Structural Estimates of Trade Elasticities

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- What we are doing
  - 2014 Cross-section gravity estimation of goods and services price elasticities.
  - Interested in how PTA endogenity, rules of origin, the role of market size (esp. as we drill down below aggregate trade) may play a role in estimated trade elasticities). We use first stage Probits and a control function approach to deal with endogeneity in depth of PTAs.
  - Also interested in obtaining price elasticities for services (a long-running issue).
- Why what we are doing matters
  - There is clear demand for trade parameter estimates that "reflect the data" for structural gravity and new (flavours of) quantitative trade models.
  - Consistent estimates of price elasticities also allow, from the same framework, for identification of plausible NTM related trade cost reductions.
  - Rules of origin and related compliance costs clearly matter to the estimates, and should also matter when we specify tariff-related experiments.
- Some context
  - The gravity model itself follows from a range of standard models (Deardorff, 1998; Head and Mayer 2014; Bekkers and Francois 2018a).
  - The recent work on modelling NTM reductions in PTAs relies on rapidly evolving gravity estimates. (e.g. Egger et al 2015; Bekkers and Rojas-Romagosa 2018).
  - Older work on preference qualifation costs remains relevant, in addition to recent emphasis on PTA endogeneity. (Carrere & De Melo 2004; Anson, Cadot et al 2005; Francois, Manchin, & Hoekman 2006,...)

Our framework: generic gravity

We work with a gravity equation of cross-border trade in sector k. The gravity model itself follows from a range of standard models (Deardorff, 1998; Head and Mayer 2014; Bekkers and Francois 2018). We define terms and start with a generalized gravity equation.

$$v_{ij,k} = A_{i,k} B_{ij,k} C_{j,k} D_{j,k} \tag{1}$$

$$s_{ij,k} = A_{i,k} B_{ij,k} C_{j,k} \tag{2}$$

In equations (1) and (2), the terms $v_{ij,k}$ and $s_{ij,k}$ represent the landed, duty inclusive value of imports (or corresponding own trade $v_{jj,k}$ and the same in share terms), indexed by source country i, destination country j, and sector k. The exact interpretation of the terms $A_{i,k}$, $B_{ij,k}$, C_j, k, and $D_{j,k}$ depends on the underlying structural model for trade. For our purposes, importer and exporter fixed effects will serve to control for the terms $A_{i,k}$, C_j, k, and $D_{j,k}$. The term $B_{ij,k}$ is model dependent, as summarized in the next slide. (Note we drop subscript k).

Our framework: the bilateral determinants of trade by model type

	B_{ij}
Armington	$(T_{m,ij}\,T_{x,ij}\tau_{ij}S_{ij})^{1-\sigma}$
Krugman-Ethier	$(T_{m,ij}\,T_{x,ij}\tau_{ij}S_{ij})^{1-\sigma}$
Melitz	$(T_{x,ij}S_{ij}\tau_{ij})^{-\theta}\,f_{ij}^{1-\frac{\theta}{(\sigma-1)}}\,T_{m,ij}^{1-\sigma\frac{\theta}{(\sigma-1)}}$
Eaton-Kortum	$(T_{m,ij}\,T_{x,ij}\tau_{ij}S_{ij})^{1-\sigma}$
where	
$T_{m,ij}$	bilateral import tariff multiplier $T_{m,ij} = (1 + t_{m,ij})$
	where $t_{m,ij}$ is the import tax rate
$T_{x,ij}$	bilateral export tax multiplier $T_{x,ij} = (1 + t_{x,ij})$
	where $t_{x,ij}$ is the export tax rate
S_{ij}	bilateral transport cost multiplier $S_{ij} = (1 + s_{ij})$
	where s_{ij} is the shipping rate
σ	elasticity of substitution in demand
f_{ij}	firm fixed cost parameter entering j from i in Melitz model
τ_{ij}	actual iceberg costs between i and j
θ	Pareto shape parameter in Melitz model

Note that with an assumption of granularity, meaning $\theta = (\sigma - 1)$, the tariff elasticity and iceberg (NTM) elasticities in Melitz collapse to the otherwise common parameterization of the Armington, Krugman-Ethier, and Eaton-Kortum models.

