TRANSPORT RESEARCH CENTRE

TRANSPORT AND INTERNATIONAL TRADE

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TRANSPORT RESEARCH CENTRE

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On the other hand, ECMT's mission is also to develop reflections on long-term trends in the transport sector and to study the implications for the sector of increased globalisation. The activities in this regard have recently been reinforced by the setting up of a New Joint OECD/ECMT Transport Research Centre.

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TRANSPORTATION COSTS AND TRADE OVER TIME

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TRANSPORTATION COSTS AND TRADE OVER TIME

SUMMARY

West Lafayette, July 2004

1. INTRODUCTION

International economists have recently begun to focus on the role played by transportation costs in determining patterns of international specialisation and trade. There are large and growing literatures that address the impact of transportation on economic geography, the expansion strategies of multinational firms, the wisdom of regional versus multilateral trade liberalisation, and the distribution of bilateral trade. These questions are fundamentally cross-sectional in nature, asking how variation in costs at a point in time influences specialisation and trade. A slightly different question, and the focus of this paper, asks: how have these costs evolved over time?

To address this question systematically, we begin by thinking about transportation costs as a wedge between prices inclusive and exclusive of shipping costs. This paper focuses on two kinds of relative prices, examines what we can learn from them and how they have evolved over time.

The import price wedge compares the price of goods at the exporter's departure port to the price at the importer's point of delivery. That is, it describes how much higher are the prices of imports as a consequence of having to pay shipping costs. Alternatively, one can think of this wedge as a protective barrier behind which less efficient domestic firms hide from the encroach of foreign competition. This wedge helps determine how much a country imports, and the size of its gains from trade. Chapter 2 of this paper describes how the level of transportation costs, and therefore the size of the import price wedge, have evolved.

The sourcing wedge compares two different foreign sources of supply: for example, the price of steel originating in Russia relative to steel originating in Korea when sold in a third market such as France. This wedge determines from whom an importer buys (or to whom an exporter sells). It may be driven by policy, such as preferential trading agreements, but also differences across sources in transportation costs. Chapter 3 of this paper describes the role of distance and transportation scale economies in determining the size of the sourcing wedge and its evolution.

The evolution of both import and sourcing wedges depend on obvious factors such as technological developments and cost shocks, but also on the transportation intensity of the goods being moved. If we compare the cost of shipping $1 of coal to $1 of computer microchips, the transportation intensity of these cargos differs for two reasons. First, $1 of coal is bulkier and heavier than $1 of computer microchips, requiring greater stowage space and fuel expenditure to move. Second, microchips may require higher quality transportation services, greater care in handling and more rapid delivery than coal. To understand the evolution of import and sourcing wedges it is then necessary to understand how the composition of traded goods, and the intensity with which they use transportation services, has changed. Chapter 4 focuses on the evolution of the weight of trade and the demand for timeliness.

It should be noted that no single source of data provides a definitive picture of the costs of transport. Only a small number of countries track transportation costs as part of their trade data, and only the United States has done so for a significantly long time span.

Lacking a single, comprehensive data set, this paper gathers together an eclectic mix of data on prices for international ocean and air transportation. Primary sources include: index numbers for ocean shipping prices, gathered from shipping trade journals; air freight prices constructed from survey data on air cargo; and freight expenditures on imports, collected by customs agencies in the United States, New Zealand and a number of Latin American countries. A major weakness of the study is that data on overland transport are not provided. These data are much harder to obtain and, in any case, regulation of and infrastructure for overland transport are sufficiently different across countries that information gleaned from one source would have little relevance to other markets.

2. THE IMPORT WEDGE: PRICES AT HOME AND ABROAD

In this chapter, we address the evolution in the import wedge — the price of goods at the exporter's departure port relative to the importing destination. Among other things, understanding the evolution of this price wedge can be useful for understanding the role of declining transportation costs in explaining growing world trade. Economic historians have shown that substantial reductions in shipping costs played a key role in the first era of globalisation from 1850-1913. The post-war era has also been characterised by rapid trade growth. While the precise causes of post-war trade growth are not well understood, declines in transport costs top the list of usual suspects.

We begin by examining the size of *ad valorem* transportation costs for several countries. We emphasize *ad valorem* rather than per unit costs as this is the relevant number for understanding the size of the import wedge. That is, we can write the value of imports valued cif (inclusive of shipping costs) at the point of delivery as $p * q = (p + f)q$, where q is the quantity shipped, p is the origin price, f is the shipping bill per quantity, and p* is the delivery price inclusive of shipping costs. Rearranging, the shipping cost gives the wedge, or difference, between the origin and destination prices, $p*/p = 1 + f/p$. In addition to describing the degree to which prices are higher for consumers of imports, the wedge describes how much "protection" domestic firms have from foreign competition.

The data we examine come from customs declarations forms, in which the importing country requires the shipping firm to report the value of the shipment measured fob (free on board, or exclusive of shipping costs, or pq above) and cif. To simplify the reporting, we aggregate over multiple shipments and exporters to calculate the *ad valorem* freight bill, f/p, as the total freight bill paid, divided by total value shipped. Equivalently, this can be thought of as a trade-weighted average of shipping costs for each individual shipment.

Table 1 reports *ad valorem* shipping costs — i.e. shipping costs expressed as a percentage of the value of goods shipped — for a number of countries in 1994 and 2000, in aggregate and by 1-digit SITC goods classification. Shipping costs create a substantial wedge between home and foreign prices for all countries except the US (this is primarily because US imports are dominated by North American goods with very low shipping rates). Small and land-locked countries pay higher costs than large countries with ocean access. Rates differ substantially across products, with *ad valorem* costs being much higher for bulk commodities than for manufactures.

