of the world. Formally, denoting  $E_{ij}$  to be the export of good i of country j, and assuming that there are n commodities and m countries engaged in trade, then the RCA can be defined as:

$$RCA_{jr} = \frac{(\sum_j / \sum_{j \neq 1} \sum_{jr})}{(\sum_{s \neq 1} \sum_{sj} / \sum_{j \neq 1} \sum_{js})}$$

|  |                                    |
|--|------------------------------------|
| Share of good j<br>in country r's<br>total exports | Good j's share<br>in world exports |
|--|------------------------------------|

In practice, the ranking of the RCA index usually not only reflects fundamental comparative advantage, but also government policy distortions, which may subsidize or restrict exports of particular commodities.

Website, while the RCA indices were calculated from the United Nations Commodity Trade Statistics database. Data on total agricultural exports were used in calculating the RCA indices for the 110 disaggregated food and agricultural commodities, and data on total merchandise exports were used in the indices for the five aggregated agricultural commodities.

## Econometric Issues

In pooling cross-section and time series data, we have to take into account variations (i) across time, (ii) across export destinations, and (iii) joint disturbance in both dimensions. Therefore, the error term in the equation can be decomposed as follows:

$$\mu_{isrt} = \sigma_{ir} + \lambda_{it} + v_{isrt}$$

Where  $\sigma_{ir}$  is the importing country effect,  $\lambda_{it}$  is the time effect, and  $v_{isrt}$  is a white-noise disturbance term. Such an error structure leads to the use of a two-way error component model. In such models, both the importing country's specific error  $\sigma_{ir}$  and time error  $\lambda_{it}$  is assumed to be normally distributed random effects. An estimated generalized least square (EGLS) procedure will be used to estimate such models. It involves estimating each of the variance components in the first stage and applying generalized least squares (GLS) to the data in the second stage by incorporating the estimated variance-covariance matrix obtained in the first stage.

There are three reasons to make such an assumption on the error structure. First, both the physical distance and the linguistic similarity index are time-invariant measures.<sup>4</sup> Assuming  $\sigma_{ir}$  to be fixed would make it impossible to estimate their coefficients. Second, some computational advantages accrue from using a random-effect model rather than a fixed-effect specification when the number of importing countries is as large as in our sample. Finally, since there is incomplete data on real GDP and exchange rates for importing countries, our sample does not include all trading partners of the United States (only about two-thirds). Thus,  $\sigma_{ir}$  should be considered as being randomly distributed when making inferences about parameters of the population.

Another econometric issue is how to deal with those countries with which the United States has zero exports. There are a large number of such observations, especially in the detailed commodity data. Alternative methods have been proposed (Frankel, 1997). An observation with zero export value can be simply omitted, which may lead to selectivity bias. Arbitrary small numbers may be used in place of zeros. A semi-logarithmic formulation and Tobit estimator can be used with the loss of interpreting the estimated coefficients as elasticities (Havrylyshyn and Pritchett, 1991). The approach used in this study is based on Eichengreen and Irwin (1995). It preserves the double-log form, and yields results similar to the Tobit model.

In such an approach, the dependent variable is transformed as  $\ln(1 + \text{exports})$ . When the value of

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<sup>4</sup> The linguistic index is invariant because it changes slowly and because of serious data constraints in constructing a time series of such an index.

exports is large, the dependent variable is roughly equal to  $\ln(\text{exports})$  and the constant elasticity relationship is preserved. For small export values, the dependent variable is roughly equal to exports itself, approximating the semi-log Tobit relationship. After the data transformation, the equation is estimated by a scaled OLS estimator in which the least squares estimates are divided by the share of observations of U.S. exports not equal to zero (Eichengreen and Irwin, 1995), and the Tobit method, which allows simultaneous modeling of the threshold effect of zero versus positive trade and estimation of the elasticities of the dependent variable with respect to the various regressors (Boisso and Ferrantino, 1997).

## **Major Estimation Results**

### *1) Estimation results at aggregate level*

The estimation results from the three methods are quite similar, especially for the scaled OLS and Tobit models. The estimated coefficients for major explanatory variables such as distance, United States and importing country's GDP, the real exchange rate, and arable land endowment in the importing country, all have the expected sign and most are statistically significant.

The estimated coefficients of U.S. GDP are highly significant regardless of the estimation procedure. This shows that economic growth in the United States has a strong impact on U.S. agricultural exports. Bulk, intermediate and horticultural products have elasticities greater than one while consumer-ready and other agricultural products have elasticities less than one. This indicates that the exports of bulk and intermediate products expanded at a more rapid rate relative to U.S. GDP growth than exports of consumer-ready products, with the latter having relied more heavily on the domestic market. However, U.S. aggregate agricultural exports grew faster than GDP, indicating that the international food and agricultural market is an important source of growth for the U.S. economy.

The elasticity of the importer's GDP is also significant (with consumer-ready products in the error-component model the only exception) and greater than one for U.S. bulk, intermediates, and total agricultural exports, but less than one for horticultural, consumer-ready and other agricultural commodities. The estimated elasticity of the importer's per capita income indicates U.S. bulk and intermediate exports are necessities for the importing country while horticultural, consumer-ready and other agricultural products are luxuries, consistent with our a priori expectations.

The elasticities of real exchange rates are all negative and statistically significant (except other agriculture in the error component model). The magnitude of these estimates shows that U.S. exports of horticultural and consumer-ready products are more sensitive to changes in exchange rates than bulk products since the former are relatively more elastic with respect to price than the latter.

All the coefficient estimates of arable land in importing countries have the expected negative sign and are statistically significant, indicating a strong negative correlation between U.S. agricultural exports and importing countries agricultural land endowment. The Balassa index is not used in the aggregate equations because the land variable appears to be a sufficient proxy for comparative

advantage for the broad commodity aggregates. The elasticities of agricultural land in importing countries are relatively larger for bulk commodities than other products, indicating land endowment in the importing countries has a stronger impact on U.S. bulk exports than other commodities. This is consistent with intuition. However, the coefficients of the adjacency dummy are all negative, which contradicts the conventional wisdom that a common border will boost trade. The negative coefficient may be explained by the fact that the NAFTA countries are all net agricultural exporters. The use of land as an explanatory variable to represent comparative advantage in the model may not be sufficient to fully isolate the geographic effects from the Coals to Newcastle effects we discussed earlier.

The impacts of language similarity are all positive and statistically significant for horticultural, consumer-ready, and other agricultural products but insignificant for bulk and intermediate products in the scaled OLS and Tobit models. This may be explained by the notion that marketing horticultural and consumer-ready products demands more language proficiency than bulk products. Possessing a common language enables U.S. suppliers to be more effective with promotional activities and enables them to better understand how to differentiate products that suit the tastes of foreign consumers. Note, that all estimates for the effect of language similarity in the random effect model are statistically insignificant. However, their signs being positive conform with our expectations.

The estimated distance elasticities are always negative and statistically significant in each of our estimated models. The estimated coefficients on the log of distance for the five major categories of U.S. agricultural exports range from -1.5 to -2, which means that when the distance between the United States and the importing country increases by 1 percent, U.S. total agricultural exports will decline by 1.5 to 2 percent. The negative impacts of distance on horticultural products and bulk commodities are relatively larger than for the other agricultural commodity groupings. The stronger negative effect of distance on horticultural products is consistent with the fact that horticultural products are the most expensive to transport because of their bulkiness relative to value and the higher handling costs given their high degree of perishability. However, the larger distance elasticity for bulk commodities is somewhat surprising. Perhaps this can be explained by differences in the rate of technological change characterizing the various agricultural subsectors. In recent years, rapid technological innovations have taken place in the way agricultural perishables are shipped. By contrast, little has changed in the way in which bulk commodities are transported.

