

15.D

Transport Margins and Modes

Mark Gehlhar and Robert McDougall

This chapter covers the development of the international transportation margins implicit in the merchandise trade data set (chapter 15.B), and estimates of the modal shares in these margins

15.D.1 Introduction

The GTAP data base uses three main data sources for margins trade. In this chapter we discuss two of them. The merchandise trade data set contains margins data implicitly, as differences between *fob* and *cif* values. Section 15.D.2 describes how these margins were estimated. We also use a modal shares data set, showing the modal composition of margins for all commodities between any two countries. This data set however is extrapolated using heroic assumptions from source data for United States trade only. Section 15.D.3 describes the source data and section 15.D.4 explains how we extrapolated it to all pairs of countries.

15.D.2 International Transportation Margins

Transportation margins for the version 5 data base are constructed in the same manner as version 4. The primary source of transport margins for version 5 is from detailed U.S. data.¹ There is no complete data source for obtaining global bilateral transport margins. Having actual detailed margin data for the United States with its trading partners provides the estimates of bilateral margins for all other margins. The main departure from previous versions (versions 1-3) was the use of actual transport costs data applied at the detailed commodity level (SITC 4 and 5 digit level). This is a vast improvement over using an implied *cif/fob* margin obtained from reported trade flows. This approach generates inaccurate margin estimates largely due to the reporting errors in the merchandise value of trade.

Table 15.D.1 provides examples of actual transport margins for individual commodities. These margins are average margins across all trading partners. One notable observation is the fact that margins can vary considerably within the same sector. For example, the vegetables, fruits, and nuts sector (GSC 4) comprises of a variety of commodities. Some commodities are relatively more expensive to ship because of their lower unit value (bulky products). Those commodities have higher transport margins. A good example of this is seen in bananas and apples where margins (*cif/fob*) are 1.248 and 1.345, respectively. In contrast, almonds and hazelnuts, which have much higher unit values, have lower margins of 1.055 and 1.034, respectively. The margin for chickpeas falls in between the two examples above, at 1.124.

The chemicals, rubber, and plastics sector (GSC 33) provides another good example of variations on margins within the same sector. There are a vast array of traded chemicals with a wide range of unit values and required shipping services. Within this sector are several products ranging from plastic materials to pharmaceutical products. Some are raw industrial commodities (low unit value) which are relatively expensive to transport and others are finished consumer products (high unit value) where shipping costs are negligible. This results in varying transportation margins on individual commodities. At the low-end extreme is heterocyclic compounds (SITC 5157) with a margin of 1.008, whereas nitrogenous fertilizer (5621) has a higher margin of 1.136. Within this sector, medicaments and antibiotics have the lowest margins, 1.008 and 1.012, respectively.

Two of the most important sectors in terms of size of world trade are motor vehicles and parts (38) and electronic equipment (GSC 40). The range of margins within these sectors is much less than for other sectors. In addition, they are uniformly low margins, generally less than 1.03. The margin on finished motor vehicles (SITC 7812) is 1.021 while motor vehicle parts fall in the range of 1.03-1.04. The lowest margins found in any sector are those in electronic equipment. This is due to the extremely high unit value relative to the shipping costs. There some variation in margins because

¹ The United States Bureau of Census, Foreign Trade Statistics is the primary source of detailed transport cost data.

of the nature of electronic equipment but computer components make up the largest share of the electronic equipment sector and have the lowest margins. For example, electronic integrated circuits (SITC 7764) has a margin of 1.007. The relatively fast growth in these sectors in world trade has contributed to a lower world average margins.

Estimates of bilateral margins will vary due to the differences in the bilateral composition of trade and also, to some extent, geographical location. Countries within the same geographical region have similar margins; for example, margins for the United States, Canada, and Mexico. These are lower margins than those found with other countries. Wheat, for example, is basically a single commodity sector. The bilateral margins for wheat are fairly uniform because of this. Bilateral differences depend on whether trade is regional or not. Table 15.D.2. shows examples of this. Exports of wheat from Argentina to Brazil have a margin of 1.044, the same as the margin found on wheat exports from Canada to the United States. Exports of wheat from Argentina to Egypt have a margin of 1.0587, the same as the margin for exports of wheat from the United States to Japan. The U.S. to Japan margin is an actual margin while the margins for Argentina are an approximation. Similarly, the European Union countries adopt the same margins as intra-NAFTA and extra-NAFTA trade. France's export of wheat to Germany has the same margin as Canada's exports to the United States.

