International Trade and Unemployment: A Quantitative Framework

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Motivation

- One of the core issues in empirical international trade is the quantification of the welfare gains from trade liberalization.
- Welfare is typically measured by real income, given by the real wage bill of all employed workers, i.e., $e_j L_j w_j / P_j$.
- Hence, welfare changes induced by trade liberalization can be expressed as:

$$\hat{W}_j = \hat{e}_j \widehat{\left(\frac{w_j}{P_j} \right)}. \tag{1}$$

Motivation

- Workhorse model: gravity equation for trade flows (Eaton and Kortum 2002, Anderson and van Wincoop 2003, Anderson and Yotov 2010, Waugh 2010, Fieler 2011, Arkolakis, Costinot, and Rodríguez-Clare 2012).
- All frameworks in the literature so far assume perfect labor markets:

$$\hat{W}_j = \underbrace{\hat{e}_j}_{\overset{!}{=}1} \widehat{\left(\frac{w_j}{P_j}\right)}. \tag{2}$$

- But: Politicians care about (un)employment effects of trade liberalization.

Our contribution

- We estimate a simple structural gravity model which incorporates search frictions on the labor market.
- Our framework allows us to estimate welfare, price, **and employment** effects of trade liberalization taking into account general equilibrium (income) effects.
- Also: Evaluation of effects of labor market reforms on trading partners possible.
- Reproduces the stylized fact of a negative correlation of openness and unemployment.
- In addition, we present a method to estimate the elasticity of substitution and the matching elasticity, a measure of the extent of frictions on the labor market.

The gist of this paper

- Welfare effects are substantially magnified when allowing for imperfect labor markets.
- Preferential trade agreements between OECD countries increased welfare by 8.16% on average (as compared to 7.53% using the Anderson and van Wincoop 2003 methodology).
- Recent German labor market reforms (Hartz I-IV) increased welfare not only in Germany but also in all trading partner countries.
- Mechanism: Trade liberalization reduces aggregrate price level
  $\Rightarrow$ vacancy posting costs $\downarrow$.
  $\Rightarrow$ unemployment $\downarrow$ (as in Helpman, Itskhoki, 2010, Helpman, Iskthoki, Redding, 2010; Felbermayr, Prat, Schmerer 2011; Felbermayr, Larch, Lechthaler, 2013).

A simple model of gravity and unemployment

A simple model of gravity and unemployment: trade flows

Simplest possible framework for international trade: Armington (1969)

$$U_j = \left[\sum_{i=1}^{n} \beta_i^{\frac{1-\sigma}{\sigma}} c_{ij}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}. \tag{3}$$

The value of aggregate exports from i to j can then be expressed as

$$x_{ij} = p_i t_{ij} c_{ij} = \left(\frac{\beta_i p_i t_{ij}}{P_j} \right)^{1-\sigma} y_j. \tag{4}$$

In the appendix of our paper, we derive an observationally equivalent Ricardian-type framework of international trade à la Eaton and Kortum (2002) with unemployment.

Deriving the gravity equation

Solving the utility maximization problem and taking into account the market clearing condition (total exports = total imports) we can express bilateral trade flows as

$$x_{ij} = \frac{y_i y_j}{y^W} \left(\frac{t_{ij}}{\Pi_i P_j} \right)^{1-\sigma}, \tag{5}$$

where

$$\Pi_i \equiv \left(\sum_{j=1}^{n} \left(\frac{t_{ij}}{P_j} \right)^{1-\sigma} \theta_j \right)^{1/(1-\sigma)}, \quad P_j \equiv \left(\sum_{i=1}^{n} \left(\frac{t_{ij}}{\Pi_i} \right)^{1-\sigma} \theta_i \right)^{1/(1-\sigma)}. \tag{6}$$

The labor market

We assume that output y_i is produced by all employed workers:

$$y_i = p_i(1-u_i)L_i. \tag{7}$$

One-shot version of a Mortensen and Pissarides (1994) search and matching framework (see Rogerson et al. 2005), similar to Felbermayr, Larch, Lechthaler (2013):

$$u_j = 1 - m_j \vartheta_j^{1-\mu}. \tag{8}$$

Firms bargain with workers to split the match surplus.
w_j and u_j are determined by the job creation curve (JC) and wage curve (WC):

$$p_j = w_j + \frac{P_j c_j}{m_j \vartheta_j^{-\mu}} \quad \text{(JC)} \qquad w_j = \frac{\xi_j}{1+\gamma_j \xi_j - \gamma_j} p_j \quad \text{(WC)}. \tag{9}$$

Estimation

Estimating the gravity model

- Data: 28 OECD countries, 1950-2006, from Head et al. (2010).
- We estimate the following gravity model (OLS, Poisson):

$$z_{ij\tau} \equiv \frac{x_{ij\tau}}{y_{i\tau} y_{j\tau}} = \exp\left(k - (1-\sigma)\ln t_{ij\tau} - \ln \Pi_{i\tau}^{1-\sigma} - \ln P_{j\tau}^{1-\sigma} + \varepsilon_{ij\tau}\right),$$

where z_{ij} are normalized trade flows.

