Beyond the Iceberg Hypothesis: Opening the Black Box of Transport Costs

Online Appendix

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A. Three models: Comparison

In the paper, we compare the empirical performances of two models, where only ad-valorem costs are modeled (Model (A)) and where both ad-valorem and additive costs are modeled (Model (B)). One may object that a comprehensive study of the structure of transport costs should also include the third model with only additive costs (Model (C)). This has driven us to estimate this model as well, in which case the estimated equation is written according to: $\ln\left(\frac{p_{ik}}{\widetilde{p}_{ik}} - 1\right) = \ln\left(\frac{t_i + t_{s(k)}}{\widetilde{p}_{ik}}\right) + \epsilon_{ik}^{add}$. The results are reported in this section. We start reporting the estimates of the transport costs components under the three models. In a second step, we report the various tests of quality of fit implemented on these models.

A.1. Estimation results

In this section, we report the estimation results of the three models. Results for Models (A) (ad-valorem costs only) and (B) (both ad-valorem and additive costs) are identical to those reported in the paper. We also report the estimation results for Model (C), where only additive costs are modeled. Table A.1 reports the results for Air transport, Table A.2 for maritime transport.

Table A.1: Estimation results of the three models (Air, 3-digit level)

Year	**1974**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**	**2013**
# obs.	14955	16118	19908	24958	31037	35027	41806	40279	39351
# origin countries	152	165	169	181	207	208	211	210	210
# sectors	203	204	207	212	217	218	217	216	212
Model (A) - Iceberg transport costs only ($\widehat{\tau}^{ice}$)									
Mean (in %)	6.93	5.41	6.08	5.03	4.61	3.60	4.10	4.19	3.36
Median (in %)	5.43	3.79	5.47	4.37	3.80	2.47	3.12	3.41	2.92
Std	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02
Model (B) - With additive and ad-valorem transport costs									
Multiplicative term ($\widehat{\tau}^{adv}$)									
Mean (in %)	3.64	2.32	2.46	2.38	2.05	1.66	2.00	2.57	1.70
Median (in %)	2.71	1.57	1.79	1.60	1.39	1.20	1.57	2.24	1.72
Std	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01
Additive term ($\widehat{t/\widetilde{p}}$)									
Mean (in %)	2.56	2.04	2.83	1.83	1.64	1.30	1.43	1.13	1.01
Median (in %)	1.13	0.54	1.30	0.84	0.68	0.45	0.53	0.43	0.47
Std	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02
Model (C) - With additive transport costs only ($\widehat{t^{add}/\widetilde{p}}$)									
Mean (in %)	6.88	4.82	5.99	4.44	3.80	3.09	4.00	4.49	3.29
Median (in %)	4.45	1.82	3.36	2.27	1.72	1.39	1.93	2.72	2.06
Std	0.09	0.08	0.08	0.10	0.09	0.06	0.07	0.07	0.05

Somehow unsurprisingly, the estimated size of transport costs under Model (C) is of same order of magnitude than when transport costs are modeled as ad-valorem alone (Model (A) or of both types (Model (B)). As reported in Tables A.1 and A.2, we also get the downward trend of transport costs over time, in particular since 1980. In this respect, it is necessary to go further to characterize the empirical relevance of the model with addiitve costs only (Model (C)), by the mean of quality of fit diagnostic tests. This is reported in the next section.