Sectors with diverse commodity mix will have a wider range of bilateral margins. Table 15.D.3 provides examples of bilateral margins for the vegetables, fruits, and nuts sector (GSC 4). The average trade weighted margin for the world is 1.14, ranging from 1.04 to 1.35. This is largely due to the fact that detailed margins are weighted by the bilateral commodity composition of trade. As with wheat, adjustments are made for regional and non-regional trade. The margin for exports from the United States to Canada is 1.062 compared with the margin to Japan of 1.233. Distance matters in this case. However the margin for U.S. exports to India is only 1.059. The reason for this low margin is that the composition of exports to Japan is much different than for exports to India. Apples are the major commodity in this sector exported to Japan, whereas nuts is the major commodity exported to India. France's exports to Germany has a slightly lower margin (1.057) than U.S. exports to Canada (1.062) due to differences in the composition of commodities traded.

The chemicals sector (GSC 33) is another example where there is a wide range of margins in detailed commodities. However, the range of margins in the aggregate bilateral flows is not as large as in the vegetables, fruits, and nuts sector. The reason for this is that the underlying composition of trade in chemical products is relatively uniform. Countries tend to trade a mix of chemical products consisting of both bulk chemicals and finished consumer products such as pharmaceuticals. There is a higher degree of intra-industry trade in chemicals than in vegetables, fruits, and nuts trade. Bilateral margins for chemicals are shown in table 15.D.4.

Bilateral margins for motor vehicles and parts (GSC 38) are shown in table 15.D.5. Overall the variation in margins is small with most of the margins close to the world average of 1.019. The margin for intra-NAFTA trade is the same as for France's and Germany's trade (intra-EU trade, at

1.005). The composition of trade is very similar. Regional and non-regional trade is basically the main reason for differences in bilateral margins observed in motor vehicle trade.

The average world margin for electronic equipment (GSC 40) is nearly the same as that for motor vehicles (table 15.D.6). However, there can be some large differences depending on the countries. For example, the margin on U.S. exports to Bangladesh is 1.0202 whereas the margin on Canadian exports to Bangladesh is 1.1429. This difference cannot be attributed to geographical differences. It is due largely to the differences in the content of the electronic equipment and the individual margins applied.

15.D.3 Source Data for Modal Shares

The primary source of data on mode of transportation for merchandise trade is the same source used for transport margins. This is supplied by the U.S. Census Bureau's Foreign Trade Statistics². Information on how goods are carried by mode of transportation is collected with the bilateral trade flows for both U.S. exports and imports. The transportation modes are identified in terms of three categories: vessel, air, and other methods which includes mainly ground transportation (truck and rail). This data serves as a starting point for constructing a global data base.

Since mode of transport is identified for all trade flows, value of trade by mode can be aggregated. The value of trade by mode was obtained for all U.S. partners covering all commodities for GTAP merchandise sectors. Shares of total goods carried by each mode are calculated. This is carried out at the detailed U.S. 10-digit HS classification level using *fob* values of trade. One set of modal shares is calculated for the NAFTA partners and a second set was generated for all other countries not sharing a common border with the United States. These shares are shown in tables 15.D.7 and 15.D.8.

Most goods are carried by ground transportation for U.S. trade with Canada and Mexico. As shown in table 15.D.7 there is some variation by GTAP sector. Many of the agricultural sectors are transported entirely by ground (truck or rail) transportation. Time sensitive goods are often carried by air despite the close proximity of trading partners. Electronic equipment has a higher share that is carried by air for this reason. Mode of transport shares for non-NAFTA countries are shown in table 15.D.8. Clearly there is no ground transportation and trade is carried by vessel or air. Bulky commodities tend to have a higher share of transportation on vessel. Coal, oil, and gas are good examples. Generally the higher the unit-value for commodities, the greater the share of air transport.

