GLOBALISATION, TRANSPORT, AND THE ENVIRONMENT

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The need for a constantly expanding market for its products chases the bourgeoisie over the whole surface of the globe. It must nestle everywhere, settle everywhere, establish connections everywhere. The bourgeoisie has through its exploitation of the world market given a cosmopolitan character to production and consumption in every country. To the great chagrin of reactionaries, it has drawn from under the feet of industry the national ground on which it stood. All old-established national industries have been destroyed or are daily being destroyed. They are dislodged by new industries, whose introduction becomes a life and death question for all civilised nations, by industries that no longer work up indigenous raw material, but raw material drawn from the remotest zones; industries whose products are consumed, not only at home, but in every quarter of the globe. In place of old wants, satisfied by the production of the country, we find new wants, requiring for their satisfaction the products of distant lands and climes. In place of the old local and national seclusion and self-sufficiency, we have intercourse in every direction, universal inter-dependence of nations. And as in material, so also in intellectual production. The intellectual creations of individual nations become common property. National onesidedness and narrow-mindedness become more and more impossible …

Karl Marx and Friedrich Engels, *The Communist Manifesto* (1848)
as quoted by Friedman (2005)

… this ravening monster, the World-Market.

William Morris, *News from Nowhere* (1890)
as quoted by Wright (2004)

1. Introduction

This paper provides an examination of the phenomenon of globalisation, an overview of its transport aspects, a consideration of the environmental and resource impacts of this transport activity, and an initial discussion of what might be done to mitigate these impacts. It sets the stage for possible further work on these topics.

John Ralston Saul, Canadian philosopher and former viceregal consort, has argued that globalism has ended (Saul 2005). He used the terms 'globalism' and 'globalisation' interchangeably, but it possible in his work to distinguish the belief system, globalism, from its practice, globalisation. According to Saul, globalism is belief in "an inevitable form of internationalism in which civilisation is reformed from the perspective of economic leadership. The leadership here is provided not by people, but by the innate force of economics at work; that is, the marketplace." (Saul 2005, 19).[1*]

Globalisation, the process, has been succinctly defined as "an economic phenomenon, involving the increasing interaction, or integration, of national economic systems through the growth in international trade, investment and capital flows … [it also involves a] "rapid increase in cross-border social, cultural and technological exchange" (Australian APEC Study Centre 2005).

Saul argued that globalism/globalisation emerged in the 1970s, had its heyday in the 1980s and 1990s, and is now in decline. He wrote that the failures of globalisation—many documented by the International Labour Organisation (2004)[2]—have produced in the new century a stronger expression of national interests and more government controls over economic activity. Globalism has not been evidently replaced by a new belief system, although there are signs of a new nationalism. Saul is uncertain as to whether this can best be characterised as positive nationalism "tied to self-confidence and openness and to a concept of the public good" or negative nationalism "dependent on fear and anger and a desperate conviction that one nation's rights exist by comparison with those of another nation", or both (Saul 2005, 245).

Saul described international trade as the "simplest true evocation of globalisation" (Saul 2005, 91). He suggested that the growth in trade since 1980 has been impressive—indeed, "remarkable" and even "spectacular"—and has had some beneficial effects, although its full effects remain unknown. He also argued that "Production doesn't need to be global to be successful. There is no noble global destiny in moving inanimate objects vast distances." (Saul 2005, 31).

Other commentators have offered a more sanguine view of globalisation, including Thomas Friedman, whose book *The World is Flat* (Friedman 2005) is currently a 'best-seller' in North America.[3] Friedman argued that the third "great era of globalisation" began in 2000, following the first, from 1492 to about 1800, and the second, which

[*] Superscript numbers point to notes containing additional material beginning on Page 54. The list of cited sources begins on Page 46.

spanned the 19th and 20th centuries with interruptions between 1914 and 1945. He identified the "dynamic force" of the first era as *countries* globalising through creative use of energy resources, initially wind and wood, and then coal. The second era involved *companies* globalising, powered by falling transport costs and then falling communication costs. In the current era the key factor is "the newfound power of *individuals* to collaborate and compete globally" though a global fibre-optic network and facilitating software. Unlike in previous eras of globalisation, "individuals in every corner of the flat world are being empowered" as well as companies (Friedman 2005, 9-11).

Friedman professed enthusiasm about globalisation because it increases economic activity in ways that benefit large numbers of people in participating countries, rich and poor. He scolded the anti-globalisation movement that "emerged at the World Trade Organisation conference in Seattle in 1999 and then spread around the world in subsequent years" (Friedman 2005, 384). It has been driven, he wrote, by five disparate forces: (i) upper-middle-class American guilt at the country's "incredible wealth and power"; (ii) a rear-guard push by the "Old Left" to bring back some form of socialism; (iii) simple concern that changes are happening too quickly; (iv) anti-Americanism; and (v) concern about *how* globalisation occurs, rather than whether it should be resisted.

The last force, he continued, should be encouraged. It has been drowned out by the first three. "What the world doesn't need now is for the anti-globalisation movement to go away. We just need it to grow up. This movement had a lot of energy and a lot of mobilising capacity. What it lacked was a coherent agenda for assisting the poor by collaborating with them in a way that could actually help them. … You don't help the world's poor by dressing up in a turtle outfit and throwing a stone through McDonald's window. You help them by getting them the tools and institutions to help themselves." (Friedman 2005, 389).

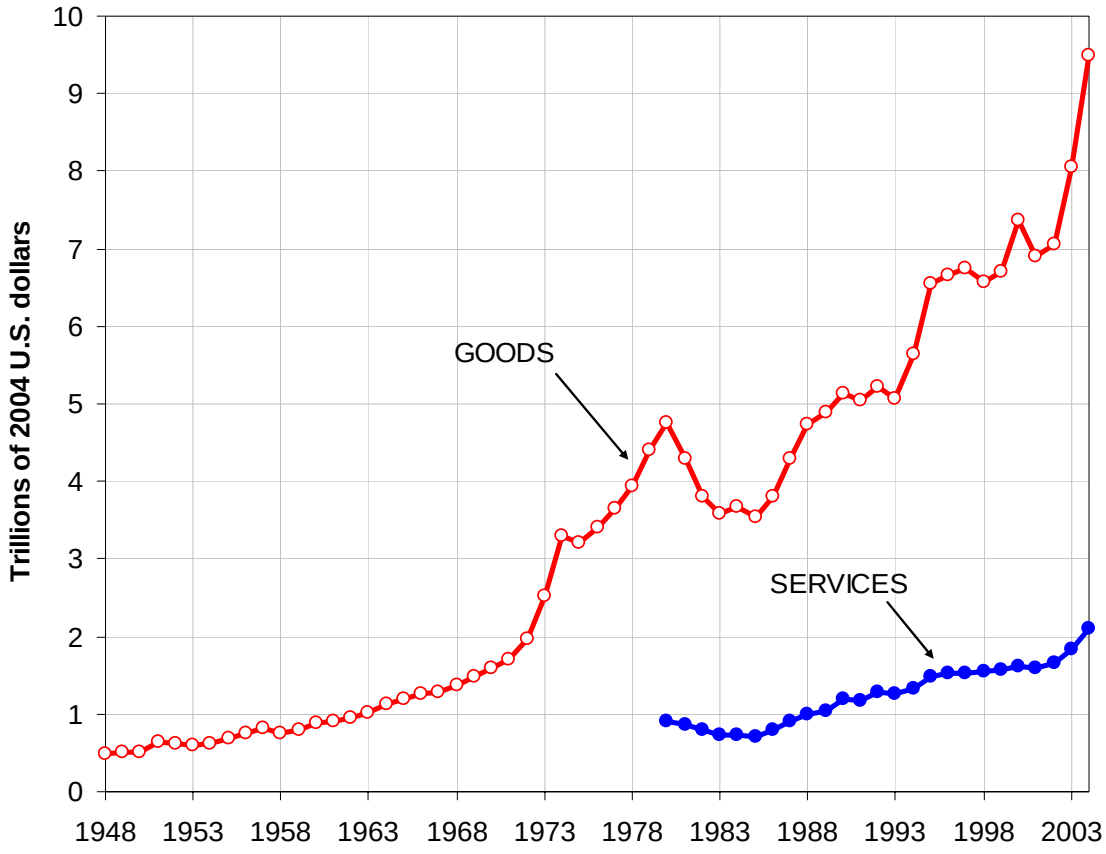
Equally enthusiastic about globalisation, and even more scathing about its opponents, is Martin Wolf, whose 2004 book *Why Globalization Works* was written to convince "religious fanatics, obscurantists, extreme environmentalists, fascists, Marxists, and … contemporary antiglobalisers … that a global market economy is highly desirable" (Wolf 2004, xiii). He noted that in the 1990s the idea of a global market seemed all-conquering, but a decade later it is on the defensive.

Wolf criticised Friedman for having exaggerated the role of technological factors, noting that these could also help governments thwart globalisation, if they chose. Nevertheless, he recognised "the abiding and enormous importance of costs of transport and communications" (Wolf 2004, 15), noting that "The colossal recent falls in the costs of communicating information must have radical effects on economies, by lowering the cost of making transactions and increasing information about available opportunities to transact" (Wolf 2004, 17). Wolf defined globalisation as "the process of integration, across frontiers, of liberalising market economies at a time of rapidly falling costs of transport and communications" (Wolf 2004, 11).

2. Trends in trade flows

The remarkable growth in international trade is shown in Figure 1, where the cumulative value of *imports* of goods and services is shown in constant U.S. dollars[4] to enable comparisons from year to year. Note that in any year world imports approximately equal world exports, and either set of data can be used. (Use of both can constitute double counting and overestimates of the amount of trade.) Note too that the data for goods imports in Figure 1 shows the *value* of goods rather than their quantity, and cannot therefore be readily translated into transport activity. In each year for which there are data (1990-2004), transport and travel services together comprised more than half of the imports of services. Transport activity associated with this trade is discussed below in Sections 6-11.

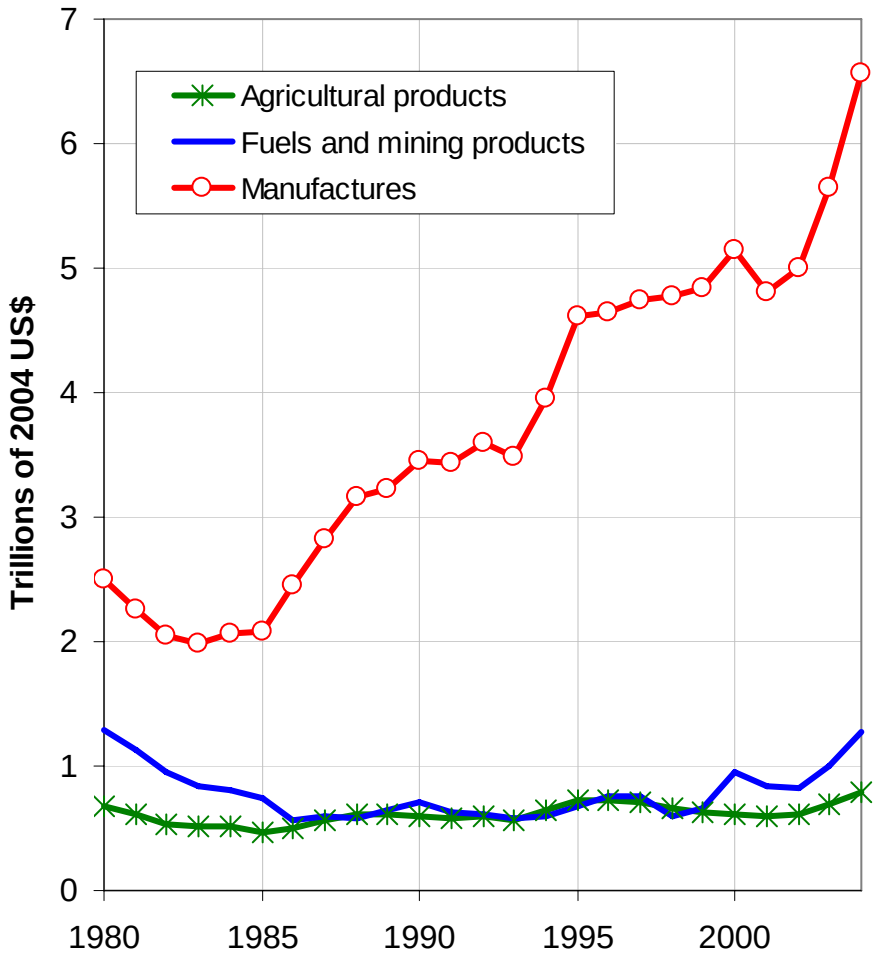
Figure 1. World imports of goods and services (available years, 1948-2004)



Source: World Trade Organisation (2005)

Figure 2 shows the *composition* of the international trade in goods by value, for each year from 1980 to 2004. Manufactured goods have provided the largest share of the total value in each year (63 per cent in 2004), and have shown the greatest growth since 1980.

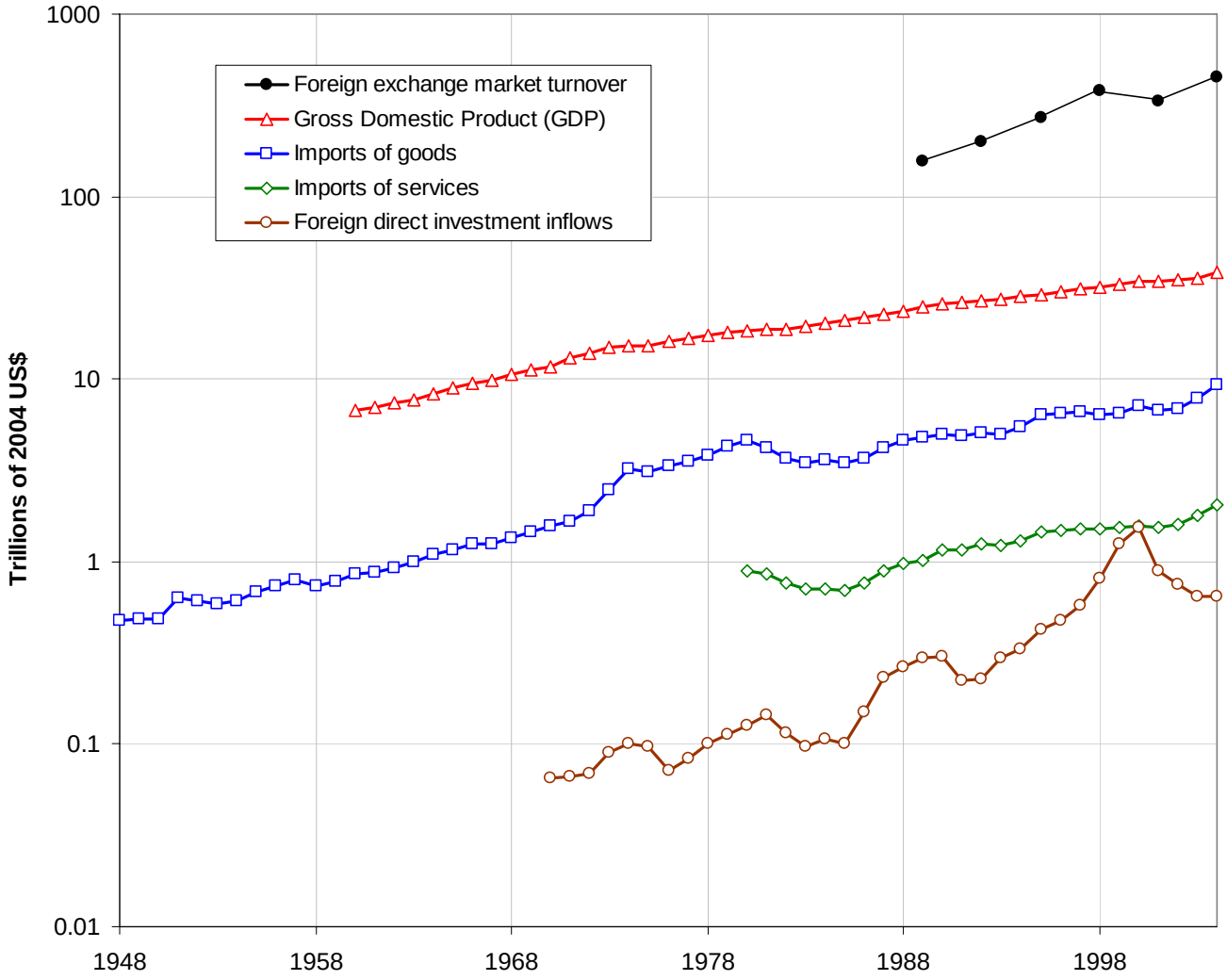
Figure 2. Elements of the international trade in goods, 1980-2004



Source: World Trade Organisation (2005)

Figure 3 puts the value of trade in the context of international flows of currency and capital, and also world GDP, showing all these indicators against one logarithmic scale. Figures 4-9 provide analysis of the data shown in Figure 3.

