Export Performance and Trade Facilitation Reform: Hard and Soft Infrastructure

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The World Bank
Outline

1. Motivation
2. Constructing Indicators Using Factor Analysis
3. Estimates in an extended gravity model
4. Illustrative simulations
5. Final Remarks
1. Motivation: What is Trade Facilitation (TF)?

- No standard definition:
  - WTO: “Simplification and harmonization of international trade procedures”
  - OECD: “Simplification and standardization of procedures and associated information flows required to move goods internationally…”
    ~ Customs (or border) facilitation

- In a broader sense:
  Trade facilitation (TF) = any policy aimed at reducing trade costs → several dimensions.
1. Motivation: dimensions of trade facilitation (TF)

- “Hard” infrastructure vs. “soft” infrastructure (institut.)
  - Road – rail infrastructure
  - Ports infrastructure
  - Airports
  - Information technology
  - Customs environment
  - Transparency and corruption
  - Business environment

- A variety of indicators and sources: how to aggregate them?
  - Average (simple & weighted)
  - Principal Components
  - Factor Analysis

- Multicollinearity issues.
Previous work (1/2)
Extensive work on trade facilitation, a small sample:

  - 4 dimensions: port efficiency, customs env., regulatory environment, IT service
  - Average of primary indicators
  - Cross section, ASEAN/world

- Iwanow & Kirkpatrick (2009)
  - Trade facilitation, narrow sense
  - Average of primary indicators
  - Focus on Africa, 2003-04
Previous work (2/2)

- WB (2007): Logistics Performance Index
  - aggregate of 7 survey measures using PCA.
  - Good country coverage, but cross-section.

- Francois and Manchin (2009)
  - Infrastructure vs. Institutions,
  - 4 Aggregated indicators in panel using PCA
  - Interpretation of indicators is less straightforward
Motivation: Question

Question: What is the impact of TF on exports performance (intensive vs. extensive)?

What we do here:

- Construct 4 composite indicators from 20+ single indicators using factor analysis (FA): Physical Infrastructure, ICT, Border & Transport Effic, and Business Environm.
- Include them in a gravity model to estimate their impact on exports (volumes + prob to export), using a Heckman selection model a la Helpman, Melitz, Rubinstein (08).
- Simulations to obtain illustrative ad-valorem equivalents.
Factor Analysis (FA) in a nutshell…

- Factor analysis (FA): causal modeling technique “explaining” correlation among set of observed variables through linear combination of few unobserved (latent) random factors (Fs).

- Underlying model (one-factor F case):
  
  \[
  X_1 = \lambda_1 F + e_1 \\
  X_2 = \lambda_2 F + e_2 \\
  \vdots \\
  X_m = \lambda_m F + e_m
  \]

  ![Diagram showing factor analysis model](image)
2. Constructing Indicators using FA: Our Recipe…

- Ingredients:
  - 20+ primary indicators (WEF, DB, TI, WDI).
  - cover 101 countries over 2004-07.
  - two groups: hard vs soft or institutions.

- Two stages:
  1. Diagnostic FA ~ letting the variables to gather in sub-groups.
  2. Re-run FA procedure on sub-groups to estimate factors ~ TF-related indicators.
ii) Estimating the indicators

**ICT**
- Availability of latest ICT technology
- Level of technology absorption
- Extent of business internet use
- Government prioritization of ICT

**Border and Transport Efficiency**
- Number of documents to export
- Number of days to export
- Number of documents to import
- Number of days to import

**Physical Infrastructure**
- Quality of ports infrastructure
- Quality of railroad infrastructure
- Quality of airports infrastructure
- Quality of roads infrastructure
- Km of roads/(surface*pop)
- %paved roads

**Business Environment**
- Government transparency
- Public trust for government
- Irreg. payments in exports and imports
- Irreg. payments in public contracts
- Measures to combat corruption
TF Indicators for Developing Countries

(A) Border and Customs Efficiency 2007

(B) Business Environment 2007

(C) ICT 2007

(D) Infrastructure 2007
Temporal evolution of indicators

- **Base=1 in 2004.**
3. Estimates in an extended gravity model: Econometric strategy