² For further documentation and description of data, see <http://www.census.gov/foreign-trade/guide/sec2.html#classification>

15.D.4 Extrapolating the Modal Shares Data

Our task now is to extrapolate the modal shares statistics (section 15.D.3) from United States trade to all trade routes.

Our guiding assumption is that trade between countries separated by water tends to use water or air rather than ground transportation. Accordingly, we divide routes into three classes: routes between countries that share a common border (*contiguous*), between countries that do not share a common border, but lie on a common continent (*intra-continental*), and between countries that do not lie on a common continent (*inter-continental*). We calculate modal shares for each route class, so that the ground mode share is greatest for the contiguous routes, smaller for the intra-continental, and very small, though still positive, for the inter-continental.

This is obviously a very crude approach. It assumes for example that ground transportation is as easy between two very distant countries on the same continent, such as Yemen and South Korea, as between two very close countries, such as the Netherlands and Denmark. But given the lack of statistical support, we think it better to take a crude approach than to spend time on speculative refinements.

For stipulating non-zero shares for ground transportation in inter-continental trade, we have a motive and a justification. The motive is that unless we do this, it may be difficult to balance our margin usage estimates against our data for margin imports (chapter 15.E). Difficulties would arise for example if the margin imports data showed high imports of “other” transport margin services by an African country that trades mostly with the United States and Japan. The justification is that ground transport margins truly are incurred in trade between countries on different continents. For example, Swiss goods consigned to the United States by sea must first move to a sea port, and are likely to do so by truck. The cost of trucking from the Swiss border to the sea port is part of the international transport margin.

One way to mitigate the problem of high ground transport shares for long intra-continental routes is to define smaller continents. Accordingly we treat Asia, Europe, and Africa as separate continents, and likewise North and South America. This ensures that, for example, the South Africa-Malaysia route is classed as inter-continental rather than intra-continental. The disadvantage of this policy is that it assigns very low ground transportation shares to some relatively short routes passing through isthmuses, for example, the route between Colombia and Nicaragua. On balance however we believe the advantages outweigh the disadvantages.

We recognize that some countries (Russia, Egypt, Turkey, Panama) lie on more than one continent, and some on none. Thus for example Turkey has intra-continental routes with both European and Asian countries; while Indonesia has intra-continental routes with none.

A possible improvement in future releases would be to count island countries with bridge or tunnel links to continents as lying on those continents. This would recognize that ground

transportation is feasible between the United Kingdom and mainland Europe, and between Singapore and mainland Asia.

Having classified the trade routes, our next task is to estimate modal shares for each class. Our approach is to construct base estimates using statistics for countries with unimpeded ground communications. We use these base estimates unaltered for trade between contiguous countries; for the other route classes, we adjust them by altering the ratio of ground to non-ground transportation. For intra-continental routes, we reduce the ground:non-ground ratio by a factor of ten; for inter-continental routes, we reduce it by a factor of one thousand.

For our base estimates we refer to the modal shares for United States trade with its immediate neighbors, Mexico and Canada. We average these across those two countries, and across both trade directions (to and from the United States), using merchandise trade weights derived from the merchandise trade data set (chapter 15.B). To avoid balancing problems downstream, we adjust the averages slightly to replace zero shares with very small non-zeros. This gives us base estimates for the modal composition of margins for each merchandise commodity. We apply these base shares to all trade routes between contiguous countries. Then adjusting them as described above, we obtain shares for intra-continental and inter-continental routes.

Table 15.D.9 show illustrative results for three commodities: coal, textiles, and electronic equipment. As it shows, the modal shares estimates are qualitatively reasonable: electronic equipment tends to travel by air and coal doesn't; contiguous countries tend to trade by ground transport and countries on different continents don't.

For the United States, we use the original source data, modified to permit minor usage of ground transportation with countries other than Canada and Mexico.