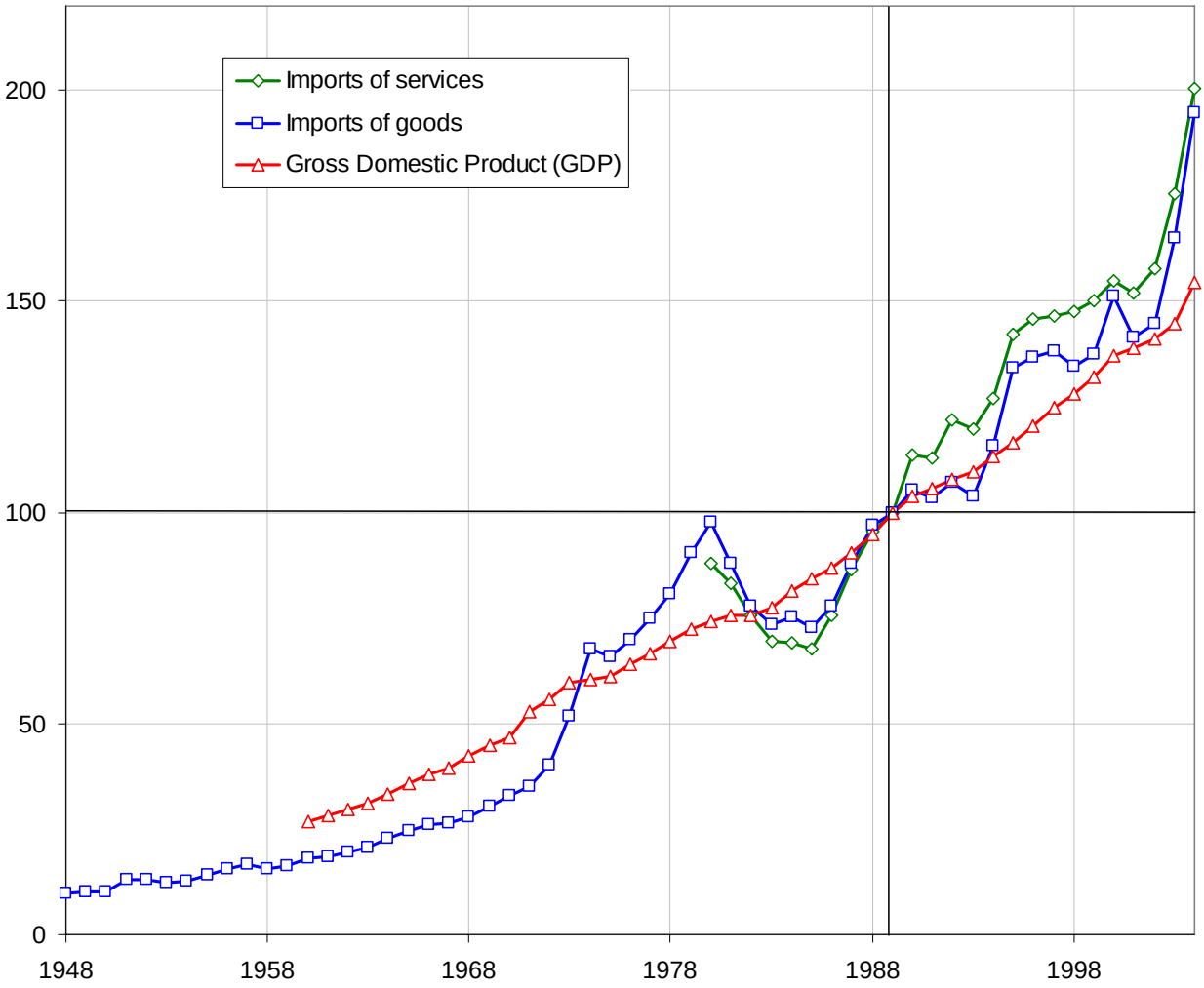
Figure 3. World globalization activity: foreign exchange activity, imports of goods and services, foreign direct investments, and GDP (available years, 1948-2004)
Note logarithmic vertical axis



Sources:
Foreign exchange market turnover: Bank for International Settlements (2005, Table B.1)
Gross Domestic Product (GDP): United Nations Statistics Division (2005, Series 29918)
Imports of goods and services: World Trade Organisation (2005)
Foreign direct investment inflows: United Nations Conference on Trade and Development (2005, Table B.1)

Figure 4 shows some of the data in Figure 3 normalised so that 1989 values are equal to 100. It indicates that the value of trade in goods has roughly tracked GDP, notwithstanding the sharp increases in trade evident in Figure 1. There have been periods when trade in goods has risen more quickly than GDP, namely 1972-1974, 1976-1980, 1983-1985, and 2002-2004, and periods when it has fallen even though GDP has risen. Note that the largest two-year increase relative to GDP (1972-1974) and the second largest (2002-2004) are respectively before and after the decades of the 1980s and 1990s, which Saul described as the heyday of globalisation. Both two-year periods were characterised by especially large increases in crude oil prices (BP 2005), but fuels' low share of trade (see Figure 2) suggests that other factors were more important.

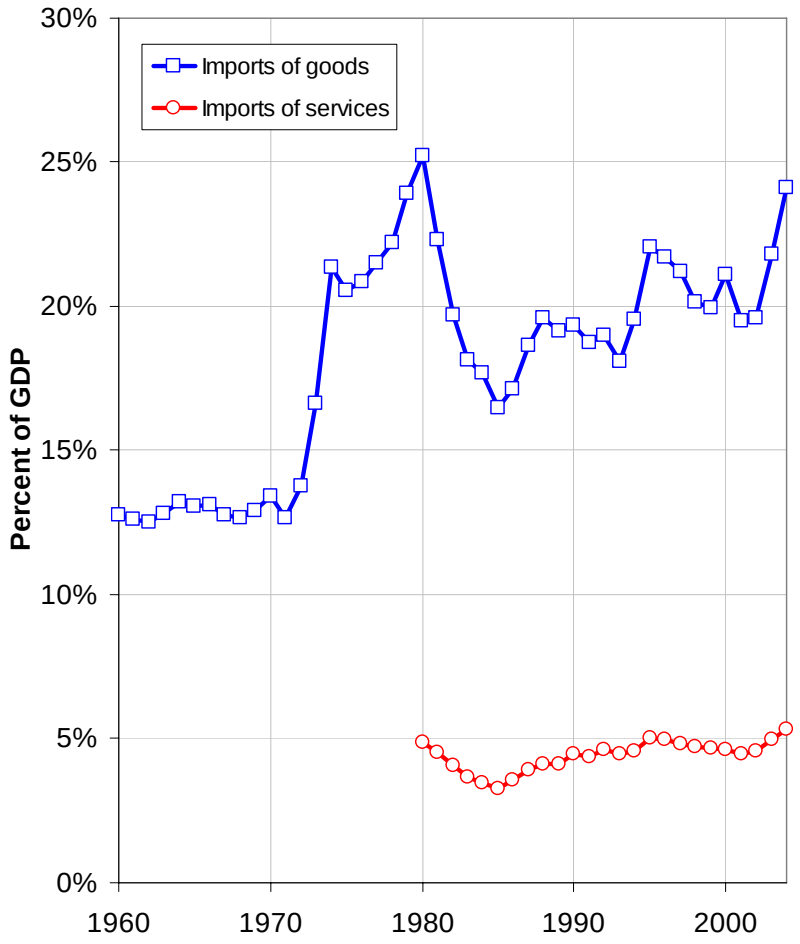
Figure 4. Normalised world GDP and world imports of goods and services (1989 = 100, available years, 1948-2004)



Sources:
Gross Domestic Product (GDP): United Nations Statistics Division (2005, Series 29918)
Imports of goods and services: World Trade Organisation (2005)

For clarity, another version of these data is presented in Figure 5. It suggests that the relative importance of trade was steady until the early 1970s and has been cyclical since then, with an extreme peak in 1980 and more modest peaks in 1988 and 1995. Since 1970, the overall trend has been upwards. Trade in services has been less volatile than trade in goods. Recent history thus suggests that another peak may be imminent. However, if we are in a new era of globalisation, as Friedman (2005) suggested, history may not be a good guide.

Figure 5. World imports of goods and services as percentages of world GDP(available years, 1960-2004)

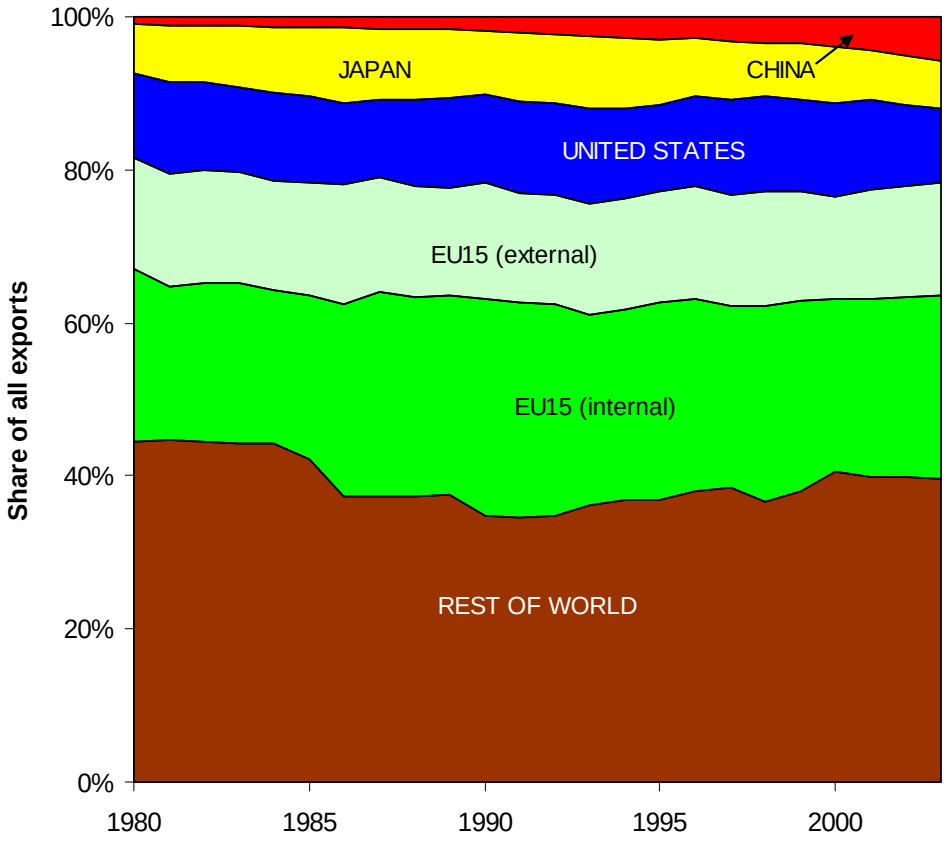


Sources:
Gross Domestic Product (GDP): United Nations Statistics Division (2005, Series 29918)
Imports of goods and services: World Trade Organisation (2005)

Analysis of country data shows that imports into the U.S. and exports from China were particularly significant contributors to the 16.5-per-cent increase in the value of world trade in 2003 and the 21.2- per-cent increase in 2004. U.S. imports rose by 8.5 and 17.1 per cent. Chinese exports grew 34.6 and 35.4 per cent.[5] The increase in trade was pervasive: most countries showed double-digit growth in both 2003 and 2004. Indeed, the U.S. share of all imports actually fell during this period.

Figure 6 shows the sharp recent increase in China's exports of goods as a share of all exports (by value), but indicates too that China's share remained relatively small at six per cent of the world total in 2003. (In 2004—not shown in Figure 6—China's share was nine per cent of the world total of exports of goods.) Figure 6 also shows that internal trade among European Union countries has comprised a significant amount of international trade: in 2003, it was 24 per cent of the world total. In comparisons with other countries, particularly the U.S., this trade may be more in the nature of inter-state trade rather than international trade. Thus, including it in data on international trade may be misleading. To put internal EU trade in context, it should be noted that the value of interstate commerce in the U.S. may be several times that of trade within the EU.[6]

Figure 6. Shares of value of world exports by country/region, 1980-2003

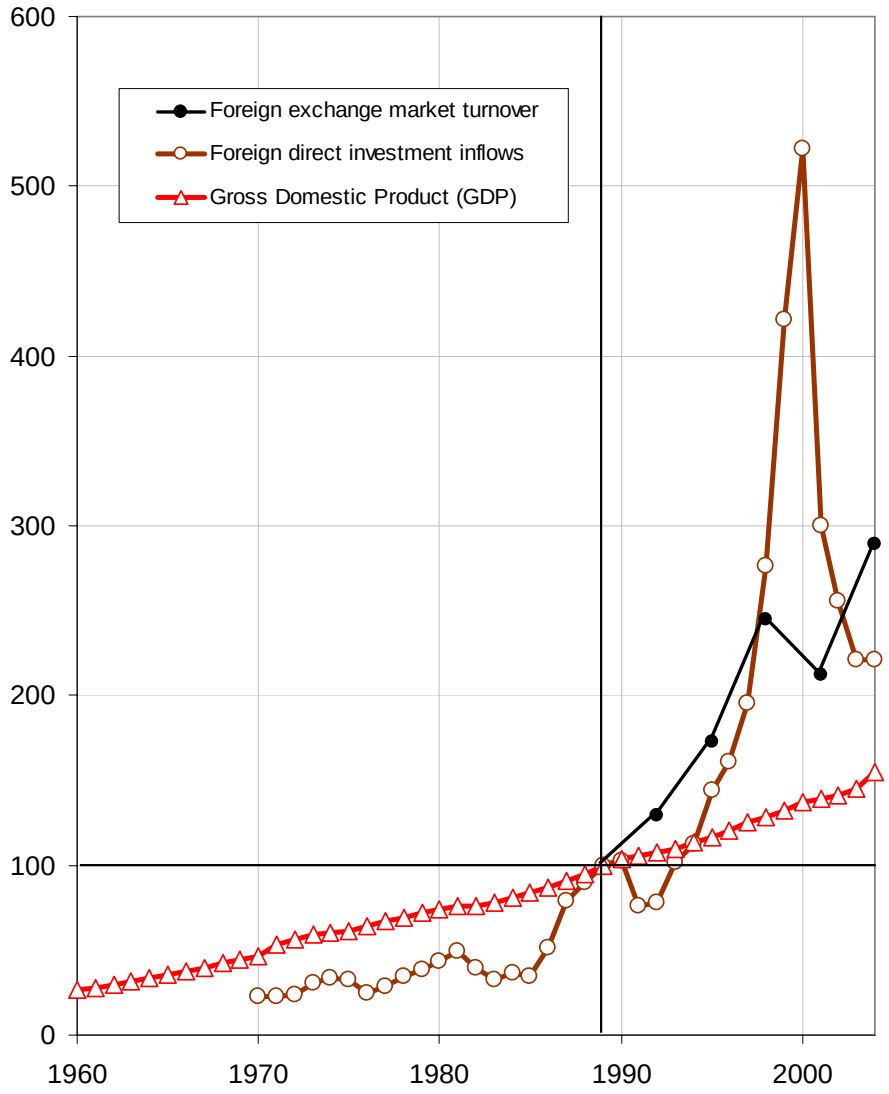


Source: World Trade Organisation (2005)

3. Trends in flows of capital

Figure 3 has already showed how the value of currency movements and foreign direct investment[7] (FDI) have changed in relation to the value of trade in goods and services and to GDP. In 2004, currency movements exceeded GDP by a factor of almost 12, trade by a factor of almost 50, and FDI by a factor of almost 700. The large discrepancies between currency transactions and the other indicators could well represent currency speculation, i.e., short-term movements of funds across currencies in the hope of profit from changes in exchange rates.