The coefficients for the time trend of the distance elasticity at the aggregate commodity level are generally not statistically significant. However, the estimates for bulk exports have significant negative signs from the scaled OLS model and the estimates for horticultural exports have significant positive signs from the error component model. These results are consistent with findings elsewhere in the empirical literature, which found no clear-cut statistical evidence of a declining role for distance in aggregate trade (Boisso and Ferrantino, 1997, Frankel, 1997).

The significant variation in the proportion of transportation-costs-to-export-value for different U.S. agricultural exports, with ratios rising for some products but falling for others, tend to average or cancel out in the broad aggregate categories. The desire to explore the role of distance at a more detailed commodity level motivates us to undertake more detailed, disaggregate

analysis.

## *2) Estimation results at detailed commodity level*

Among the 104 commodities whose distance elasticity have the expected negative sign, 43 have a statistically significant positive sign for the time trend, indicating that distance may have had a declining effect on U.S. exports. Thirty-five of the categories have a statistically significant negative sign, indicating that distance has become more of an impediment to trade with time. Finally, the other 26 are statistically insignificant, implying that the effect of distance has not changed over the sample period.

To construct the three tables, we first ran two regressions for each detailed product using two different measures of comparative advantage, one that used the importing country's arable land as a proxy and the other that used the RCA index to represent comparative advantage. All the regressions with a wrong sign for the variable representing comparative advantage were deleted. For those commodities with a statistically significant negative sign for both arable land and the RCA index, reported estimates were selected on the basis of adjusted R squares, the sign and t-statistics of other explanatory variable such as common border and language similarity index, as well as intuition. For those commodities that did not have a statistically significant coefficient estimate for either variable, additional regressions were run without any comparative advantage variables.

Many of the commodities for which distance has become less of an impediment to trade over time includes such perishable products as fresh and chilled meat, fresh eggs, flowers, fruit, vegetables and other processed products. Only a couple of bulk commodities, namely cotton seed and sugar, show diminishing effects for distance.

Commodities in the second group for which distance may have had an increasing effect are mixed. This group includes important bulk products such as wheat, soybeans, tobacco, natural rubber, barley and oats, but also quite a few processed commodities. Seventeen of the 35 commodities in this group still have a negative sign for their adjacent dummy variable, 12 of which are statistically significant, indicating that Coals to Newcastle effects may have biased the empirical estimates (compared with the first group of commodities, their estimated coefficients of the adjacent dummy are positive with only four exceptions). The adjacency variable should be positive, reflecting lower costs of doing business in a familiar, nearby market. When it is negative, it may indicate that the strong effects from comparative advantage are not being fully isolated.

The empirical results support the notion that the cost of shipping processed products such as various meats may have declined faster than the cost of shipping feed grains such as corn. The distance elasticities for most meats have a statistically significant declining trend, while the coefficient for corn is not significantly different from zero. In addition to income growth and trade liberalizing measures, transportation costs for meat may have declined relatively more than for feed grain, thus leading to a substitution of meat for feed grain in trade.

The regression model performed better at the individual agricultural product level than at the

aggregate level. Most commodity- and product-specific equations had correct signs on the estimated coefficients and were statistically significant. The coefficients of language similarity, for example, were almost always positive and statistically significant for most commodities. Moreover, the results at the detailed level often clarified ambiguous results obtained from the broad aggregate groups. For example, the estimated border effect was positive for most processed and consumer-ready products; but the border effect was negative for most bulk products. This demonstrates that adjacency facilitates trade in high-value products. It also shows that similarities in arable land endowment reduce trade between neighboring countries in specific land-intensive bulk commodities. Such offsetting effects can confuse the results when highly aggregated data are used.

## **Conclusions**

This study represents the first attempt to estimate the effects of distance on U.S. exports of specific food and agricultural commodities. By using a simple gravity model and pooling cross-section and time-series data, we found that the impact of distance on U.S. agricultural exports varies significantly for different products.

Similar to most previous gravity model estimations, we also found almost no statistical evidence to support a diminishing trend in the effect of distance on aggregate groups of commodities. Generally speaking, the gravity model performed better using more detailed, disaggregate data. The specific commodity and product approach enables us to more precisely determine the impact of technology-induced reductions in transportation costs and the role of distance. For example, the empirical evidence shows a declining impact of distance on U.S. agricultural exports for certain perishable and processed products. These findings are contrary to previous studies that have not found that the distance effect is diminishing. They are also at odds with our more aggregate results.

Two caveats need to be mentioned. Because of many missing values in the detailed disaggregated trade data, the sample size for many commodities was reduced. This could lead to possible estimation bias when using the RCA index as an explanatory variable representing an importing country's comparative advantage. To further isolate geographic effects from the impact of comparative advantage, it may be necessary to exclude Canada from the sample, especially for bulk commodities. In addition, the robustness of the coefficient estimates need to be further tested by filling those missing values in the RCA index and applying a similar model to other countries export data.

There are many factors that explain the differential growth in U.S. bulk versus perishable product exports. In this paper, we focus on one of the most important determinants, distance. When technological advances in transportation and logistics dominate, lower transaction costs reduce the elasticity of distance. However, the distance elasticity may remain unchanged or even increase over time in response to differential rates of growth in different parts of the world. More research is needed to better understand this "shift in gravity" phenomenon.

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## Wrap-up Session

MR. ARMBRUSTER: This session focuses on what this workshop is all about, looking at a research agenda for ERS. We have an excellent panel to help us think about a possible research agenda for ERS. In addition to ERS Associate Administrator Kelley White, we have Dr. Enrique Figueroa, who is the administrator of the Agricultural Marketing Service, which runs a number of marketing-related programs in the United States, particularly, and provides assistance for improving marketing facilities that interface with the transportation system; Shayle Shagam, from the USDA's World Agriculture Outlook Board, which provides important information to private- and public-sector decision makers; and Joedy Cambridge, with the Transportation Research Board, a nonprofit organization that conducts research related to maritime and intermodal transportation.

As we said at the outset, the objectives of this workshop were to raise awareness within ERS about the role of technological and structural change in shipping and its impact on global food and agricultural markets, and then identify the role of ERS in research to provide policymakers a clear understanding of the current and future role of shipping innovations.

We have discussed shipping innovations and some of the changes in laws and we haven't had much focus on the research implications. It has been pointed out that transportation costs are, indeed, on a similar level as high tariffs in their impact on competitiveness in trade. Yet, there is lots of energy and attention focused on reducing trade tariffs, but not nearly so much public attention on reducing transportation costs. Praveen Dixit did point out that one of the goals of ERS is to integrate transportation costs into trade analysis.

Our panelists will explore the implications of what we've heard the last couple of days for the ERS research agenda. We will start out with Kelley White, associate administrator of ERS.

MR. WHITE: Thanks, Walt. I feel a little bit constrained by the time dimension of transportation in trying to draw very many implications for our research program from what I've heard the last day-and-a-half. This has been an extremely interesting and very diverse set of presentations. I sat down this morning for a few minutes with a cup of coffee to think about what I might say. And I started out just trying to jot down a few of the interesting issues that have been raised. Let me just tick off a couple of them.