A.2. Quality of fit diagnostic tests

In this section, we report the results various quality of fit diagnostic tests implemented on the three models. Table A.3 reports the results for Air transport, those for maritime

Table A.2: Estimation results of the three models (Vessel, 3-digit level)

Year	1974	1980	1985	1990	1995	2000	2005	2010	2013
#obs.	19007	17356	23348	28383	32146	36090	41319	37748	38473
# origin countries	154	163	171	179	201	206	206	198	203
# sectors	239	232	232	232	228	230	231	226	224
Model (A) - Iceberg transport costs only ($\widehat{\tau}^{ice}$)									
Mean (in %)	9.79	6.53	6.88	5.67	5.14	5.10	5.47	3.99	3.60
Median (in %)	9.58	5.50	6.33	4.63	4.29	4.85	4.90	3.56	3.28
Std	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02
Model (B) - With additive and ad-valorem transport costs									
Multiplicative term ($\widehat{\tau}^{adv}$)									
Mean (in %)	5.42	3.08	4.02	3.31	2.79	2.49	2.68	1.95	2.22
Median (in %)	4.93	2.42	3.60	2.81	2.53	2.07	2.08	1.76	1.82
Std	0.04	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.01
Additive term ($\widehat{t}/\widetilde{p}$)									
Mean (in %)	5.08	3.38	3.19	2.73	2.73	2.80	3.02	2.47	1.46
Median (in %)	2.94	2.27	2.06	1.70	1.82	2.19	2.16	1.89	0.76
Std	0.09	0.05	0.04	0.04	0.04	0.04	0.04	0.03	0.02
Model (C) - With additive transport costs only ($\widehat{t}^{add}/\widetilde{p}$)									
Mean (in %)	14.51	10.05	10.47	14.62	8.37	8.02	8.41	6.40	5.23
Median (in %)	9.53	6.69	7.16	6.22	4.68	4.93	5.74	3.87	3.57
Std	0.24	0.17	0.18	0.30	0.15	0.16	0.15	0.15	0.10

transport being displayed in Table A.4. In both tables, we report the values of the R^2, the Standard Error of Regression (SER), the AIC criterion and the log-likelihood (LL) value for each of the three models. We also report the value of the log-likelihood ratio, that tests the quality of fit of the global model (Model (B)) versus either the truncated model with only iceberg cost (Model (A)) or with only additive costs (Model (C)).

Table A.3: Quality-of-fit diagnostic tests of the three models (Air, 3-digit level)

Year	**1974**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**	**2013**
R^2									
Model (A)	0.297	0.267	0.302	0.251	0.142	0.318	0.460	0.421	0.313
Model (B)	0.594	0.646	0.635	0.627	0.658	0.640	0.593	0.513	0.419
Model (C)	0.489	0.543	0.531	0.517	0.546	0.518	0.464	0.339	0.295
SER									
Model (A)	0.791	0.860	0.831	0.811	0.798	0.844	0.837	0.857	0.920
Model (B)	0.674	0.715	0.692	0.675	0.641	0.697	0.727	0.787	0.847
Model (C)	1.610	1.778	1.736	1.699	1.700	1.786	1.783	1.776	1.723
AIC criteria									
Model (A)	35675.0	41171.0	49315.0	60715.6	74386.4	87492.5	103983.0	102297.7	106130.6
Model (B)	31387.3	35738.4	42535.8	52098.9	61343.7	74954.9	92758.6	95887.1	100155.4
Model (C)	40808.1	45138.5	55214.8	69458.5	83958.6	100040.8	123592.1	129359.0	127399.2
Log-likelihood									
Model (A)	-17530.5	-20253.5	-24315.5	-29977.8	-36811.2	-43341.3	-51648.5	-50746.8	-52690.3
Model (B)	-15125.6	-17263.2	-20686.9	-25393.5	-30036.9	-36788.4	-45768.3	-47277.5	-49419.7
Model (C)	-20074.1	-22217.2	-27251.4	-34355.3	-41634.3	-49625.4	-61533.0	-64339.5	-63316.6
Test LL									
Stat LL ratio (B vs A)	4809.7	5980.6	7257.3	9168.7	13548.7	13105.7	11760.4	6938.6	6541.2
\# restrictions	16929	18098	21893	26948	33032	37027	43811	42289	41364
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stat LL ratio (B vs C)	4948.4	4954.0	6564.5	8961.8	11597.4	12837.0	15764.7	17062.0	13896.9
\# restrictions	16929	18098	21893	26948	33032	37027	43811	42289	41364
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A.4: Quality-of-fit diagnostic tests of the three models (Vessel, 3-digit level)