Figure 7. Normalised world GDP, foreign currency market turnover, and foreign direct investment (1989 = 100, available years, 1960-2004)

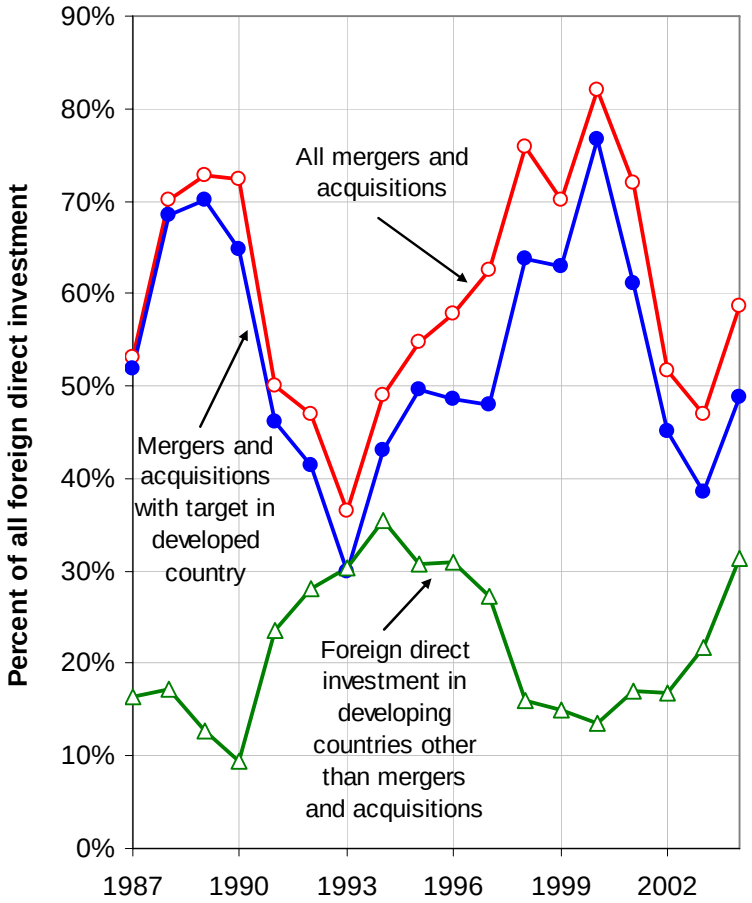


Sources:
Foreign exchange market turnover: Bank for International Settlements (2005, Table B.1)
Gross Domestic Product (GDP): United Nations Statistics Division (2005, Series 29918)
Foreign direct investment inflows: United Nations Conference on Trade and Development (2005, Table B.1)

Foreign direct investment was increasing at a furious pace towards the end of the 1990s, reaching a peak in 2000 that in real terms was more than five times higher than the total in 1989 (see Figure 7). Then it collapsed. This collapse may have contributed to the conclusion of Saul (2005) that globalism/globalisation had ended. Alternatively, it may have presaged a paradigm shift in globalisation of the kind suggested by Friedman (2004), although the logical link between a decline in FDI and the arrival of a new era of globalisation is not yet evident.

Mergers and acquisitions are a significant component of foreign direct investment. Figure 8 shows that during the period 1987-2004 they usually comprised more than 50 per cent of the total and in 2000 exceeded 80 per cent. Almost all of this activity involved businesses in developed countries. Foreign direct investment in developing countries has tended to decline in years when there was much mergers and acquisitions activity in developed countries, and to increase in other years, suggesting competition for a limited pool of capital, although one that was growing until 2001 (Figure 7).

Figure 8. Mergers and acquisitions and other investment as a share of all foreign direct investment, 1987-2004

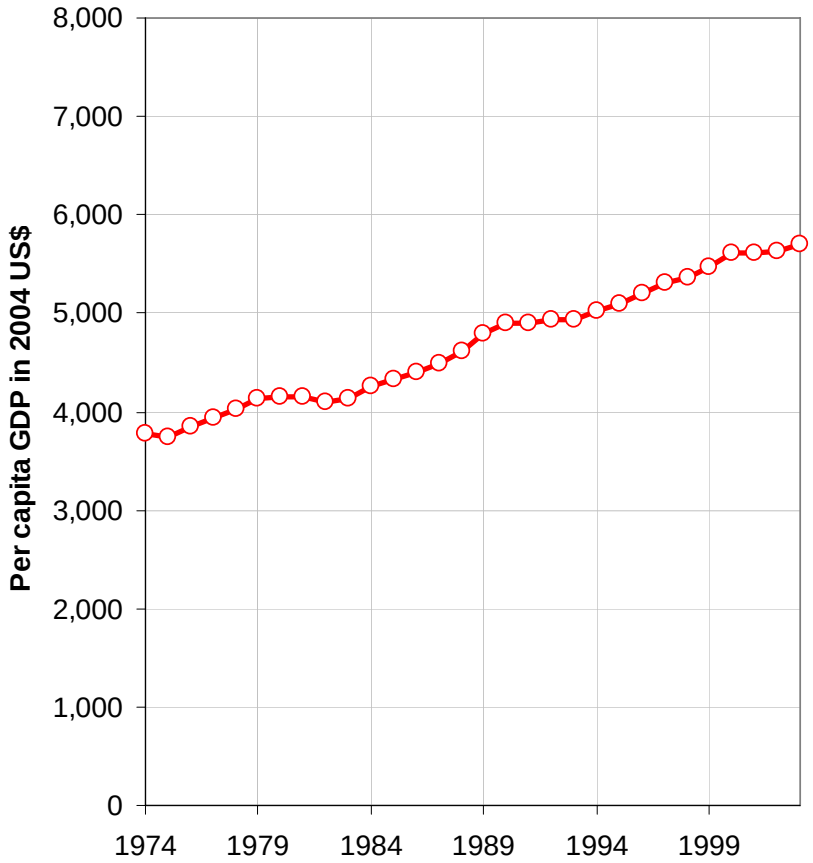


Sources:
Foreign direct investment inflows: United Nations Conference on Trade and Development (2005, Table B.1)
Mergers and acquisitions: United Nations Conference on Trade and Development (2005, Tables 7.1 and 7.2)

4. A note on absolute and relative growth

The forgoing analysis was made without reference to population growth. World population grew by 58 per cent between 1974 and 2003, from 4.00 to 6.31 billion. Thus, while world GDP grew by 138 per cent in real terms during this period, GDP *per capita* grew by 'only' 51 per cent (Figure 9). In terms of average individual well being, per capita values are of more importance. However, the present concern is chiefly with environmental impacts. For these, *total* amounts of transport activity are of more significance than relative or unit amounts, whether denominated to population or GDP. Accordingly, the focus so far has been on absolute rather than relative activity.

Figure 9. Per-capita GDP, 110 countries/economies, 1974-2003



Sources:
GDP: United Nations Statistics Division (2005, Series 29918)
Population: United Nations Statistics Division (2005, Series 13660)

5. Preliminary conclusions re. trade, capital movements, and globalisation

The extensive available data on the real *value* of trade suggest that trade in goods has increased in absolute importance (Figure 1 and Figure 3) and in relation to GDP (Figure 4 and Figure 5), although somewhat spasmodically in both cases. Trade in manufactures has comprised by far the largest part of this trade and its growth. Trade in services has also increased, although more evenly.

Capital movements have grown more than trade although even more erratically (Figure 2). A huge overburden of currency activity has also been detected, which may represent currency speculation. Whether and how the level of such speculation might influence trade requires investigation.

The marked increase in the real value of world trade implies a possible substantial increase in transport activity. Moreover, even if globalisation had not been associated with an overall increase in the *value* of trade, it could still have involved changes in the amounts of goods movement activity through increased separation of suppliers and markets. For example, fashion goods sold in Toronto may once have been manufactured in New York State but may now be produced in China. Equally important for transport activity could be changes in marketing practice, involving frequent changes in product, such the case illustrated in Box 1. Both kinds of change could involve much more transport activity without necessarily increasing the total value of trade.

Box 1. Fast fashion and cheap chic

'Cheap chic' is transforming the retail business, forcing companies to spot, make, ship and sell new goods faster, and at lower prices, than ever before.

DCK Concessions Ltd, the UK owner of the Diva Canada jewellery chain, has 50 designers scouring top global fashion shows, sending digital images directly to factories in China, South Korea, Thailand, and India.

Teams in the factories make up the samples, which are sent to the UK head office for approval within a week. The head office sends a box containing hundreds of pieces to its divisions every week. Diva Canada picks about 70 samples, and the finished products arrive at its stores about six weeks later.

"Our whole business is predicated on the fact that you walk into a Diva store today and it should look different a month from now", said Adam Goldberg, chairman of Diva Canada.

The regular price of cheap-chic items is low enough to encourage purchasers to discard their recent purchases when newer, more au courant items come along. If an item does not sell within two months it is marked down by as much as 90 per cent to make way for new products.

Diva's shipments are flown in directly to Montreal from overseas factories and then sent by courier to stores in Ontario and Quebec. "It is more expensive to ship by air, but a worthwhile expense, shaving what could be up to four weeks off the delivery time," said Goldberg.

"It's a wake-up call for traditional department stores, who continue to struggle." said Joe Manget, of the Boston Consulting Group. "Even so, some long-standing Canadian retailers are making fast-fashion strides."

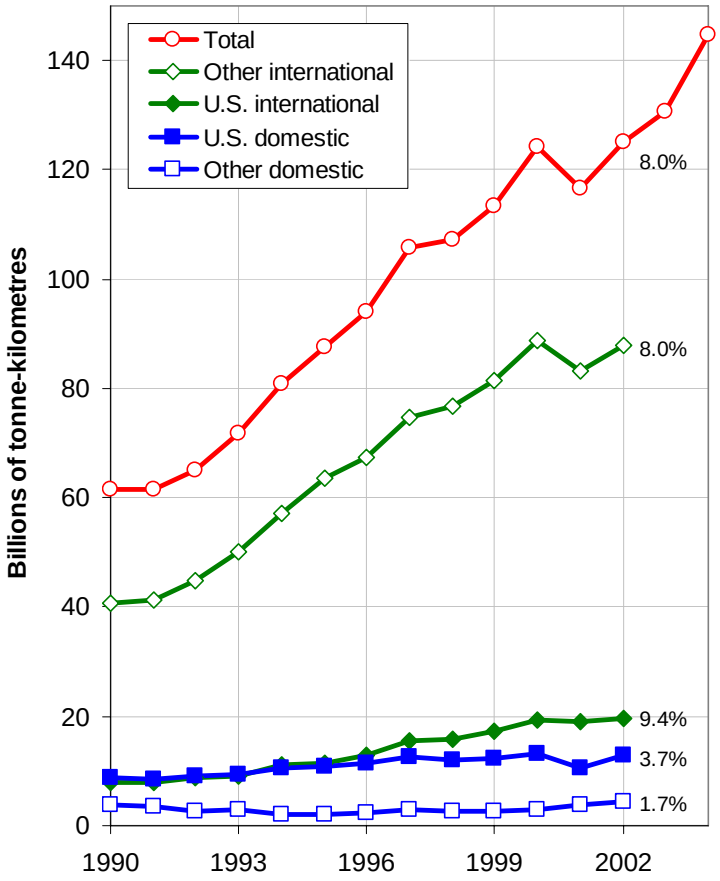
Adapted from Strauss (2005)

6. Movement of freight and people by air

The foregoing raised the possibility that international transport activity could have increased substantially since the 1970s. Such an increase would be evident chiefly in the movement of goods, by sea and air where the trade is intercontinental and additionally by rail and road where goods are moved between countries on the same continent.

A commensurate increase in the international movement of people might also be expected. Some of this would be associated with stimulating and servicing the international movement of goods. Some could arise from other aspects of globalisation. For example, the large increase in foreign direct investment shown in Figure 7 would likely have required a substantial amount of travel, particularly the mergers and acquisitions detailed in Figure 8. The aspects of globalisation involving what was described above as "cross-border social, cultural and technological exchange" (Australian APEC Study Centre 2005) might also be expected to be associated with increased travel, including travel for tourism.

Figure 10. Movement of freight by air, international and domestic, totals, U.S., and other, available years 1990-2004

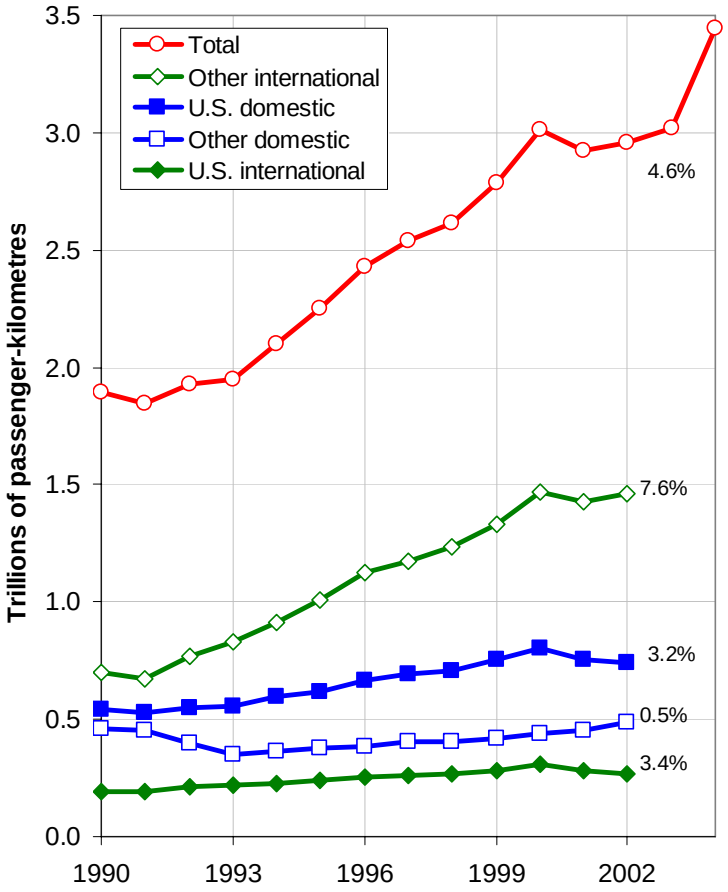


Percentages are average annual rates of increase, 1990-2002.
Sources: United Nations Statistics Division (2005, Series 12890) The totals for 2003 and 2004 are from International Civil Aviation Organization (2005a)

Figure 10 and Figure 11 show international and domestic movement *by air* of goods and people, respectively, for the period 1991-2002 or 1991-2004.[8] The U.S. is shown separately because of its large shares, particularly of domestic aviation activity. The rates of increase in international activity are particularly striking (other than that for international travel to and from the U.S.), and can be taken to reflect globalisation. Another striking feature is the large increase in the movement of freight compared with that for the movement of people.