Why is the United States not a player in ocean transportation? What difference does it make? We have been told that economies of scale are driving the structure of ocean shipping, which has implications for the economic viability of the ports, and that we may end up with all of our agricultural commodities being shipped out of Portland, Oregon. At what point do the diseconomies of the collection or concentration of commodities at a single port and the diseconomies of distribution of imports from a single port outweigh the economies of larger ships?

What are the economic implications of changing transportation technology for the structure of the transportation industry and, thus, for the location and structure of agricultural production,

processing, and distribution? What are the implications of changes in transportation technology and infrastructure for international competitiveness?

What are the implications of what we're told is the deteriorating and depreciating nature of the internal U.S. transportation infrastructure at the same time our competitors in Latin America are investing heavily in modern transportation infrastructure and liberalizing their internal transportation policy? We have talked almost exclusively in the last day-and-a-half about inter-country transportation. It may well be that the implications of differences in internal transportation may be more important than differences in international transportation costs for competitiveness.

And what are the relative trade effects of further deregulation of transportation versus investment in transportation infrastructure?

What are the opportunities for new transport technology--containers, for example--to provide cheaper and more effective means for identity preservation of specialized GMO-created varieties of what in the past have been commodities but now are differentiated products? Is it going to be possible to load containers with a differentiated type of corn at the farm, seal that container and transport it to its ultimate end-user without having to have a whole new set of silos? If we go that direction, what are the implications for where those kinds of differentiated commodities can be produced? Are small farmers disadvantaged by that kind of technological change?

And finally, we haven't talked a great deal about the consumer implications of changes in transportation technology and transportation policy.

Now, all of these are interesting and, I think, researchable economic issues. Which of them should be part of the ERS research portfolio? I'm not sure I know, but I think there are some criteria that we want to use in deciding. First of all, is the issue compatible with the ERS mission, which is to provide economic information to improve public and private decision making with respect to agriculture and the rural economy. And we really are responsible for providing information to improve private decision making if there is a large public good dimension to provide that information; otherwise, the private sector should provide it. In terms of improving public decisionmaking, we have to ask ourselves if there is a public policy issue associated with these interesting, researchable economic questions.

Given that the answer to all those questions is "Yes," that this is something ERS has a legitimate claim on doing, we have to ask what is it that we stop doing if we're going to do those things? Or do we have some excess capacity so that we don't have to stop doing anything? And given that we have the capacity to do it, do we have a comparative advantage in doing it?

The pie chart presented this morning showing the percentage of bulk trade that is agricultural vividly made the point that in many types of transportation services, rendered agriculture is a relatively minor actor. Which says we probably don't have a comparative advantage in doing basic transportation research on the implications of liberalization or changes in technology.

I would conclude that our comparative advantage is in finding ways to include transportation or

border variables in our models and analyses, not only in research but also in our situation and outlook analysis. Especially when making long-term forecasts of changing competitive advantages of commodities, we need to consider both internal transportation regimes and changing costs of transportation among countries.

So, let me stop at that.

MR. ARMBRUSTER: Thanks, Kelley. I should note that Kelley has the requisite educational background to talk about this set of research issues, and he has a lot of research experience in the international agricultural trade arena. And he has experience leading research programs both at USDA and FAO.

Our next speaker, Enrique Figueroa, spent about 11 years on the faculty at Cornell University before coming to his administrator's post in the Agricultural Marketing Service here in USDA in October 1997. Enrique operates in an area where he hears a lot from producer groups and others who are affected by marketing programs, including transportation.

MR. FIGUEROA: I am going to take a slightly different approach than Kelley, even though I concur with a number of the things that he just pointed out. The position that I have at the USDA has allowed me to have a vantage point on some issues that I think are developing and will develop in the near-term future that I think is relevant and important for you to consider in formulating your research agenda.

Kelley already mentioned the issue about the movement of identity preserved products. I think that the railroad industry is moving toward a model of unit train shipments. As you know, there are now four Class I railroads. They are very much, in my judgment, oriented for unit trains of 100 plus cars.

On Tuesday, Du Pont announced that they were going to buy out Pioneer Hybrid. Those firms roughly have patented about 200,000 genes in corn and soybeans. And what they are inferentially going to do is to design corn or soybeans or something else specific for the end- user.

If the poultry producer wants a certain profile of nutritional content in the corn for chicks for the first two weeks and another profile in the corn for the next three or four weeks, then they will provide it. They will do that for pork. They will do that for beef. They will do that for wheat. General Mills will say, "I want this kind of flour," and they will develop it and then lease the seed rights to farmers. And the only way for that approach to be a viable enterprise is for the companies to control the distribution of the product, which means moving a lot of grain from point X to point Y with the integrity maintained.

So the issue to me for your research agenda is to what extent the implications of that kind of development in the technological field of seed manufacturing is compatible with developments in the U.S. transportation system? How is it that those two forces are going to be reconciled and hopefully moved in the same direction so they do not disrupt the movement of product internally? Obviously, that has implications for the movement of product in international markets as well.

Some of you may be familiar with the Army Corps of Engineers' nearly completed \$50 million study of the Upper Mississippi-Illinois water system. They were scheduled to complete it the end of this year. I think now they've changed their date for the end of next year. It has significant implications for what kind of infrastructure changes are made to those two river systems. I think Kelley is exactly right in that the reason that we have been players in the international markets in grain is because we deliver corn to the Gulf ports at a fairly reasonable price and therefore we can compete in the world markets. If that cost of getting it to port increases (i.e., the infrastructure costs internally), then we may not be as competitive as we think.

AMS is in the process of developing a long-term transportation study with a number of feed lot operators in the Imperial Valley of California. They told me, and I have no reason to disbelieve them, that it costs more to move grain into the Imperial Valley of California from the Midwest than to move grain from the Midwest into Tokyo. They are now considering importing grain from the Pacific to feed California cows because it is cheaper to feed China corn in California than to feed Midwest corn in the Imperial Valley. That has very strong political implications. As you know, producers stopped a load of imported barley in Stockton. But the economics are pointing that way.

Are developments in transportation scale neutral for small farmers, medium-sized farmers, and large farmers? To what extent is the research agenda going to provide answers to that particular question?. Some of you are probably aware that the farm economy has really gone through very severe stress. Hog prices hit historical lows in December. Secretary Glickman appointed a Pork Crisis Task Force. There is severe stress in the farm economy, particularly among small producers. Congress is interested in maintaining small- and medium-sized operations. To what extent is the transportation system facilitating, encouraging, supporting, and sustaining that goal?

To what extent is the research agenda going to provide good information for policymakers in the debate for the 2001 Farm Bill. My guess is that there is going to be more in the Farm Bill that addresses the issue of different farm sizes than we've seen in the past. What is the research agenda capability to generate good information for policymakers so they can formulate their positions for this particular Farm Bill?

Last, let me point out that my agency is responsible for developing the organic rule. I was in Europe a month ago for a conference called BioFac, which is now the largest conference in the world with regards to organic products. There were about 35,000 attendees. Almost every country in the world had a booth to display organic products. I met with officials from various EU countries. The Netherlands has just passed a law requiring that all school lunch programs have a minimum of 15 percent organic food; 15 percent is not much, but compared to the 1 percent in this country, that is a very significant amount. And the shipments have to be maintained separately, not as a commodity, but as a differentiated product.