Year	**1974**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**	**2013**
R^2									
Model (A)	0.450	0.415	0.427	0.456	0.438	0.401	0.378	0.350	0.339
Model (B)	0.612	0.575	0.571	0.590	0.611	0.571	0.541	0.491	0.462
Model (C)	0.424	0.401	0.374	0.429	0.456	0.431	0.417	0.358	0.349
SER									
Model (A)	0.576	0.620	0.569	0.592	0.615	0.652	0.673	0.740	0.758
Model (B)	0.484	0.528	0.493	0.514	0.512	0.551	0.578	0.656	0.684
Model (C)	1.271	1.339	1.283	1.326	1.302	1.319	1.336	1.392	1.410
AIC criteria									
Model (A)	33328.81	33010.27	40275.70	51142.62	60414.92	71365.89	85051.02	84789.89	88191.87
Model (B)	27331.52	28067.31	34170.52	43664.74	49275.33	60475.91	73020.09	76161.33	80873.72
Model (C)	46082.40	44370.26	58829.71	71461.52	77052.41	88746.51	103310.93	101166.91	104290.27
Log-likelihood									
Model (A)	-16287.40	-16129.13	-19767.85	-25169.31	-29790.46	-35263.95	-42122.51	-41998.95	-43692.93
Model (B)	-12985.76	-13353.65	-16398.26	-21171.37	-23905.66	-29490.96	-35844.04	-37418.66	-39751.86
Model (C)	-22674.20	-21814.13	-29045.86	-35403.76	-38125.20	-43963.25	-51245.46	-50348.45	-51783.14
Test LL									
Stat LL ratio (B vs A)	6603.28	5550.96	6739.18	7995.88	11769.59	11545.98	12556.94	9160.56	7882.15
# restrictions	393	395	403	411	429	436	437	424	427
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stat LL ratio (B vs C)	19376,88	16920,95	25295,20	28464,79	28439,08	28944,59	30802,84	25859,58	24062,55
# restrictions	393	395	403	411	429	436	437	424	427
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The main result that emerges is that the model with additive costs only (Model (C)) is dominated (in terms of quality of fit properties) by the model with multiplicative costs only (Model (A)), which is itself dominated by the complete model (Model (B)), whatever the type of diagnostic test considered.

B. Transport Cost Estimates: Yearly Detailed Results

In this section, we report the detailed results of the estimation driven at the 3-digit classification level. Table B.1 reports the results for each year over 1974-2013 for Air transport; Table B.2 reports similar results for Vessel. In both cases, we report the estimated values of the transport costs (weighed mean and median) when only ad-valorem costs are modeled (Model (A)) and when both additive and ad-valorem costs are modeled (Model (B)).

Table B.1: Air: Transport costs estimates, all years, 3-digit

Year	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Model (A) - With only Ad-Valorem Trade Costs ($\widehat{\tau}^{ice}$, in %)																				
Mean	6.9	7.5	7.2	7.7	6.9	6.1	5.4	6.0	6.4	6.9	7.2	6.1	6.4	6.6	5.7	5.3	5.0	5.1	4.9	5.1
Median	5.4	6.4	6.9	7.1	6.3	5.3	3.8	4.9	5.3	6.1	6.7	5.5	5.9	6.3	5.3	4.6	4.4	4.5	4.5	4.4
Model (B) - With Additive & Ad-Valorem Trade Costs																				
Ad-valorem term ($\widehat{\tau}^{adv}$, *in %*)																				
Mean	3.6	3.7	3.9	3.8	3.2	3.0	2.3	2.8	2.8	2.6	3.3	2.5	3.2	2.6	3.1	3.1	2.4	2.7	2.2	2.4
Median	2.7	2.7	2.9	2.7	2.1	2.4	1.6	1.8	1.9	1.9	2.7	1.8	2.1	2.0	2.0	1.9	1.6	1.5	1.5	1.6
Additive term ($\widehat{t}^{add}/\widetilde{p}$, *in %*)																				
Mean	2.6	3.0	2.3	3.1	2.6	2.1	2.0	2.0	2.3	2.8	2.5	2.8	2.6	2.9	1.7	4.6	1.8	1.8	1.9	1.9
Median	1.1	1.2	0.9	1.3	1.1	0.7	0.5	0.6	0.8	1.0	1.0	1.3	1.3	1.5	1.0	0.7	0.8	0.6	0.9	0.8
# observations	14955	15299	11397	10707	15222	15684	16118	16864	17322	18180	20644	19908	20695	20793	24663	25197	24958	25156	26191	28296