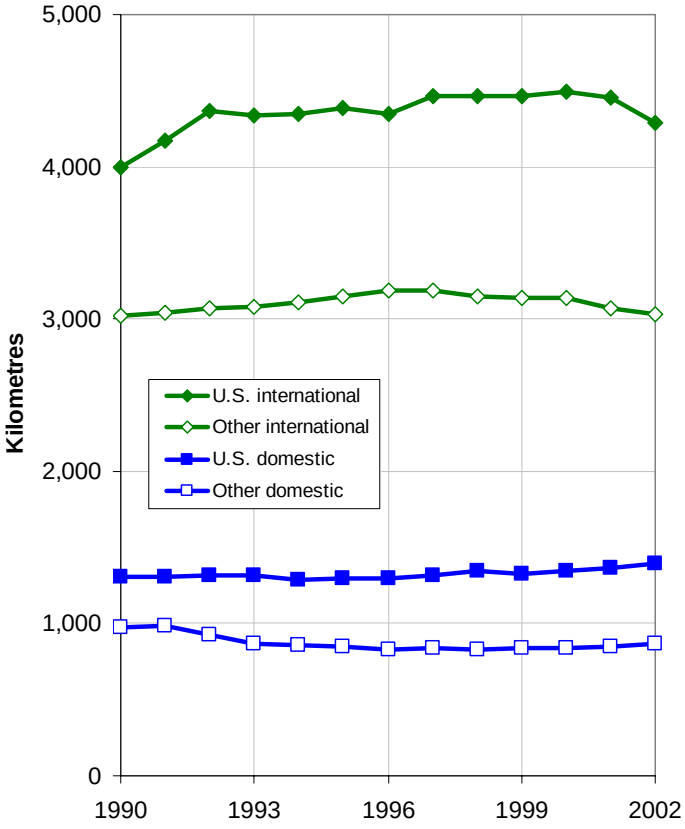
Figure 12 provides information about changes in the *length* of passenger trips by air. The relative constancy of average distances travelled is apparent, for both international and domestic trips.[9] The main factor in the increase in passenger travel portrayed in Figure 11 may thus have been an increase in the *number* of trips rather than an increase in the *length* of trips. Over the period 1990-2002, people travelled more, but not on average to more distant places. Distances travelled by freight items may have declined over this period, particularly for domestic air freight.[10]

Figure 11. Movement of people by air, international and domestic, totals, U.S., and other, available years 1990-2004



Percentages are average annual rates of increase, 1990-2002.
Sources: United Nations Statistics Division (2005, Series 12870); the totals for 2003 and 2004 are from International Civil Aviation Organization (2005a)

Figure 12. Average length of passenger trips by air, international and domestic, U.S. and other, 1990-2002



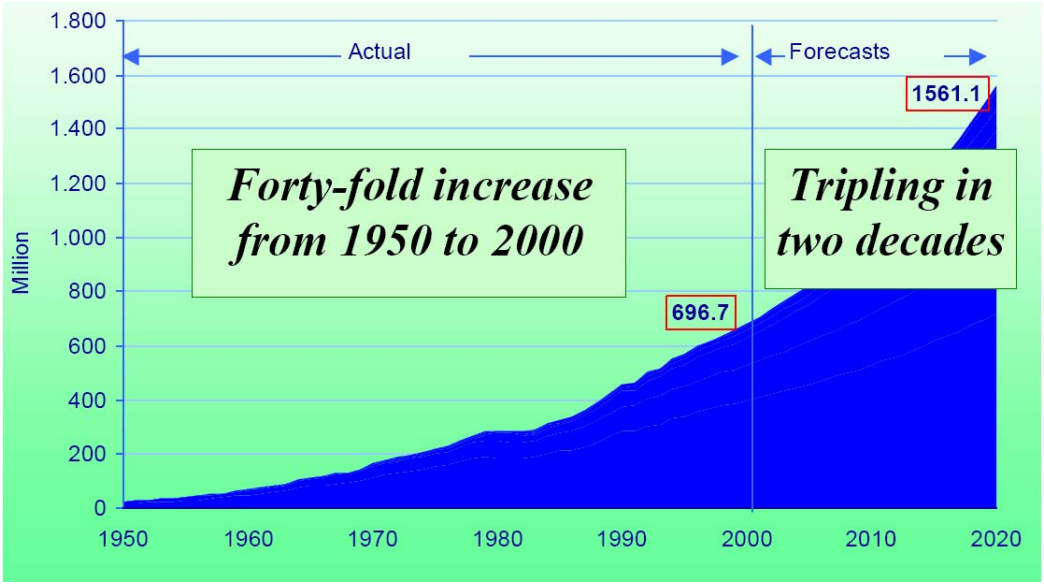
Source: United Nations Statistics Division (2005, Series 12870 and 12880)

The longer-distance movement of people was discussed at some length in a recent OECD report (OECD 2005a). Tourism appears to account for more than half of such trips and a larger share of the growth in air travel. However, some definitions of tourism are broad enough to include much business travel, and trips are often undertaken for many purposes, making it difficult to identify precise shares of all long-distance travel.

Whether such travel is for tourism or business, or both, if it is international its growth can be considered a manifestation of globalisation. A further complicating factor is that a substantial share of longer-distance trips is made *within* the U.S., and thus they may not qualify as instances or tourism or globalisation. In 2001-2002, U.S. residents made 3.4 times as many such trips as EU15 residents, but many more of the latter's trips are included in tourism statistics (OECD 2005a).

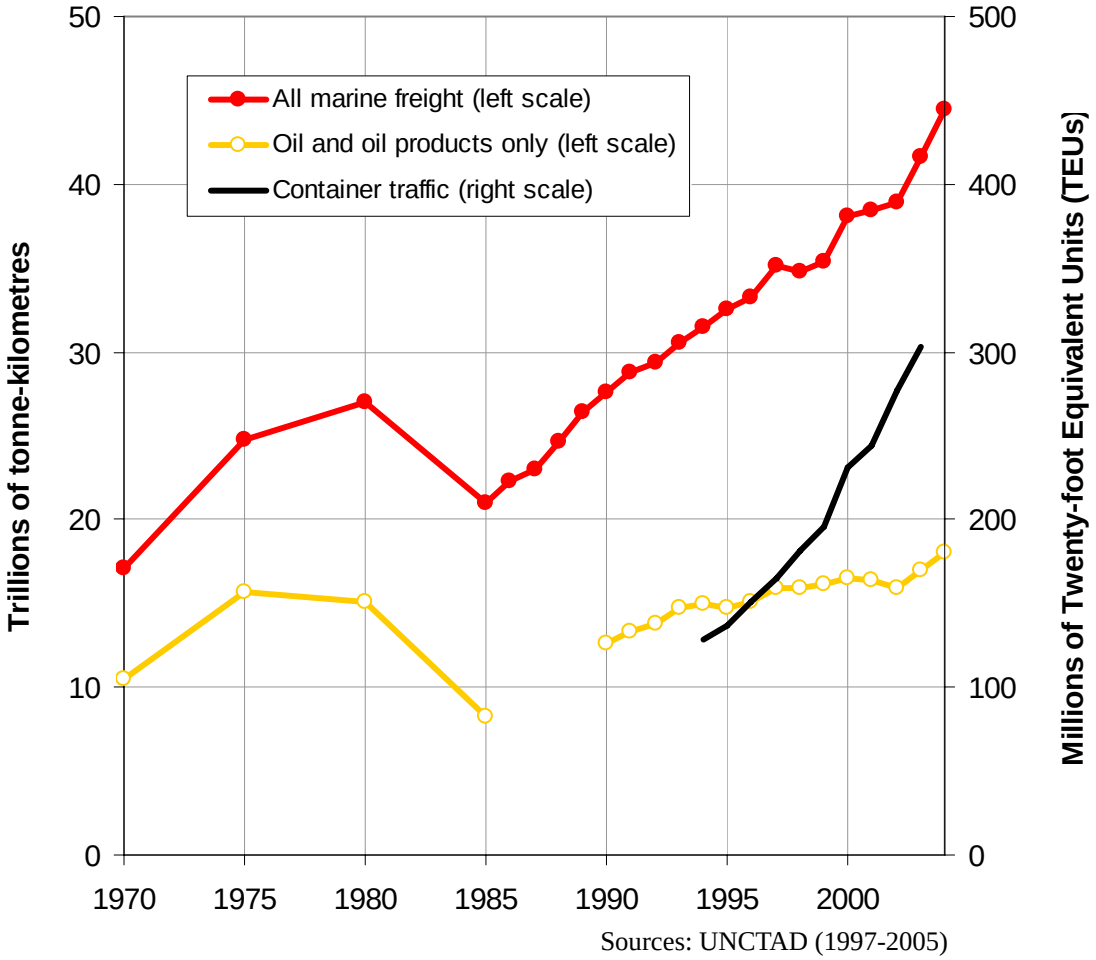
Notwithstanding these analytical challenges, the growth in tourism is impressive. It and anticipated further growth are shown in Figure 13. Although far from all longer-distance travel is made by air (OECD 2005a), tourism travel by air appears to be a signficant component—perhaps the most significant component—of the remarkable increase in international air travel portrayed in Figure 11.

Figure 13. Past and future international tourist activity



Source: World Tourism Organisation (2004)

Figure 14. Movement of freight by sea: total tonne-kilometres (closed circles, left scale) oil and oil products (open circles, left scale) and container traffic (right scale)



Sources: UNCTAD (1997-2005)

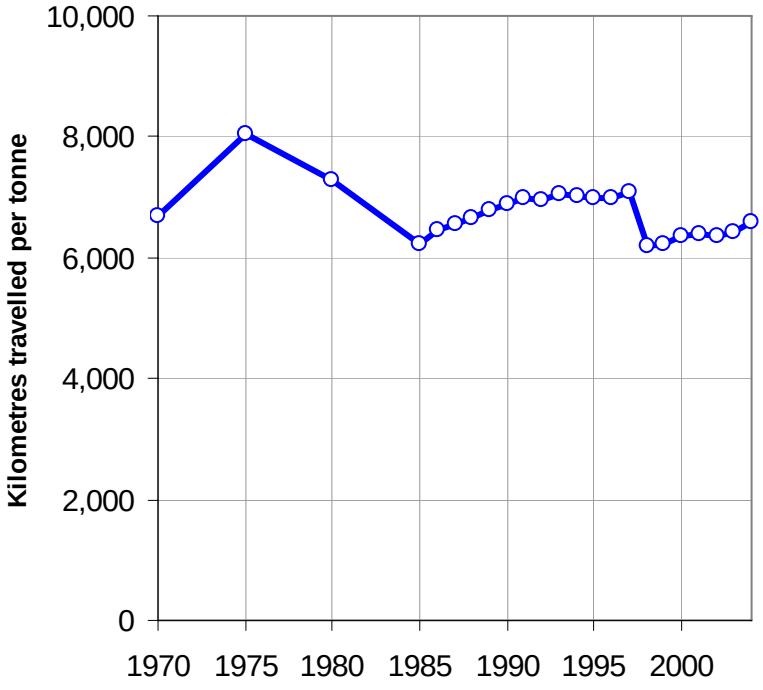
7. Movement of freight by water

Data for domestic and international marine freight movement—in ships of 100 tonnes gross weight and larger—are represented in Figure 14. Oil and oil products are shown separately. In the 1970s, these items comprised more than half of marine freight movement, but since 1985 other marine freight traffic has grown much more steeply. From 1990-2002, tonne-kilometres performed by water increased by an average of 2.9 per cent annually, a rate considerably lower than the average increase for air freight during the same period (8.0 per cent; see Figure 10). Over the most recent two years the annual increase in marine freight activity, as shown in Figure 14, has been 6.9 per cent. Movement of freight by container, also shown in Figure 14, has grown much more steeply, by 10.0 per cent annually between 1995 and 2003.

Note that if each loaded TEU contained an average of 14 tonnes of merchandise (Hamburg Shipowners' Association 2006), the container traffic represented in Figure 14 comprised only about 0.6 per cent of the total tonne-kilometres performed as international trade in 2003. Oil and oil products comprised 34 per cent of the total. Bulk 'dry goods', chiefly iron ore, coal, and grain, comprised the remainder.

Figure 15 shows the average distance moved by each tonne of marine freight (calculated by dividing tonne-kilometres by tonnes moved). Possibly unlike air freight, for which distances may have declined (see Note 10), the distances moved by marine freight ap-

Figure 15. Average distance travelled by marine freight, 1970-2004



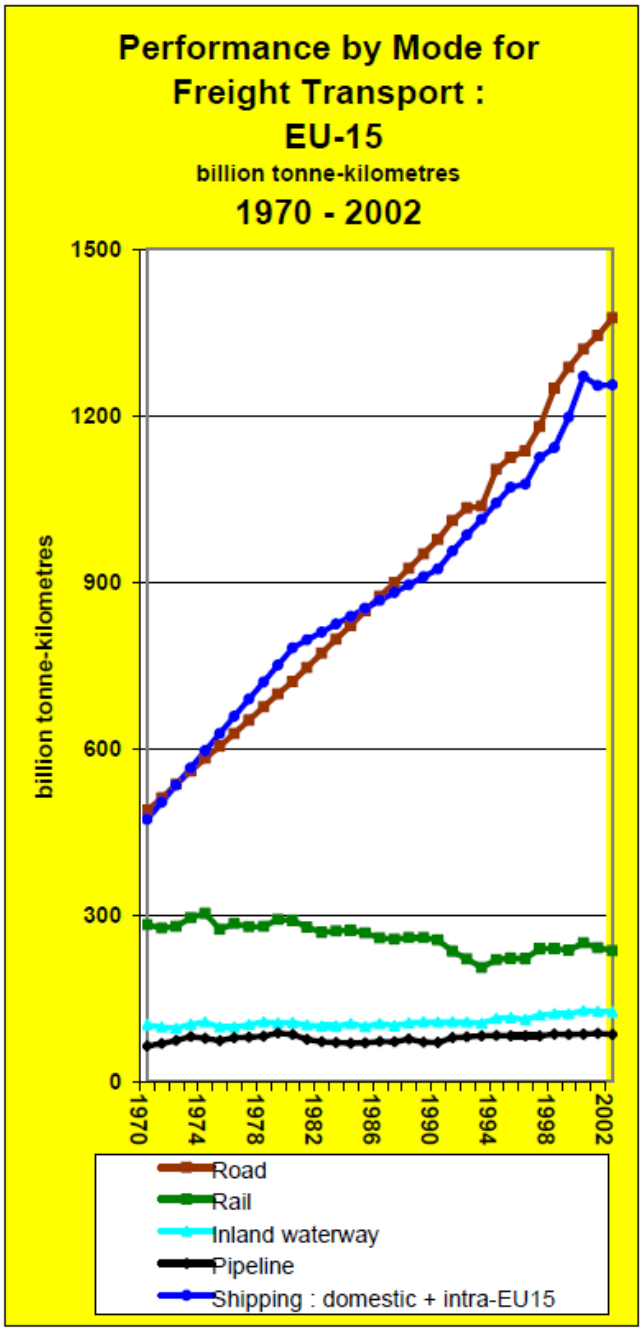
Sources: UNCTAD (1997-2005)

pear to have remained relatively constant. Thus, the increase in marine activity appears to have resulted from more freight being moved, rather than from freight being moved over longer distances. Over the period 1990-2004, the average distance moved by each tonne of oil or oil products was 7,485 kilometres; the average distance moved by each tonne of other internationally traded items was 6,222 kilometres. The finding of near constancy in trading distance over time is consistent with at least two recent analyses. Berthleon and Freund (2004) found that the average distance that trade travels "declined slightly" between 1980 and 2000. Carrere and Schiff (2004) reported a small increase in this distance (4.0 per cent) for OECD countries between 1962 and 2000, and a larger decrease (8.4 per cent) across the same years for non-OECD countries.

In Europe, a considerable share of freight is moved by short-sea or coastwise shipping, including an unidentified portion of freight movement among European countries. Figure 16 shows that at least until 2000, such freight movement kept rough pace with freight movement by road. (To the extent that Figure 16 represents ships of 100 tonnes gross weight and more, its shipping data may be included in those represented in Figure 14.) Also shown in Figure 16 is freight movement by inland waterway, which may be domestic or other intra-EU15. Added to the coastwise shipping in Figure 16, the result is a total of freight movement by water that considerably exceeds movement by road.

Coastwise and inland movement by water is often overlooked as a major factor in freight movement, whether international or local. In the U.S., for example, 17 per cent of freight tonne-kilometres were performed by water in 2001—including coastwise, lakewise, internal, and intraport traffic—compared with 37 per cent by rail, and 26 per cent by road (Bureau of Transportation Statistics, 2005a). In Canada in 2003, the corresponding figures were 30 per cent of freight movement by water, 40 per cent by rail, and 29 per cent by road (Natural Resources Canada, 2005). In Japan in 2002, 45 per cent of freight movement was by water, 50 per cent by road, and 4 per cent by rail (Ministry of Land, Infrastructure and Transport 2005). In Hong Kong, the world's busiest container port, Pearl River trade comprised 28 per cent of port activity in 2003 (Hong Kong Trade Development Council 2005).

Figure 16. Freight movement in Europe (EU15)



Notes: Road: haulage on national territory
Sea: Intra-EU traffic including domestic traffic. The estimates for maritime traffic are based on different statistical sources as from 2001 and remain subject to revision.

Source: Reproduced from European Commission (2004, Figure 3.2.1)

8. Movement of freight by road

Some of the *intra*continental trade has been touched on in the presentation of aviation and marine activity, but the largest part of this trade is usually by rail or road. Table 1[11] shows, for example, that by value at least 79 per cent of the trade between the U.S. and Canada or Mexico in 2004 was by road or rail, mostly the former. Data for this trade across time are available also only in terms of dollar values. They are represented in Figure 17, which shows all U.S. merchandise trade with Canada and Mexico, and also this trade's share of all U.S. merchandise trade. Data in the indicated source suggest that the value moved by road or rail remained essentially constant over this period.