Except for United States routes, the modal shares estimates lack direct statistical backing. We have described them as "extrapolated"; we might equally well say that we made them up, using the United States modal shares as a guide. We consider that they are broadly plausible; but until broader statistical support is obtained, that is all that we can claim for them.

Table 15.D.1 Examples of Detailed Margins at SITC Classification Level

SITC Classification	<i>cif/fob</i>
5774 Almonds	1.055
5775 Hazelnuts	1.034
573 Bananas	1.248
574 Apples	1.345
575 Grapes	1.370
5422 Chickpeas	1.124
5157 Heterocyclic compounds	1.008
5121 Acyclic monohydric alcohols	1.111
5161 Ethers	1.105
5162 Acyclic monohydric alcohols	1.031
5429 Medicaments	1.008
5513 Essential Oils	1.025
5621 Chemical fertilizer nitrogenous	1.136
5711 Polyethylene	1.109
5812 Plastic tubes pipes and hoses	1.071
5411 Provitamins natural or produced	1.015
5413 Antibiotics	1.012
7812 Motor vehicles for transport of persons	1.021
7843 Other vehicle parts	1.037
7841 Chassis fitted with engines	1.040
7842 Bodies for motor vehicles	1.068
7764 Electronic integrated circuits	1.007
7768 Piezoelectric crystals	1.018
7642 Microphone and loudspeakers	1.044

Table 15.D.2 Selected Examples of Bilateral Margins: the Case for Wheat

Exporter	Importer	<i>cif/fob</i>
Argentina	Brazil	1.0443
Argentina	Egypt	1.0587
Argentina	Indonesia	1.0587
Argentina	Iran	1.0443
Australia	Egypt	1.0587
Australia	Pakistan	1.0587
Canada	Belgium	1.0587
Canada	Indonesia	1.0587
Canada	Japan	1.0587
Canada	Mexico	1.0446
Canada	United States	1.0446
France	Egypt	1.0587
France	Germany	1.0446
France	Italy	1.0446
Germany	Belgium	1.0446
USA	Japan	1.0587
USA	Mexico	1.0446
USA	Pakistan	1.0587
USA	Philippines	1.0587

Table 15.D.3 Sector Bilateral Margins in GTAP: Vegetable, Fruits, and Nuts

	USA	Canada	Mexico	Japan	Germany	France	Argentina	Brazil	India	Bangladesh	Average
USA		1.062	1.048	1.233	1.068	1.103	1.133	1.133	1.059	1.286	1.133
Canada	1.060		1.056	1.354	1.125	1.197	1.176	1.135	1.118		1.107
Mexico	1.069	1.065		1.449	1.204	1.279		1.130	1.130		1.089
Japan	1.060	1.113				1.059					1.118
Germany	1.038	1.250	1.125			1.048		1.077			1.077
France	1.157	1.241	1.000	1.154	1.057		1.167	1.100			1.075
Argentina	1.291	1.293	1.200	1.143	1.338	1.251		1.135			1.206
Brazil	1.045	1.043		1.200	1.221	1.198	1.138				1.131
India	1.034	1.086		1.028	1.088	1.063		1.125		1.070	1.090
Bangladesh											1.544
Average	1.172	1.091	1.077	1.261	1.098	1.128	1.129	1.133	1.073	1.095	1.142