- Augmented gravity: 2-stage Heckman selection model, corrections based on Helpman-Melitz & Rubinstein (HMR, 2008) attempting to deal with 2 potential bias:
  - Zero trade flows
  - Unobserved firm-level heterogeneity
- Deal with endogeneity, multilateral resistance.
- Different samples
- Robustness to other estimation methods
First stage: Selection equation

Average Tariff

Information and Communications Technology Indicator

Active Preferential Trade Agreement

Time and Importer dummies

Entry Costs

$\beta_0 + \phi_1 \ln(\text{Border}_\text{Transport}_\text{Efficit}_{it}) + \phi_2 \ln(\text{Business}_\text{Environment}_{it}) + \phi_3 \ln(\text{ICT}_{it}) + \phi_4 \ln(\text{Infrastructure}_{it}) + \beta_1 \ln(1 + t_{ij}) + \beta_2 \ln(\text{GDP}_{it}) + \beta_3 \ln(\text{Population}_{it}) + \beta_4 \ln(\text{Distance}_{ij}) + \beta_5 \text{RTA}_{ijt} + \beta_6 \text{Landlocked}_i + \beta_7 \text{Border}_i + \beta_8 \text{Common}_\text{Language}_{ij} + \beta_9 \text{Colonial}_\text{Relationship}_{ij} + \beta_{10} \text{Common}_\text{Colonizer}_{ij} + \tau_t + I_j + \delta_1 \text{Entry}_\text{Cost}_{ijt} + u_{ijt} > 0$

t = 2004-2007

i = Exporter

j = Importer
Second stage: Outcome equation

\[
\ln(X_{ijt}) = \beta_0 + \phi_1 \ln(\text{Border}_\text{Transport}_\text{Effic}_{it}) + \phi_2 \ln(\text{Business}_\text{Environment}_{it}) + \phi_3 \ln(\text{ICT}_{it}) + \\
\phi_4 \ln(\text{Infrastructure}_{it}) + \beta_1 \ln(1 + t_{ijt}) + \beta_2 \ln(\text{GDP}_{it}) + \beta_3 \ln(\text{Population}_{it}) + \beta_4 \ln(\text{Distance}_{ij}) + \beta_5 \text{RTA}_{ijt} + \\
\beta_6 \text{Landlocked}_{i} + \beta_7 \text{Border}_{ij} + \beta_8 \text{Common}_\text{Language}_{ij} + \beta_9 \text{Colonial}_\text{Relationship}_{ij} + . \\
\beta_{10} \text{Common}_\text{Colonizer}_{ij} + \alpha_1 (\text{Inv}_\text{Mills}) + \alpha_2 (\text{zeta}) + \alpha_3 (\text{zeta}_{sq}) + \tau_t + I_j + \varepsilon_{ijt}
\]

Terms addressing bias due to potential unobserved firm level heterogeneity (HMR)

Active Preferential Trade Agreement

Tariff

Information and Communications Technology Indicator

Time and Importer dummies

\[t = 2004-2007\]

\[i = \text{Exporter}\]