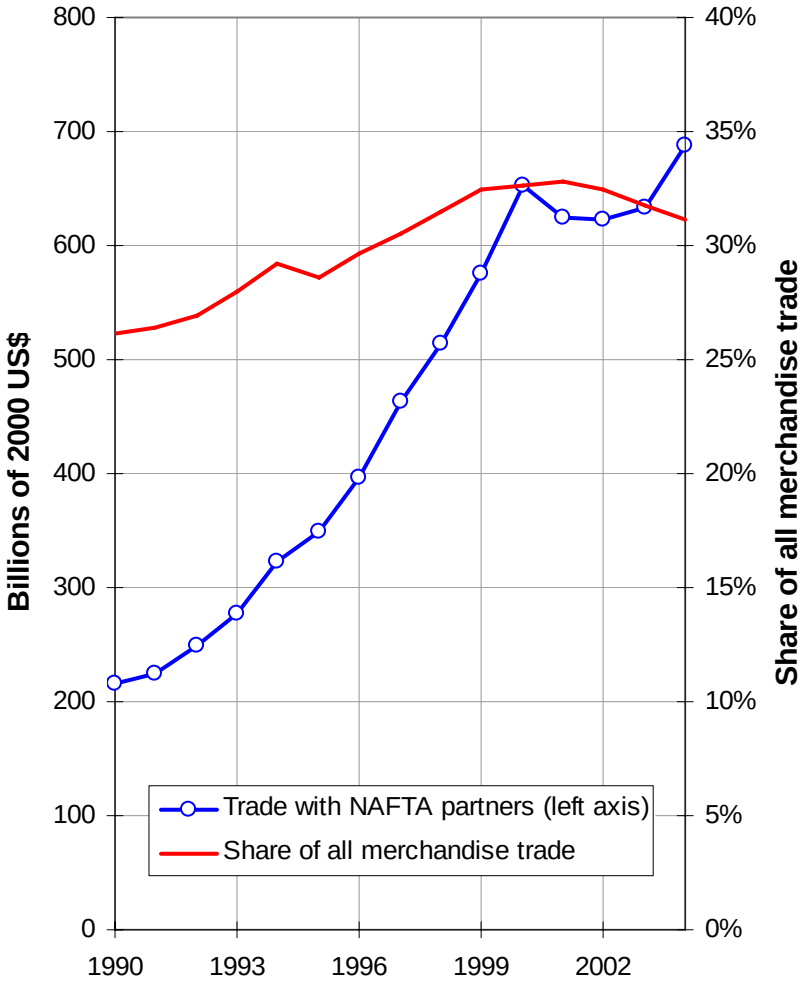
Table 1. Value in U.S. trade in 2004 with Canada and Mexico by mode carried; with estimates of quantities carried

Mode	Value in billions of US$	Per cent of total value	Value per tonne (US$)	Tonnes shipped (millions)	Per cent of total tonnes
Road	453	64%	875	517.9	40%
Rail	108	15%	247	436.7	34%
Water	46	6%	447	103.0	8%
Pipeline	39	5%	208	187.6	15%
Air	32	4%	93,845	0.3	0%
Other	34	5%	903	37.7	3%
TOTAL	712	100%		1,283.3	100%

Sources:
Values shipped: Bureau of Transportation Statistics (2005b, Table A-1)
Values per tonne: Bureau of Transportation Statistics (2005b, Table 1)
See Note 11 on estimates of value per tonne and thus tonnes shipped.

An interesting feature of Figure 17, which may be no more than a coincidence, is that the implementation of the North American Free Trade Agreement (in 1994) appears to have resulted in a *reduction* in the subsequent years in the share of trade between the U.S. and the other NAFTA countries. The more significant feature of Figure 17 is the decline in the value of this trade in 2001, and its lower level in 2001-2003 than in 2000, although not in 2004. The lower level of NAFTA-oriented trade in 2001-2003 mostly reflected the decline in total U.S. trade in these years, although Figure 17 suggests also that some disengagement from NAFTA could also be a factor.

Figure 17. Value of U.S. merchandise trade with Canada and Mexico (left panel) and this trade as a per cent of all such U.S. trade (right panel); 1990-2004

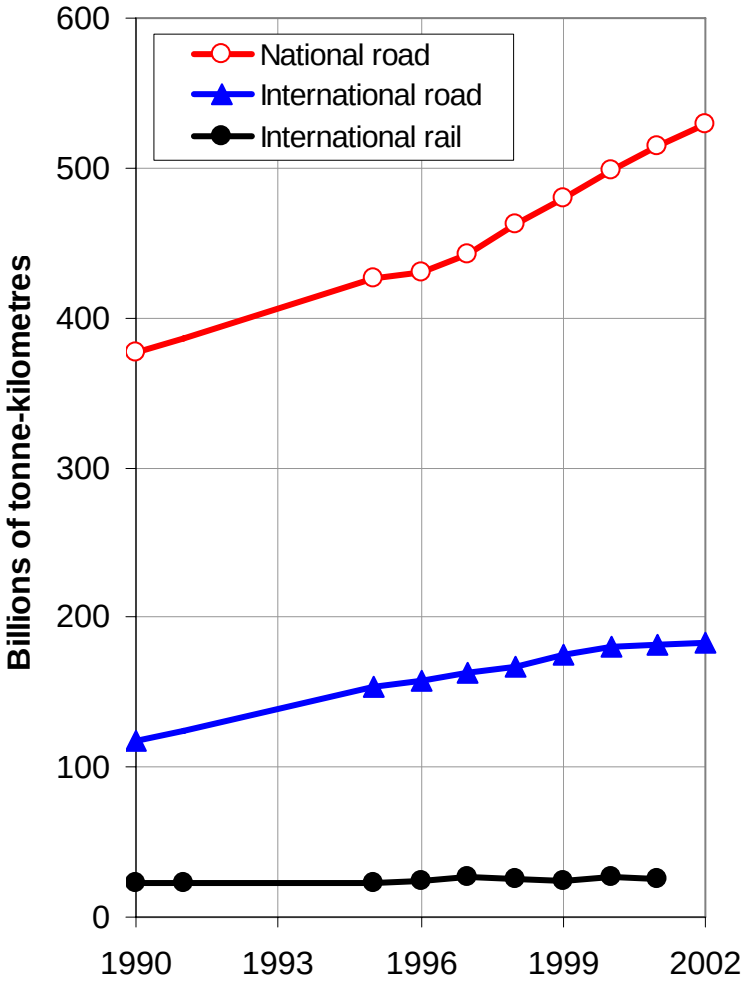


Source: U.S. Bureau of Transportation Statistics (2005b, Table 1)

Data discussed during the last two paragraphs concern the *value* of trade, which may be only a weak surrogate for the amount of international transport activity. Few comprehensive data exist on the amount of this activity by transport mode in North America.

Data on national and international road freight transport are available for some European countries. They are shown in Figure 18. Almost all the international freight movement is to other EU countries. Again there is a suggestion of a retreat from international activity during the present decade. International road freight movement grew annually by 4.4 per cent in the 1990s, but by only 0.9 per cent between 2000 and 2002. Domestic road freight movement grew annually by 2.8 per cent in the 1990s, but by 3.1 per cent between 2000 and 2002. (The rail freight data in Figure 18 are discussed in the next section.)

Figure 18. National road freight and international road and rail freight loaded or unloaded in seven EU countries (BE, DK, ES, FR, NL, PT, UK), 1990-2002



Source:
Road: Eurostat (2004, Tables 2 and 3)
Rail: European Commission (2003, Table 5.21)

9. Movement of freight by rail

Except in North America (see Table 1), there is relatively little international movement of freight by rail. Rail freight has been in substantial decline in most countries outside North America. Significant exceptions have been China and India, which recorded increases in tonne-kilometres performed of more than 150 per cent and more than 100 per cent respectively (from already large bases) between 1981 and 2001 (United Nations Statistics Division 2005, Series 29510). Almost all the rail freight in these two countries is domestic, although, particularly in the case of China, much of it likely serves as the first or second link of an international shipment.

The situation in Europe (EU15), illustrated in Figure 16 and Figure 18, is more typical, particularly the overall decline in rail freight and the substantial increase in movement of freight by road.

The superiority of rail freight compared with other freight modes—from an energy perspective—is often not fully appreciated. It is illustrated in Table 2, which portrays *domestic* Canadian data for 1990 and 2003 for surface modes other than pipeline. (All freight movement in Canada by rail and water, and almost all freight movement by road, is powered by diesel engines.). As will be discussed further in Section 13, environmental impacts of transport are strongly correlated with fuel use.

Table 2. Tonne-kilometres performed by mode and average end energy use per tonne-kilometre moved, Canada, 1990 and 2003

	Tonne-kilometres			Megajoules per tonne-km		
Mode	**1990**	**2003**	**Change**	**1990**	**2003**	**Change**
Rail	248,371	322,664	+30%	0.34	0.22	-35%
Water	190,115	237,400	+25%	0.56	0.43	-23%
Road	106,555	234,022	+120%	4.47	3.24	-28%

Source: Natural Resources Canada (2005)

Table 2 shows that in 2003, compared with movement of freight by rail, movement by water consumed about twice as much fuel per tonne-kilometre, and movement by road consumed about 15 times as much. Also noteworthy are the large increase in road freight between 1990 and 2003 and the considerable improvements in fuel efficiency achieved by all represented modes.

Note that the marine freight characterized in Table 2 involves Great Lakes and coastwise shipping, which, chiefly because smaller vessels are used, is inherently less fuel efficient that oceanic shipping (see Section 12). However, electric freight trains would be even more efficient that the diesel trains shown in Table 2 (and capable of use of

renewable energy). Thus, there could be merit in substituting movement of freight by electric train for movement by sea, not only because of evident time savings but also to reduce oil use.

The most ambitious such substitution project under consideration would involve moving freight from Asia to Europe by rail, and then by ship to North America, rather than across the Pacific (UIC 2004). The 'Northern East-West Corridor' (NEW) concept is set out in Figure 19. Commercialization of the concept began during 2005.[12]

Figure 19. The Northern East-West Corridor (NEW) concept for enhanced Eurasian rail links

Reproduced from UIC (2004)

10. Conclusion regarding the movement of freight

Based partly on the foregoing, the author's very rough estimates of the shares of world-wide international trade performed by the different transport modes are set out in Table 3, in terms of both tonne-kilometres performed and shipment value.[13]

Table 3. Mode shares of international trade's transport activity

Mode	Tonne-kilometres	Shipment values
Water	95%	55%
Road	2.5%	3.0%
Rail	1.0%	0.5%
Pipeline	1.0%	0.5%
Air	0.5%	41%

These estimates appear consistent with those for the U.S. and Japan in Table 4. (Note that this table portrays tonnes moved rather than tonne-kilometres performed.)

Table 4. Transport mode share of imports and exports, by weight and value, U.S. and Japan, 2001

	United States				Japan			
	Imports		Exports		Imports		Exports	
Mode	**value**	**weight**	**value**	**weight**	**value**	**weight**	**value**	**weight**
Water	45.5	78.7	27.2	75.1	70.7	99.8	74.8	99.2
Air	23.4	0.3	34.4	0.6	29.3	0.2	29.3	0.8
Land	26.2	20.8	29.5	23.9	0.0	0.0	0.0	0.0
Miscellaneous	5.0	0.2	8.9	0.8	0.0	0.0	0.0	0.0

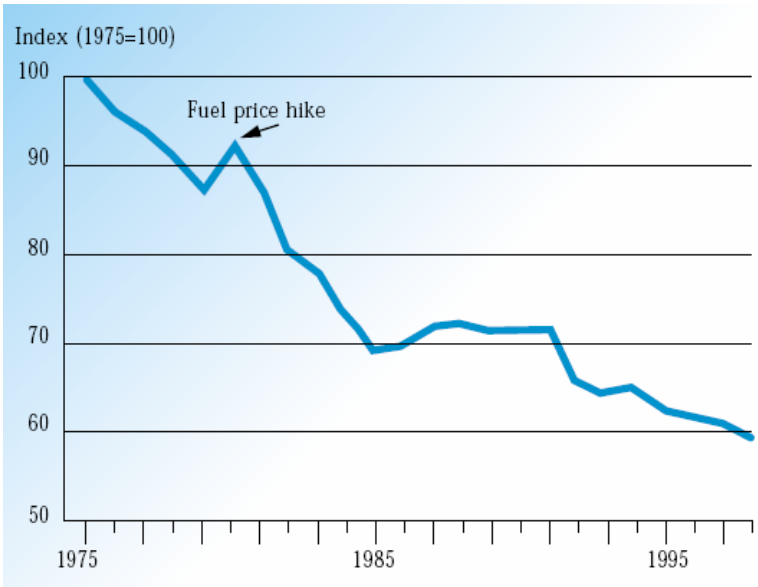
Source: Adapted from Table IIB.3 of World Trade Organization (2004)

From a transport perspective, the importance of freight movement by ocean and other water modes is overwhelming. When shipment value is considered, water modes are still the most important but air freight is also significant.

11. Transport and time costs

To the extent that globalisation involves increased trade, it depends on affordable movement of freight and, to a lesser extent, people. The most conspicuous change in international transport costs has been the decline in real air fares, particularly before 1985, as illustrated in Figure 20 for the period 1975-1998.

Figure 20. Real air fares, worldwide, 1975-1998



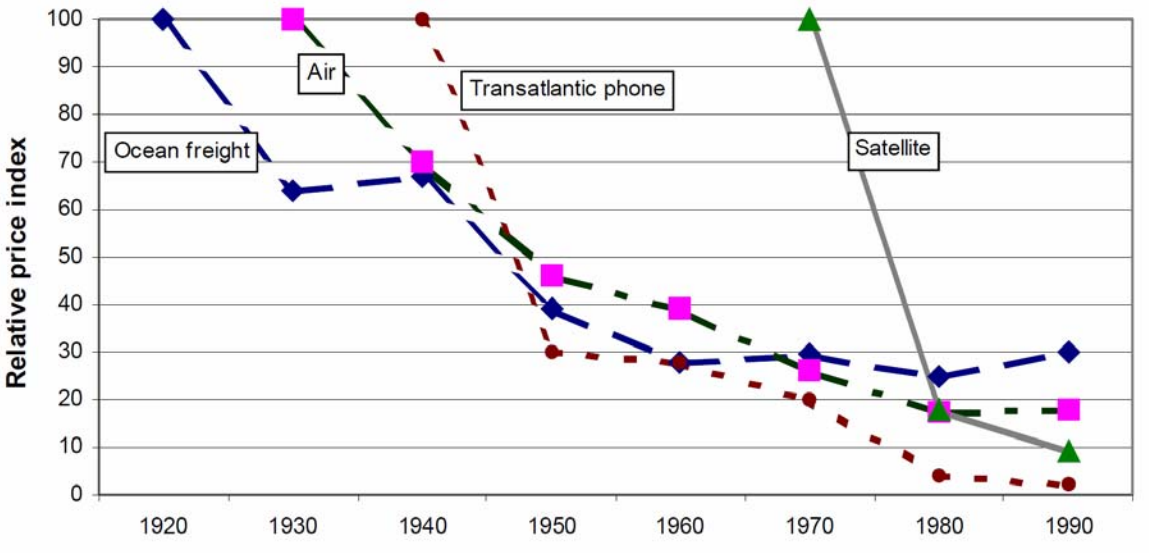
Reproduced from ATAG (2000)

Since 1998, U.S. domestic air fares appear to have continued to fall, although international fares seem to have risen (American Express 2005; Bureau of Labour Statistics 2006).[14] The continuing fall in shorter-distance fares, which may not be confined to the U.S., may have occurred because of the proliferation of low-cost carriers and because of operating efficiency improvements effected by "mainstream" carriers (Economist 2005), also known as 'legacy carriers'. Longer-distance fares may be more susceptible to higher fuel prices, discussed in Section 12.

Actual data on long-term trends in air fares are not readily available, and data on trends in freight rates are more elusive, for all modes. When considering international trade, marine freight rates are the most critical factor from a transport perspective because almost all international trade is carried by ship (see Table 3). A World Bank (1995) chart is often reproduced showing that transport and communications costs "plummeted during the 20th century" (e.g., CEC 2002; Wolf 2005), including ocean freight costs. A version of this chart is reproduced here as Figure 21.

However, there has been questioning as to whether ocean freight rates have actually fallen in real terms. Hummels (1999) concluded that they have not, a finding reflected in the outcome of a Round Table held by the European Conference of Ministers of Trans-

Figure 21. Changes in transport and communications costs 1920-1990



Reproduced from CEC (2000), based on World Bank (1995)

port held in September 2004 (ECMT 2005a), in which Hummels participated. These are the published conclusions of the Round Table:

- The traditional measure of transport costs per tonne, which is important for estimates of the development of transport equipment use and infrastructure planning, does not show a secular, overall decline in international transport costs. Ocean shipping prices increased from the beginning of the seventies until the mid-eighties and have declined since then. Prices of maritime transport services per tonne are, however, about the same as they were at the beginning of the seventies.