Trade costs are specified as

$$t_{ij\tau}^{1-\sigma} = \exp(\beta_1 PTA_{ij\tau} + \beta_2 \ln DIST_{ij} + \beta_3 CONTIG_{ij} + \beta_4 LANG_{ij}),$$

and control for $\Pi_{i\tau}$ and $P_{j\tau}$ using importer-time and exporter-time FEs.

▸ endogeneity of *PTA*

Estimating σ and μ

We can use the structure of our model to estimate the elasticity of substitution σ and the elasticity of the matching function μ.

We need data on

- unemployment rates (data on employment and labor force levels),
- replacement rates.

In addition, we assume that the bargaining power of the workers is 0.5 in all countries.

▸ more details

Results for gravity model OECD sample, 1950-2006

	(1) OLS $\ln z_{ij\tau}$	(2) PPML $z_{ij\tau}$	(3) OLS $\ln x_{ij\tau}$	(4) PPML $x_{ij\tau}$	(5) OLS $\ln z_{ij\tau}$	(6) PPML $z_{ij\tau}$	(7) OLS $\ln x_{ij\tau}$	(8) PPML $x_{ij\tau}$
Second stage								
$\ln DIST_{ij}$	-1.050***	-0.669***	-1.041***	-0.816***	-1.050***	-0.669***	-1.040***	-0.813***
	(0.009)	(0.027)	(0.010)	(0.010)	(0.009)	(0.027)	(0.010)	(0.010)
$CONTIG_{ij}$	0.097***	0.276***	0.116***	0.414***	0.097***	0.275***	0.115***	0.414***
	(0.019)	(0.030)	(0.019)	(0.018)	(0.019)	(0.030)	(0.019)	(0.018)
$COMLANG_{ij}$	0.386***	0.769***	0.387***	0.150***	0.386***	0.769***	0.387***	0.151***
	(0.019)	(0.049)	(0.019)	(0.017)	(0.019)	(0.049)	(0.019)	(0.017)
First stage								
$PTA_{ij\tau}$	0.274***	0.308***	0.267***	0.332***	0.274***	0.311***	0.276***	0.341***
	(0.016)	(0.019)	(0.017)	(0.019)	(0.014)	(0.016)	(0.015)	(0.013)
Estimated elasticities								
σ	2.349***	2.535***	2.349***	2.395***	2.349***	2.535***	2.350***	2.395***
	(0.303)	(0.051)	(0.024)	(0.728)	(0.352)	(0.195)	(0.255)	(0.476)
μ	0.946***	0.928***	0.947***	0.938***	0.946***	0.928***	0.947***	0.938***
	(0.003)	(0.007)	(0.001)	(0.009)	(0.005)	(0.007)	(0.003)	(0.008)
zero trade		X		X		X		X
symmetric $t_{ij\tau}$	X	X	X	X				
asymmetric $t_{ij\tau}$					X	X	X	X
N	36,945	37,741	37,493	38,313	36,945	37,741	37,493	38,313

Counterfactual analysis of trade liberalization

Counterfactual analysis of trade liberalization

- To evaluate the treatment effect of signing a *PTA*, one has to resolve the gravity price system using the estimated trading cost parameters in $\hat{t}_{ij}$ for the counterfactual scenario (no *PTA*s), taking into account the counterfactual change in GDPs.
- The theoretical structure then allows counterfactual calculation of changes in
  - GDP $\hat{y}_j$,
  - trade flows $\hat{x}_{ij}$,
  - welfare (EV_j, real GDP),
  - **and employment** $\hat{e}_j$.

Counterfactual analysis: welfare changes

- Welfare effects:

$$\hat{W}_j = \hat{e}_j \hat{\lambda}_{jj}^{\frac{1}{1-\sigma}},$$

  where $\hat{e}_j$ is the employment change, $\hat{\lambda}_{jj}$ the change in the share of domestic expenditures, and $1/(1-\sigma)$ the partial elasticity of imports with respect to variable trade costs.
- If $\mu = 1$: our model collapses into the Anderson and van Wincoop (2003) model where all changes in GDP are due to price changes.
- Then, $\hat{e}_j = 1$ and $\hat{W}_j = \hat{\lambda}_{jj}^{1/(1-\sigma)} \Rightarrow$ Arkolakis et al. (2012) equivalence holds.