Our framework: estimation strategy

$$v_{ij,k} = A_{i,k} B_{ij,k} C_{j,k} D_{j,k}$$
$$s_{ij,k} = A_{i,k} B_{ij,k} C_{j,k}$$

- 2014 Cross-section: trade, pairwise socio-political, geographic distance, & domestic sales data.
- 1st stage Probits, control function approach to deal with endogeneity in PTA depth.
- 2nd stage PPML & zero inflated binomial regressions: fixed effects controlling for A,C, & D terms.
- We are interesting in identifying trade elasticities at the sector level (currently GTAP sectors) for goods and services.
- For services, we exploit AVE estimates from the World Bank's STRI project, combined with a re-working of the underlying STRI data so we can separate intra-EU from extra-EU applied STRI values, as well as the implied AVE preference margin, to obtain services price elasticities.
- For goods, we explore two specifications of rules of origin and related compliance costs. These matter for elasticity estimates and NTM volume effect estimates within PTAs.

First Stage Regressions

First stage probit regressios for control function

name	description	Depth = 1	Depth = 2	Depth = 3	services agreement
lnDist	log distance	-0.961	-0.706	-0.960	-0.318
		(0.036)***	(0.030)***	(0.046)***	(0.025)***
mass	Economic mass of exporter and importer together (product of log GDPs)	0.003	0.004	0.061	0.046
		(0.010)	(0.007)	(0.010)***	(0.005)***
contig	common border	-0.745	0.117	0.099	0.454
		(0.119)***	(0.108)	(0.229)	(0.099)***
lnHindex	Trade embeddedness index for 2013	0.697	1.503	-5.690	-3.300
		(0.263)***	(0.250)***	(0.626)***	(0.238)***
comlang_ethno	common language ethnic	0.293	-0.419	0.401	0.239
		(0.118)**	(0.101)***	(0.204)**	(0.089)***
comlang_off	common language official	0.138	0.490	-0.312	0.161
		(0.116)	(0.100)***	(0.213)	(0.090)*
comcol	common colony	-0.099	0.154	-0.650	0.213
		(0.078)	(0.094)	(0.239)***	(0.086)**
colony	former colony	1.346	-0.032	-0.722	-0.203
		(0.253)***	(0.142)	(0.230)***	(0.122)*
POL	polity index	-0.058	0.110	0.012	-0.004
		(0.016)***	(0.013)***	(0.027)	(0.012)
sd_lnHindex_lnT	interaction lnHindex and sd_lnMFNavg	-2.445	1.805	3.721	3.414
		(0.904)***	(0.717)**	(1.515)**	(0.616)***
sd_lnMFNavg	ln of average pairwise MFN tariff	9.168	-7.825	-17.420	-14.778
		(3.566)**	(3.119)**	(7.115)**	(2.672)***
OECD	pairwise OECD dummy	-1.451	-2.661	-1.508	-3.219
		(0.454)***	(0.107)***	(0.176)***	(0.086)***
	N	18,906	18,906	18,906	18,906
	Pseudo R-sqaured	0.577	0.488	0.794	0.502

notes: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. All regressions include source and destination fixed effects.