My guess is that you will see more of this developing in Europe. We need to have research that addresses this development. What are the implications for the transportation system? My judgement is that once USDA issues a final rule there will be a significant increase in volume,

particularly because we are going to have standards for livestock and poultry products that require all the inputs, particularly grain, also be organically certified. The demand for transportation for these products is going to be changing.

One last thing, to what extent is the infrastructure, both domestically and internally as well as in international markets, going to be geared to East-West trade versus North-South trade? What about our port capacities, how the boats and ships and vessels call on ports going North-South versus East-West? My guess is that you will see much more trade--this is a longer-term issue--going North-South within the U.S. and with U.S. trading partners than East-West.

So with that, I hope I've contributed to your two days of deliberations. Thank you.

MR. ARMBRUSTER: Thank you, Enrique. I think you highlight some very real issues that the commodity groups and processors in the U.S. are going to need to be paying attention to in terms of future trade. And there are some research issues there that are yet to be looked into.

We'll now turn to Shayle Shagam, who is the livestock analyst with the World Agriculture Outlook Board. Prior to his assignment there, he spent a number of years at ERS.

MR. SHAGAM: This has been a very interesting conference. I am glad for the opportunity to have listened to the discussion and to have learned quite a bit about the impact or the lack of impact transportation may have on some of the competitive issues. What I would like to talk about is what the potential impacts may be for an ERS research agenda.

We see the growing trend toward regionalization in international trade among countries bordering one another. We heard from Professor Frankel yesterday that distance matters. But there are other things, such as a common border and language, that may matter to as great or to a greater extent. Two questions come to mind.

The first is, if we look at what is happening in the EU where they have removed border controls, have we seen any changes in the structure or the cost of transportation? You don't have to go through the customs clearance processes. I don't know if any trucker from any country in the EU can compete in any other country; in other words, can a French trucker pick up a load and deliver it somewhere in Italy. But do those kind of questions make a difference in terms of the impact of distance?

It also has some implications for the United States and NAFTA. If you do away with the cabotage laws, can a trucker from Mexico pick up a load and deliver it somewhere in the United States? For livestock, a significant cost is incurred by a Canadian trucker trying to bring a load of live animals or meat into the U.S. because of the lack of back-haul freight. In other words, if you are delivering a load of beef from a plant in Calgary to Los Angeles, you must have a load going back to Vancouver or someplace. You couldn't pick up a load in Los Angeles and drop it off in Spokane on your way back. So that, in fact, I was told, increased the cost for a Canadian trucker. Does that have a potential impact on who can compete and what kind of price and services they can offer?

For example, is it worthwhile to establish a slaughter plant in Mexico; bring in U.S. livestock, slaughter it in Mexico, and ship the product back to the United States, assuming you can meet the relevant health and safety issues.

The second point is that I'm very pleased that we have people like Heidi because many years ago when I was struggling to do a project for the Meat Export Federation on the cost of delivering meat from various countries into Japan, I called every shipper to try to find the relevant cost of transportation. We didn't have an organization like currently exists in AMS to provide one place for information on a bunch of transportation issues.

But what is the relevant cost of transportation? Do we really know? I had a call one time from a gentleman who hauled livestock to and from Mexico trying to figure out what the cost of delivering livestock to Mexico was from U.S. farms or packing plants. He had just had his truck seized. So do you figure in the cost of that truck in the transportation cost? He was absolutely positive that I should be figuring in the cost of his truck because he was never going to get the thing back again. So those are the questions that have to be raised as well as defining the real cost of the transportation.

The third point is to ask what are the new technologies on the horizon that will alter the cost and potentially the structure of shipping? We heard about the large-sized container vessels that will limit the number of ports they can service. Another question is whether some of these technologies are being pushed forward by industries? As industries consolidate and have sufficient market power, is it worthwhile for them to develop new methods of transportation of some goods that they then suggest to the industry, or are they simply going to be the adopters of whatever technology the industry cares to offer them?

The next question concerns industrial structure. We've heard that you're going to go from a cartel to an oligopoly. Is firm behavior going to change? It may just be that the three firms that are left are going to sit around the table in the morning and determine what the freight rates are going to be for the future. So you've got a cartel that simply exists but didn't have the formal sanction that a cartel formerly had. Does this have an impact on the transportation of grain or meat?

Currently there is the potential merger of the Illinois Central Railroad and Canadian National Railroad. And one of the issues that has come up is will there be sufficient competition in some of the rural areas of Kansas. That is obviously an issue that policymakers have to consider before they give sanction to mergers.

Finally, I raise an issue because it may hold some interesting questions for ERS in terms of supporting USDA's mission. Are we going to see the movement of transportation centers and delivery points for entering this country at different locations than currently? When I first started in ERS most imported meat came into Philadelphia. Why Australian meat was delivered all the way to Philadelphia as opposed to Los Angeles, I don't know. That was the way it was, I was told. Then, eventually Los Angeles began to increase its share of imported meat.



Does ERS have the ability to look at some of these issues about regional delivery of product as a budgetary issue? Where would you put resources if the Animal and Plant Health Inspection Service (APHIS) or the grain inspection service (GIPSA) has to look at building facilities to test product or to increase inspectors? Are there things we can tell them about where future resources might be better allocated? I note this question has arisen in the case of livestock, with APHIS trying to determine if they're going to hire staff. What are the times they need to have people on board to look at livestock? Are there specific times of the year when livestock crosses the border and more staff is needed than other times of the year?

The same question can hold on locational questions as well. If Baltimore is not going to be as important a delivery point for product, do you take resources away from Baltimore and reallocate them to Spokane? ERS may be able to answer some of these questions about where imported product is going to be entering the U.S. market.

Those are the five questions that came to mind as I listened to the workshop discussion. Again, it was a very useful set of discussions, and I appreciate the opportunity to participate.

MR. ARMBRUSTER: Thank you, Shayle, for identifying those questions, which I think have some real relevance to the ERS research agenda.

Our final presenter is Joedy Cambridge, who is with the Transportation Research Board, which is a nonprofit organization. Joedy intends to tell us about the organization with which she works. But suffice it to say that she works on maritime and intermodal research and technology activities and has extensive experience with that in the industry and in her current position.

MS. CAMBRIDGE: Okay. I know some of you in the room are familiar with TRB because Jim serves on one of my committees, Bill Hall serves on one of my committees, and others of you, I know, have participated in some TRB activities.

As Bill mentioned, TRB is the largest unit of the National Research Council. And the National Research Council, for those of you who are not familiar with it, is really the operating arm of the National Academies of Science and the National Academy of Engineering. We are under the authority of the National Academy of Sciences. We serve as an advisor to the Federal Government.

We are private, nonprofit, independent, and self-governing. And one of the reasons that people turn to the NRC and the TRB for a lot of their research is because we are independent. We offer an unbiased look at critical issues. And we do this through study panels that we put together, and through more than 200 volunteer committees on various topics.

I also have some brochures here that give an overview of TRB and information on getting involved in TRB committees.

TRB's activities are sponsored by state DOTs, the administrations of the U.S. Department of Transportation, the U.S. Army Corps of Engineers, the Environmental Protection Agency,

AMTRAK, as well as a number of industry associations. Sponsors are ex officio members of TRB's executive committee, and there is a minimum dollar amount that these organizations contribute to have a seat on that committee.