Table 1. **Ad valorem shipping costs : 1994 and 2000**

1994

	USA	Argentina	Brazil	Chile	Paraguay	Uruguay	N. Zealand
All goods	3.8	7.5	7.3	8.8	13.3	4.6	8.3
Food and live animals	8.2	9.9	10.4	12.7	12.0	3.6	14.5
Beverages & tobacco	6.9	11.3	9.0	8.4	10.4	4.8	9.4
Crude materials	8.2	15.2	7.7	12.0	10.2	3.7	16.3
Mineral fuels, lubricants	6.6	14.7	10.7	11.8	20.9	4.7	9.9
Animal & vegetable oils, fats	7.1	10.8	5.4	9.3	12.5	2.6	10.6
Chemicals & related products	4.5	7.6	6.8	10.2	10.4	3.0	9.0
Manufactured goods (by material)	5.3	9.4	8.5	10.9	11.2	4.7	10.0
Machinery & transp. equipment	2.0	5.6	5.1	6.3	13.8	4.1	6.3
Miscellaneous manufactures	4.7	9.3	8.1	9.1	15.2	5.8	6.6
All other goods, NES	1.0	4.5	0.8	7.6	6.8	2.5	0.6

2000

	USA	Argentina	Brazil	Chile	Paraguay	Uruguay	Bolivia	Colombia	Ecuador	Mexico	Peru
All goods	3.3	8.3	10.6	15.5	9.6	7.0	8.4	8.1	19.2	3.6	13.4
Food and live animals	7.7	9.4	9.2	12.5	10.8	8.0	16.1	12.9	13.8	6.0	13.5
Beverages & tobacco	5.2	7.1	5.5	7.0	6.3	4.9	7.5	6.3	8.5	7.3	5.5
Crude materials	7.5	12.3	7.2	13.2	16.5	13.8	10.6	11.7	14.2	5.5	12.8
Mineral fuels, lubricants	4.1	29.7	15.7	28.9	23.9	12.3	16.2	22.7	25.9	6.9	23.4
Animal & veg. oils, fats	6.6	7.8	6.2	12.1	6.7	5.1	8.4	11.8	11.4	7.3	16.0
Chemicals & related prod.	3.0	6.4	5.3	8.8	9.0	5.0	9.2	7.2	9.2	6.6	9.0
Manuf. goods (by material)	5.1	7.1	6.8	9.8	8.5	6.2	9.7	7.8	10.5	13.2	9.9
Machinery & transp. equip.	1.9	4.2	4.1	6.8	9.4	4.9	5.4	4.1	5.8	7.6	6.4
Miscellaneous manufactures	4.9	6.4	5.7	6.5	16.0	7.0	7.9	6.8	9.0	19.5	7.0
All other goods, NES	1.0	11.4	8.7	6.4		5.2	7.9	12.0	49.7	1.7	6.4

Note: Table reports shipping charges paid as a percentage of goods value shipped, aggregating over all exporters for each importer and commodity.
Sources: US Census, Statistics New Zealand, ALADI Secretariat, ECLAC 811 Database.

Total *ad valorem* costs are actually larger than these data suggest. These customs data typically cover only the international leg of transport, omitting inland charges. For shipments to and from coastal locations this will be accurate, but shipments inland will be more expensive. Case study evidence shows that international ocean freight comprises only a third of total door-to-door shipping charges, and this fraction has changed little over time. Also, the Table 1 numbers are trade-weighted averages of shipping costs. When importers choose export sources so as to minimise freight costs, the Table 1 numbers attach a large weight to unusually small costs and small weights to unusually large costs; i.e. the trade-weighted average understates true rates. Simple average freight rates for these countries are roughly double those reported in the table.

How have these numbers changed over time? Figure 1 reports time series variation in aggregate *ad valorem* freight rates for the US and New Zealand. (A broader set of countries would be highly desirable but these are the only countries whose public use trade data includes a lengthy time series on shipping costs.) The longer New Zealand series show rates fluctuating between 7 and 11 per cent of import value but not declining over time. Data on freight charges in US trade show declines, but much of this is because the data series begins at the same time that the first oil shock dramatically increased shipping costs. While US data exhibit declining rates after 1974-98, imputing 1973 values from other sources eliminates nearly this entire decline.