Counterfactual analysis of PTA inception controlling for trade imbalances in 2006, selected countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	PLM	SMF	share %GDP SMF		SMF	SMF	PLM	SMF
	%GDP	%GDP	$\%\ln(\hat{p})$	$\%\ln(\hat{e})$	$\%\hat{e}$	Δu	%EV	%EV
Australia	16.45	17.40	92.75	7.25	1.17	-1.10	16.49	17.43
Austria	17.73	19.01	91.69	8.31	1.46	-1.37	20.59	22.12
Belgium	18.25	19.61	91.45	8.55	1.55	-1.40	21.92	23.57
Canada	20.70	22.16	90.60	9.40	1.90	-1.75	28.24	29.72
France	15.70	16.71	92.88	7.12	1.11	-1.00	15.22	16.43
Germany	15.27	16.22	93.31	6.69	1.01	-0.90	13.77	14.91
Greece	15.62	16.60	92.92	7.08	1.10	-0.99	15.10	16.24
Ireland	16.19	17.20	92.66	7.34	1.17	-1.11	16.35	17.49
Italy	15.22	16.15	93.27	6.73	1.01	-0.94	13.83	14.94
Japan	9.25	9.28	101.03	-1.03	-0.09	0.09	-1.24	-1.26
Spain	15.15	16.07	93.25	6.75	1.01	-0.92	13.86	14.93
Sweden	16.17	17.22	92.61	7.39	1.18	-1.09	16.39	17.62
Switzerland	18.50	19.89	91.31	8.69	1.59	-1.51	22.66	24.34
United Kingdom	13.61	14.31	94.49	5.51	0.74	-0.70	9.92	10.72
United States	9.92	10.08	99.63	0.37	0.04	-0.03	0.30	0.49
Average	12.73	13.28	96.59	3.41	0.55	-0.50	7.53	8.16

OECD sample, counterfactual analysis in percent of PTA inception controlling for trade imbalances

μ	σ	PLM %GDP	SMF %GDP	SMF %$\hat{e}$	SMF %Δu	PLM %EV	SMF %EV
0.2	5	4.81	16.68	11.91	-9.24	2.75	15.25
	10	2.13	7.11	5.00	-4.22	1.20	6.33
	15	1.37	4.51	3.16	-2.74	0.77	3.98
0.5	5	4.81	7.54	2.75	-2.41	2.75	5.67
	10	2.13	3.32	1.20	-1.08	1.20	2.44
	15	1.37	2.13	0.77	-0.70	0.77	1.55
0.75	5	4.81	5.69	0.90	-0.81	2.75	3.71
	10	2.13	2.52	0.40	-0.36	1.20	1.61
	15	1.37	1.62	0.25	-0.23	0.77	1.03
0.9	5	4.81	5.10	0.30	-0.27	2.75	3.07
	10	2.13	2.26	0.13	-0.12	1.20	1.34
	15	1.37	1.45	0.08	-0.08	0.77	0.85
0.99	5	4.81	4.83	0.03	-0.03	2.75	2.78
	10	2.13	2.14	0.01	-0.01	1.20	1.21
	15	1.37	1.37	0.01	-0.01	0.77	0.78

Conclusions

- We present the first structural gravity model which allows for imperfect labor markets.
- The additional richness of incorporating labor market frictions comes at minimal cost: it only requires an estimate of the elasticity of the matching function.
- We estimate all our parameters using information on trade flows, gravity variables, unemployment rates, work force data, and replacement rates.
- We evaluate preferential trade agreements, labor market reforms and border effects and find that welfare effects are substantially magnified as compared to the standard perfect labor markets structural gravity framework.

Thank you very much for your attention!

I am looking forward to your questions and the discussion.

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Backup material

Counterfactual analysis of trade liberalization and SUTVA

- How much does trade increase by the *PTA*'s observed in 2006?
- Why can't we simply interpret the regression coefficient on *PTA*?

Counterfactual analysis of trade liberalization and SUTVA

- How much does trade increase by the *PTA*'s observed in 2006?
- Why can't we simply interpret the regression coefficient on *PTA*?
- At best, β_{PTA} is an average treatment effect.
- Crucial assumption: Stable Unit Treatment Assumption (SUTVA)
  $\Rightarrow$ The treatment has to be small, no general equilibrium (income) effects!
- In a gravity model, SUTVA is violated. Why?

$$x_{ij} = x_{ij}(P_j, \Pi_i) \quad \text{where} \quad \Pi_i \equiv \Pi_i \left(\sum_{j=1}^{n} P_j \right), \quad P_j \equiv P_j \left(\sum_{i=1}^{n} \Pi_i \right).$$

  $\Rightarrow$ Anderson and van Wincoop (2003) rely on theoretical structure to solve for counterfactual (no *PTA*) P_j's and Π_i's to solve the SUTVA problem.

