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Relative Prices and Empirical Trade Patterns

Nazif Durmaz* and Henry Thompson†

*University of Houston-Victoria, †Auburn University

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Nazif Durmaz
University of Houston – Victoria

Henry Thompson
Auburn University

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This paper examines empirical links between relative prices and bilateral trade based on constant cost trade theory. The global models are built from the World Input-Output Database WIOD aggregated to three, four, and five regions and goods. The simple model assumes relative labor shares are relative prices and average relative price is the terms of trade. Trade patterns are complex among partially specialized regions. Model predictions are compared to observed net exports in seven different aggregations. Regression analysis also examines the effects of relative prices on the total bilateral net exports across models.

Key terms: relative prices; comparative advantage; trade patterns; partial specialization

Durmaz: Department of Economics and Finance, 206 Katy, University of Houston-Victoria, Katy, TX 77449, 281- 396-3700, *durmazn@uhv.edu*

Thompson: Department of Economics, 125 Miller Hall, Auburn University AL 36849, 334-844-2910, *henry.thompson@auburn.edu*

Relative Prices and Empirical Trade Patterns

The example of Ricardo (1817) with relative prices based on labor inputs led to the constant cost model with two countries completely specialized to gain from trading two goods. Relative prices, however, have long been known to fail to predict comparative advantage with three or more countries and goods. McKenzie (1952) and Jones (1961) identify the efficient goods for any number of countries in the minimum cross product of the global input matrix. Complete specialization following the McKenzie-Jones efficiency maximizes global output.

Complete specialization requires a condition that can be called global comparative advantage GCA with a lower price in each country for its efficient good relative to every other country not only in their efficient good but also relative to every other good. Thompson (2020) shows this is unlikely with as few as three countries and three goods. The present paper analyzes the constant cost theory of relative prices and trade in models with three, four, and five countries and goods aggregated in the World Input-Output Database WIOD of Timmer, Los, Stehrer, and de Vries (2015).

Relative prices as relative labor shares lead to partial specialization and complex trade patterns between regions in the present models. The simple approach is to assume the terms of trade at the average relative price. As a result, the partially specialized regions export different goods, export and import the same good, and produce for their own consumption. The simplest constant cost model leads to complex trade patterns.

The models with three regions aggregate the 43 WIOD countries into America, Asia-Pacific, and Europe. The 56 WIOD goods are aggregated into resources, manufactures, and services in the orders of the McKenzie-Jones efficiency. Two different aggregations of resources and manufactures are examined in the 3x3 models. The lack of global comparative advantage implies partial specialization leading to six possible trade patterns with the outcome depending on the three terms of trade. The regions at the extremes of each relative price ranking are assumed to trade those two goods. The direction of trade of the middle country in each of the three rankings is determined by the terms of trade.

Trade in 4x4 models is examined in two aggregations of regions and two aggregations of goods. North America and Latin America are first separated, then China and the rest of Asia-Pacific. Resource-based manufactures are treated separately, followed by disaggregation of professional and personal services. The 5x5 model with the full disaggregation is examined.

Predictions of the different models are compared to bilateral net exports in the WIOD data. Regressions analyze the effects of differences in relative prices on total net exports for each of the pairs of regions and goods. The effects of aggregation are discussed.

Section 1 discusses derivation and aggregation of relative prices and bilateral net exports. Section 2 reviews the empirical literature on constant cost trade theory. Sections 3 and 4 present the 3x3 models with the two aggregations of resource goods. Sections 5 and 6 present two 4x4 models separating North America and Latin America, one that separates professional services. Sections 7 and 8 do the same separating China from the rest of Asia-Pacific. Section 9 presents the 5x5 model with all of the present disaggregation and discusses higher dimensional models.

1. The present aggregation of the WIOD Data

The WIOD data of Timmer, Los, Stehrer, and de Vries (2015) covers 43 countries and 56 industries in the International Standard Industrial Classification Revision 4 (ISIC Rev 4). The data includes harmonized the Socio-Economic Accounts SEA and World Input-Output Tables WIOT. The WIOT are national input-output tables that include bilateral trade built from publicly available data in national accounts, supply use tables, and trade statistics providing final consumption by industry. The goods may be intermediate or final products for households, firms, or government. Nominal values are based on free-on-board prices estimated with transport margins. The final and intermediate goods and services include input-output relationships.

The labor share of gross value added in an aggregated industry is the weighted sum of the underlying industries. Production processes are reflected in vector of cost shares as discussed in Belotti, Borin, and Mancini (2020). The labor share of value added is wL_j/y_j where w is the wage, L_j is the labor input, and y_j is value added in industry j. Treating relative labor shares as relative labor inputs assumes a competitive labor market and fixed input proportions.