- International transport costs per tonne have declined for air transport, although not in such a dramatic way that it could account for the strong intensification of international trade.

- More important for the measurement of the trade frictions resulting from transport costs is the cost of transport service per value of goods traded. While corresponding prices for ocean shipping have decreased for some countries and some goods, this is not a universal phenomenon.

- Transport costs per value units have substantially decreased for air transport.

- The increase in international trade has been accompanied by a massive increase in the value/weight ratio of the goods traded. This implies the increased impact of variations in international transport costs on the incentives to trade goods and services internationally.

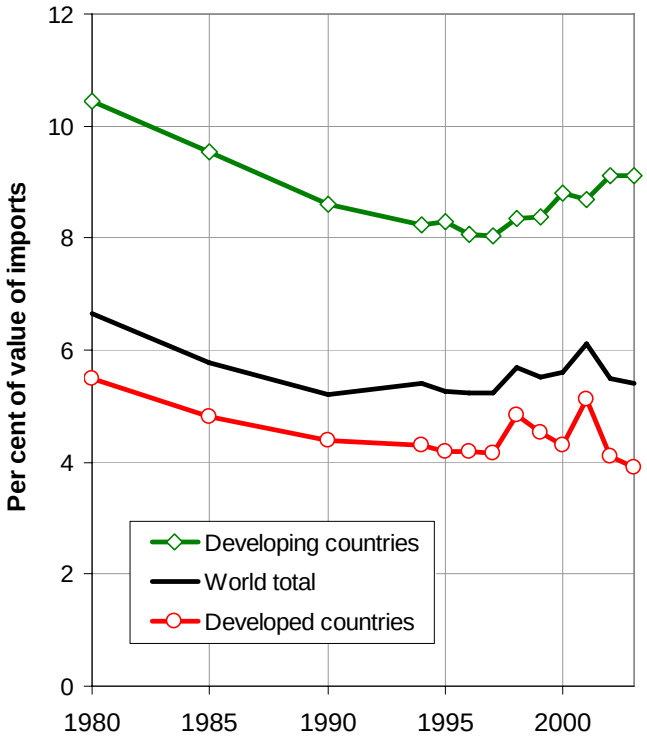
- The structural shift of trade flows has been accompanied by a strong shift in the modal split of international transport.

The published conclusions of the ECMT event made reference to an assessment of the *average* share of international transport costs in the cost of imports, based on the work of Anderson and van Wincoop (2004). It was estimated for the U.S. to add 12 per cent to the import value of the material or product. (An additional nine per cent was attributed to "the time value of goods in transit", a matter discussed below.)

This assessment differs from data provided by the United Nations Conference on Trade and Development (UNCTAD 1997-2005).[15] These data are presented in Figure 22, which shows that for developed countries, including the U.S., transport costs as a share of the *value* of imports have tended to decline since 1980, and are now around *four per cent* of import value. Transport costs for the developing countries represented in Figure 22 comprise a much high share, and have been increasing since 1997.[16]

Such low transport cost shares are also implied in a publication of the international shipping industry (ICS-ISF, 2005), which provides information about the share of ocean freight costs in the *retail price* of consumer items. These examples range between 0.15 and 1.6 per cent and include 1.4 per cent of the price of a US$700 television set, 0.7 per cent of the $150 price of a vacuum cleaner, and 1.0 per cent of the $15 price of a kilogram of coffee.[17] When considering all freight movement worldwide, the possibly very low shares of transport costs are offset by higher transport share in the costs of raw

Figure 22. Freight costs as a percentage of the c.i.f. value of imports, world, and developed and developing countries, available years 1980-2003



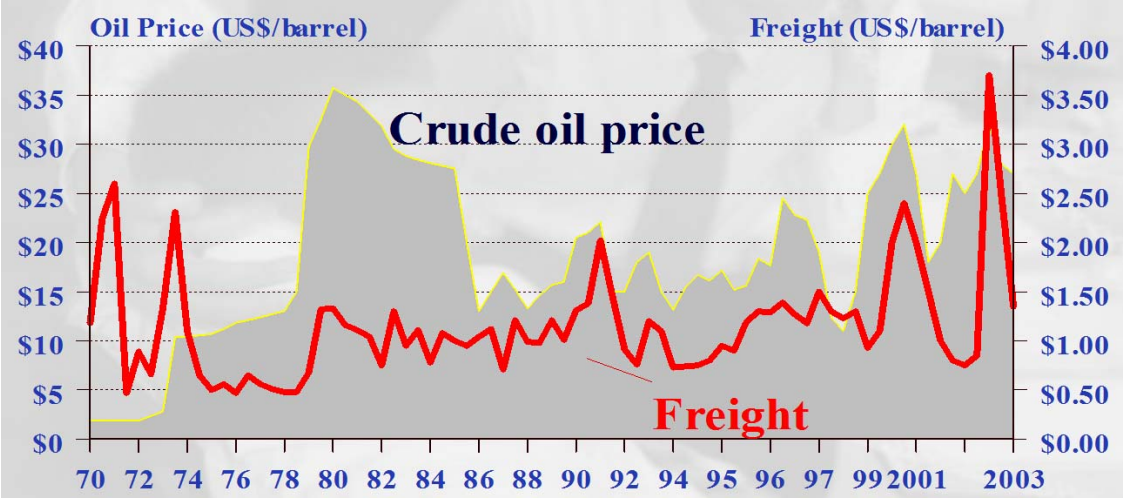
Source: UNCTAD (1997-2005)

material. The same source cites a cost of moving a tonne of iron ore from Australia to Europe at $US12. This is 20-50 per cent of the price received by an Australian supplier, according to the negotiated price of iron ore.[18]

However, the most important point is that all these shares are small, i.e., less or much less than 10 per cent of the landed price of products, or well within the range of price fluctuation of raw materials. A reasonable conclusion could be that, in general, transport costs have mostly been a relatively insignificant factor in international trade.

Figure 22 may suggest that the transport cost of international trade is relatively constant over time. In reality there can be substantial intra-year variation. Figure 23 shows as much as a threefold variation in the cost of shipping a barrel of crude oil within the space of 12 months (ranging from about three per cent to about 13 per cent of the market value of the oil).

Figure 23. Crude oil prices and shipping costs per barrel

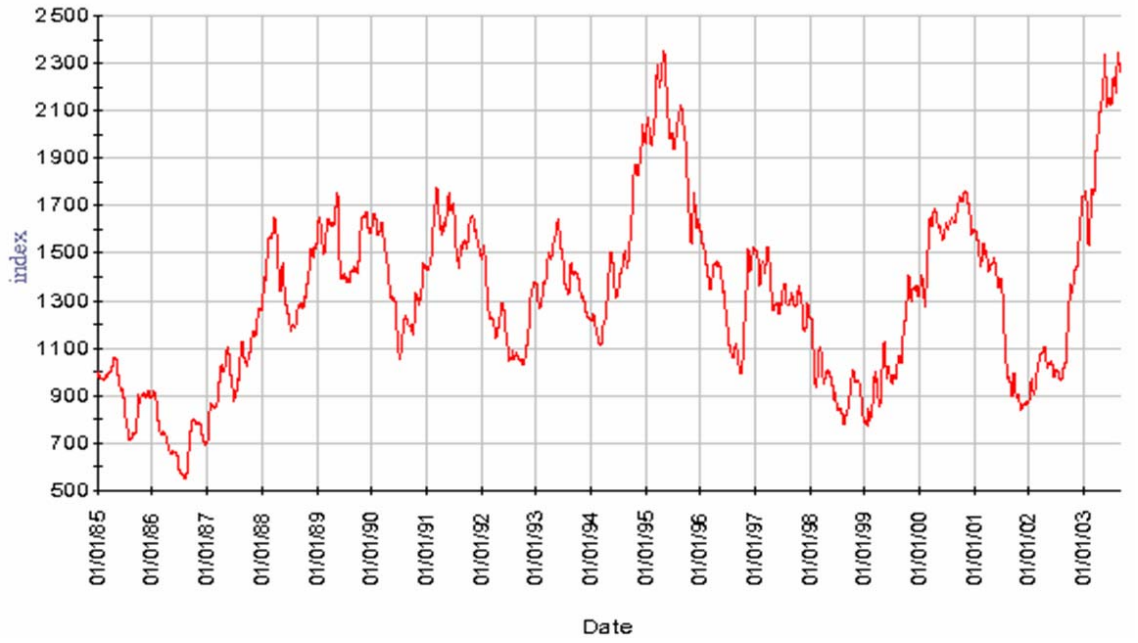


Reproduced from Kerr-Dineen (2003)

Figure 24 suggests almost as much variability of rates for shipping dry bulk cargo. A standard index of bulk cargo rates is the Baltic Dry Index, provided by London's Baltic Exchange, which handles about 50 per cent of the world tanker business and about a third of the bulk dry cargo business. In Figure 24 are indications that dry cargo rates can rise and fall by a factor of more than two in a few months.

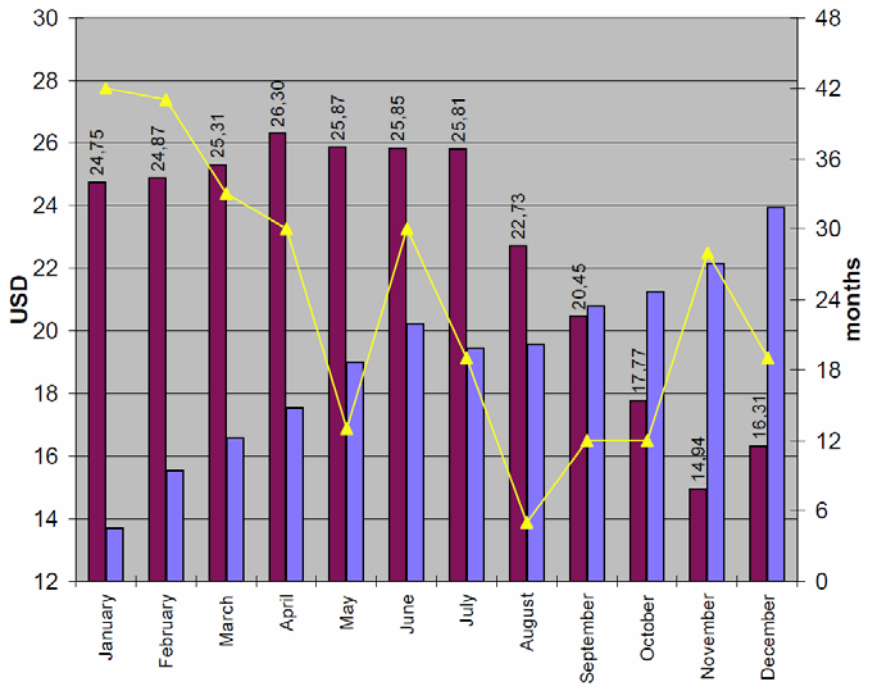
Hamburg brokers control about 75 per cent of containership charters. The Hamburg Index (actually a set of indices) reflect the work of 20-30 of these brokers. Figure 25 shows there can be almost as much short-term variability in containership charter rates as is shown in Figure 24 for rates for shipping dry bulk cargoes.

Figure 24. Baltic Dry Index (bulk cargo vessel charter rates), 1985-2003



Reproduced from Kerr-Dineen (2003)

Figure 25. Hamburg Index (containership charter rates), US$/day, 2004-5



Reproduced from Hamburg Shipbrokers'Association (2006)

Note: This version of the Hamburg Index concerns vessels carrying 1,000-1,299 containers (nominally carrying 14 tonnes each), chartered for periods of three months or more. The left bar of each pair shows 2005 data for the respective month; the right bar shows 2004 data. The line, read against the right scale, shows average charter periods for the 2005 months.

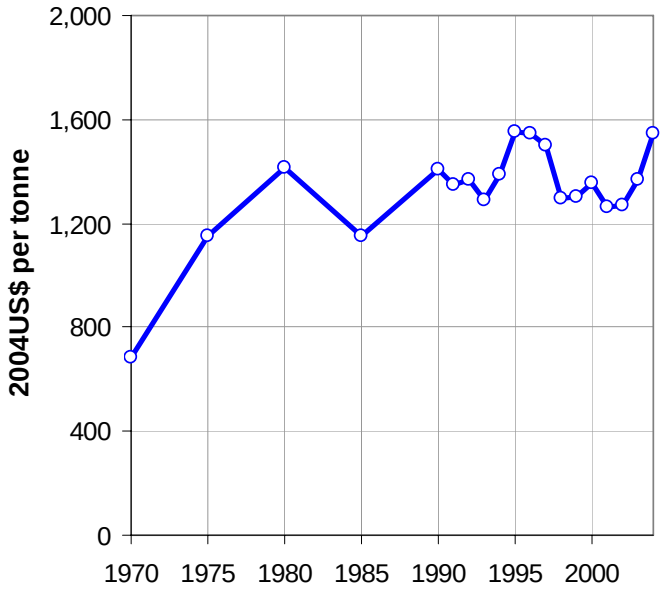
Another difference between ECMT's conclusions about freight rates and the data presented here concerns the conclusion that "The increase in international trade has been accompanied by a massive increase in the value/weight ratio of the goods traded". Combining data represented in Figure 1 and Figure 22 allows a series of estimates of the value/weight ratio of goods traded, in 2004 U.S. dollars per tonne. The series is provided in Figure 26, which suggests that the ratio increased until 1980 *but has remained relatively constant since then*.

The question of the average value per weight of trade is of importance in understanding the factors in the growth of movement of goods by air. If the unit value of trade is increasing, there could be a tendency to move more freight by air because the high cost of air freight—discussed below—would overall be a less significant component of eventual retail prices. If, as appears, there has been little increase in the unit value of trade, this factor could not readily be used to explain the growth in air freight activity.

Figure 10 describes the substantial rate of growth in air freight activity across the period 1990-2004. It has already been noted that this rate has exceeded the nevertheless substantial rate of growth in movement by water (see Figure 14 and associated text). However, the rate of growth in air freight activity has been less than the rate of growth in container traffic movement by water, also shown in Figure 14, with which it may be a more direct competitor.

Air freight costs are an even more elusive matter than those of marine freight.[19] Part of the challenge is the clear linkage to the highly variable costs of air travel,[20] which may

Figure 26. Constant U.S. dollar value per tonne of the worldwide trade in goods, 1970-2004



Sources:
Value of trade in goods: World Trade Organization (2005)
Weight of trade in goods: UNCTAD (1997-2005)

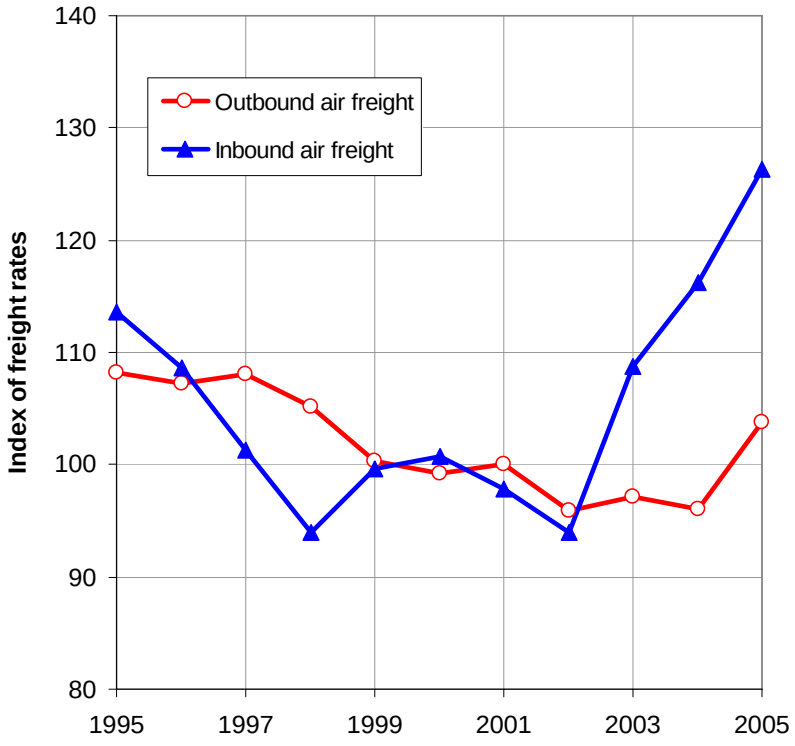
involve fares for the same journey that vary by a factor of up to ten. Much air freight travels in regularly scheduled passenger aircraft. Indeed, reporting on the industry often combines passenger and freight movement (e.g., International Civil Aviation Administration 2005a), equating each carried tonne of freight with about eleven carried passengers. Few data on trends in air freight costs are available, and for the most part it may be reasonable to assume that they have tracked average passenger fares (see Figure 20 and associated text, including Note 14). This could imply that they have declined for shorter-distance freight movement and increased for longer-distance freight movements.