Second Stage Regressions – all goods

Stage 2 PPML Regression, Aggregate Trade in Goods

name	description	no control	control	control & ROO cost	control & utilization
DEEP1	Depth = 1	-0.117	0.289	0.460	0.463
		(0.105)	(0.145)**	(0.147)***	(0.139)***
DEEP2	Depth = 2	0.077	0.304	0.459	0.409
		(0.079)	(0.020)***	(0.010)***	(0.032)***
DEEP3	Depth = 3	0.157	0.266	0.416	0.358
		(0.092)*	(0.113)**	(0.102)***	(0.111)***
EUN	Intra-EU trade	0.782	1.142	0.966	1.029
		(0.099)***	(0.176)***	(0.138)***	(0.152)***
lnDist	log distance	-0.435	-0.347	-0.347	-0.345
		(0.014)***	(0.022)***	(0.022)***	(0.021)***
lnDist2	log internal distance (home trade)	-0.326	-0.354	-0.360	-0.359
		(0.041)***	(0.048)***	(0.043)***	(0.045)***
POL	polity index	0.064	0.038	0.037	0.037
		(0.010)***	(0.006)***	(0.006)***	(0.006)***
lnHindex	Trade embeddedness index for 2013	3.888	3.368	3.352	3.342
		(0.477)***	(0.256)***	(0.263)***	(0.277)***
comcol	common colony	0.256	0.315	0.310	0.321
		(0.193)	(0.216)	(0.219)	(0.213)
comlang_ethno	common language ethnic	0.333	0.327	0.327	0.338
		(0.189)*	(0.182)*	(0.182)*	(0.191)*
comlang_off	common language official	-0.216	-0.208	-0.209	-0.226
		(0.267)	(0.271)	(0.269)	(0.278)

name	description	no control	control	control & ROO cost	control & utilization
contig	common border	0.605	0.689	0.686	0.679
		(0.127)***	(0.117)***	(0.118)***	(0.112)***
colony	former colony	0.239	0.326	0.325	0.326
		(0.052)***	(0.043)***	(0.043)***	(0.044)***
home	dummy for home (domestic) trade	7.477	8.353	8.256	8.187
		(0.424)***	(0.571)***	(0.643)***	(0.704)***
homePCI	interaction of home and log per capita income	-0.400	-0.427	-0.417	-0.408
		(0.020)***	(0.015)***	(0.016)***	(0.018)***
homePOL	interaction of home and composite polity index	0.028	0.014	0.014	0.012
		(0.005)***	(0.009)	(0.009)	(0.009)
homeEUN	home trade is with an EU Member State	0.680	0.680	0.667	0.668
		(0.131)***	(0.212)***	(0.200)***	(0.205)***
lnT	ln(1+t) where t is the applied tariff	-4.394	-4.921	-5.366	-5.352
		(0.681)***	(0.558)***	(1.002)***	(0.922)***
ROO	Interaction of ln(1+mfn) and dummy for FTA trade (so excluding EU trade)				2.234
					(0.640)***
	N	19,044	19,044	19,044	19,044
	Pseudo R-sqaured	0.999	0.999	0.999	0.999
	Chi2 for control function		7.7e+03	1.1e+04	142.422
	Pr (Chi2)		0.000	0.000	0.000
	AIC	449.069	428.532	427.548	427.480
	BIC	8,281,199	7,890,100	7,871,361	7,870,063

notes: * p <0.1; ** p <0.05; *** p <0.01. All regressions include source and destination fixed effects.

Source: own estimates.