Table 1 shows the 56 industries and the present aggregation to five goods. The average percentage of each good in GDP across countries is included. Professional-financial services P has by far the largest average share of GDP at 42% with trade-personal services T following at a distant 23%. These two services are disaggregated in some of the models. Manufacturing accounts for 18% of GDP equal to the sum for the roughly equal resources R and resource-based manufactures F that are treated separately in some of the models.

* Table 1 *

The average share of total trade as exports plus imports X+M for each of the of goods is also reported. The most heavily traded good by far is manufactures M at 62% followed by resource-based manufactures F at a distant 25%. These two goods M and F account for only 27% of world output but 87% of trade. The service categories T-P are the mirror image accounting for only 12% of world trade and 65% of output. Resources R account for only 2% of world trade.

The trade intensity index in Table 1 is the ratio of the share of total trade to the share of GDP. Manufactures M is by far the most intensely traded good at 3.44 followed by resource-based goods F at 2.78. The other three goods are much less intensely traded. Trade-personal services T at 0.30 include transport, warehousing, and wholesale trade. Resources R at 0.25 are difficult to trade directly but of course are the basis of resource-based goods and a good share of manufactures. Professional-financial services P has the lowest trade intensity at 0.12 due to its focus on law, education, and administration. The present models examine aggregations of R-F, F-M, and T-P.

Table 2 shows aggregations of the 43 WIOD countries into five regions. Note the countries in the data are not comprehensive accounting for 86% of global GDP. As examples, North America NA is Canada and the US, and Latin America LA Brazil and Mexico. The three aggregated regions have about equal shares of global GDP with America AM accounting for 30% and Asia-Pacific AP and Europe EU both at 28%. In the disaggregation, NA has five times the output of LA while CH and AS have equal sizes.

* Table 2 *

The share of each region in total global trade X+M is highest at nearly half for EU followed at a distance by NA and AS at 17%, CH at 13%., and LA the lowest by far at 4%. The intensity index of total trade relative to GDP is highest in EU at 1.75 followed by AS at 1.21. CH ranks next at 0.93 then LA at 0.80. NA is by far the lowest with a trade intensity of 0.68.

2. The empirical literature on constant cost comparative advantage

Empirical tests of classical comparative advantage begin with MacDougall (1951, 1952) comparing relative labor productivities and export volumes in American and British manufacturing industries and finding higher productivity associated with exports. MacDougall, Dowley, Fox, and Pugh (1962) find similar results in the same data adjusted for tariffs. Stern (1962) improves the measure of relative productivity including factors other than labor and finds similar results. Balassa

(1963) updates the data and finds supporting evidence. Kreinin (1969) and Sailors and Bronson (1970) also find supporting results. In contrast, McGilvray and Simpson (1973) find contrary evidence across 34 sectors in the UK and Ireland in data from 1963 including capital and labor inputs with correct signs for only two of twelve insignificant correlations.

Falvey (1981) makes the point that factor cost shares and price elasticities would have to be similar across industries for meaningful empirical analysis based on labor input alone. Falvey finds ambiguous evidence on the relative price hypothesis in the data of Arrow, Chenery, Minhas, and Solow (1961) with capital and labor inputs for 24 manufacturing industries and 19 countries. Deardorff (1984) points to a lack of freestanding empirical tests of constant cost trade theory.

Eaton and Kortoum (2002) find evidence that relative productivities influence bilateral trade among 19 OECD countries in a model including distance and utility maximization as well as technology diffusion. Costinot, Donaldson, and Komunjer (2012) apply the Eaton-Kortoum model to 13 manufacturing industries in OECD countries finding exports have better technology. Golub and Hseih (2012) analyze the effect of relative productivities across US trading partners finding some support for classical comparative advantage but weak explanatory power. Costinot and Donaldson (2012) evaluate microlevel data on agriculture in a multi-factor model concluding that differences in labor productivities contribute to output levels.

3. Relative prices and trade in a 3x3 model

The following 3x3 model aggregates the 43 countries in Table 2 into America AM, Asia-Pacific AP, and Europe EU. These regions have nearly equal weights in world output in Table 2. Their trade weights relative to output as (X + M)/GDP are the highest for EU at 76% followed by AP at 45% and AM at a distant 30%. Their shares of total exports X + M are 49% for EU, 30% for AP, and 21% for AM. Two different aggregations of goods are considered.