Available data on recent changes in international air freight rates reveal a complex pattern. Figure 27 suggests that rates to and from the U.S. were mostly falling during the period 1995-2002. However, since 2002, rates for inbound freight have risen steeply, and a rise in rates for outbound freight may have begun in 2005.

Factors in recent increases could have included both increases in demand (particularly for inbound freight movement, perhaps because of the processes illustrated in Box 1) and increases in fuel prices.

The available evidence does not point to a substantial shift to carriage of international trade by air. Air freight has grown dramatically, but so has freight movement by water. Nevertheless, an importer could well face a decision as to whether to ship by one mode or the other (such as that faced the importer described in Box 1).

Figure 27. Indices of air freight rates to and from the U.S., 1995-2005



Source: Bureau of Labor Statistics (2006)

One comparison of the unit costs of air freight (i.e., cost per tonne-kilometre) and movement by water suggests that the former exceeds the latter by a factor of about 57 (Frankel 2005). If the difference in unit value of the shipped material is assumed to be that implied here in Table 3, i.e., a factor of 142,[21] the result corresponds closely to the conclusion of Hummels (2001) that *ad valorem* air freight rates are typically 2.5 times higher than ocean freight rates". Hummels used this estimate to conclude that on average the time savings from air travel is worth 0.8 per cent of the value of product shipped per day. Thus, if shipping an item by sea takes 31 days, and by air takes one day, the difference would be equivalent to about 24 per cent of the value of the product shipped.

For most products, this 25 per cent benefit hardly begins to offset the huge additional cost of shipping by air. However, for some items—e.g., flowers and some fruit, and perhaps the items discussed in Box 1—the time savings is worth very much more than 0.8 per cent of the value per day.

Hummels (2001) has argued that falling time costs may have replaced falling transport costs as a stimulus to trade. This argument has been taken up by others, including Deardorff (2005, 19), who concluded that "the role of time in trade is becoming increasingly important, at the same time that the ability of technology to reduce the time required for trade has improved. The resource costs of trade will never be negligible, but the importance of time seems to loom ever larger in many products".

In some parts of the world, notably North America and Europe (see Table 1 and Figure 18) considerable amounts of trade is performed by land surface modes: road, rail, and pipeline. Costs of using these modes fall between those for water and air modes. Frankel (2005) has provided a comparison. If the cost of moving a tonne kilometre of freight by water is 1.0 unit, that for movement by pipeline is 1.5 units, by rail is 3.6 units, by road is 29 units, and, as noted above, by air is 57 units. In these places, the role of costs and other factors in choice of mode is a matter of substantial importance, but available resources preclude further examination here.

A reasonable conclusion about transport prices is that for most international trade they represent a relatively insignificant part of final product costs. This is because of the extraordinarily low cost of shipping items and material by sea. Air freight is very much more expensive, but its use for high value items means that its share of final product cost can be relatively low. Alternatively, it may reduce extremely high time costs, creating value that end-users will pay for.

Several cautions about transport and time costs are in order. There is surprisingly little public information about them, especially for air freight. Costs of freight movement can be highly variable. They may not have declined as much as several analysts have supposed, and they many now be increasing, perhaps chiefly on account of rising fuel prices.

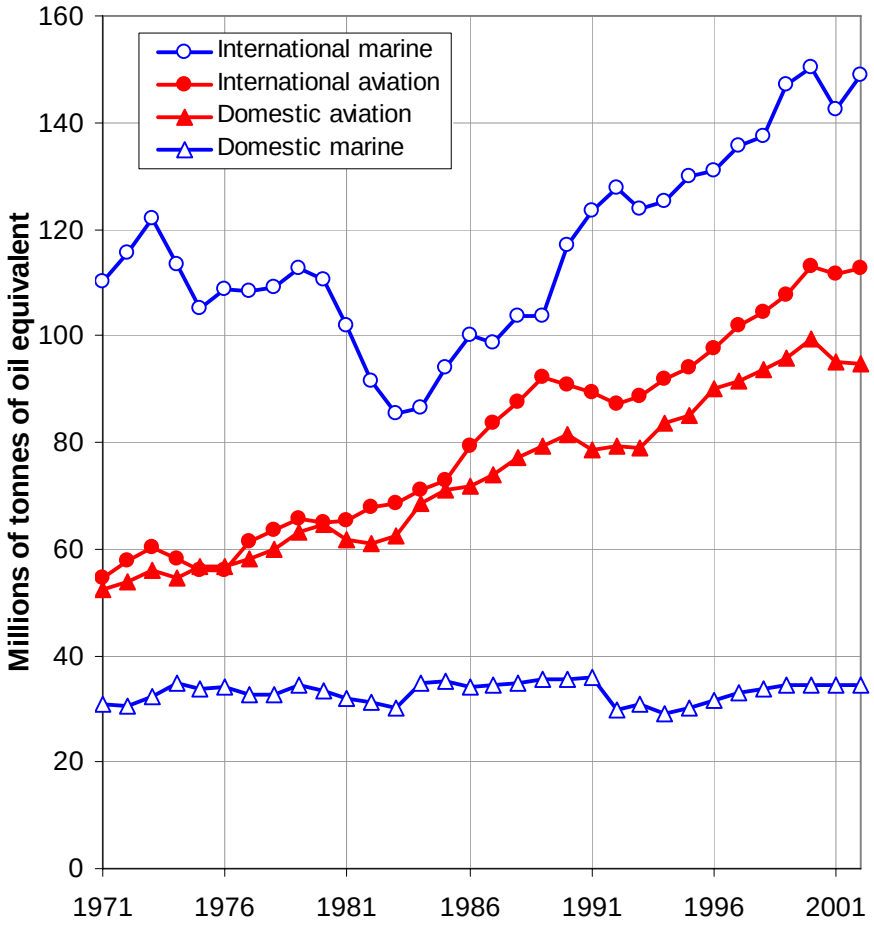
12. Potential impact on trade of higher transport fuel prices

Because of the previous section's conclusion that, in almost all cases, transport costs of international trade are a relatively small component of prices paid by end-users, it could follow that increased fuel prices would have little impact on trade activity. It may nevertheless be useful to examine the fuel component of the transport costs of trade and how it might change.

All aviation and marine traffic is fuelled by oil products on which, by international agreement, no taxes are paid. As a consequence, aircraft and vessel operators have essentially direct exposure to crude oil prices. If the market price for crude oil rises by a factor of four, as it has during the last decade, their fuel costs rise by approximately this factor.

Figure 28 shows trends in the overall use of transport fuel for aviation and marine purposes.[22] Total consumption for international and domestic aviation—including all

Figure 28. Petroleum products use for transport by international and domestic marine and aviation. World, 1971-2002

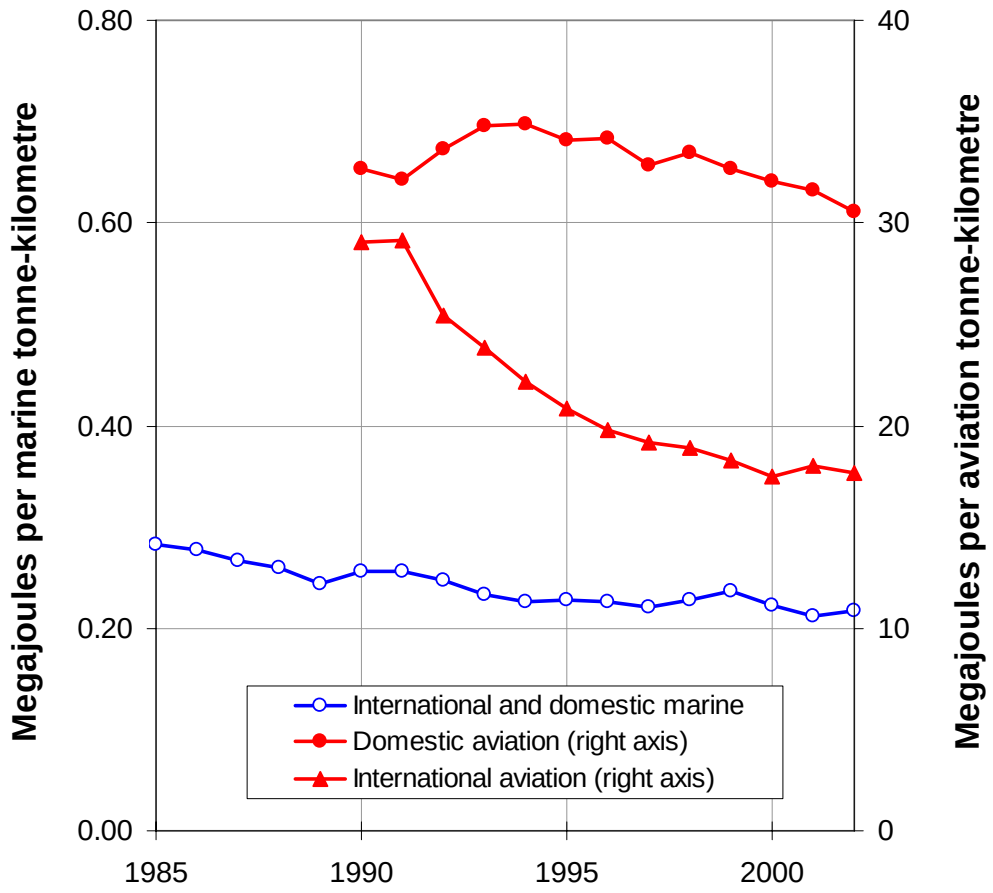


Source: OECD (2006)

freight and passengers[23]—rose fairly steadily across the period 1971 to 2002, at average annual rates of 2.4 and 1.9 per cent, respectively.[24] Total consumption for international marine transport rose by an average of 1.0 per cent annually across the whole period. However, it fell between 1971 and 1982, largely on account of a fall in oil shipments (see Figure 14). Then it increased at 2.6 per cent annually from 1982-2002. Total consumption for domestic marine transport hardly changed across the period 1971-2002.[25]

Rates of fuel consumption, expressed as energy use per tonne-kilometre performed, are shown in Figure 29. Rates of energy use for marine transport fell more or less gradually across the period 1985 to 2002. Rates for international aviation fell steeply in the early 1990s but more recently seem to have levelled off. Rates for domestic aviation, by contrast, have remained relatively unchanged. Considering all aviation, the decline in unit energy consumption has been impressive: by 21 per cent between 1990 and 2002, an average of 2.0 per cent annually.[26] Note that the (right-hand) scale for aviation energy intensity covers *50 times* the range of the (left-hand) scale for the energy intensity of marine freight movement. Considering all aviation and all marine transport, performing

Figure 29. Rates of energy use by marine and aviation transport.
World, available years, 1986-2002



Sources: Fuel use: OECD (2006). Marine TKM: As for Figure 14.
Aviation TKM: As for Figure 10 (using total weight carried data).

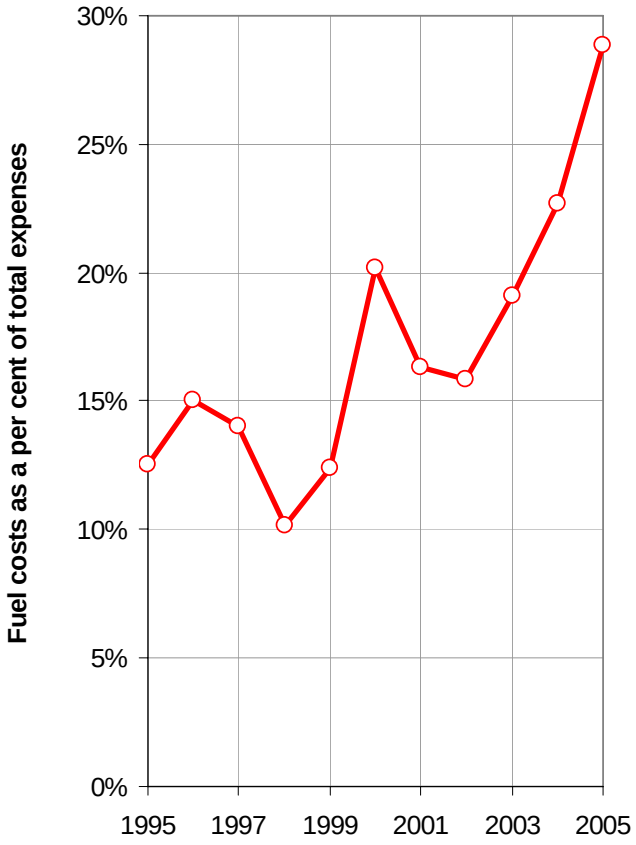
a tonne-kilometre of freight movement by air in 2002 required expenditure of *101 times* as much energy as performing a tonne-kilometre by water.

This much greater energy intensity comprises a substantial portion of the much greater cost of air freight per tonne-kilometre compared with marine freight, noted in Section 11 as differing by a factor of about 140. The main contributor to the difference between the factors could well be the greater economies of scale achievable in marine transport.

Note that the marine energy intensity data in Figure 29 are much lower than the Canadian data depicted above Table 2 (0.21 vs. 0.49 megajoules/tonne-kilometre). The data in Table 2 are for inland and coastal vessels that are smaller and inherently less efficient than the predominantly ocean-going vessels represented in Figure 29. Note too that the overall energy intensity of marine traffic represented in Figure 29 is similar to that for the rail freight traffic shown in Table 2.

Data on fuels' shares of the operating costs of the different modes are not readily available. The author's estimates for aviation during the period, which is likely to have the highest shares, are set out in Figure 30.[27] They appear to be a little lower than estimates for an earlier but overlapping period in Hennigan (1999). The increase in share from 1998 to 2005 corresponds to a 3.9-fold increase in the price paid for aircraft fuel. If jet

Figure 30. Fuel use by aviation as a per cent of total expenses, 1995-2005



fuel prices were to increase another 3.9 times, and total fuel use were to remain unchanged (it has tended to increase, see Figure 28), fuel costs alone would amount to 122 per cent of total 2004 expenses.

A similar analysis cannot be performed for ocean shipping, chiefly because of a lack of available data on operating expenses. There are hints that fuel's share of total costs may also be substantial. One source suggested that "cost of fuel as a proportion of total running costs rose from 10 per cent in 1900 to between 25 and 60 per cent by 2000" (Hamer 2005). Another source stated, "A thorough analysis of the costs of operation of the ship, including capital costs, operating and repair costs, and financing, shows that the overwhelming cost driver for high speed ocean transportation is the cost of petroleum-based fuel for the ships." (Marine Transportation Center 2000). A third source included the following: "More than any other transportation mode, most modern shipping activity is designed to minimize fuel consumption because it helps minimize operating costs" (Corbett 2004). Whether "running costs" and "operating costs" in these observations correspond to the total costs—capital and leasing costs included—included in the above aviation analysis is not clear.

Another hint as to the importance of fuel costs in ocean shipping comes from information about fuel surcharges applied by shipping companies when fuel prices rise. According to the U.S. Department of Agriculture (2005), these can amount to as much as 28 per cent of the price quoted for shipping a 20-foot container of (say) almonds (16 tonnes) from Los Angeles to Singapore (US$256 of a total price of $916). Assuming that some of the cost of fuel is in the basic "ocean rate", the fuel share of the total transport cost would appear to be higher than 28 per cent.

Speed is a critical factor in marine fuel use, more than for other modes because water resistance acts in a different way from air resistance. According to material produced by the United States Naval Academy (2003), the relationship between hull resistance and ship's speed varies with the nth power of the speed, where n is two at low speeds and as high as five at high speeds. "Therefore the horsepower required can be proportional up to the ship speed raised to the sixth power!" Wind resistance, by contrast, generally varies with the square of the vehicle speed.

According to MAN (2005), "… the increase in ship size has been followed by a corresponding demand for higher design ship speeds". McKesson (2000) has argued, "The change in ship size does not in itself explain the substantial increase in the average engine power seen in recent years. Hence, it can be assumed that the design speed has increased. Increase in average engine size is an indication of a changed demand pattern toward higher powered ship types". Corbett (2004, 747) noted that "Although container ships are not often as large as tankers, they have much larger power plants to accommodate greater vessel speeds". He also observed that "most ships carry loads that average 50-65% [of] capacity or less".