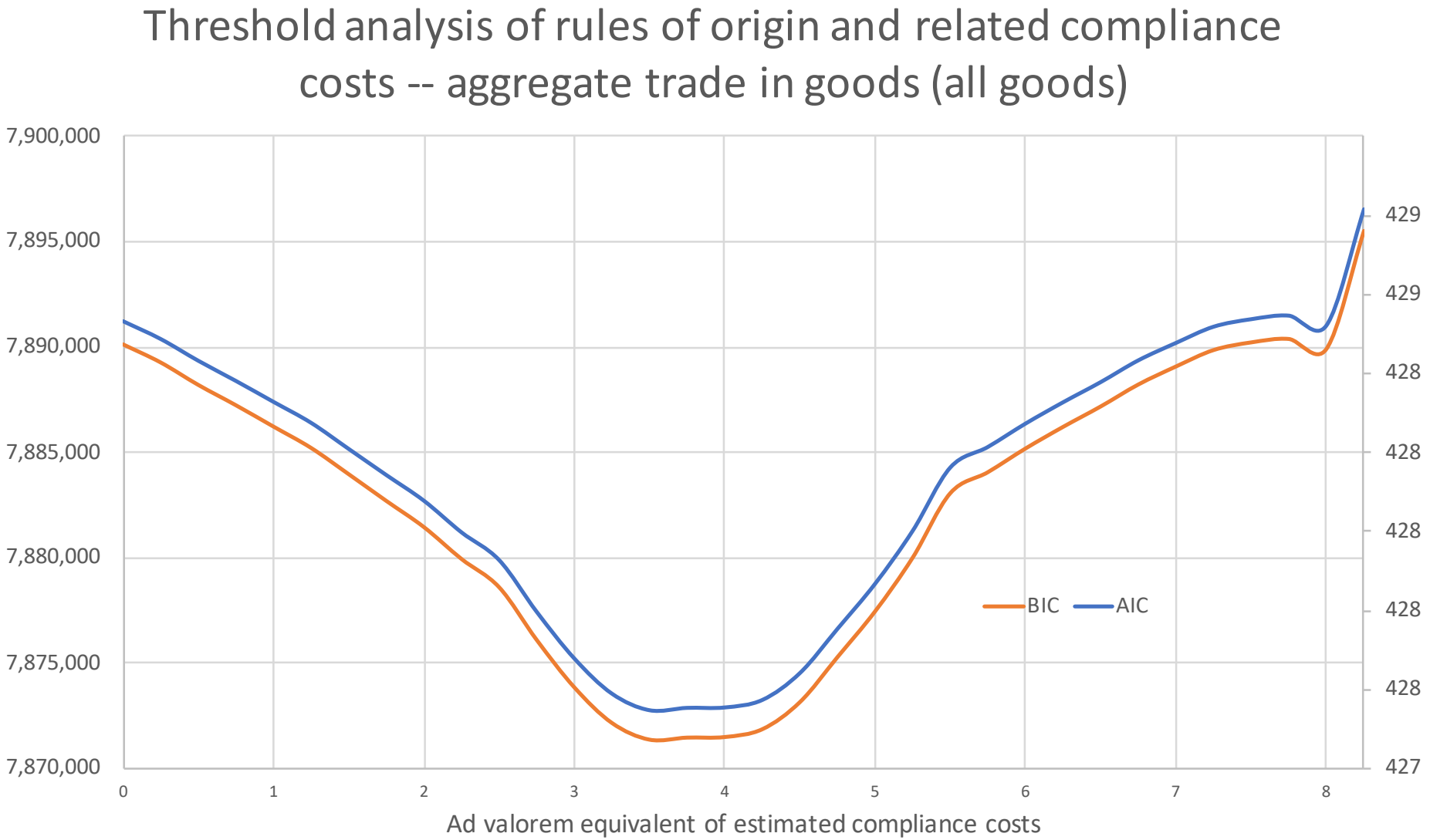
Compliance costs in PTAs

$$V_{i,j} = A_i B_{ij} C_j D_j (1 + \tilde{t}_{i,j})^{\xi} \Big|_{V_{i,j} \neq 0}$$
$$\tilde{t}_{i,j} = mfn_{i,j} \text{ if } mfn_{i,j} \leq R$$
$$\tilde{t}_{i,j} = R \text{ if } mfn_{i,j} > R$$

where:
$V_{i,j}$ value of bilateral trade
A_i source specific fixed effect
C_j destination specific fixed effect
D_j destination specific fixed effect
$B_{i,j}$ pairwise variables apart from tariffs
R generic preference ad valorem qualification cost
ξ tariff elasticity as defined above

This is similar to Francois, Hoekman, and Manchin (WBER 2006). We basically test alternative specifications across a range of postulated values for R and identify the best fit. Alternatives we have not yet explored involve fixed vs variable costs, variations by PTA features, rules of origin types, and interaction with measures of border procedure efficiency.

Compliance costs in PTAs



Source: own estimates.