Table 3 shows model-M with its aggregation of the 10 classifications of 56 goods in Table 1. Resource-based goods C are defined as resources R plus resource-based manufactures F. Manufactures M are metals and manufacturing-utilities. Services S include trade-personal T as well as financial-professional P.

* Table 3 *

Table 3 shows AM with the lowest unit inputs for C and S, and AP the lowest for M. EU does not have the lowest unit input for any good. The McKenzie-Jones efficiency ranks the regions AM-AP-EU and goods C-M-S along the main diagonal in Table 3. Global output would be maximized by this order of complete specialization with EU oddly specialized in S even though its unit input is the highest in that good.

Table 4 shows relative prices in model-M derived as ratios of the unit inputs in Table 3. Global comparative advantage GCA holds for AM with the lowest relative prices for C in the p_{CM} and p_{CS} rankings. Asia-Pacific AP also has GCA in M in the p_{RM} and p_{MS} rankings. The lack of GCA for EU leads to partial specialization in every region and a complex trade pattern determined by the three terms of trade tt. The present approach is to assume the extreme regions at the ends of each relative price ranking trade those two goods. Extreme AM exports C to AP in exchange for M and S in the p_{CM} and p_{CS} rankings, while EU exports S to AP in exchange for M.

* Table 4 *

Figure 1 includes this extreme country trade with exports near the country of origin. The two potential directions of trade for each of the three middle regions imply six possible trade patterns. In the p_{CM} ranking, middle region EU would export C to AP if $tt_{CM} > 0.82$ or M to AM if $tt_{CM} < 0.82$. The present assumption is that the terms of trade for each pair of goods are the average of the relative prices across regions. In the p_{CM} ranking the average $tt_{CM} = 0.79$ implies EU exports M to AM in exchange for C. For the other two tt_{CS} = 0.79 implies EU exports S to AM for C while tt_{MS} = 1.009 implies AM exports S to AP for M.

* Figure 1 *

In this trade pattern AM exports its GCA good C to both other regions as does AP for its GCA good M. EU exports S to both other regions. Partial specialization is necessary to support this complex trade pattern as AM must produce C-S, and EU-AP must produce S-M. There is bilateral trade in S between AM-AP. There are two instance of simultaneous export and import of the same good in different directions, AM exporting S to AP for M as it imports S from EU with exports of C. Trade in M by the EU similarly goes in different directions. The possibility of such a complex trade pattern implied by relative price competition among three or more regions and goods has not been noted in the literature.

Table 5 reports the corresponding net exports in billions of US dollars in the WIOD data with positive signs indicating exports from the first region and negative signs exports from the second. For instance, AP is a net exporter of 85 R to AM. The trade balances are -443 for AM, 53 for EU, and 390 for AP. The asterisk* indicates a correct prediction of trade and superscript^{C} a consistent prediction of two-way trade. Model-M predicts or is consistent with 6/9 = 67% of the directions of net exports. The model is correct for five of the six directions of trade in AP-AM, and for four in EU. The model is correct for all directions of trade in M-S but only for one in C noticeably missing AM imports.

* Table 5 *

A larger difference in a relative price between two regions would theoretically increase their bilateral trade in those two goods. Consider the differences in Table 4 between AM-AP for p_{MS} of 0.02 = 1.01 – 0.99 and p_{CM} of -0.35 = 0.60 – 0.95. These relative price differences relate to net export levels AM-AP in Table 5. In the p_{MS} ranking AP has the lower relative price and would export M to AM in exchange for S. The AM-AP column in Table 5 reports net exports of 238 M for AP and 9 S from AM. Their total trade is derived as 247 = 9 – (-238). A larger difference in p_{MS} would increase this total trade suggesting a positive relationship between differences in relative prices and trade levels in the sample.

The difference in p_{CM} between AM-AP illustrates a negative relative price difference as well as trade in the direction opposite to the model. With its lower relative price AM would export C to AP in exchange for M. The AM-AP column in Table 5 shows AM imports 85 C from AP. Total trade is discounted by these imports according to 153 = -85 – (-238). A larger absolute difference in p_{CM} would increase total trade. The absolute values of relative prices differences capture this total trade level.

The 3x3 models have nine observations of absolute differences in relative prices and total trade levels. In all models, regression analysis examines the dummy variable effects for pairs of trading countries and pairs of goods. The strongest result in model-M includes the negative effect of C-S trade leading to an R^2 of 0.40, a zero intercept, and a t-statistic of 0.37 for relative prices. The absolute difference in relative prices between countries has a positive but insignificant effect on trade in this small sample.