Figure 1 -- Ad-valorem freight costs
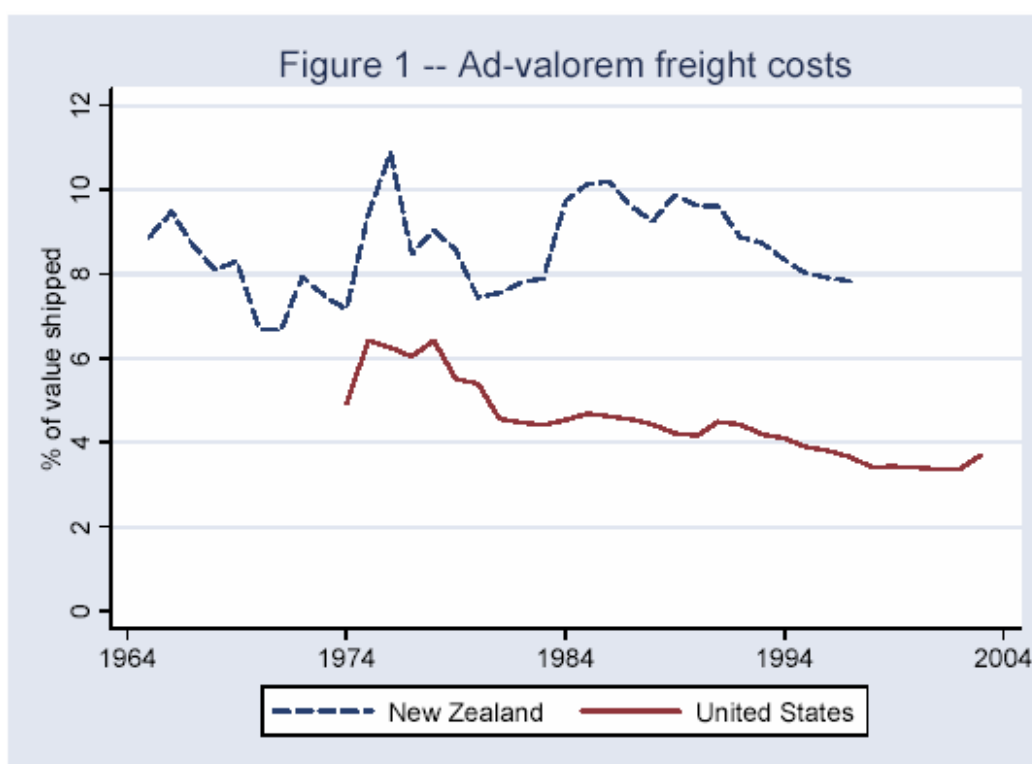
2.1. Modal prices

These aggregate series fail to reflect a set of important changes in the modal composition of trade. In the US, airborne trade with partners outside of North America rose from 10 per cent of all shipments by value in 1965 to half of all shipments by 2002. Worldwide, the weight of trade that is air shipped has grown even faster. From 1963-96, seaborne trade in non-bulk products (measured in tonne-km performed) increased four-fold. In that same period, airborne trade (measured in tonne-km performed) increased 45-fold. Next, we examine changes in the price of air *versus* ocean shipping.

2.1.1   *The cost of ocean shipping*

We begin by providing index numbers for unit prices ($/quantity) of ocean-borne shipping. Price indices for ocean shipping are available from several sources, with varying coverage of time periods, goods shipped and routes. The indices reported here are chosen because they offer the longest time series of data.

Two of the indices, constructed by the *Norwegian Shipping News (NSN)*, cover voyage charter and time charter tramp shipping. A voyage charter is a contract to ship a large quantity of a dry bulk commodity between specific ports. The *NSN* voyage charter price index represents a weighted bundle of spot market prices ($/ton) for shipping major bulk commodities on several important routes worldwide. A time charter is a contract to employ the services of an entire ship for a set period of time (usually up to a year). The *NSN* time charter index reports a weighted bundle of spot charter prices for ships of various sizes ($/tonnage) in many ports worldwide. To evaluate the real costs of shipping over time, we deflate these indices using the US GDP deflator.
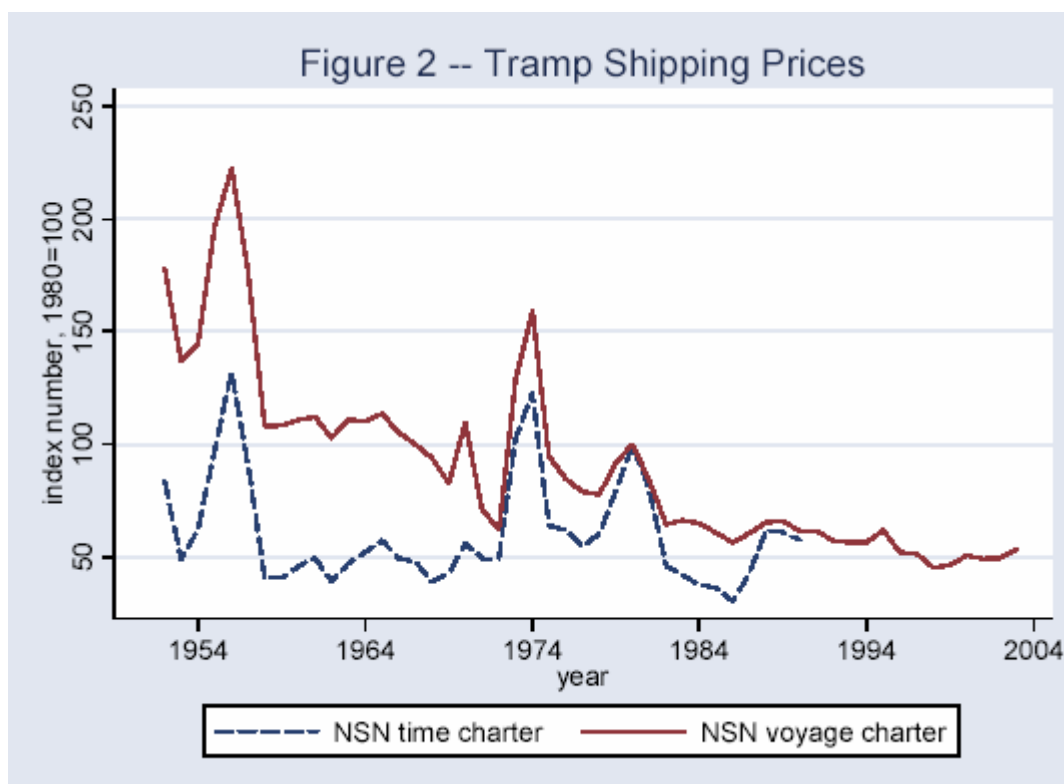