\[j = \text{Importer}\]
## Baseline Estimates

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Selection</th>
<th>Outcome</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln(Border_Transport_Effic_i)</td>
<td>0.071 [0.041]*</td>
<td>0.265 [0.025]***</td>
<td>-0.03 [0.041]</td>
</tr>
<tr>
<td>Ln(Business_Environment_i)</td>
<td>0.147 [0.030]***</td>
<td>-0.047 [0.030]</td>
<td>0.183 [0.031]***</td>
</tr>
<tr>
<td>Ln(ICT_i)</td>
<td>0.118 [0.036]***</td>
<td>0.066 [0.028]**</td>
<td>0.005 [0.036]</td>
</tr>
<tr>
<td>Ln(Infrastructure_i)</td>
<td>0.467 [0.045]***</td>
<td>0.196 [0.040]***</td>
<td>0.417 [0.046]***</td>
</tr>
<tr>
<td>Ln(1+Tariff_ij)</td>
<td>-1.462 [0.222]***</td>
<td>-0.352 [0.173]**</td>
<td>-1.509 [0.220]***</td>
</tr>
<tr>
<td>Ln(GDP_i)</td>
<td>1.078 [0.014]***</td>
<td>0.387 [0.015]***</td>
<td>1.011 [0.014]***</td>
</tr>
<tr>
<td>Ln(Population_i)</td>
<td>0.154 [0.014]***</td>
<td>0.096 [0.014]***</td>
<td>0.133 [0.015]***</td>
</tr>
<tr>
<td>Ln(Distance_ij)</td>
<td>-1.131 [0.018]***</td>
<td>-0.404 [0.025]***</td>
<td>-1.047 [0.018]***</td>
</tr>
<tr>
<td>RTA_ij</td>
<td>0.432 [0.037]***</td>
<td>1.046 [0.140]***</td>
<td>0.555 [0.037]***</td>
</tr>
<tr>
<td>Landlocked_i</td>
<td>-0.163 [0.034]***</td>
<td>-0.147 [0.031]***</td>
<td>-0.097 [0.035]***</td>
</tr>
<tr>
<td>Border</td>
<td>1.047 [0.073]***</td>
<td>-0.11 [0.216]</td>
<td>1.161 [0.068]***</td>
</tr>
<tr>
<td>Common_Language</td>
<td>0.597 [0.036]***</td>
<td>0.577 [0.047]***</td>
<td>0.443 [0.037]***</td>
</tr>
<tr>
<td>Colonial_Relationship</td>
<td>0.442 [0.060]***</td>
<td>-0.807 [0.229]***</td>
<td>0.567 [0.057]***</td>
</tr>
<tr>
<td>Common_Colonizer</td>
<td>0.962 [0.057]***</td>
<td>0.097 [0.049]**</td>
<td>0.921 [0.058]***</td>
</tr>
<tr>
<td>Entry_Cost_ij</td>
<td></td>
<td>-0.171 [0.052]***</td>
<td></td>
</tr>
<tr>
<td>Lag_positive_X_ij (=1[Xij(t-1)&gt;0])</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>40400</td>
<td>40400</td>
<td>40400</td>
</tr>
</tbody>
</table>

Robust standard errors clustered by country pairs in brackets
“Multilateral resistance”-correction terms for bilateral dummies and continuous variables.

Ex:

$$Border_{-MRT} = Border - \left[ \left( \sum_{k=1}^{N} \delta_k Border_{ik} \right) + \left( \sum_{m=1}^{N} \delta_m Border_{mj} \right) - \left( \sum_{k=1}^{N} \sum_{m=1}^{N} \delta_k \delta_m Border_{km} \right) \right]$$