4. A 3x3 model narrowly defining resource goods

Table 6 presents model-R motivated by the missed direction of trade in resource goods in model-M. The resource good R is defined as in Table 1. Food-textiles-wood-chemicals F are included in the broad manufacturing sector N with metals-manufacturing-utilities M. The order of the McKenzie-Jones efficiency is the same as model-M. Isolating R reveals a disadvantage for AP as its unit input in R rises while the unit inputs in AM and EU fall compared to model-R in Table 3.

* Tables 6 *

Table 7 shows the relative prices in model-R maintain the GCA of AP in the broad manufacturing sector N and the GCA of AM in resources R. The lack of any GCA for EU again implies partial specialization leading to a complex trade pattern. Trade between the extreme regions involves AP exports of M to EU for S and to AM for R, and AP exports of S to AM for R. Middle country trade is determined by the average relative price across regions.

* Table 7 *

Table 8 evaluates the prediction of the net exports in model-R. In the p_{RN} ranking middle EU exports N to AM for R. In the p_{RS} ranking middle EU exports S to AM for R. In p_{NS} middle AM exports S to AP for N. Model-R is consistent with 8/9 = 89% of net exports. The only miss is the predicted lack of trade in R between AP-EU that is close to zero.

* Table 8 *

Regression analysis for model-R has the most favorable results includes the marginally insignificant dummy variable for R-S trade. The R^2 is 0.33 with a zero intercept and a relative price t-statistic of 0.76 that is somewhat stronger than model-M but insignificant. While the regression results are weak in the two 3x3 models, the 4x4 models increase the number of observations from 9 to 36.

5. Models separating North America and Latin America

The 4x4 models in the next two sections separate North America NA from Latin America LA. NA is larger accounting for 85% of GDP and 81% of total trade X + M in America AM. One aggregation of goods separates resource-based manufactures F as in 3x3 model-R. A second aggregation separates professional-financial services P from trade-personal services T with the broad manufacturing sector N in model-M.

Table 9 reports unit inputs in model-A separating resource-based manufactures F. The McKenzie-Jones efficiency ranking is R-F-M-S for NA-AP-LA-EU. The lowest input of R is for NA and the second lowest for LA, the two spanning the weighted average for aggregate AM in model-R. In services S the inputs of NA-LA span their aggregate AM. Disaggregation reveals advantages for LA in S and for NA in R. The inputs of F-M in AP-EU both span their aggregate N in model-R.

* Table 9 *

Table 10 reports six sets of relative prices revealing a lack of GCA. The GCA of AP in broad manufacturing N in model-R is lost to NA in F and LA in M. Extreme region trade implies NA exports R to AP for M-S, LA exports M to NA for F, and AP exports F to LA for R. Trade in S between NA-LA goes in both directions.

* Table 10 *

Figure 2 shows the directions of trade based on the six terms of trade at average relative prices. These terms of trade lie between EU-AP in the p_{RF}-p_{RM}-p_{RS} rankings and between AP-EU for p_{FM}-p_{MS}-p_{FS}. AP exports F-M-S to every other country. The same is true for LA and M, and for EU and S. To support these exports every region must diversify into at least three goods excluding M for NA, R for AP, and F for EU and LA.

* Figure 2 *

Table 11 shows model-A is consistent with 16/24 = 67% of the directions of net exports. The directions of five of the six net exports of M are correct as are four for R and S. The region most consistently following relative prices is AP in all twelve instances of trade followed by the other regions at seven apiece.

* Table 11 *

The regression for model-A includes the positive effect of M-S trade and the negative effect of AP-LA trade. The R^2 is 0.23 with a zero intercept and a P-value for relative prices of 0.04 that strongly supports the relative price hypothesis. This and the following 4x4 model separating NA and LA with strong empirical support for the relative price hypothesis illustrate the pitfalls of aggregation to a 3x3 model.

6. Separating professional services

Table 12 presents unit inputs in model-P separating services into professional-financial P and trade-transport-personal T with the broad manufacturing N in model-M. The disaggregation reveals advantages in T for AP and in P for EU that are hidden by their aggregation in S. Lower inputs of R in NA and N in LA are also revealed compared to those of their aggregate AM. Lower inputs for NA-AP-LA in T and for EU in P are also revealed relative to the aggregate S in model-A. The McKenzie-Jones efficiency ranks the goods R-N-T-P in the regions NA-AP-LA-EU.