We also have a number of affiliates, all of whom have designated representatives as official liaisons to TRB. The U.S. Department of Agriculture is one of our affiliate members; Eileen Stommes is the official USDA representative. But we also have a number of other organizational affiliates from both the private and public sector.

We also have university representatives from all over the country. This is a real advantage because we have those links directly to all the major research institutions.

Another thing that my division of the TRB does every year is to visit all 50 States. They are divvied up among our 14 senior program officers and we go out and make what are called "research correlation service visits." That means we visit the DOTs, the major transportation facilities, the major research institutions, major industry associations that relate to transportation, be it the Asphalt Association or groups like the Tennessee Valley Authority, the Waterways Experiment Station of the U.S. Army Corps of Engineers. We are out there every year finding out what research is going on and what research needs have been identified at various locations.

This is all plugged into a research database that we have that States can tap into. Recognizing that we have limited resources, both in terms of money and manpower, we feel that being a clearinghouse for research is probably one of the most valuable services that TRB provides.

The mission of TRB is to promote innovation and progress in transportation by stimulating and conducting research, by facilitating dissemination of information, and encouraging the implementation of research results. Obviously, this is one of the reasons that Bill called me when he first started talking about this workshop.

Our specific goals are to foster and contribute significantly to the research, development, and implementation of new transportation technologies and innovative practices in the United States to strengthen our activities in the nonhighway modes. TRB first began 75 years ago as the Highway Research Board, and it was 25 years ago that it became the Transportation Research Board. And slowly, but surely, we are getting beyond the asphalt and concrete to really focus more attention on the other modes of transportation. Also, to contribute to decisionmaking on national transportation policy issues, to improve communication and public awareness of issues in transportation both here and abroad, and to promote greater participation in our activities by the private sector.

Our activities range from policy studies, which are part of our division B, Policy Studies and Information Services, and I have a couple of examples. This is one recent report, "Policy Options for Intermodal Freight Transportation." This one was just recently published and issued. And here's another one, "Paying Our Way: Estimating the Marginal Social Cost of Freight Transportation." We also have one underway right now on freight transportation capacity into the 21st century, again an issue that's certainly of great interest to your constituency.

We hold an annual meeting here in Washington, DC in January. About 8,000 people attend from all over the world. We have about 450 concurrent sessions that run from Sunday through Thursday. I strongly encourage you to get information about it off our website and possibly participate in some future year.

Just as an example, solicited research papers are presented. We also get unsolicited research papers that are peer-reviewed and many of these are presented at the annual meeting. Some get published in our Transportation Research Record series. I brought one example that features ports, waterways, and marine transportation. Most of these papers deal specifically with inland waterway transportation.

We also have invited presentations. We had an excellent one this year by Tim Gerik of the Iowa Corn Growers Association who talked about the developments happening outside the United States that are going to affect the competitiveness of U.S. agricultural exports, specifically some of the inland waterway developments in South America. As they become capable of transporting their agricultural commodities more competitively than we can, it is going to have a significant impact on U.S. agricultural exports. And, of course, the biggest concern is that if they can develop an inland waterways system that does not require the kind of major infrastructure investment that our inland waterways system now requires as it gets updated, that is going to have a significant impact. He also pointed out the issues relating to rail transportation, issues for the agricultural growers, including the cost and the lack of equipment. So, really, it all just mushrooms and everything affects everything else.

TRB holds mid-year committee and task force meetings. Every year we have a summer Ports and Waterways Conference. Last year it was in Seattle, the year before that it was in Gulfport, Mississippi, and in July 1999, it is going to be in Duluth, Minnesota. So, obviously, we will have a very heavy emphasis in this program on agricultural and bulk shipping.

We also organize annual specialty conferences on a number of issues. For example, a freight intermodal conference is coming up in Long Beach in February 2000. We are cosponsors of a number of other meetings and conferences that are actually put together by other organizations.

TRB has a number of publications, including the *Record*, which I showed you earlier. We also put out a bimonthly research magazine. The one for May-June of 1998 focuses on ports and waterways. It includes an article on the impact of megaships on landside infrastructure and one on transportation data that you may find of interest. We publish special reports, as I mentioned, and reprints and CD-ROMs of all the research papers presented.

Study titles that either have already been published or will be published include "Measuring the Relationships Between Freight Transportation Services and Industry Productivity" and "Financing and Improving Highway Access to U.S. Intermodal Cargo Hubs," both relevant to the workshop topic, as you can see. There is a whole range of things that we get involved in. I strongly encourage you to build on some of the work that we do and also to suggest research topics. Our committees put out calls for papers and we welcome any suggestions and ideas from

groups such as yours.

MR. ARMBRUSTER: Thank you, Joedy. I think you can see there's an opportunity for some interaction between TRB and the Economic Research Service. As you look at research issues, there might be some TRB materials and findings to help you further refine your research agenda related to transportation and trade.

Now, we'll take any questions from the audience. If you have a question for a specific person, identify them, otherwise we will throw it open to the whole panel.

MS. BALLENGER: I think if it is directed to anybody, it would probably be best directed to Joedy. We've talked a lot over the last couple of days about technological change in transportation, and, clearly, there has been an awful lot. But we haven't talked much, with maybe the exception of some of Dick Parry's comments about the ARS work, about where those innovations are coming from and what is driving them.

There is some good research that we could take a look at to help us better identify the driving forces behind these innovations and the relative roles of the public versus private sector in transportation-related innovations. I'm not just talking about the ships themselves, but the whole set of things that we've talked about in terms of cold or supply chain management over the last couple of days.

MS. CAMBRIDGE: Well, I can't say that there is any easy way to find this information. We do compile all of these. We have what is called the Transportation Research Information Service, or TRIS, database, which is searchable, and it does include things that relate to transportation technology, as well as transportation economics and transportation planning. So if there is a particular topic that you are interested in, that is a good place to start. We work jointly with the Bureau of Transportation Statistics to compile materials that get entered into TRIS, which ranges from journal articles, to technical studies, to policy studies.

TRIS has been around for a number of years. Just about anything that is going on in transportation research gets submitted and entered into the TRIS database.

We also coordinate with groups such as SNAME, the Society of Naval Architects and Marine Engineers. In May, we will be hosting one of their committee meetings at TRB. So we keep our contacts and we have liaisons with all these other industry groups. There is also the American Society of Civil Engineers. And, again, we cosponsor things that go on with these other organizations. But we are the central clearinghouse for all of the stuff that is going on out there.

MR. ARMBRUSTER: Another question?

MS. GLASER: Lewrene Glaser, ERS. Joedy, what kind of air transportation information is in the database?

MS. CAMBRIDGE: We have a whole set of committees that deal only with aviation; aviation

issues, aviation technology, and public policy issues such as noise. I know one of the points someone made this morning was that U.S. airports never prevent old airplanes from landing at U.S. airports. Not quite true. It depends on how much noise that old aircraft makes. But yes, there is a senior program officer who is an aviation specialist who can certainly help you and refer you to some information.

But on the cargo side, I would also encourage you to touch base with the Cargo Airline Association, which is based here in Washington, DC. Steve Alterman is the executive director.