Figure 2 -- Tramp Shipping Prices

Figure 2 displays time series plots for time and voyage charters. Leaving aside very large price spikes in the oil shock years, and in the 1954-57 period, the time charter series shows no clear decline, while the voyage charter series exhibits downward trends in prices relative to the US GDP deflator. This suggests that the real price of bulk shipping, measured in dollars per tonne, has declined over time. However, when deflated by the price of the bulk commodities typically shipped via tramps, voyage charter rates are roughly constant and time charter rates are increasing. That is, the price of bulk commodities has fallen faster than the unit cost of tramp shipping, yielding no change or even increases in the *ad valorem* barrier to trade posed by international transport.

While bulk commodities represent a large fraction of world trade by weight, they are a small and declining fraction of world trade by value. A third index, calculated by the German Ministry of Transport, measures liner shipping prices. The index heavily emphasizes general cargo, including containerised shipping and manufactured merchandise of all sorts, and so is more representative of the commodity composition of the majority of world trade.

Figure 3 reports movement in the liner shipping price index relative to the German and US GDP deflator. Beginning in 1954, prices rise slightly through 1970, then sharply until a 1985 peak, with declines thereafter. The largest single rise occurs between 1973 and 1974. Note that rates rising through 1985 and declining thereafter closely match the aggregate New Zealand freight expenditure data from Figure 1[1]. Though they rise and fall sharply, liner prices in 2000 remain very close to prices in 1970.

Figure 3 -- Liner Shipping Prices
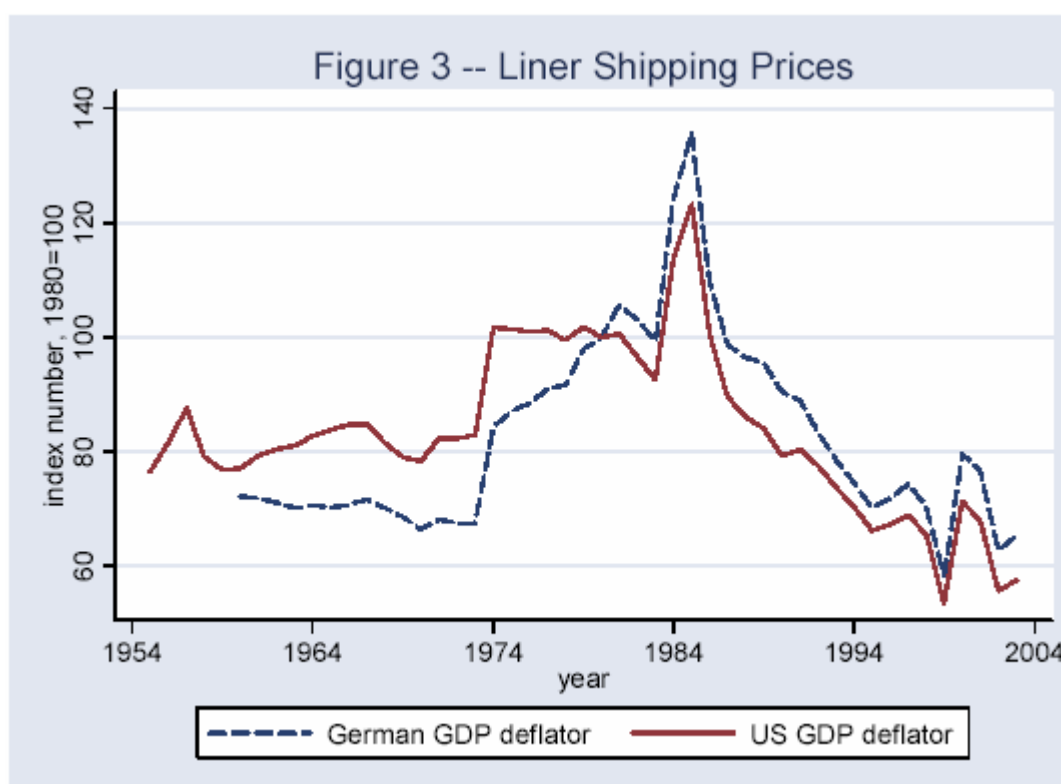
2.1.2   Costs of air shipping

Annualised growth rates for world air freight revenues (measured relative to tonne-kilometres shipped), constructed from *World Air Transport Statistics* (WATS), are reported in Figure 4[2]. The numbers show rapid declines in average revenues in the 1950s, 60s and 80s, with slow declines in the 90s and increases in the late 1970s.