* Table 12 *

Table 13 reports the relative prices in model-P revealing a GCA for NA in R and one for AP in N. All trade between AM and AP is as extreme countries in the rankings. Including middle country trade, EU exports of P and LA exports of T to all other regions. AP exports both T and N to the other three regions. Each region must produce at least three goods to support exports.

* Table 13 *

Table 14 shows 67% consistency in model-P including five of the six instances of trade in R, four for N-P, and three for T. The regression including the negative effect of NA-AP trade has an R^2 of 0.19, a zero intercept, and a 0.01 P-value for relative prices strongly supporting the relative price hypothesis.

* Table 14 *

7. Two 4x4 models separating China and Asia-Pacific

The following two models are motivated to focus on China separate from the rest of Asia-Pacific AS. China CH accounts for 49% of GDP and 44% of total trade X + M in the aggregate Asia-Pacific AP.

Table 15 shows unit inputs in model-C that disaggregates personal S and professional P services as in the previous model-P. The aggregation of AM in this model-C hides the lower inputs of LA relative to NA in every good except R compared to model-P. The aggregation of CH and AS in model-P conceals the lower inputs of CH in every good except R. The McKenzie-Jones efficiency in model-C is R-N-T-P for AM-CH-AS-EU as in Table 15.

* Table 15 *

Table 16 shows the relative prices in model-C revealing GCAs for AM in R and for CH in N. AM and CH stand out with other lowest relative prices, AM for T relative to N, CH for T relative to P, and for both AM and CH in both T and P relative to R.

* Table 16 *

Table 17 reports the complex trade pattern for model-C. CH exports N and T to every other region as does AM for T and AS for P. Each region must produce at least three goods to support exports. Model-C is consistent with 58% of the observed bilateral exports in Table 17. Including the marginally insignificant negative effect for AM-CH trade, the regression has an R^2 of 0.12 with a zero intercept and a P-value of 0.08 supporting the relative price hypothesis.

* Table 17 *

Table 18 shows unit inputs in 4x4 model-Q motivated to focus on disaggregating resource-based manufactures F as in the 3x3 model-A. The inputs for EU are identical to model-A in Table 9. The aggregated AP in Table 9 hides the low inputs of CH in F-M-S and AS in R. The aggregated AM in Table 18 hides the lower inputs of NA in R-F and the lower inputs of LA in M-S in model-A. The McKenzie-Jones efficiency is R-F-M-S for AM-AS-CH-EU.

* Table 18 *

Table19 show the relative prices in model-Q. The only GCA is for AM in R. CH exports M to every other country, as does AS for F. Every country must produce three goods to support exports.

* Table 19 *

Table 20 shows model-Q is consistent for 58% of the directions of net exports. CH is most consistent with the theory in 7 of its 12 instances of net exports with AS and EU following at 6 and AM at 5. The model is most successful for net exports of S in 4 of its 6 instances. The most favorable regression includes a positive effect for M-S trade leading to an R^2 of 0.14 with a zero intercept and P-value for relative prices of 0.34. Among the 4x4 models, this model-Q is the least supportive of the relative price hypothesis. Disaggregating NA and LA leads to stronger results than separating CH and AS. Disaggregating F and N leads to stronger results than separating T and P.

* Table 20 *

8. The 5x5 model and higher dimensional models

Table 21 shows the unit inputs in the model with all five goods R-F-M-T-P and regions NA-AS-LA-CH-EU in the McKenzie-Jones orders. Compared to model-Q, NA is revealed to have lower inputs in R and F than LA with the opposite for M. CH is revealed to have advantage in T compared to P with the opposite for AS and EU. Compared to model-P, AS is revealed to have an advantage in R over CH while CH has lower inputs than AS in T and P. NA and CH are revealed to have more of an advantage in F and CH in M.

* Table 21 *

Table 22 shows the relative price rankings that reveal no global comparative advantage. The average relative price as the terms of trade leads to a complex trade pattern. There is little specialization with LA producing every good for export and the other regions four of the five goods. Out of the 50 instances of bilateral trade 36% involve trading the same good in both directions. Figure 3 shows this very complex trade.

* Table 22 * Figure 3 *

Table 23 reports the model is consistent with 62% of the 50 instances of bilateral trade. EU is the region most consistent with the relative price hypothesis at 75%. The least consistent regions are AS and CH at 55%. In contrast, the aggregate AP the most consistent region in the 3x3 and 4x4 models. Trade in M is most consistent at 80% of its instances and R the least consistent at 50%. In the regression analysis, the positive CH-EU and negative NA-CH trade effects stand out. Including them with the positive R-M effect leads to an R^2 of 0.16 with a negative intercept term and a 0.03 P-value strongly supporting the relative price hypothesis.