Detailed goods sectors

Tariff elasticities for industrial goods and processed foods

product category	PPML	weighted PPML	zero inflated binomial
forestry	-23.699 (8.172)***	-4.601 (1.084)***	-4.137 (1.269)***
fisheries	-9.572 (1.867)***	-11.336 (6.524)*	-15.882 (8.642)*
processed ruminant meats	-4.509 (0.537)***	-3.914 (0.538)***	-4.52 (0.733)***
other processed meats	-4.427 (1.128)***	-8.051 (1.251)***	-8.925 (1.505)***
vegetable oils	-2.528 (0.847)***	-4.42 (0.980)***	-3.994 (0.932)***
dairy products	-9.023 (1.311)***	-8.439 (1.543)***	-10.734 (2.158)***
processed rice	-1.606 (0.247)***	-3.228 (0.962)***	-5.929 (0.965)***
sugar	-0.963 (0.946)	-5.558 (2.248)**	-8.223 (2.930)***
other processd foods	-7.152 (0.786)***	-8.452 (1.630)***	-11.081 (1.732)***
beverages and tobacco	-1.234 (0.667)*	-1.961 (0.532)***	-2.447 (0.651)***
textiles	-7.852 (1.360)***	-9.207 (1.335)***	-11.092 (1.647)***
clothing	-7.612 (0.773)***	-7.301 (1.933)***	-10.349 (2.631)***
leather goods, footwear	-8.446 (0.472)***	-3.446 (1.132)***	-4.931 (1.256)***
lumber	-18.63 (1.053)***	-10.688 (1.612)***	-15.886 (2.207)***
paper, printing	-16.195 (0.652)***	-9.39 (1.012)***	-8.648 (1.601)***
chemicals, rubber, plastics	-10.827 (1.110)***	-11.723 (4.422)***	-12.43 (4.652)***
non-metallic mineral products	1.592 (1.582)	-0.657 (1.950)	-0.44 (2.147)
iron and steel	-10.47 (4.532)**	-8.357 (2.458)***	-9.899 (1.909)***
non-ferrous metals	11.415 (3.627)***	-11.125 (3.090)***	-15.418 (3.002)***
fabricated metal products	-13.898 (2.957)***	-10.394 (1.740)***	-11.464 (1.519)***
motor vehicles	-3.847 (2.214)*	-7.815 (1.642)***	-9.728 (1.915)***
other transport equipment	-14.693 (2.751)***	-1.61 (1.203)	-0.499 (1.747)
electrical machinery	2.966 (3.231)	-16.18 (4.163)***	-18.411 (4.420)***
other machinery	-20.492 (4.428)***	-11.81 (3.509)***	-13.292 (3.994)***
other manufactured goods	-19.931 (1.084)***	-10.986 (2.616)***	-12.758 (3.495)***
all goods	-5.352 (0.922)***	-5.545 (1.302)***	-5.889 (1.106)***

notes: * $p<0.1$; ** $p<0.05$; *** $p<0.01$. All regressions include source and destination fixed effects.

Second Stage Regressions – all services 1 of 2

Stage 2 PPML Regression, Aggregate Trade in Services

		no control	control	control & STRI margin	control & AVE margin	control & overhang	control, AVE & overhang
EUN	Intra-EU trade	0.381	0.390				
		(0.054)***	(0.127)***				
SDAT	Services agreement	-0.065	0.179	0.158	0.169	1.072	1.094
		(0.016)***	(0.073)**	(0.096)*	(0.093)*	(0.201)***	(0.218)***
lnDist	log distance	-0.134	-0.125	-0.141	-0.134	-0.124	-0.135
		(0.012)***	(0.018)***	(0.021)***	(0.016)***	(0.003)***	(0.008)***
lnDist2	log internal distance (home trade)	-0.048	-0.066	-0.063	-0.064	-0.081	-0.078
		(0.066)	(0.055)	(0.056)	(0.056)	(0.003)***	(0.004)***
POL	polity index	0.019	0.013	0.010	0.011	0.036	0.032
		(0.013)	(0.010)	(0.009)	(0.010)	(0.023)	(0.022)
lnHindex	Trade embeddedness index for 2013	2.863	2.875	2.861	2.865	3.454	3.429
		(0.034)***	(0.127)***	(0.133)***	(0.128)***	(0.055)***	(0.044)***
comcol	common colony	0.134	0.184	0.171	0.175	0.199	0.187
		(0.209)	(0.229)	(0.226)	(0.225)	(0.479)	(0.485)
comlang_ethr	common language ethnic	0.158	0.144	0.149	0.143	0.094	0.089
		(0.136)	(0.123)	(0.134)	(0.134)	(0.202)	(0.214)
comlang_off	common language official	0.407	0.404	0.403	0.411	0.308	0.317
		(0.131)***	(0.114)***	(0.120)***	(0.123)***	(0.265)	(0.276)
contig	common border	0.339	0.313	0.302	0.303	0.321	0.305
		(0.014)***	(0.026)***	(0.030)***	(0.030)***	(0.046)***	(0.055)***

notes: * p <0.1; ** p <0.05; *** p <0.01. All regressions include source and destination fixed effects.