I've only been at TRB for two-and-a-half years and prior to that I spent about 20 Years in consulting and did a combination of aviation and maritime work. And we did a very comprehensive study on the economic impact of the all-cargo airline industry on the U.S. economy and gathered a lot of proprietary data and information that was then aggregated in the final report that was published. But that was prepared for the purpose of going up on the Hill on behalf of the air cargo industry.

So there is some information out there but it certainly is a little harder to get hold of than it is for some of the other modes. But I would encourage you to contact CAA because they do have a lot of information available.

MR. ARMBRUSTER: Is there another question from the audience?

PARTICIPANT: How do shipping rates differ by commodity breakdown?

MS. REICHERT: For high-value products, there are three different ways: by weight, which would be in metric ton for some commodities such as poultry, beef, cotton; for other commodities, especially fruit, it is on a per-package basis, such as \$3 per package; or per each 20- or 40-foot container. So it depends mostly on commodity and then also by trade route. Does that help you?

MR. ARMBRUSTER: The point is the Agricultural Marketing Service (AMS) has some data available on this. I think one of the things we have found through interaction with AMS colleagues the last several days is there is potentially a lot of opportunity to interact on your research agenda with AMS. Enrique identified the need for some information to answer questions that are coming forward in their programs. They have some data sources and people working on transportation. So ongoing interaction seems to be a real need and opportunity as you develop your research agenda further, as well as with the TRB people, obviously.

MR. ARMBRUSTER: Now I would like to turn it over to Bill for closing comments. But first, I think we should thank Bill and Nicole and whomever really did the work behind the scenes putting this program together. It has been a good focus on transportation-related issues that will have an impact on the competitiveness of trade from the U.S. viewpoint in the future. Also, let's thank our panelists from this last session.

## Participants

**Walter J. Armbruster** joined Farm Foundation in 1978 and became managing director in 1991. He previously worked in the U.S. Department of Agriculture on marketing efficiency, institutions and policy issues. The Indiana native received B.S. and M.S. degrees in agricultural economics from Purdue University and a Ph.D. in agricultural economics from Oregon State University. His research position in USDA's Economic Research Service was followed by two years as the staff economist for USDA's Agricultural Marketing Service. In this role, he advised the agency administrator on a variety of marketing policy issues involving food and agricultural product marketing. Dr. Armbruster has served as author or editor on a number of marketing research, education and policy publications and provided leadership to organize institutions that continue to stimulate work in these areas.

Armbruster is past president of the American Agricultural Economics Association; secretary-treasurer of the International Association of Agricultural Economists; past chairman of the Council on Food, Agricultural and Resource Economics; chairman, National Farm-City Council; and member of the executive committee of the National Policy Association's Food and Agricultural Committee. He recently completed a term as president of the American Agricultural Law Association. Armbruster has served on numerous regional research and extension committees of the land grant university system, professional association committees, national advisory boards and USDA committees. He is also involved in his homeowners' association, youth club, and church in Darien, Illinois.  
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**William C. Bailey** is Professor of Agribusiness, Massey University. He is currently working with the New Zealand Dairy Board and several New Zealand ports on supply chain management issues.

Prior to his appointment, Bailey was a senior official in the U.S. Department of Agriculture and chief economist for the U.S. Senate Committee on Agriculture, Nutrition, and Forestry. In addition, he was vice president of a Washington, DC-based trade policy research company whose clients included the world's largest agricultural firms, and manager of commodity analysis for a major food company. Bailey also owns a 120-hectare corn/soybean/wheat farm in the central United States.

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**Bob Blair** is senior economist with the Federal Maritime Commission's Bureau of Economics and Agreement Analysis. His areas of expertise include antitrust/competition analysis, and the U.S.-Asia trades. He has also conducted research on liner shipping and U.S. agricultural exports.

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**Joedy W. Cambridge** joined the Transportation Research Board (TRB) in 1996 as port and intermodal specialist responsible for directing TRB ' s maritime and intermodal research and technology activities. She provides professional staff support to TRB committees on inland water transport, ports and channels, intermodal freight transportation, ferry operations, intermodal freight terminal design and operations, military transportation and logistics, and international trade and transportation and to the newly formed TRB task force on transportation infrastructure security. She also conducts annual research correlation visits to state DOTs, MPOs, port, transit, and airport authorities, and universities to identify critical research needs and discuss ongoing research activities.

Prior to joining TRB, she spent more than 25 years as a consultant to ports, airports, federal, state, and local government agencies as well as private sector clients on projects involving strategic planning, market analysis, forecasting, facility design and operations, and survey/interview programs. She has authored a number of research reports and articles and made presentations on a broad range of transportation issues to organizations and institutions throughout the country.

She is actively involved in a number of professional organizations in the areas of transportation and logistics and is a past national president of the Transportation Research Forum. She serves as TRB ' s liaison to the Maritime Administration, the U.S. Army Corps of Engineers, the U.S. Coast Guard, the Defense Advanced Research Projects Agency, and other agencies, associations and organizations involved in marine and intermodal transportation. A native of Minnesota, Cambridge earned a B.A. from Macalester College and an M.B.A. from The George Washington University and has done post-graduate work at Northwestern University.

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**James A. Caron** is the program manager of Shipper and Exporter Assistance (SEA) at the U.S. Department of Agriculture. SEA is a 12-person team of marketing specialists, economists, traffic managers, engineers and horticulturists who provides periodic market information, technical assistance, regulatory representation, special reports, and educational programs to assist farmers and agribusiness firms to competitively ship products to foreign markets. Caron has served in the Department of Agriculture for more than 20 years, mainly in the field of international shipments of grain and high-valued agricultural products. He has managed exporter assistance and market research programs for 12 years, serving as branch chief and division director in the Office of Transportation and the Agricultural Marketing Service. His research includes studies on the domestic shipment of cotton, fresh produce, farm inputs and the feasibility of using futures markets on the ocean freight market for bulk grains. Caron has also traveled extensively overseas working cooperatively with the Foreign Agricultural Service on projects involving lowering the cost of shipping U.S. grain and HVP agricultural products to countries in Asia, Latin America,

North Africa, and the Middle East. In 1992, he spent two months in Russia coordinating the distribution of the first U.S. humanitarian food aid shipments to that country. For his contribution to this effort, Caron received the USDA Superior Service Award. He is currently working on studying the impact Y2K will have on the distribution of food in the United States and to our trading partners.

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**Enrique E. Figueroa**, who was appointed administrator of the Agricultural Marketing Service (AMS) of the U.S. Department of Agriculture (USDA) in October 1997, is responsible for over 50 federal programs. As administrator, he has responsibility for facilitating the strategic marketing of agricultural products in domestic and international markets. AMS' mission is to facilitate the marketing and distribution of agricultural products, ensure fair trading practices, and assure consumers of an abundant, high-quality food supply. AMS gathers and disseminates market news reports on commodities and grades and certifies products based upon nationally recognized AMS standards; improves market facilities and transportation systems; purchases various commodities for Federal feeding programs; and oversees industry efforts to expand consumption of their products.

Figueroa comes to USDA from Cornell University where he was appointed an assistant professor in 1986 and then, in 1992, promoted to associate professor in the Department of Agricultural, Resource and Managerial Economics. Throughout his stay at Cornell, Figueroa's work focused on horticultural product marketing issues. Prior to that he was a post-graduate research agricultural economist and a research assistant in the Department of Agricultural Economics at the University of California at Davis.