Continued

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Model (A) - With only Ad-Valorem Trade Costs ($\widehat{\tau}^{ice}$, in %)																				
Mean	4.6	4.6	4.2	4.1	3.8	3.8	3.6	3.5	3.8	3.9	4.0	4.1	3.9	4.1	4.1	4.0	4.2	3.9	3.7	3.4
Median	3.7	3.8	3.1	3.0	2.7	2.8	2.5	2.4	2.7	2.6	2.9	3.1	2.7	3.0	3.2	3.0	3.4	3.1	3.0	2.9
Model (B) - With Additive & Ad-Valorem Trade Costs																				
Ad-valorem term ($\widehat{\tau}^{adv}$, *in %*)																				
Mean	2.3	2.1	1.9	1.8	1.8	1.8	1.7	1.6	1.6	1.9	1.9	2.0	1.8	2.3	2.3	2.3	2.6	2.2	2.2	1.7
Median	1.3	1.4	1.4	1.3	1.3	1.5	1.2	1.1	1.2	1.4	1.4	1.6	1.4	1.9	1.9	1.8	2.2	1.7	1.9	1.7
Additive term ($\widehat{t}^{add}/\widetilde{p}$, *in %*)																				
Mean	1.7	1.6	1.5	1.5	1.4	1.4	1.3	1.3	1.6	1.4	1.5	1.4	1.3	1.2	1.2	1.2	1.1	1.1	0.9	1.0
Median	0.8	0.7	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.5
# observations	29948	31037	32187	33502	33492	33523	35027	34885	35159	35891	36990	41806	42554	40858	40159	38275	40279	41190	40909	39351

As mentioned in the paper, the estimates for Air transport costs in 1989 lead to a surprising high value for the additive component (the additive cost is estimated to amount to 4.6% of the export price, whereas it amounts to 2.5% on average between 1974 and 1988, and to 1.7% over the following decade 1990-2000. This can be attributed to the presence of outliers in the distribution of the additive costs estimates, with a maximum value for $\widehat{t}/\widetilde{p} =$ 10,000%, whereas it amounts to 1,690% on average over 1974-1988 and to 1,500% on average over 1990-2000. Accordingly, in the paper we discard this year 1989 when we report the average values over the period of the transport costs estimates in Air transport. One can yet mention that this does not make much difference. When 1989 is included, the weighed mean transport cost value amounts to 1.9% for the ad-valorem component ($\widehat{\tau}^{adv}$ = 1.9%, vs 1.8% when 1989 is excluded. The weighed median value is left unchanged, as the additive component (with weighed mean and median values of $\widehat{t}/\widetilde{p} =$ 2.5% and 1.8%, whether 1989 is included or not.