* Table 23 *

Table 24 compares results in regression analysis across the nine models. Disaggregation generally increases the significance of relative prices except for model-Q. The weakest results by far are the two 4x4 models separating CH and AS. The average of the R^2 across models is 0.22. The relative price hypothesis is strongly supported except in the two 3x3 models and model-Q where the effect has the predicted sign but is insignificant.

* Table 24 *

The predicted bidirectional trade in the model is consistent with observed exports in either direction. The present steps of disaggregation increase the predicted share of bidirectional trade from 11% to 36% of the instances of bilateral trade. In a 10x10 model there would be 45 relative price rankings leading to 225 possible trade patterns and certainly a much higher percentage of predicted bidirectional trade. The present WIOD data with 43 countries aggregated to the same number of goods would imply 37,926 possible trade patterns, one of which would be consistent with the observed trade pattern. Disaggregation would also seem likely to increase support for the relative price hypothesis in regression analysis.

9. Conclusion

The present results suggest relative prices in constant cost theory go farther than might be appreciated toward explaining observed trade patterns. Relative labor shares in the present aggregations of the WIOD data treated as relative prices imply partial specialization and complex trade patterns. The present assumption that the terms of trade are the average relative price leads to predictions generally consistent with observed net exports. Regressions including dummy effects for pairs of countries and goods support the relative price hypothesis of Ricardo. The effects of relative prices can be expected to improve in more disaggregated models.

To refine the model, including country sizes and utility maximization would lead to endogenous terms of trade and a unique predicted trade pattern. Considering country sizes can also lead to partial specialization and trade with countries too small to support complete specialization as shown in Thompson (2018). Capital input can be included in the fixed factor proportions model developed in Thompson (2010). Including tariffs and transport costs would certainly improve the model and likely improve empirical results as well.

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Table 1. Industry aggregations

Categories		Industries		Categories		Industries
Resources	R			Trade services	T	
8% GDP	A01	Crops, animals		23% GDP	G45	Trade, vehicle repair
2% X+M	A02	Forestry, logging		7% X+M	G46	Wholesale trade
Intensity 0.25	A03	Fishing, aquaculture		Intensity 0.30	G47	Retail trade
	B	Mining, quarrying			H49	Transport, pipeline
					H50	Water transport
Resource-based	F				H51	Air transport
9% GDP	C10	Food, beverage			H52	Warehouse
25% X+M	C13	Textiles, apparel			H53	Postal, courier
Intensity 2.78	C16	Wood, cork			I	Hotel, restaurant
	C17	Paper			J58	Publishing
	C18	Printing, recording			J59	Movies, music
	C19	Coke, refined			J61	Telecom
	C20	Chemical			J62	Programming
	C21	Pharmaceutical				
	C22	Rubber, plastic		Professional	P	
	C23	Mon-metallic		42% GDP	K64	Financial services
				5% X+M	K65	Insurance, pensions
Manufactures	M			Intensity 0.12	K66	Auxiliary financial
18% GDP	C24	Basic metal			L68	Real estate
62% X+M	C25	Fabricated metal			M69	Legal, management
Intensity 3.44	C26	Electronics, optical			M71	Engineering
	C27	Electrical equip			M72	Scientific R&D
	C28	Machinery, equip			M73	Research
	C29	Motor vehicles			M74	Other
	C30	Transport equip			N	Administrative
	C31	Furniture			O84	Public admin
	C33	Repair, installation			P85	Education
	D35	Electricity, gas			Q	Health, social work
	E36	Water, treatment			R-S	Other services
	E37	Sewage, waste			T	Household
	F	Construction			U	Foreign org

Table 2. Country aggregations

AM America	AP Asia-Pacific	EU Europe
		32 countries
LA Latin Am	CHN China	28% GDP
BRA MEX	14% GDP	49% X+M
5% GDP	13% X+M	Intensity 1.75
4% X+M	Intensity 0.93	
Intensity 0.80		
	AS Rest of AP	
NA North Am	AUS IDN IND	
CAN USA	JPN KOR TWN	
25% GDP	14% GDP	
17% X+M	17% X+M	
Intensity 0.68	Intensity 1.21	