Table 15.D.4 Sector Bilateral Margins in GTAP: Chemicals, Rubber, Plastics

	USA	Canada	Mexico	Japan	Germany	France	Argentina	Brazil	India	Bangladesh	Average
USA		1.0225	1.0262	1.0416	1.0360	1.0357	1.0514	1.0515	1.0804	1.0368	1.0428
Canada	1.0320		1.0227	1.0706	1.0346	1.0408	1.0619	1.1064	1.0608	1.0000	1.0392
Mexico	1.0252	1.0188		1.0481	1.0346	1.0521	1.0611	1.0489	1.0503	1.0000	1.0390
Japan	1.0378	1.0461	1.0459		1.0355	1.0333	1.0441	1.0405	1.0525	1.0536	1.0526
Germany	1.0324	1.0362	1.0437	1.0320		1.0225	1.0408	1.0480	1.0562	1.0576	1.0311
France	1.0351	1.0393	1.0328	1.0277	1.0204		1.0367	1.0363	1.0387	1.0303	1.0257
Argentina	1.0448	1.0571	1.0429	1.0597	1.0294	1.0493		1.0495	1.0250	1.0000	1.0468
Brazil	1.0580	1.0453	1.0381	1.0461	1.0395	1.0460	1.0611		1.0554	1.0909	1.0571
India	1.0435	1.0257	1.0312	1.0415	1.0327	1.0329	1.0264	1.0398		1.0253	1.0393
Bangladesh	1.0548	1.0769	1.0000	1.0000	1.0500	1.0000			1.0857		1.0688
Average	1.0401	1.0272	1.0298	1.0444	1.0276	1.0258	1.0512	1.0536	1.0836	1.0634	1.0400

Table 15.D.5 Sector Bilateral Margins in GTAP: Motor Vehicles and Parts

	USA	Canada	Mexico	Japan	Germany	France	Argentina	Brazil	India	Bangladesh	Average
USA		1.005	1.004	1.017	1.015	1.017	1.019	1.019	1.020	1.020	1.016
Canada	1.005		1.005	1.015	1.018	1.020	1.022	1.019	1.020	1.143	1.009
Mexico	1.004	1.005		1.011	1.020	1.020	1.017	1.018	1.118	1.000	1.006
Japan	1.017	1.017	1.019		1.018	1.019	1.019	1.018	1.044	1.026	1.025
Germany	1.017	1.017	1.018	1.015		1.005	1.020	1.021	1.024	1.023	1.010
France	1.014	1.011	1.016	1.011	1.005		1.017	1.019	1.028	1.021	1.008
Argentina	1.015	1.000	1.000	1.000	1.000	1.000		1.017	1.000		1.018
Brazil	1.017	1.031	1.019	1.000	1.019	1.018	1.018		1.000		1.018
India	1.016	1.018	1.020	1.042	1.024	1.024				1.016	1.018
Bangladesh				1.056							1.021
Average	1.020	1.011	1.010	1.023	1.015	1.013	1.024	1.024	1.030	1.026	1.019

Table 15.D.6 Sector Bilateral Margins in GTAP: Electronic Equipment

	USA	Canada	Mexico	Japan	Germany	France	Argentina	Brazil	India	Bangladesh	Average
USA		1.0046	1.0043	1.0169	1.0151	1.0174	1.0188	1.0189	1.0202	1.0202	1.0158
Canada	1.0045		1.0055	1.0149	1.0181	1.0201	1.0223	1.0193	1.0202	1.1429	1.0085
Mexico	1.0043	1.0053		1.0107	1.0204	1.0198	1.0169	1.0185	1.1176		1.0057
Japan	1.0170	1.0173	1.0193		1.0179	1.0187	1.0187	1.0179	1.0441	1.0263	1.0251
Germany	1.0175	1.0169	1.0176	1.0153		1.0047	1.0200	1.0210	1.0240	1.0227	1.0097
France	1.0141	1.0110	1.0164	1.0112	1.0046		1.0171	1.0186	1.0281	1.0213	1.0082
Argentina	1.0154	1.0000	1.0000	1.0000	1.0000	1.0000		1.0169			1.0177
Brazil	1.0170	1.0306	1.0187	1.0000	1.0195	1.0182	1.0178				1.0176
India	1.0161	1.0183	1.0200	1.0417	1.0240	1.0238				1.0156	1.0179
Bangladesh				1.0556							1.0208
Average	1.0197	1.0111	1.0096	1.0227	1.0149	1.0132	1.0236	1.0244	1.0295	1.0262	1.0195

Table 15.D.7 Share of Merchandise Transported by Mode: United States Trade with NAFTA