Table B.2: Vessel: Transport costs estimates, all years, 3-digit

Year	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Model (A) - With only Ad-Valorem Trade Costs ($\widehat{\tau}^{ice}$, in %)																				
Mean	9.8	9.9	8.9	8.3	8.1	7.5	6.5	6.0	6.3	7.0	7.0	6.9	6.7	6.2	6.1	5.7	5.7	5.5	5.0	5.2
Median	9.6	8.5	8.0	7.3	7.1	6.5	5.5	5.0	5.9	5.7	6.1	6.3	7.0	6.3	5.7	4.8	4.6	4.4	4.2	4.7
Model (B) - With Additive & Ad-Valorem Trade Costs																				
Ad-valorem term ($\widehat{\tau}^{adv}$, *in %*)																				
Mean	5.4	4.8	5.4	5.2	5.9	4.6	3.1	3.3	3.4	4.2	4.1	4.0	3.9	3.6	4.0	3.0	3.3	3.0	2.6	2.9
Median	4.9	4.1	4.8	4.4	5.4	4.0	2.4	2.9	2.9	3.9	3.5	3.6	3.6	3.0	3.5	2.6	2.8	2.7	2.3	2.6
Additive term ($\widehat{t}^{add}/\widetilde{p}$, *in %*)																				
Mean	5.1	5.5	3.5	3.5	2.5	3.1	3.4	2.9	3.5	2.9	3.2	3.2	2.9	2.8	2.4	2.9	2.7	2.8	2.7	2.7
Median	2.9	3.6	1.9	1.7	1.2	1.7	2.3	1.5	2.3	2.0	2.3	2.1	1.8	1.8	1.3	2.0	1.7	1.7	1.8	1.6
# observations	19007	18710	13615	12826	16601	17274	17356	17788	18075	18883	21650	23348	23729	23626	27661	29106	28383	28095	29050	30839

Continued

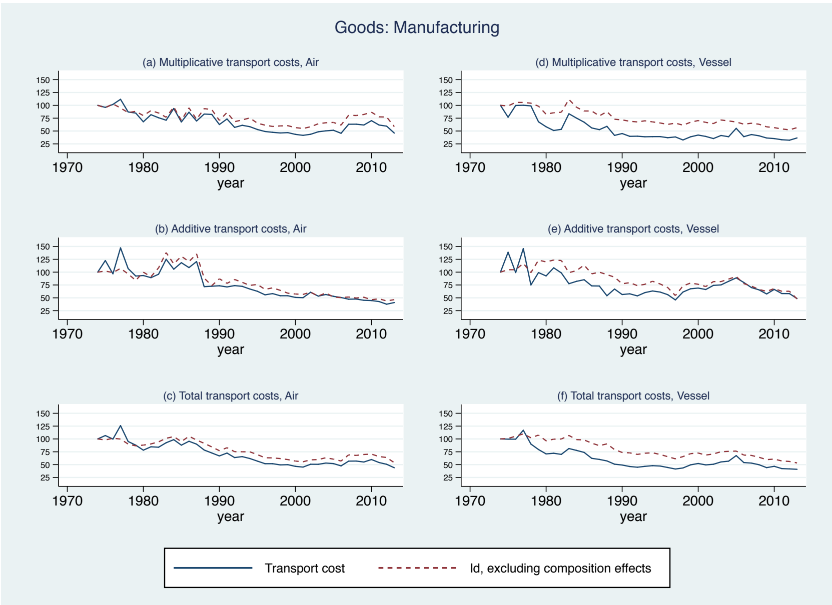
Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Model (A) - With only Ad-Valorem Trade Costs ($\widehat{\tau}^{ice}$, in %)																				
Mean	5.2	5.1	4.8	4.7	4.8	5.0	5.1	5.0	4.8	5.2	5.4	5.5	4.8	4.7	4.4	4.3	4.0	3.5	3.6	3.6
Median	4.1	4.3	3.9	3.9	3.9	4.5	4.9	4.6	4.1	4.8	5.1	4.9	4.2	4.2	3.8	4.1	3.6	3.0	3.1	3.3
Model (B) - With Additive & Ad-Valorem Trade Costs																				
Ad-valorem term ($\widehat{\tau}^{adv}$, *in %*)																				
Mean	2.6	2.8	2.6	2.5	2.2	2.5	2.5	2.7	2.4	2.4	2.7	2.6	2.3	2.5	2.1	2.2	1.9	1.8	1.8	2.2
Median	2.2	2.5	2.2	2.2	1.9	2.1	2.1	2.6	2.3	1.9	2.8	2.2	1.9	2.3	1.8	2.0	1.8	1.6	1.4	1.8
Additive term ($\widehat{t}^{add}/\widetilde{p}$, *in %*)																				
Mean	2.9	2.7	2.5	2.5	3.2	2.8	2.8	2.4	2.6	3.2	2.9	3.0	2.8	2.4	2.4	2.1	2.5	1.9	1.9	1.5
Median	2.0	1.8	1.6	1.3	2.0	2.0	2.2	1.6	2.0	2.5	1.9	2.2	1.9	1.8	2.1	1.7	1.9	1.6	1.6	0.8
# observations	31865	32146	32344	33181	33986	34585	36090	36407	37255	37672	37757	41431	41763	39604	38950	37332	37748	38562	38387	38473