Figure 4 -- Worldwide air revenue per ton-km
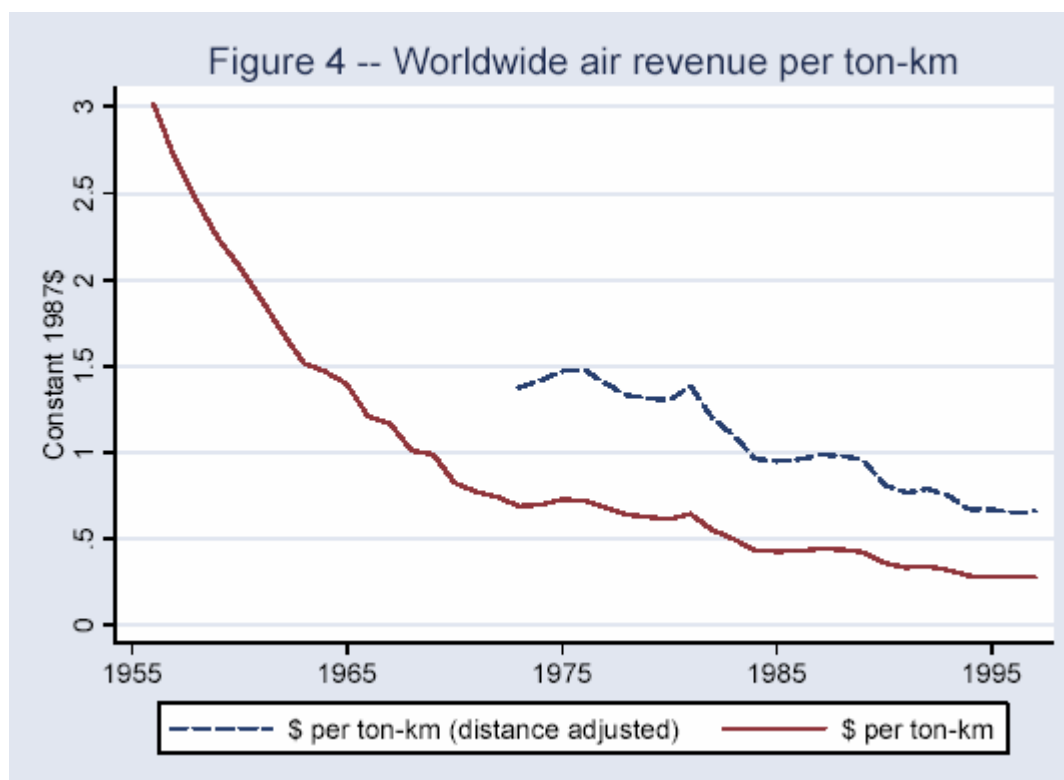
The International Civil Aviation Organization (ICAO) "Survey of International Air Transport Fares and Rates", published annually from 1973-93, contains rich overviews of air cargo freight rates for air travel markets around the world. In Table 2, this author reports annualised rates of change in air freight rates for each route group between 1973 and 1993. The nominal values from the ICAO Survey are deflated using the US GDP deflator to get a real price per kilogramme shipped, and by an index of air-shipped traded goods prices. The latter allows a calculation of changes in the *ad valorem* freight rates for air shipped goods.

Measured in prices per kg shipped, worldwide we see an annual rate of decline of around 1.5 per cent. Prices decline on almost all routes, but they decline more on long routes and on those involving more developed nations. Declines in *ad valorem* rates are much larger than price per kg freight rates: 3.5 per cent per year over all routes. This is explained by substantial real increases in the price per kg of predominantly air-shipped goods.

Table 2. **Changing air fares by region**
(annual rates of change)

	Shipping price per kg (tsso$) 1973-93	Shipping price per $ shipped 1973-93
All Routes	-1.53	-3.48
Developed Nation Routes:		
North Atlantic	-2.22	-4.16
Mid Atlantic	-1.26	-3.22
S Atlantic	-1.13	-3.06
North and Mid Pacific	-2.39	-4.33
South Pacific	-1.74	-3.69
Developing Nation Routes:		
North to Central America	1.04	-0.97
North and Central America to South America	-0.14	-3.12
Europe to Middle East	-0.58	-2.56
Europe and ME to Africa	-1.13	-3.09
Europe/ME/Africa to Asia/Pacific	-0.92	-2.88
Local Routes:		
Local Asia/Pacific	-0.95	-2.87
Local North America	-0.80	-2.77
Local Europe	-0.42	-2.39
Local Central America	2.10	1.43
Local South America	-0.83	-2.80
Local Middle East	-0.52	-2.50
Local Africa	-0.14	-2.12

Notes:
(1) All series expressed in terms of annualised growth rates.
(2) Price per kg and *ad valorem* freight rate series constructed using mean shipping distance within that route group.
(3) Price per kg deflated using US GDP deflator. Ad-valorem rates constructed using a price per kg import price index.

3. THE SOURCING WEDGE

In this chapter we address the sourcing wedge, which compares prices for two different foreign sources of supply. This wedge determines from whom an importer buys (or to whom an exporter sells). While a great many factors affect the size of this wedge, we focus on the role of distance and transportation scale economies in determining the size of the sourcing wedge and its evolution.

3.1. The role of distance

Distance impedes trade to a surprising extent. Roughly half of world trade takes place between countries located within 3 000 kilometres of each other. Regression analysis affirms that the trade-distance relationship is robust to the inclusion of a wide variety of partial correlates, with typical estimates suggesting that doubling distances halves trade.

Transportation costs are an obvious starting point for explaining this fact. It is clearly less expensive to ship from the UK to France than from Australia to France. Each km travelled requires greater fuel, manning and capital expenses. The question is, how much? The simplest way to calculate this is to estimate an elasticity of shipping costs with respect to distance, and to see how it has evolved over time. Hummels (1999) provides these estimates for air and ocean shipping at each point in time from 1974-98. Comparing a long (9 000 km) route to a short (1 000 km) route for comparable ocean-shipped commodities, the longer route was 59 per cent more expensive in 1974, but only 32 per cent more expensive in 1998. For air shipping, the longer route was three times as expensive in 1974, but only 68 per cent more expensive in 1998.