where: $\delta_{i,t} = \frac{Y_{i,t}}{\sum_j Y_j}$

- Baier and Bergstrand (2008,JIE) correction for OLS.
- Behar et al (2009) extend the calculation of corrected terms to a two-stage Heckman procedure.
<table>
<thead>
<tr>
<th></th>
<th>ENTRY COST -MRT</th>
<th></th>
<th>INTERACTIONS WITH GDPpc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Outcome</td>
<td>Selection</td>
<td>Outcome</td>
</tr>
<tr>
<td>Ln(Border_Transport_Effic_i)</td>
<td>0.111 [0.042]***</td>
<td>0.226 [0.024]***</td>
<td>0.463 [0.314]</td>
</tr>
<tr>
<td>Ln(Business_Environment_i)</td>
<td>0.259 [0.032]***</td>
<td>0.004 [0.027]</td>
<td>0.344 [0.155]**</td>
</tr>
<tr>
<td>Ln(ICT_i)</td>
<td>-0.218 [0.038]***</td>
<td>0.04 [0.026]</td>
<td>-1.552 [0.200]***</td>
</tr>
<tr>
<td>Ln(Infrastructure_i)</td>
<td>0.651 [0.047]***</td>
<td>0.173 [0.037]***</td>
<td>1.313 [0.252]***</td>
</tr>
<tr>
<td>Ln(1+Tariff_ij)</td>
<td>-2.151 [0.236]***</td>
<td>-0.325 [0.163]**</td>
<td>-1.37 [0.223]***</td>
</tr>
<tr>
<td>Ln(GDP_i)</td>
<td>1.193 [0.015]***</td>
<td>0.324 [0.013]***</td>
<td>1.027 [0.018]***</td>
</tr>
<tr>
<td>Ln(Population_i)</td>
<td>0.098 [0.015]***</td>
<td>0.074 [0.014]***</td>
<td>0.11 [0.020]***</td>
</tr>
<tr>
<td>Ln(Distance_ij)</td>
<td>-0.024 [0.001]***</td>
<td>-0.022 [0.002]***</td>
<td>-1.064 [0.018]***</td>
</tr>
<tr>
<td>Ln(GDP_i) x Ln(ICT_i)</td>
<td></td>
<td></td>
<td>0.225 [0.027]***</td>
</tr>
<tr>
<td>Ln(GDP_i) x Ln(Infrastructure_i)</td>
<td></td>
<td></td>
<td>-0.13 [0.031]***</td>
</tr>
<tr>
<td>Ln(GDP_i) x Ln(Border_Transport_Effic_i)</td>
<td></td>
<td></td>
<td>-0.068 [0.042]</td>
</tr>
<tr>
<td>Ln(GDP_i) x Ln(Business_Environment_i)</td>
<td></td>
<td></td>
<td>-0.028 [0.022]</td>
</tr>
<tr>
<td>RTA_ij</td>
<td>0.98 [0.026]***</td>
<td>0.735 [0.059]***</td>
<td>0.49 [0.038]***</td>
</tr>
<tr>
<td>Landlocked_i</td>
<td>0.049 [0.036]</td>
<td>-0.165 [0.028]***</td>
<td>-0.121 [0.039]***</td>
</tr>
<tr>
<td>Border</td>
<td>2.311 [0.067]***</td>
<td>0.552 [0.138]***</td>
<td>1.095 [0.068]***</td>
</tr>
<tr>
<td>Common_Language</td>
<td>0.64 [0.035]***</td>
<td>0.64 [0.049]***</td>
<td>0.406 [0.038]***</td>
</tr>
<tr>
<td>Colonial_Relationship</td>
<td>-0.175 [0.047]***</td>
<td>-0.595 [0.129]***</td>
<td>0.554 [0.056]***</td>
</tr>
<tr>
<td>Common_Colonizer</td>
<td>1.327 [0.062]***</td>
<td>0.126 [0.047]***</td>
<td>0.963 [0.060]***</td>
</tr>
<tr>
<td>Entry_Cost_ij</td>
<td></td>
<td>-0.283 [0.046]***</td>
<td></td>
</tr>
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<td>40400</td>
<td>40400</td>
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</tr>
</tbody>
</table>
Marginal impact of TF Indicators as function of GDP per capita
Robustness: multicollinearity and endogeneity

- 2-stage procedure to isolate the “part” of indicators uncorrelated by GDPpc and Pop:
  1. Estimate:
     \[
     \ln(TF_{k, it}) = \beta_0 + \beta_1 \ln(GDP_{pc, it-1}) + \beta_2 \ln(Population_{i, it-1}) + \tilde{e}_{k, it}
     \]
     Use of lagged terms to reduce bias for reverse causality.
  2. Include residuals \( \tilde{e}_{k, it} \) as proxies for the indicators in extended gravity

- Instrument indicators with its lagged variables.
Robustness checks

- Dealing with endogeneity:
  - IV-type with residuals: (i) regress TF on lagged GDPpc and pop. (ii) estimated errors as IV for indicators (François and Manchin for infrastr)
  - 3 year lagged-TF
  - New goods

- Average values

- Sum of exporter & importer indicators

- Indicators as average of single components.
Robustness checks

- Different type-of estimation methods (OLS, Tobit, Eaton-Tamura Tobit, PPML)
- Different samples:
  - Fuels, Minerals (higher elasticity of physical infrastructure), Manufactures, textiles
  - South North vs North-South
4. Illustrative simulations

- Using baseline gravity estimates, we provide counterfactual estimates of gains.
  1. What is the impact on exports growth of improving indicators half the way to the level of the top performer in the region?
  2. What is the equivalent tariff cut that increase exports by the same amount?

\sim \text{ad-valorem equivalent}
5. Concluding Remarks

- Use of FA to construct TF-related indicators.
- Positive impact of indicators on export performance, specially infrastructure.
  - 2nd Global Aid For Trade review: 53% of 25.4 billion USD committed in 2007 related to infrastructure.
- Differentiated impact of TF-variables according to per capita income.
- Simulations show that there gains are big, comparable to gains of tariff cuts.