C. Eliminating the composition effects: Primary vs. Manufacturing sector

In this section, we refine the characterization of the trend patterns of international transport costs, by distinguishing the trade flows for primary goods and manufactured goods. The evolution in transport costs over time, by transport mode (overall transport costs and composition effects excluded) are reported in Figure C.1 for the manufacturing sector, and in Figure C.2 for the primary goods. For sake of reading clarity, we also report the results obtained on the whole range of trade flows, in Figure C.3 (i.e., Figure 2 of the paper).

The classification retained to categorize trade flows follows the UNCTAD classification (on STIC Revision 3). Are considered as "primary goods" all flows recorded as "Food and live animals" (First digit "0" in the SITC Classification), "Beverages and tobacco" (First digit "1"), "Crude materials, inedible, except fuels" (First digit "2"), "Mineral fuels, lubricants and related materials" (First digit "3"), "Animal and vegetable oils, fats and waxes" (First digit "4"), "Pearls, precious & semi-precious stones" (Classified "667" in the SITC Classification) and "Non-ferrous metals" (classified "68" in the SITC Classification).

Figure C.1: Transport costs (with and without composition effects), Manufacturing



As reported in Figures C.1 and C.2, the "raw" transport costs are (or the unfitted transport costs, in plain blue line) have regularly declined over the period in both sectors, by roughly the same order of magnitude (50% in Air, 60% in Vessel). However, contrasting these two broad sectors conveys a contrasted message about the role of trade composition effects in accounting for this trend pattern. Comparing Figure C.1 reports a very similar time trend decomposition than what is obtained on the whole range of goods (Figure C.3). In Air transport, most of the decrease can be imputed to the reduction of"ceteris paribus" transport costs (the dotted red line), trade composition effects playing virtually no role (Figure C.1, left-hand panels (a), (b) and (c)). Trade composition effects matter more in maritime transport (Figure C.1, right-hand panels (d), (e) and (f)), primarily in the ad-valorem component. Similarly as the conclusion drawn on the whole range of flows, the 60% decrease in the unfitted transport costs in Vessel can de decomposed in a

Figure C.2: Transport costs (with and without composition effects), Primary goods