In sum, costs are substantially rising in distance, but this effect has diminished over time. Further, the effect is much larger for air shipping than it is for ocean shipping. This is relevant because air shipping is more likely to be used the longer the route. The effect is a significant flattening in the relationship between shipping costs and distance.

However, it should be noted that despite this change in shipping costs, the grip of geography on trade flows themselves remains. Distance affects trade as much, or more, today as it did forty years ago. The reasons for this are not entirely clear, but one intriguing possibility related to transportation intensity is discussed in chapter 4. In particular, the dollar cost of an extra km travelled may be falling, but the time cost may be rising as traded goods become more time sensitive.

3.2. Scale economies in transportation

A second major factor in the size of the sourcing wedge is scale economies in shipping. The circumstantial evidence for investigating scale economies in shipping can be seen by examining freight costs for large *versus* small countries. Examining Table 1, we see that larger importers have smaller shipping costs for comparable goods. Or, consider Japan and the Ivory Coast, equidistant from the US West and East Coasts, respectively. US importers from the Ivory Coast pay shipping

costs which are twice as high as those from Japan, even after adjusting for differences in the commodity composition of trade. More systematically, Hummels and Skiba (2004) use data from many importer-exporter pairs to estimate that doubling trade quantities results in a 12 per cent reduction in shipping costs.

What is the source of scale economies in shipping? One possible source lies in the domestic trade infrastructure built up by each country. Ports (and the internal road or rail system necessary to reach them) tend to be large lumpy investments. If the fixed costs are large enough, an increased trade scale will benefit the investing country directly, and perhaps some of its trade partners, through lowered shipping costs.

Scale economies may also operate at the level of the country pair and the trade route. The capacity of a modern ocean-going liner vessel is large relative to the quantities shipped by most exporters. As a consequence, goods are almost never shipped from point to point directly between the exporter and importer. Instead, a liner vessel may stop in a dozen ports in many different countries.

As trade quantities increase it is possible to more effectively realise gains from several sources. First, a densely traded route allows for effective use of hub-and-spoke shipping economies – small container vessels move quantities into a hub where containers are aggregated into much larger and faster containerships for longer hauls. Examples include the European hub of Rotterdam, as well as Asian hubs in Singapore and Hong Kong.

Second, the movement of some goods requires specialised vessels. Examples include ships specialised to move bulk commodities, petroleum products, refrigerated produce and automobiles. Increased quantities allow introduction of these specialised ships along a route. Similarly, larger ships will be introduced on heavily traded routes, and these ships enjoy substantial cost savings relative to older, smaller models still in use. (One source of scale advantage is in crew costs, which are roughly independent of ship size.)

An historical example of these effects in combination can be seen in the introduction of containerised shipping. Containerised shipping is thought by many specialists to be one of the most important transportation revolutions in the 20th century. The use of standardised containers provides cost savings by allowing goods to be packed once and moved over long distances via a variety of transport modes (truck, rail, ocean liner, rail, then truck again) without being unpacked and repacked.

Despite these advantages, containerised shipping did not diffuse immediately throughout the world. Instead, it was first introduced in the US in the 1960s, then on US-Europe and US-Japan routes in the late 60s and 70s, then to developing countries from the late 70s onward. The degree of containerisation varies markedly across regions, and is positively correlated with route GDP.

An obvious explanation for this slow diffusion lies in the fixed costs of adoption. To make full use of containerisation requires container-ready ocean liners and ports adapted to container use (specialised cranes, storage areas and rail-heads). Building container ports typically requires large capital expenses, and will not be undertaken unless a large volume of trade can be moved through them. Similarly, shipping companies will not dedicate a container-ready ocean liner to a route unless there is a sufficient volume of trade along that route. Finally, the full benefit of containerisation may not be enjoyed unless it is combined into hub-and-spoke systems at the regional level that allow the matching of differently sized ships to appropriate route lengths. Thus, adoption of a revolutionary shipping technology like containerisation depends on the scale of trade at the level of the exporter, and the exporting route.

Apart from the advantage it imparts to large countries, the existence of scale economies in transport has several interesting implications. While trade growth can lead to higher transport prices, especially as port facilities suffer congestion, it can also lead to scale benefits as described here. This suggests that trade liberalisation can lead to a virtuous cycle: tariff reductions spur trade growth, which lowers transport costs, leading to further growth. Also, to the extent that shipping scale economies are regional in scope, transportation facilities become a kind of regional public good. That is, increases in trade between the US and Argentina benefit these partners, but also the other countries (Brazil, Venezuela, the Caribbean) lying along the route. It follows from this that countries may prefer to see tariff liberalisation concentrated among regional neighbours.

4. CROSS-COMMODITY VARIATION: TRANSPORT INTENSITY

Cost shocks and technological innovation play an important role in the time series changes in transportation costs. Another critical factor is changes in the transport intensity of traded goods. In this chapter we discuss two significant changes in transport intensity. The first relates to the value of transportation services needed to move $1's worth of a good. The second relates to changes in the quality of transportation services, in particular, delivery times.

4.1. The weight-value ratio

Transportation specialists are accustomed to thinking of transportation costs in per-unit terms: the cost of transportation services necessary to move grain a tonne-km or to move one TEU container from Rotterdam to Hong Kong. International trade specialists who pay attention to shipping costs as an impediment to trade, are accustomed to thinking of these costs in *ad valorem* terms: the cost of transportation services necessary to move a dollar of grain or microchips between two points. The distinction is important because even if the cost of moving one TEU remains constant, the *ad valorem* cost and the implied impediment to trade can change if the contents of the container change.