His experience also includes work as a staff assistant to the House Committee on Agriculture for the U.S. Congress in 1982 and 1984. He spent 4 years with the California Conservation Corps from 1976 to 1980. He has an M.S. and Ph.D. in agricultural economics from the University of California at Davis, along with an M.S. in horticulture. His B.S. degree in agricultural education is from California State University in Fresno. Figueroa has extensive experience in research, extension, and teaching. He has worked on a number of projects in many parts of the world and has trained a number of graduate students.

Since joining AMS, Figueroa has been appointed to USDA's Hispanic Advisory Council, USDA's Hispanic Association of Colleges and Universities (HACU) Leadership Group, and the White House Initiative on Educational Excellence for Hispanic Americans. In addition, Figueroa was selected as a fellow of the Mexican and American Solidarity Foundation.

**Jeffrey Frankel** has been a Member of the President's Council of Economic Advisers for two years. (President Clinton announced his intention to nominate Frankel in September 1996, and the Senate voted to confirm him in April 1997.) Frankel's responsibilities on the Council include international economics, macroeconomics, industrial organization, and the environment.



Until moving to Washington, Frankel was professor of economics at the University of California, Berkeley, having joined the faculty in 1979. In addition, he was a research associate at the National Bureau of Economic Research in Cambridge, Mass., where he directed the program in International Finance and Macroeconomics; and senior fellow, Institute for International Economics, Washington, D.C.

He served as senior staff economist at the Council of Economic Advisers from 1983 to 1984. In 1988 and 1989, he was a visiting professor of public policy at Harvard University. He has frequently been a visiting scholar at the International Monetary Fund and the Federal Reserve Board. He has also had appointments at the University of Michigan, Yale University, The World Bank, and the Federal Reserve Bank of San Francisco.

Frankel is a specialist in international economics, finance, and macroeconomics. His research interests include the globalization of financial markets, the workings of the foreign exchange market, targets and indicators for monetary policy, the term structure of interest rates, monetary determinants of agricultural prices, international macroeconomic policy coordination, regional trading blocs, financial issues in Japan and the Pacific, emerging markets, and trade and growth in East Asia. He is now adding to the list, the economics of global climate change policy.

Recent books include *Financial Markets and Monetary Policy* (MIT Press, 1995); *The Microstructure of Foreign Exchange Markets* (U. Chicago Press, 1996), *The Regionalization of the World Economy* (U. Chicago Press, 1997), and *Regional Trading Blocs* (IIE, 1997). Frankel is also coauthor (with R. Caves and R. Jones) of the textbook *World Trade and Payments* (8th ed., 1999). In 1991, he won first prize in the AMEX Bank Review Awards for his essay, "Is a Yen Bloc Forming in Pacific Asia?" His most recent academic article is "Does Trade Cause Growth?" *American Economic Review*.

He was born in San Francisco in 1952, graduated from Swarthmore College in 1974, and received his Ph.D. from MIT in 1978.

He is married to Jessica Stern, a fellow at the Council on Foreign Relations. In 1994 to 1995, she was a director for Russian affairs at the National Security Council. She was the model for the Nicole Kidman character in the 1997 movie *The Peacemaker*.

**Madeleine Gauthier** is currently a research associate with Cornell University based at ERS with the Specialty Crops Branch. She is working on analysis of the global market for apples. She has experience in trade policy analysis, economic modeling, and economic development. She received her Ph.D. in agricultural economics from Cornell University.

**Mark Gehlhar** is with ERS's Markets and Trade Division-Agricultural Outlook Branch. He received a B.A. from the University of Wisconsin in his home state and worked in the dairy industry with a private firm for two years before returning to graduate school. He received a Ph.D. from Purdue University in 1994. Gehlhar has been actively involved in the Global Trade Analysis Project (GTAP) and was responsible for the estimation of the trade and transport components of the model. He has conducted studies on multilateral and regional trade agreements

as well as growth and structural changes in world trade.

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**Bill Hahn** has a Ph.D. in Agricultural Economics from the University of California, Davis, and has worked at ERS since 1986. He is currently in the Animal Products Branch, Market and Trade Economics Division.

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**Bill Hall** has spent 19 years in the international transportation industry and for the last 11 years has been working as a consultant doing transport feasibility and planning studies for private investors, shippers, carriers, and public agencies. His emphasis is on container, perishable, general cargo, bulk agricultural, and mining logistics. Hall has project experience in North America, Latin America, Africa, and East Asia. He is a partner in the Seaport Group, a small consulting firm in Seattle and Vancouver that specializes in port planning and logistics analysis.

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**Brian McGregor** specializes in providing information on the handling and transportation of perishable products. He is a supervisory agricultural marketing specialist with USDA's Shipper and Exporter Assistance program.

The *Tropical Products Transport Handbook* he wrote has been widely distributed in Spanish and Russian and excerpts are now being published in one of the local languages in India.

Throughout his 15-year USDA career, McGregor has worked with shippers, importers, and exporters throughout Latin America, most recently in Brazil. He has done similar work in Asia and Europe and is the U.S. member of the United Nations Working Party on the Transport of Perishable Foodstuffs.

Prior to joining USDA, Brian worked for the railway company, Fruit Growers Express, which designed, built, leased, and sold refrigerated boxcars. In his last position there, he operated the facility that tested the efficiency of mechanical refrigeration and insulation.

Brian likes to keep up-to-date on the latest transport technology.

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**Richard Parry** serves as the assistant administrator for technology transfer in the Agricultural Research Service (ARS), USDA. This office is responsible for facilitating, promoting, and implementing commercialization of discoveries by ARS scientists while fostering the development of partnerships between producers, academe, and agencies of the federal and state governments. ARS has a vigorous technology transfer team that prepares patents, negotiates licenses, and establishes Cooperative Research and Development Agreements (CRADA) with the private

sector. This program accelerated the development of inventions into new technologies that have become successful solutions to problems in every phase of agriculture. Examples include: reduction of food pathogens; improvements in permanent press cotton; development of biodegradable plastics; discovery of market opportunities for new crops; development of new biological pest control products; development of new vaccines and delivery methods for vaccines against poultry diseases; and development of 100 percent soybean printing inks.

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**Shirley Pryor** joined the Economic Research Service in 1977 after 18 years with the U.S. Agency for International Development serving in Haiti, Bangladesh, and Tunisia. While with AID, she undertook various types of staff work and managed food and agricultural policy projects. Recently, her research has focused on the nonagricultural parts of the economy that have an impact on the agricultural sector.

Originally from Long Island, Pryor earned a BA from Smith College before joining the Peace Corps and serving in Tanzania for 4 years. After returning to the United States, she earned an MA from Howard University in African Studies, an MA from Michigan State in economics, and a Ph.D. from Michigan State in agricultural economics. She has a 14-year-old daughter.

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**Heidi Reichert** received a B.S. in horticulture production from the University of Maryland. While earning her degree, Reichert was employed in the U.S. Department of Agriculture's Office of International Cooperation and Development where she worked with exporters and importers as part of the Caribbean Basin Initiative. Later, she worked as a laboratory assistant at USDA's Agricultural Research Service where she assisted in soil microbial research aimed at improving the productivity of organic farming.