Source: own estimates.

Second Stage Regressions – all services 2 of 2

		no control	control	control & STRI margin	control & AVE margin	control & overhang	control, AVE & overhang
colony	former colony	0.163	0.168	0.153	0.159	0.146	0.136
		(0.020)***	(0.027)***	(0.026)***	(0.033)***	(0.005)***	(0.006)***
home	dummy for home (domestic) trade	12.334	12.481	12.219	12.298	10.064	9.850
		(0.527)***	(0.365)***	(0.338)***	(0.402)***	(0.037)***	(0.049)***
homePCI	interaction of home and	-0.587	-0.593	-0.587	-0.588	-0.250	-0.246
	log per capita income	(0.001)***	(0.005)***	(0.004)***	(0.003)***	(0.044)***	(0.046)***
homePOL	interaction of home and	0.046	0.043	0.043	0.043	-0.188	-0.188
	composite polity index	(0.010)***	(0.011)***	(0.011)***	(0.011)***	(0.041)***	(0.040)***
homeEUN	home trade is with an EU Member State	-0.146	-0.057	-0.109	-0.080	-0.001	-0.024
		(0.096)	(0.154)	(0.149)	(0.132)	(0.090)	(0.083)
STRImargin	intra-EU vs extra-EU STRI margin			-2.076			
				(0.914)**			
AVEmargin	AVE margin for intra-EU vs extra-EU trade				-3.478		-3.182
					(0.997)***		(0.126)***
SDAT_hang1	Interaction of SDAT and STRI binding overhang					-2.587	-2.694
						(0.301)***	(0.344)***
	N	19,044	19,044	19,044	19,044	12,644	12,644
	Pseudo R-sqaured	1.000	1.000	1.000	1.000	1.000	1.000
	Chi2 for control function		13.9692	7.4739	9.4494	16.8279	14.9809
	Pr (Chi2)		0.0002	0.0063	0.0021	0	0.0001
	AIC	106.598	106.058	106.293	105.939	104.620	104.427
	BIC	1,764,186	1,753,885	1,758,348	1,751,618	1,148,744	1,146,308

-4.5 is a good guess for all services.

Source: own estimates.

Second Stage Regressions – detailed service sectors

Price elasticity estimates detailed service sectors

	AVE margin coefficient		price elasticity
water services	-8.035	(3.548)**	-9.035
construction 1/	-3.012	(1.219)**	-4.012
other transport	-0.624	(0.464)	-1.624
water transport	-2.459	(0.512)***	-3.459
air transport	-0.804	(0.302)***	-1.804
communications	-1.928	(3.236)	-2.928
finance	-18.751	(12.846)	-19.751
insurance	-1.924	(0.873)**	-2.924
business services	-0.412	(0.140)***	-1.412
consumer services	-7.856	(2.351)***	-8.856
public services	-5.907	(4.588)	-6.907

1/ weighted regression

* p <0.1; ** p <0.05; *** p <0.01. All regressions include source and destination fixed effects. specification is identical to aggregate services regressions.

Summary, future work

- We have developed price elasticities reflecting the underlying structure of (GTAP) model data, while controlling for endogeneity of PTAs and the effect of rules of origin and compliance costs on elasticity estimates.
- Once we allow for endogeneity of preference utilization in PTAs, there are clear effects from PTAs that we may miss when controlling only for the endogeneity of the PTA itself. Preference qualification (rules of origin compliance) costs certainly matter for experiment design.
- Ongoing STRI projects should yield clear benefits in the estimation of both parameters and likely costs linked to services trade.
- Concerns raised in the recent academic literature about error structures and influential observations (Head and Mayer 2014) merit worrying about.