To see this, suppose we sell q TEU containers of a good at a price p, and pay shipping costs f per container shipped[3]. What is the ratio of destination to origin prices?

$$p*/p = (p+f)q/pq = 1 + f/p$$

If the container holds scrap metal, p is low and the ratio p*/p is high. If the container holds micro chips, p is very high and the ratio p*/p is close to 1.

This observation is important because the commodity composition of world trade has shifted dramatically in the last thirty years. Trade in manufactures has grown much more rapidly than trade in bulk commodities. As this happens, the weight/value ratio of trade drops, and with it, one measure of transport intensity drops as well.

Between 1970 and 1999, WTO data show that the real value of trade in all products grew 18-fold in real terms, while trade in manufactures grew 22-fold, and trade in agricultural and mining goods

grew ten-fold. Meanwhile, tonnage moved via seaborne and airborne shipping together slightly more than doubled[4]. Altogether, that implies that the weight/value ratio of total trade fell by a factor of nine since 1970.

One implication of the drop in weight/value ratio is the shift toward air shipping and away from ocean shipping. Air shipment is more likely to be used when the *ad valorem* price differential between the two modes is small. That is most commonly the case when the freight bill is a small fraction of the value of the good, that is, when the weight/value ratio for the product is small. Consider this example. A consumer wants to import a $16 bottle of wine from France. Air shipping costs of $8 are twice ocean shipping costs of $4. Going from ocean to air increases the delivered cost by $4 or 25 per cent. Now suppose the consumer's tastes improve and he wants to import a $160 bottle of wine from France. The shipping costs are the same, but now the $4 cost to upgrade to air shipping represents just a 2.5 per cent increase in the delivered price. The consumer is much more likely to use the more expensive shipping option when the effect on delivered price is smaller.

The broader point is that transportation demand is derived from import and export demand. No-one values transportation directly, they value it only as part of a process of getting internationally traded goods to their final consumers. And those consumers are sensitive to changes in the delivered price, not to changes in the transportation price. If the cost of transportation substantially affects the delivered price, as in the first example, modal choice will be driven by cost considerations. But if the transportation price is but a small fraction of the delivered price, it will likely be trumped by other factors such as timeliness or reliability. The same lesson is true of all cost differentials related to transportation. When shippers are deciding which modes to use, or which ports to use, they look at cost differentials. But if these cost differentials have a minor effect on the delivered price, other factors will get greater weight.

The wine example just given also illustrates a second implication of the weight-value ratio for trade. Consider the size of the sourcing wedge, the relative price of goods from two sources when shipped to a third destination, when those goods are of different quality and price. France pays $10 to ship a $50 bottle of wine to the US, while Chile pays $10 to ship a $10 bottle. Exclusive of shipping costs, the French wine is 5 times more expensive. Inclusive of shipping costs, the French wine is only 3 times more expensive ($60/20). The higher the shipping costs, the smaller is the gap between the delivered prices of high- and low-quality goods. Hummels and Skiba (2004) show evidence that this effect plays an important role in two places. As in the French/Chile wine example, high shipping costs cause importers to shift demand to high-quality sources. High shipping costs also cause a particular exporter to ship high-quality wine to distant destinations while reserving lower-quality wine for the domestic market. As shipping costs rise or fall over time, these quality shifting effects rise and fall with them.

4.2. Timeliness

Up to this point we have focused on the cost of shipping a good, measured either in quantity or value terms, taking as fixed the quality of the transportation service. However, there have been pronounced changes in the quality of international transport over the past thirty years, the most notable being transportation time. Today, shipping containers from European ports to the US Midwest requires 2-3 weeks; to Far Eastern ports as long as six weeks. In contrast, air shipping requires only a day or less to most destinations. Ocean liner service itself has become much faster than in years past, both because the ships are larger and faster, and because their loading and unloading times are dramatically lowered by containerisation.

How valuable is timeliness? Two recent empirical papers shed light on this point. Evans and Harrigan (2003) show that timeliness in the apparel industry has a pronounced effect on sourcing patterns. Clothing lines that have high restocking rates within a given buying season are much more likely to be sourced locally than those in which orders are taken once per season. Hummels (2001) estimates a demand for timeliness by examining the premium that shippers are willing to pay for speedy air shipping relative to slow ocean shipping. He shows two effects. First, for every day in ocean travel time that a country is distant from the importer, the probability of sourcing manufactured goods from that country drops by 1 per cent. Second, conditional on exporting manufactures, firms are willing to pay just under 1 per cent of the value of the good per day to avoid the travel delays associated with ocean shipping.

Why are these effects so large? The per-day time cost of the good is a function of two factors. The first is the per-day interest rate on the good in transit, otherwise known as pipeline inventory. The second factor is a "depreciation rate" for the good. The depreciation rate encompasses any reason that a newly-produced good might be preferable to an older good.

Obvious examples include spoilage that is literal and predictable, such as with fresh produce or cut flowers. Depreciation may also reflect the immediate need for the good, and lost profitability/utility from the good if it is not available. More generally, with long lags between production ordering and final sales, firms may face a mismatch between what consumers want and what the firm has available to sell. Consumers will pay a premium to purchase goods containing "ideal" characteristics, but firms may not be able to predict far in advance what constitutes the ideal. Firms that can wait longer to produce are better able to match the ideal characteristics and capture that premium. This can be accomplished either by producing locally, or by producing at a distance and air shipping.