After completing her B.S., Reichert started working for USDA's Foreign Agricultural Service where she was a partner in a team that managed bi-national research projects with offices in Egypt. Today, Reichert works as a horticulturist in the Shipper and Exporter Assistance Program in the Agricultural Marketing Service of USDA. Her main responsibilities include the production of the *Ocean Freight Rate Bulletin*, a monthly publication that tracks the shipping rates of various containerized agricultural commodities. Reichert also helps plan and conduct seminars designed to educate shippers and exporters about the intricacies of exporting high-valued agricultural products. Currently, she is working toward an MA in international trade at George Mason University.

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**Shayle Shagam** is the livestock analyst with the World Agricultural Outlook Board. Previously, he served for 12 years as an international livestock analyst with the Animal Products Branch of ERS. He has an M.S. in agricultural economics from Michigan State University.

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**Robert L. Thompson** is a sector strategy and policy advisor in the Rural Development Department at The World Bank. He was formerly president and CEO of the Winrock International Institute for Agricultural Development (1993-98), dean of agriculture (1987-93) and professor of agricultural economics (1974-93) at Purdue University, as assistant secretary for economics at the U.S. Department of Agriculture (1985-87), and senior staff economist for food and agriculture at the President's Council of Economic Advisers (1983-85). He received his Ph.D. from Purdue University. He is immediate past president of the International Association of Agricultural Economists, a fellow of the American Agricultural Economics Association and of the American Association for the Advancement of Science, and a Foreign Member of the Royal Swedish Academy of Agriculture and Forestry and of the Ukrainian Academy of Agricultural Sciences.

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**Robert Tse** is an agricultural economist in the Office of the Administrator of the Foreign Agricultural Service (FAS) at USDA where he is responsible for intergovernmental liaison with state departments of agriculture and state legislatures. He is currently working on a project with the National Conference of State Legislatures (NCSL) to ensure that state legislatures are aware of the connection between global food and agriculture export opportunities and state economic development.

Prior to this assignment, Tse worked in the office of the assistant deputy administrator for marketing where he focused on analysis of global consumer demand for U.S. food and agricultural products, particularly high-value consumer foods. He assessed the impact of international demographic shifts, changing tastes and trends, the development of a global middle class, and changes in international food delivery systems on opportunities for U.S. food and agricultural exports. His extensive experience in analyzing consumer foods includes cross-commodity analysis of frozen food, meats and grains, and food ingredients. He has written numerous articles analyzing the market for high-value consumer food products and country markets for U.S. consumer foods. He has also conducted global market strategic planning sessions with the Oregon Department of Agriculture and the California Department of Food and Agriculture.

Tse represents FAS and USDA at international and national conferences. In 1996, he spoke at the Pacific Economic Cooperation Council (PECC) Food and Agriculture Forum in Hong Kong on strategically linking the U.S. agribusiness commodity system and the U.S. industrial refrigeration sector to global consumer market dynamics.

In 1995, he was part of the team that developed the U.S. Department of Agriculture's Long-term Agriculture Trade Strategy, the first such strategy submitted to Congress by a secretary of agriculture. For this work he received the Department of Agriculture's (Group) Honors Award for Excellence. He also received a Merit Citation for his analytical contribution to the Long-term Agricultural Trade Strategy.

Previously, Tse was a global market analyst for consumer foods. His analyses of country markets and high-value consumer foods have been published in *Agricultural Trade Highlights and Ag Exporter*. This work has also been cited by national media and industry trade publications. Tse holds a J.D. from Boston College Law School, an M.S. in agricultural economics from Purdue University and a B.A. in American history from Brown University.

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**Zhi Wang** earned a Ph.D in applied economics at the University of Minnesota and currently is an economist at the Economic Research Service, U. S. Department of Agriculture, through a cooperative agreement with Purdue University. He was previously a research fellow at the Chinese Academy of Agricultural Sciences and served on the board of directors of the Chinese Economists Society (1992-93). His major fields of study include computable general equilibrium modeling, economic integration among Pacific Rim countries, the behavior of economic agents under quantity constraint, and international trade.

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**Michael Wootton** joined Sunkist Growers in January 1997 as director of Federal Government affairs in Washington, DC, after concluding 24 years of government service, primarily in the U.S. House of Representatives and the U.S. Senate, where he worked on the staffs of six California legislators, four representatives and two senators.

He served as legislative assistant and district assistant to Rep. Charles Teague (R-CA); district assistant and administrative assistant to Rep. Bob Lagomarsino (R-CA); state director of Senate operations for Sen. Pete Wilson (R-CA); administrative assistant to Sen. John Seymour (R-CA); and administrative assistant to Reps. Michael Huffington and Elton Gallegly (R-CA).

Additionally, Wootton served as district director of the International Trade Administration, U.S. Dept. of Commerce in San Diego (1981-83) and as legislative director for the Washington office of the law firm of McDermott, Will and Emery (1993-95).

Wootton has an undergraduate degree from the University of San Francisco, where he also attended graduate school in international relations. He served in the U.S. Army Signal Corps, attaining the rank of captain.

**Thomas Kelley White, Jr.**, was born August 6, 1935, and grew up on a farm in Henry County, Georgia. He is the father of two daughters, Elizabeth W. Carroll and Susan W. Johnson.

Kelley earned a B.S. in Agriculture with a major in plant genetics from the University of Georgia in 1957. He was also commissioned a second lieutenant in the U.S. Army. After completing active duty in the Army, he returned to the University of Georgia where he earned an M.S. in agricultural economics in 1960. In 1966, he was awarded a Ph.D. degree in agricultural economics by North Carolina State University. He has also completed the U.S. Army's Basic

Infantry Officer Course and the U.S. Office of Personnel's Senior Executive Education Program at the Federal Executive Institute.

Kelley was graduate instructor at the University of Georgia (1958-60), instructor at North Carolina State University (1960-63 and 1965-66) and agricultural economist with the N.C. State/U.S. AID Mission in La Molina, Peru (1963-65). In 1966, he joined the faculty of the Agricultural Economics Department of Purdue University where he served as assistant, associate, and full professor. He was a member of the Purdue University/U.S.AID project to assist the Federal University of Vicosa in Brazil (1969-71). He was Purdue University's director of international programs in agriculture and director of international education and research (1977-80).

In 1980, Kelley became director of the International Economics Division of the Economic Research Service, U.S. Department of Agriculture and, in 1987, he became director of the Agriculture and Trade Analysis Division in the same agency. In both of these positions, he had overall responsibility for a staff of 150 to 200 economists conducting the U.S. government's primary program of research and analysis on foreign agriculture and agricultural policy.

In 1990, Kelley became director of the Policy Analysis Division of the Food and Agriculture Organization of the United Nations (FAO) headquartered in Rome, Italy. His division was responsible for monitoring and analysis of national agricultural policies, for providing training in policy analysis for developing country governments, and for providing assistance and advice to governments on agricultural policy problems.

In 1995, he was named director of the newly created Agriculture and Economic Development Analysis Division of the FAO. The division was responsible for a program of research, analysis, and studies of agriculture and rural development within the context of general economic development. The division also was responsible for FAO's program of food security analysis. At the end of 1995, Kelley returned to the Economic Research Service where he currently serves as the associate administrator.

During his professional career, Kelley has authored or co-authored several book chapters and more than 50 professional papers. He is a member of the American Agricultural Economics Association, the International Association of Agricultural Economists, the International Agricultural Trade Research Consortium, and the Senior Executive Association. In a professional capacity, he has traveled and worked in more than 35 countries.