Thus, unless offset by fuller loading, a tendency towards deployment of faster, container vessels for carriage of international trade could lead to a reversal of the steady decline in the overall energy intensity of marine freight vessel noted in Figure 29. alternatively, it may be possible to achieve substantial fuel savings by reducing speeds.

Fuel costs are a significant element in aviation and could well be a significant element in movement of freight by water. However, because as was demonstrated in the last section, transport costs are generally only a small share of the eventual retail price of goods, or within the range of fluctuation of the cost of raw materials, even large increases in fuel costs are unlikely to have a significant impact on international trade.

13. Environmental impacts of transport activity

In 1997, OECD held a workshop on ‘Globalisation and the Environment’ that grappled with the environmental dilemma of globalisation, stated in this way:

> … globalisation could intensify existing, and create new, pressures on the environment and natural resources through intensified trade and investment. On the other hand, globalisation could promote a more efficient allocation of environmental factors of production and use, as well as wider diffusion of cleaner technologies. Governments are now confronting the challenge of how to optimise the environmental and other benefits of globalisation (OECD 1998, 3).

Numerous topics were discussed in depth, but there was almost no mention of transport’s impacts. Even when transport might have been discussed, as in one paper’s section entitled ‘Globalisation and greening the supply chain’, the focus was elsewhere, in this case on green purchasing (Hanmer & del Rosario, 85). Transport and its impacts appear to have been ignored, or taken for granted.

Transport is not ignored when it occurs near where people live. However, most transport associated with trade and other potential aspects of globalisation occurs in other places—high in the sky and far away on the oceans, or on motorways rather than in cities—and, accordingly, its impacts receive relatively little attention.

An earlier OECD conference, titled ‘Toward Sustainable Transportation’, included a session on ‘Industry and the Global Economy—Trade-Related Challenges’ that touched a little on environmental impacts of globalisation. The conference summary (OECD 1997, 34) noted that globalisation could contribute to increases in freight transport, with corresponding adverse impacts, but it could also “be a positive factor in the quest for sustainable transportation” specifically through the introduction of supply-side innovations, including high-speed rail. The summary noted that “the liberalisation of trade regulations [allowed] the possibility of facilitating sustainable transportation, perhaps through opportunities to change practices that may arise as trade flows change”.

The environmental impacts of aviation lie chiefly in its effects in the vicinity of airports and in its potential contribution to climate change. The former comprise noise and emissions from aircraft that are landing, taxiing, and taking off. Except for noise, these impacts have not been well studied (Hume & Watson 2003).

There are particular concerns about aviation’s contribution to potential climate change. It contributes in at least three ways. The first is that it burns fossil fuel thereby releasing carbon dioxide. In this, it is no different from almost all other transport, except that the rates of fuel burn per second and per person- or tonne-kilometre are higher than for other modes.

Another way in which aviation contributes to potential climate change is that it results in production of ozone at the boundary of the troposphere and the stratosphere—the tropopause—i.e., at a height of about ten kilometres, where most long-distance aircraft

fly. This happens to be the height at which ozone is the most effective as a greenhouse gas, and where it has a relatively long residence time.[28] A third contribution comes for the formation of contrails when the warm humid aircraft exhaust gases mix with the colder drier ambient air. The water precipitates out as particles in the exhaust plume. Persistent ice is formed that traps heat near the Earth's surface.[29]

The result of these and other effects, according to the Intergovernmental Panel on Climate Change (Penner et al. 1999), is that burning a litre of jet fuel at the height where most commercial aircraft vehicle-kilometres are performed has two to four times the radiative forcing effect of burning a litre of fuel at sea level. Work done since the IPCC report was prepared has supported this conclusion (Lee & Raper 2003; Sausen et al. 2005; Stordal et al. 2004).

Thus, travelling from Toronto to Paris and back by air—a total of about 12,000 kilometres—has the global warming equivalent of travelling 36,000 kilometres by car, assuming the fuel use per person-kilometre is about the same for each mode. The same effect would be achieved by moving 90 kilogram of freight by air across the same distance.

Much less work has been done on emissions from shipping. They can be of concern for two reasons. One factor is the amount of fuel that is used, although this could be less than is used for aviation (see Figure 28), and is certainly much less than is used worldwide by road traffic: in 2002, 0.28 vs. 1.45 billion tonnes of oil equivalent (OECD 2006). As with any other burning of fossil fuel, the result is emissions of carbon dioxide and consequent potential climate change (although see below for a contrary effect) and emissions of nitrogen oxides, which contribute to smog and eutrophication. Because ships engines are almost all diesel engines with minimal particulate controls, there can be local concentrations in the air of inhalable matter.

Another factor is the high sulphur content of the bunker fuel used by nearly all freight-carrying ships, resulting in substantial near-shore and mid-ocean emissions of sulphur oxides and exacerbation of acidification and particulate formation. However, Grübler (2002) has noted that sulphur emissions from shipping comprise only a small share of anthropogenic emissions, the total mostly comprises emissions from the burning of coal and metallurgic processes.

Sulphur compounds and other emissions from the burning of ships' fuel appear to enhance the formation of low-level clouds that have a negative radiative forcing (i.e., global warming) effect. A preliminary estimate of this effect suggested that it could more than offset the positive radiative forcing effect from emissions from the burning of ships' fuel (Capaldo et al. 1999). Thus, the net contribution of ocean freight to potential climate change could be favourable, i.e., it reduces the possibility of climate change.

The environmental impacts of road and rail traffic have been noted in several OECD and other publications (e.g., OECD 2002) and are not further elaborated here.

14. Mitigating the impacts of globalisation-related transport activity

There are essentially two ways in which the impacts of globalisation-related transport activity could be reduced. One is to reduce the amount of the activity. The other is to arrange that the impacts per unit of activity are less severe.

A preliminary question, however, is whether there is good reason to seek to reduce these impacts, beyond the evident desirability of minimizing environmental impacts of any kind.

A preliminary answer based on the foregoing, pending further investigation and analysis, is that air freight consumes a disproportionately large amount of fuel in relation to it evident benefits, and is accordingly responsible for a disproportionate amount of environmental impact.

Movement of freight by water, however, accounting for almost all international trade, produces relatively few environmental impacts and may even have a beneficial effect towards reducing the potential for climate change. Actions could be taken to reduce these impacts. They would mostly be directed toward reducing fuel consumption by reducing speeds, increasing the degree of loading, deploying larger vessels, and effecting technological improvement in hull design and other factors that reduce fuel use.

Ocean freight also has the opportunity to use alternative, even renewable power systems, notably wind (Figure 31), which could reduce consumption of conventional fuels by up to a third (Hamer, 2005).

Figure 31. Freighter with kite

Reproduced from Economist (2005)

Aviation has no such opportunities for use of renewable fuels, or even for deployment of alternative fuels to the current predominant use of fossil-fuel-based kerosene.

Accordingly, a strategy to reduce the environmental impacts of the transport aspects of globalisation might well begin with identifying approaches to reducing the participation of air freight.

A second step could be to reduce the energy intensity and thus the emissions resulting from air freight, perhaps chiefly by optimising the logistics of air freight from an energy perspective.

A third step could be to reduce the intensity of fossil fuel use in ocean freight, perhaps chiefly by reducing vessel speeds and maximising loads, but also by deploying systems involving renewable resources, notably wind.

Finally, consideration could be given to reducing the amount of ocean-borne trade, but only if the environmental advantages of doing so were to evidently exceed the costs of reducing trade activity.

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Gross Domestic Product ((Source: World Trade Organisation (2005))05, Series 29918)

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Notes

[1] Globalism also has at least one other meaning: “the belief that we share one fragile planet the survival of which requires mutual respect and careful treatment of the earth and of all its people”. See Ritchie (2005).

[2] The main criticisms of globalization set out by the International Labour Organisation (2004) are in this quotation from Page X of the report: “The current process of globalization is generating unbalanced outcomes, both between and within countries. Wealth is being created, but too many countries and people are not sharing in its benefits. They also have little or no voice in shaping the process. Seen through the eyes of the vast majority of women and men, globalization has not met their simple and legitimate aspirations for decent jobs and a better future for their children. Many of them live in the limbo of the informal economy without formal rights and in a swathe of poor countries that subsist precariously on the margins of the global economy. Even in economically successful countries some workers and communities have been adversely affected by globalization. Meanwhile the revolution in global communications heightens awareness of these disparities.”

[3] At the end of 2005, *The World is Flat* ranked sixth and seventh in sales of hardcover non-fiction books in the U.S. and Canada. It has sold relatively less well elsewhere, but in the UK was the Financial Times/Goldman Sachs ‘business book of the year for 2005’.

[4] For simplicity, constant U.S. dollar estimates in this paper—except where provided in the cited sources—have been estimated by applying the U.S. Consumer Price Index at http://oregonstate.edu/Dept/pol_sci/fac/sahr/cv2005.pdf to current U.S. dollar estimates provided in the cited sources. This makes some allowance for inflation, and may provide for better comparisons across years than use of current dollars. However, it does not properly represent differences among countries in real price levels, or even how inflation may have affected trade values involving the U.S. A more sophisticated representation of these matters is beyond the scope of this paper.

[5] China’s *imports* of raw materials have also increase at astonishing rates. According to Haralambides (2004), who used China Customs Statistics, China’s imports of iron ore grew by 258% between 1995 and 2003 (17.3%/year) and her imports of crude oil and oil products grew by 278% (18.0%/year). Preliminary information from the China Customs agency indicate that China’s exports rose by 28.4% during 2005 and imports rose by 17.6%, resulting in a trade surplus valued at US$101.9 billion, up from $32 billion in 2004. The surplus for 2005 has been described by one U.S. economist as being “more fiction than fact”, in that it falls far short of estimates derived from the bilateral trade balances of Chaina’s major trading partners. The likely 2005 surplus was said to be in the order of $400 billion (McKenna 2006).

[6] Available data on the value of interstate trade in the U.S. are for 1993, and for movement by lorry (truck) only. Then, the value of shipments leaving states for other states was $2.52 trillion (Bureau of Transportation Statistics 1997, Table 1). In that year, the value of internal EU15 trade, by all modes, was $0.94 trillion (World Trade Organisation 2005).

[7] Foreign direct investment usually refers to the purchase of a foreign asset in a way that provides some control over the asset,. It can be distinguished from international grants, loans, and portfolio investments.

[8] Note that Figure 10 and Figure 11 concern movement of freight and passengers, respectively, on the scheduled airlines of the 188 member states of the International Civil Aviation Organization. Other movement by air is not included, which may result in underestimation, particularly in the case of freight.

[9] A longer series of estimated trip lengths is available for U.S domestic air travel (Bureau of Transportation Statistics 2005a, Table 1-35M). It shows average trip length rising steadily from 938 kilometres in 1960 to 1,292 kilometres in 1990, and then, within a few kilometres, corresponding to the data in Figure 12.

[10] This statement is based on analysis of data in International Civil Aviation Organization (2001 and 2005). However, the second of these reports appears to contain errors in the way data on international aviation are presented, and any statement about them must be tentative. Ad hoc correction of these errors allowed the conclusion that in 1991 and 2003 international freight items moved an average of 5,718 and 5,247 kilometres, respectively, and domestic freight items moved an average of 1,670 and 745 kilometres, respectively.

[11] The estimates of value per tonne in Table 1 are based on *all* freight movement in the U.S. and may not apply with precision to shipments to and from Canada and Mexico. In the source for these estimates, values were based on 2002 data and expressed in 2000$; they have been adjusted using the U.S. Consumer price index to 2004$ (at http://oregonstate.edu/dept/pol_sci/fac/sahr/sahr.htm). Amounts shipped were expressed in short tons and converted to tonnes.

[12] See the June and December 2005 newsletters of the NEW project at http://www.transportutvikling.no/english/frameset_news.html (accessed January 6, 2006).

[13] These are very preliminary estimates for 2003 based on water, road, rail, pipeline and air modes performing respectively 40, 1.0, 0.5, 0.,5, and 0.15 tonne-kilometres, with each tonne being valued at respectively US$500, 1,000, 500, 500, and 100,000. For a historical perspective on how international freight movement changed until 1990, see Gilbert (2002).

[14] According to American Express (2005), the average domestic air fare paid for business travel in the U.S. fell by 13% between 2000 and 2004, and was falling further during 2005. However, the same source indicated that international air fares paid for business travel were rising steeply during 2005. According to the U.S. Bureau of Labor Statistics (2006), international air fares rose by about 40% in real terms between 1995 and 2005.

[15] Part of the explanation for the discrepancy between the UNCTAD data and those noted in the ECMT report may lie in inadequacy of the UNCTAD data noted by Anderson and van Wincoop (2004), quoting from unpublished work of Hummels: “quality problems should disqualify these data from use as a measure of transportation costs in even semicareful studies”. Hummels had reached this conclusion, wrote these authors, because many of the UNCTAD data points are imputed and because no account is taken of compositional changes in trade flows over time.

[16] Note that according to UNCTAD (1997-2005) the data in Figure 22 are not complete in that they do not represent “countries of Central and Eastern Europe and republics of the former Soviet Union, and socialist countries of Asia”.

[17] Another source of information about shares of transport costs is a recent report prepared for OECD's Maritime Transport Committee (OECD 2005b). The table on Page 25 of this report shows a range of shipping costs as a share of retail prices from 0.08% to 21.5%, with most values being under 4.0%.

[18] According to Toth (2005), the f.o.b. price *before* sea freight for Australian iron ore has ranged from US$23 per tonne in 2002 to $58 per tonne in 2005.

[19] According to World Trade Organization (2004, 119), "Data on air cargo costs are difficult to obtain".

[20] According to Airbus (2004, 61), 41% of air freight tonne kilometres were performed in passenger aircraft in 2003. This share is expected to decline to 34% by 2023, although the amount performed in this is expected to grow from 58 billion to 151 billion tonne-kilometres. Almost all other air freight is carried in dedicated air freighters.

[21] The corresponding factor differences in unit value implied in Table 4 for the U.S. and Japan are U.S. imports, 135; U.S. exports, 158; Japan imports, 207; Japan exports, 49. There is no ready explanation for the low last value.

[22] It should be noted that there has been a controversy in the academic literature concerning the extent of fuel use for shipping. Corbett and Koehler (2003) concluded that consumption may be substantially more than reported because ships use fuel assigned to domestic uses. The argued as a result that "allocation of emissions to international shipping routes may underestimate near-costal emissions from ships". These conclusions have been countered by Endresen et al (2004), whose criticisms that have been partially accepted by Corbett and Koehler (2004).

[23] Because of the close interlinking of passenger and much freight movement by air (see Note 20), it's hard to separate fuel use for the two purposes. Data on fuel consumption by dedicated freight aircraft are not available.

[24] The caution about the data in Figure 10 (see Note 8) applies to the aviation data in Figure 28.

[25] Note that marine consumption in both cases includes a very small but not identifiable amount for passenger traffic.

[26] The caution about the data in Figure 10 (see Note 8) applies to the aviation data in Figure 29.

[27] The estimates in Figure 30 depend on three sources. Aviation fuel use for 1995-2002 is from OECD (2006). Fuel use for 2003-2005 was assumed to be the same as in 2002. The price of aviation fuel was taken from Hansman (2005, Slide 26), which shows the price paid per barrel of jet fuel for 1990-2005. Operating expenses were taken from ICAO (2005b). They were assumed to be the same in 2005 as in 2005, plus the additional cost of fuel.

[28] For a fuller discussion of the impacts of aviation on the global climate see Lee & Raper (2003). These authors explained how ozone is formed at this height because the high temperature causes the nitrogen and oxygen in the air to combine to form first nitric oxide and then nitrogen dioxide (NO_2), collectively known as nitrogen oxides. NO_2 catalyzes production of ozone, essentially through speeding up a naturally occurring process. The process breaks down another greenhouse gas in the atmosphere, methane, but not in sufficient quan-

tities to offset the additional greenhouse effect provided by the added ozone. The net result is an increase in radiative activity (global warming effect).

[29] According to a report by NASA (2004), aircraft contrails and consequent formation of cirrus clouds could have been responsible for nearly all of the warming observed over the United States from 1975-1995. When aviation was curtailed over the United States for three days from September 11, 2001, the diurnal temperature range increased by more than 1°C, attributed to absence of contrails (Travis, Carleton, & Lauritsen 2002.).