Specific examples of goods with this property may be useful here. Toy manufacturers generally do not know in advance which toys will emerge from among hundreds of competitors to capture the hearts and minds of children during the holiday gift-giving season. The "ideal" types command price premia over the non-ideal types. As firms near the holidays, they receive market signals (product reviews, early sales) about the ideal type, and can adjust accordingly. As Evans and Harrigan (2003) demonstrate, apparel is another example where ideal characteristics are difficult to discern well in advance, and firms must produce (and ship) much closer to sales dates, or restock mid-season. Finally, personal computers exhibit extreme time sensitivity of this sort. Standardised packages do not appeal to many consumers, who are willing to pay more for a customised computer, manufactured to particular specifications (CPU speed, screen size, amount of RAM). So manufacturers simply do not build the computer until they know the precise ideal characteristics.

There are several factors that may explain increases in time sensitivity in the past decades. The first is the commodity composition of trade. The estimates in Hummels (2001) show that bulk commodities and simple manufactures exhibit no time sensitivity. As trade shifts from these products toward more complex manufactures, time sensitivity grows. Trade has grown most rapidly in those products with the highest estimated time sensitivity. (Note, however, that the causality may go the other way. Trade in time-sensitive goods may be rising precisely because the cost of rapidly shipping them has fallen so dramatically.)

Second, time sensitivity is rising even within particular goods. As consumers grow richer, their willingness to pay for precise product characteristics grows. That in turn puts pressure on manufacturers to produce to those specifications, and be rapidly adaptable; and for richer consumers fast delivery times become part of the expected service quality.

Finally, the post-war era has seen rapid growth in other forms of integration, in particular in foreign direct investment and vertical specialisation/fragmentation. Vertical specialisation, or more broadly multi-stage production, may be especially sensitive to lags and variability in timely delivery. The absence of key components can render idle an entire assembly plant. An emergency shipment that arrives in a timely fashion may be worth many times the nominal price of the component, while late arrivals are of considerably depreciated value. Inventory on-hand must also be increased in order to accommodate arrival time variations. This in turns magnifies the costs of defects in component quality, as sizeable inventories (at the plant, in transit) may be built up before defects are detected. The defect problem motivates "just-in-time" inventory techniques, which aim to minimise both the inventory on hand and in the pipeline. Clearly, the ability to implement a just-in-time strategy is limited when parts suppliers are a month of ocean transit time removed from the assembly plant.

The broad point is that rapid declines in air transport costs, and the corresponding reduction in the cost of time-savings, may be responsible for the growth of time- and coordination-intensive forms of integration. And the growth in time- and coordination-intensive forms of integration puts further demands on timeliness in delivery.

5. CONCLUSIONS

In this paper, we have discussed the evolution of international transportation costs. The major findings are these:

- Transportation costs create a significant wedge between prices of domestic and foreign goods, and between prices of different foreign goods in home markets. The size of this wedge differs greatly across countries, depending on their distance to markets, level of development, commodity composition of trade and market size.

- In aggregate, these costs have declined over time, owing principally to very rapid declines in the price of air shipping, and a compositional shift in trade toward light manufactures.

- However, while trade has become lighter, and therefore less transport-intensive per dollar shipped, it has also become more time sensitive.

NOTES

1. Anecdotal and case study evidence suggests that the especially rapid liner price increases that occurred in the 1970s for German trade appear to have occurred more broadly. UNCTAD's annual *Review of Maritime Transport* reported annual liner rate increases of 10-15 per cent across nearly all routes. Studies of rates on US North Atlantic liner routes found real increases (relative to the dollar deflator) ranging from 21 to 26 per cent between 1971 and 1975, comparable to those found in German trade. Sletmo and Williams (1981) report nominal rate increases of between 61 and 103.5 per cent.

2. The latter calculation assumes a cost technology for air shipping given by $C=a_t(ton)(km)^{.5}$ where a_t is a time-specific cost shifter. If the elasticity of costs with respect to distance shipped is less than one, doubling the distance shipped results in a decline in average costs per tonne-miles. WATS data indicates a rapid rise in mean distance shipped over time, and so average revenue must be adjusted accordingly.

3. Of course, if shipping costs are proportional to the price shipped, then the ratio p*/p is the same with or without shipping costs. Hummels and Skiba (2004) estimate an elasticity of freight prices, with respect to the price of goods shipped, of 0.14. This means that a rise in the price of the good creates only a small increase in shipping prices.

4. If we consider only non-bulk dry cargos, the weight of seaborne and airborne cargos together grew by a factor of 3.5. This calculation ignores growth in overland (rail, road) international shipping. If land-based shipping represented a large and growing share of world trade, this calculation would overstate the drop in the weight/value ratio. However, for most countries, overland trade is either unimportant in terms of its weight share of trade or, for countries like Germany, the weight share of overland trade has been roughly constant over time.

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TRANSPORT AND INTERNATIONAL TRADE

With the removal of many trade policy barriers, further international economic integration depends largely on the reduction of trade costs originating in the transport sector.

The Round Table discussion focused on the structure and development of international transport costs over the past decades and the benefits to be expected from investment in international transport facilities and the reduction of the costs of crossing borders.

Background papers were provided by David Hummels (Purdue University), Anthony Venables (London School of Economics and Centre for Economic Policy Research) as well as Harry Broadman and John S. Wilson (World Bank).

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