Table 3. Unit inputs in model-M

		AM	AP	EU
C	R F	0.35	0.55	0.52
M		0.583	0.579	0.63
S	T P	0.58	0.59	0.61

Table 4. Relative prices in model-M

	AM	AP	EU
p_{CM}	0.60	0.95	0.82
p_{CS}	0.60	0.94	0.84
p_{MS}	1.012	0.99	1.03

Table 5. Observed trade in model-M

	AM-AP	AM-EU	AP-EU
C	-85	-49	58^{0}
M	-238*	-77*	48*
S	9^{C}	-3*	-30*

*correct ^{C}consistent

Table 6. Unit inputs in model-R

		AM	AP	EU
R		0.29	0.69	0.46
N	F M	0.522	0.523	0.60
S	T P	0.58	0.59	0.61

Table 7. Relative prices in model-R

	AM	AP	EU
p_{RN}	0.55	1.32	0.77
p_{RS}	0.50	1.17	0.76
P_{NS}	0.91	0.89	0.99

Table 8. Observed trade in model-R

	AM-AP	AM-EU	AP-EU
R	2.5*	3.4^0	-0.3*
N	-326*	-129*	107*
S	9.5^C	-2.6*	-30.2*

* correct [C]consistent

Table 9. Unit inputs in model-A

		NA	AP	LA	EU
R		0.27	0.69	0.33	0.46
F		0.38	0.42	0.48	0.54
M		0.61	0.58	0.46	0.63
S	T P	0.589	0.587	0.49	0.61

Table 10. Relative prices in model-A

	NA	AP	LA	EU
p_{RF}	0.71	1.63	0.69	0.85
p_{RM}	0.44	1.19	0.73	0.74
p_{RS}	0.46	1.17	0.68	0.76
p_{FM}	0.62	0.73	1.05	0.86
p_{FS}	0.65	0.72	0.98	0.89
P_{MS}	1.034	0.99	0.93	1.030

Table 11. Observed trade in model-A

	NA-AP	NA-EU	NA-LA	AP-EU	AP-LA	EU-LA
R	21*	24^{0}	-93*	-3*	-4*	-100
F	-1038*	-553	-98	691*	78*	35^{0}
M	-1813*	-552*	-747*	375*	328^{C}	160
S	86^{C}	25	-34	-302*	-8^{C}	51*

* correct ^{C}consistent ^{0}predicted zero

Table 12. Unit inputs in model-P

		NA	AP	LA	EU
R		0.27	0.69	0.33	0.46
N	F M	0.53	0.52	0.47	0.60
T		0.56	0.57	0.45	0.63
P		0.6033	0.60	0.51	0.6032

Table 13. Relative prices in model-P

	NA	AP	LA	EU
p_{RN}	0.51	1.32	0.72	0.77
p_{RT}	0.49	1.22	0.742	0.738
p_{RP}	0.45	1.14	0.65	0.77
P_{NT}	0.959	0.92	1.04	0.961
p_{NP}	0.88	0.87	0.91	1.00
p_{TP}	0.92	0.94	0.87	1.04

Table 14. Observed trade in model-P

	NA-AP	NA-EU	NA-LA	AP-EU	AP-LA	EU-LA
R	21*	24*	-93[0]	-3*	-4*	-10*
N	-2851*	-1105	-845	1066*	406*	194*
T	43	86*	-44*	-213	2[C]	42
P	44	-60*	10	-89*	-10[C]	9*

*correct [C]consistent

Table 15. Unit inputs in model-C

		AM	CH	AS	EU
R		0.29	0.76	0.55	0.46
N	F M	0.52	0.47	0.60	0.60
T		0.54	0.49	0.62	0.63
P		0.593	0.589	0.61	0.60

Table 16. Relative prices in model-C

	AM	CH	AS	EU
p_{RN}	0.55	1.62	0.92	0.77
p_{RT}	0.53	1.55	0.88	0.74
p_{RP}	0.48	1.30	0.89	0.77
P_{NT}	0.97	0.95	0.963	0.961
p_{NP}	0.88	0.80	0.98	1.00
p_{TP}	0.91	0.84	1.01	1.04

Table 17. Observed trade in model-C

	AM CH	AM AS	AM EU	CH AS	CH EU	AS EU
R	-2	27*	34	17*	13	-16*
N	-2233*	-1024	-1299*	723	1161*	-95*
T	12^{C}	28	44	-62*	-105*	-108
P	25*	29	-70*	-54*	-82*	-7*

*correct ^{C}consistent

Table 18. Unit inputs in model-Q

		AM	AS	CH	EU
R		0.29	0.55	0.76	0.46
F		0.40	0.45	0.41	0.54
M		0.58	0.66	0.51	0.63
S	T P	0.58	0.614	0.55	0.612

Table 19. Relative prices in model-Q

	AM	AS	CH	EU
p_{RF}	0.72	1.22	1.87	0.85
p_{RM}	0.49	0.82	1.49	0.74
p_{RS}	0.50	0.89	1.39	0.76
p_{FM}	0.681	0.676	0.80	0.86
p_{FS}	0.69	0.73	0.74	0.89
P_{MS}	1.01	1.08	0.93	1.03