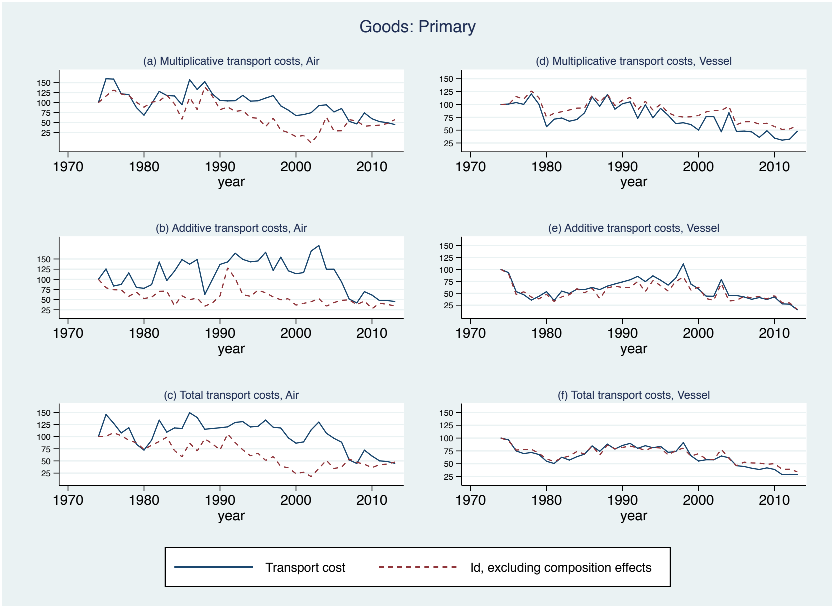
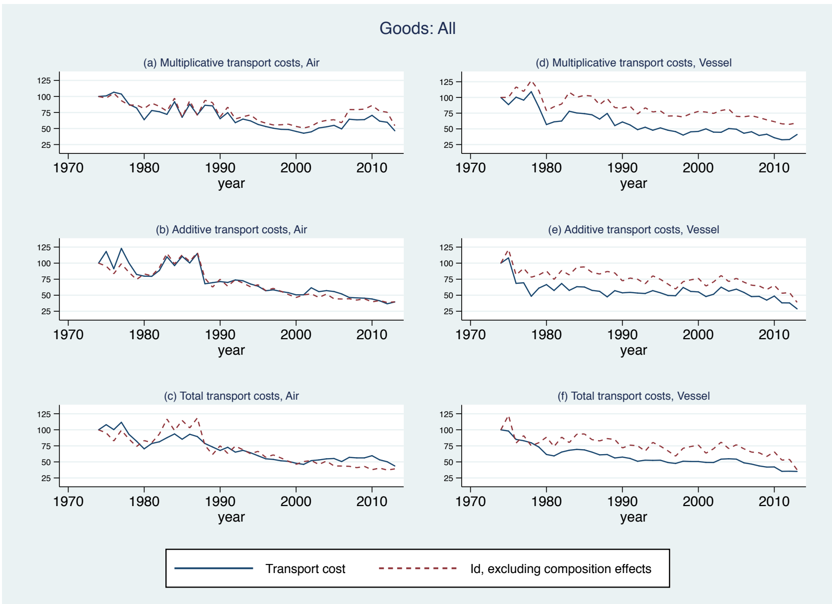


Figure C.3: Transport costs (with and without composition effects)



50% decrease in the "ceteris paribus" transport costs (fitted), the 10% remaining to trade composition effects.

The message is strikingly different when the same decomposition is driven for primary goods only. In this case, it is in air transport that composition effects do matter (Figure C.2, left-hand panels (a), (b) and (c)), while we observe not much role for them in maritime transport (Figure C.2, left-hand panels (d), (e) and (f)). In air transport further, composition effects matter by partially offsetting the decrease in the "ceteris paribus" transport costs (ie, implying a reduction in the "raw" transport costs over time much less pronounced than the fitted transport cost measures).

One way to reconcile the contrasted results displayed in Figure C.2 (primary goods), with respect to Figure C.1 (manufacturing) and Figure C.3 (all flows) is to investigate the share of primary goods in total flows. The results are reported in Figure C.4. In Air transport, the share of primary goods in the total value of US imports is negligible, by around 10% all over the period from 1974 to 2004. Primary goods make a higher proportion of trade flows in maritime transport, especially over 1974-1982 (between 40% and 60%). On the following sub-period though, their share has fallen to 20-30%. Given the modest proportion of primary goods in total imports flows of the US economy, in favor of the manufactured sector, it is hence not surprising that the diagnosis made about the time trend of transport costs when all types of flows are considered, is driven by the trend patterns that occur within the manufacturing sector.

Figure C.4: Share of primary goods in the value of total US imports