Endogeneity of *PTA*

- Countries do not randomly sign a *PTA* (see e.g. Baier and Bergstrand 2004, 2007, 2009) $\Rightarrow$ Endogeneity!
  $\Rightarrow$ We use the two-step methodology from Baier and Bergstrand (2007) and Anderson and Yotov (2011).
- First step: Estimate equation (10) using (directional) bilateral FEs, i.e.

$$z_{ij\tau} = \exp\left(k + \beta_1 PTA_{ij\tau} + \varphi_{i\tau} + \phi_{j\tau} + \nu_{ij} + \varepsilon_{ij\tau}\right). \tag{10}$$

- Second step: Re-estimate equation (10) to obtain estimates for the coefficients β_2 to β_4 using only exporter- and importer-time varying FEs and constrain the coefficient of *PTA*, β_1, to the estimate of the first step.

Estimating σ in the spirit of Bergstrand, Egger, Larch (2013)

Taking ratios of predicted trade flows $\hat{x}_{ij}$ and $\hat{x}_{mj}$, we end up with:

$$\frac{\hat{x}_{ij}}{\hat{x}_{mj}} = \frac{\widehat{t_{ij}^{1-\sigma}}}{\widehat{t_{mj}^{1-\sigma}}} \left(\frac{\beta_i(1-\gamma_i+\xi_i)y_i\xi_m(1-u_m)L_m}{\beta_m(1-\gamma_m+\xi_m)y_m\xi_i(1-u_i)L_i} \right)^{1-\sigma}. \tag{11}$$

Assuming that labor market parameters and β_j's are equal, we can solve for σ:

$$\sigma = 1 - \ln\left(\frac{\hat{x}_{ij}\widehat{t_{mj}^{1-\sigma}}}{\hat{x}_{mj}\widehat{t_{ij}^{1-\sigma}}} \right) / \ln\left(\frac{y_i(1-u_m)L_m}{y_m(1-u_i)L_i} \right). \tag{12}$$

Alternatively, when country-level data on replacement rates γ_j (and bargaining power ξ_j) are available, only β_j's have to be assumed to be equal.

Estimating μ

$$1 - u_j = \Xi_j \left(\frac{p_j}{P_j} \right)^{\frac{1-\mu}{\mu}} = \Xi \left(\frac{p_j}{P_j} \right)^{\frac{1-\mu}{\mu}}. \tag{13}$$

Assuming that labor market parameters and β's are equal, we can solve:

$$\mu = \frac{1}{1 + (1 - \hat{\sigma}) \ln \left(\frac{1-u_j}{1-u_m} \right) / \ln \left(\frac{\mathbb{t}_j}{\mathbb{t}_m} \frac{\sum_{i=1}^{n} \widehat{t_{im}^{1-\sigma}} \mathbb{t}_i}{\sum_{i=1}^{n} \widehat{t_{ij}^{1-\sigma}} \mathbb{t}_i} \right)}. \tag{14}$$

Alternatively, when country-level data on replacement rates γ_j (and bargaining power ξ_j) are available, only β_j's have to be assumed to be equal.

US-CAN sample, counterfactual analysis of erasing the US-CAN border for various parameter values

μ	σ	average %GDP			average %$\hat{e}$			average %EV		
		total	US	CAN	total	US	CAN	total	US	CAN
0.2	5	11.82	6.63	71.26	9.42	4.34	67.58	12.28	5.46	91.00
	10	4.73	2.27	33.14	3.79	1.52	30.01	4.84	1.90	38.91
	15	2.94	1.32	21.69	2.36	0.89	19.41	2.99	1.11	24.87
0.5	5	4.08	2.32	24.37	2.05	0.79	16.64	4.32	1.58	36.25
	10	1.73	0.90	11.39	0.88	0.31	7.53	1.81	0.62	15.68
	15	1.10	0.55	7.44	0.56	0.19	4.88	1.14	0.39	10.02
0.75	5	2.58	1.60	13.95	0.66	0.24	5.54	2.79	0.96	24.21
	10	1.11	0.65	6.51	0.29	0.10	2.52	1.19	0.39	10.48
	15	0.71	0.41	4.25	0.19	0.06	1.63	0.75	0.25	6.69
0.9	5	2.10	1.38	10.47	0.22	0.08	1.84	2.29	0.77	20.19
	10	0.91	0.57	4.88	0.10	0.03	0.84	0.98	0.32	8.74
	15	0.58	0.36	3.18	0.06	0.02	0.54	0.63	0.20	5.58
0.99	5	1.88	1.28	8.88	0.02	0.01	0.17	2.07	0.69	18.36
	10	0.82	0.54	4.13	0.01	0.00	0.08	0.89	0.29	7.95
	15	0.52	0.34	2.70	0.01	0.00	0.05	0.57	0.18	5.07