Table 20. Observed trade in model-Q

	AM-AS	AM-CH	AM-EU	AS-CH	AS-EU	CH-EU
R	27*	-2	34	-17	-16*	13
F	-127*	-988^{C}	-588	-572	-142	833*
M	-896	-1245*	-712	-150*	47	328*
S	58	37	-26*	117*	-114*	-187*

*correct ^{C}consistent

Table 21. Unit inputs, 5x5 model

	NA	AS	LA	CH	EU
R	0.27	0.55	0.33	0.76	0.46
F	0.38	0.45	0.48	0.41	0.54
M	0.61	0.66	0.46	0.51	0.63
T	0.56	0.62	0.45	0.49	0.63
P	0.6033	0.61	0.51	0.59	0.6032

Table 22. Relative prices, 5x5 model

	NA	AS	LA	CH	EU	avg
p_{RF}	0.71	1.22	0.69	1.87	0.85	1.07
p_{RM}	0.44	0.82	0.73	1.49	0.74	0.85
p_{RT}	0.49	0.882	0.742	1.55	0.738	0.879
p_{RP}	0.45	0.89	0.65	1.30	0.77	0.81
p_{FM}	0.62	0.68	1.05	0.800	0.86	0.803
p_{FT}	0.68	0.72	1.07	0.828	0.86	0.835
p_{FP}	0.63	0.74	0.94	0.69	0.90	0.78
p_{MT}	1.09	1.07	1.02	1.04	1.00	1.05
p_{MP}	1.01	1.09	0.89	0.87	1.04	0.98
p_{TP}	0.92	1.01	0.87	0.84	1.04	0.94

Table 23. Observed trade, 5x5 model

	NA AS	NA LA	NA CH	NA EU	AS LA	AS CH	AS EU	LA CH	LA EU	CH EU
R	23^{0}	-93*	-2	24*	-4*	-17	-16*	-0.1	10^{c}	13
F	-126	-33^{c}	-691^{c}	-499*	-10	-505^{c}	-124	-67	-29*	705*
M	-790*	-812*	-1244*	-606*	117	-218*	29^{c}	-231^{c}	-166^{c}	456
T	34*	-44*	9	86*	5*	62^{c}	-108	3	-42	-105^{c}
P	32	10*	11	-60*	3	54^{c}	-7^{c}	13*	-9^{c}	-82^{c}

*correct ^{C}consistent ^{0}predicted zero

Table 24. Summary of Regression Analysis

	3x3		4x4				5x5
	M	R	A	P	C	Q	
Intercept	57.27 (58.8)	108.2 (84.2)	35.08 (174.3)	-365.5 (219.7)	-220.5 (207.2)	20.09 (158.4)	-150.2*** (55.9)
Relative price differences	112.3 (301.4)	152.6 (201.9)	915.3** (430.3)	1840** (716.4)	939.8* (512.0)	311.2 (322.2)	331.2** (152.4)
Regions effects	--	--	AP-LA -556.8** (267.0)	NA-AP -835.2* (436.5)	AM-CH -648.2 (420.5)	--	CH-EU 188.9 (134.0) NA-CH -188.2 (137.3)
Goods effects	C-S -154.0* (78.83)	R-S -187.1 (110.3)	M-S 646.1** (284.0)	--	--	M-S -463.5 (275.0)	R-M 344.8** (134.2)
R^2	0.40	0.33	0.23	0.19	0.12	0.14	0.16

(SE) *0.10 **0.05 ***0.01

Figure 1. Predicted trade in model-M

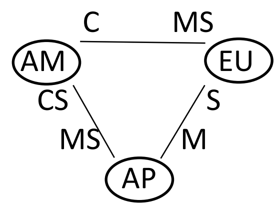

Figure 2. Predicted trade in model-A

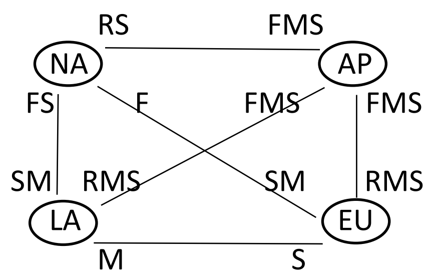

Figure 3. Predicted trade in 5x5 model