Partners			
GTAP Sectors	Ground	Vessel	Air
pdr	1.0000	0.0000	0.0000
wht	0.8925	0.1075	0.0000
gro	0.8200	0.1800	0.0000
v_f	0.9700	0.0292	0.0009
osd	1.0000	0.0000	0.0000
c_b	1.0000	0.0000	0.0000
pfb	1.0000	0.0000	0.0000
ocr	0.9911	0.0066	0.0023
ctl	0.9978	0.0005	0.0017
oap	0.9952	0.0001	0.0047
wol	1.0000	0.0000	0.0000
for	0.7658	0.2341	0.0001
fsh	0.9730	0.0123	0.0147
col	0.8340	0.1660	0.0000
oil	0.9703	0.0297	0.0000
gas	0.9995	0.0005	0.0000
omn	0.2880	0.6996	0.0124
cmt	0.9994	0.0001	0.0005
omt	0.9824	0.0155	0.0021
vol	0.9940	0.0059	0.0000
mil	0.9693	0.0305	0.0002
pcr	0.9840	0.0000	0.0160
sgf	0.9999	0.0000	0.0001
ofd	0.9828	0.0115	0.0057
b_t	0.9963	0.0035	0.0002
tex	0.9913	0.0004	0.0083
wap	0.9742	0.0016	0.0242
lea	0.9727	0.0014	0.0259
lum	0.9764	0.0230	0.0006
ppp	0.9379	0.0586	0.0036
p_c	0.2968	0.7032	0.0000
crp	0.9492	0.0408	0.0100
nmm	0.9052	0.0924	0.0024
i_s	0.9525	0.0465	0.0010
nfm	0.9308	0.0086	0.0606
fmp	0.9703	0.0079	0.0218
mvh	0.9993	0.0003	0.0005
otn	0.8422	0.0035	0.1543
ele	0.7097	0.0008	0.2895
ome	0.8897	0.0016	0.1088
omf	0.9089	0.0110	0.0801

Table 15.D.8 Share of Merchandise Transported by Mode: United States Trade with Non-NAFTA

Partners		
GTAP Sectors	Vessel	Air
pdr	0.9637	0.0363
wht	0.8300	0.1700
gro	0.8702	0.1299
v_f	0.9245	0.0755
osd	0.9594	0.0406
c_b	1.0000	0.0000
pfb	0.9866	0.0134
ocr	0.8645	0.1355
ctl	0.0035	0.9965
oap	0.8040	0.1961
wol	0.9957	0.0043
for	0.9729	0.0271
fsh	0.0614	0.9386
col	0.9992	0.0008
oil	0.9665	0.0335
gas	0.9970	0.0030
omn	0.1964	0.8036
cmt	0.9642	0.0358
omt	0.9337	0.0663
vol	0.9903	0.0097
mil	0.9668	0.0333
pcr	0.9934	0.0066
sgr	0.9987	0.0013
ofd	0.9410	0.0591
b_t	0.9367	0.0633
tex	0.7868	0.2132
wap	0.7474	0.2526
lea	0.7784	0.2216
lum	0.9607	0.0393
ppp	0.8531	0.1469
p_c	0.9982	0.0018
crp	0.6447	0.3553
nmm	0.8293	0.1707
i_s	0.9739	0.0261
nfm	0.6456	0.3544
fmp	0.8085	0.1915
mvh	0.9741	0.0259
otn	0.5560	0.4440
ele	0.3230	0.6770
ome	0.6129	0.3872
omf	0.6427	0.3573

Table 15.D.9 Modal Shares Estimates for Selected Commodities

Coal			
	Ground	Vessel	Air
Contiguous	0.50	0.49	0.01
Intra-continental	0.09	0.89	0.01
Inter-continental	0.00	0.98	0.02
Textiles			
	Ground	Vessel	Air
Contiguous	0.96	0.03	0.01
Intra-continental	0.69	0.25	0.06
Inter-continental	0.02	0.79	0.19
Electronic equipment			
	Ground	Vessel	Air
Contiguous	0.80	0.06	0.15
Intra-continental	0.28	0.20	0.52
Inter-continental	0.00	0.27	0.72