A Structural Quantitative Analysis of Services Trade De-liberalization

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Motivation

- Global trade in services amounted to more than 20 percent of total trade in 2015 (UNCTAD).

- The share of services value added embodied in gross exports in the manufacturing sector for OECD countries in 2011 amounted to 37% of total value added (TiVA, OECD).

- Yet, many quantitative open-economy models portray countries to produce manufacturing goods only (e.g. Costinot et al, 2012) or services to be non-tradable (e.g. Eaton and Kortum, 2002).

- We know much less about key parameters governing quantitative responses of the services sector than about those of manufacturing.
Contribution

- Outline a tractable multi-sector-multi country model for services and goods (a blend of Chaney, 2008; Arkolakis 2010; Caliendo and Parro, 2015).
- Estimate the underlying deep parameters of the model (elasticity of substitution; shape of productivity distribution; shape of market penetration cost function) based on German firm- and transaction-level data.
- Quantify overall trade costs (variable plus fixed) and decompose them into observable (e.g. STA membership) and unobservable components based on WIOD.
- Calibrate the model based on WIOD and analyze forms of shut-down in preferential trade-agreement membership for individual and all countries jointly.
Data

- World Input-Output Database (WIOD)
- Transaction- and Firm-level data compiled by the Deutsche Bundesbank (SITS: Statistics on International Trade in Services; Ustan: Data on firms’ financial statement)
- We consider individually 43 country destinations (28 EU countries and 15 other major economies) plus one rest of the world
- We group individual services into five broad categories
  1. Transport Services
  2. Construction Services
  3. ICT Services
  4. Other Business Services
  5. Other Services
- We treat manufacturing and other (non-service) sectors as one block each
## Descriptives (SITS dataset)

### German Service Exporters in 2014

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>1st</th>
<th>25th</th>
<th>50th</th>
<th>75th</th>
<th>99th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total exports</td>
<td>14,184</td>
<td>2</td>
<td>100</td>
<td>527</td>
<td>2,677</td>
<td>165,908</td>
</tr>
<tr>
<td>Exports per service-market</td>
<td>1,251</td>
<td>2</td>
<td>50</td>
<td>166</td>
<td>563</td>
<td>16,569</td>
</tr>
<tr>
<td>Number of service categories</td>
<td>1.34</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Number of markets</td>
<td>5.70</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>45</td>
</tr>
</tbody>
</table>

*Note: 126,314 observations (firm-service category-country triplets). Exports reported in thousand €.*

- **Substantial firm-level heterogeneity**
- **Right-tailed distribution of service producers’ export activity is similar to the one documented for exporters of manufactures in different datasets (e.g. Eaton et al., 2011)**
Exporter heterogeneity across markets and sectors

- Right-skewness of the distribution of service producers' export activity prevails across all destinations and types of service
- The degree of heterogeneity differs across destinations and service type
Firms’ sales distribution

Note: Each dot corresponds to the mean of three adjacent firms.

▸ If sales were distributed Pareto, log sales plotted against log rank should appear as a straight line.

▸ We find substantial deviations from a linear relationship across service-country pairs.
Theoretical framework

We model German services trade along the lines of meanwhile workhorse models of international trade:

▶ As in Melitz (2003), we assume that firms
  ▶ produce a specific variety and monopolistically compete in a Dixit-Stiglitz framework,
  ▶ are heterogeneous with respect to their productivity.
▶ As in Chaney (2008) firms’ efficiency is Pareto distributed.
▶ As in Arkolakis (2010) and Eaton, Kortum, Kramarz (2011) not all consumers in a market are reached due to market penetration costs.
▶ As in Caliendo and Parro (2015) sectors are linked by an observable input-output structure.
Theoretical framework (cont’d)

Following Arkolakis (2010), we assume that firm $v$ in country $i$ offering a variety of sector $s$-output in market $j$ must incur a cost

$$f^s_{ij}(v) = f^s_{ij} \left[ 1 - \left( 1 - n^s_{ij}(v) \right) \right]^{1-1/\lambda_j^s} \cdot 1 - 1/\lambda_j^s,$$

with

- a component of fixed costs common to all firms in country $i$ trading a variety of sector $s$ in market $j$, $f^s_{ij} > 0$
- the fraction of customers reached by firm $v$, $n^s_{ij}(v) \in [0, 1]$
- the shape parameter of market penetration costs, $\lambda_j^s > 0$
  - which implies $\partial f^s_{ij}(v)/\partial n^s_{ij}(v) > 0$, and
  - nests the fixed cost specification as in Melitz (2003) as $\lambda_j^s \to \infty$
Theoretical framework (cont’d)

Sales of firm $v$ offering service $s$ in market $j$ are then given by

$$x_{ij}^s(v) = n_{ij}^s(v) \left( \frac{p_{ij}^s(v)}{P_j^s} \right)^{1-\sigma^s} E_j^s, \text{ with } \sigma^s > 1.$$  

The optimal pricing decision of firm $v$ with efficiency $\phi(v)$ in country $i$ paying input costs $c_i^s$ and facing an iceberg-type trade cost $\tau_{ij}^s \geq 1$ is given by

$$p_{ij}^s(v) = \frac{\sigma^s}{\sigma^s - 1} \frac{\tau_{ij}^s c_i^s}{\phi(v)}.$$

Firm-specific optimal degree of market penetration

$$n_{ij}^s(v) = 1 - \left[ \frac{\phi_{ij}^s}{\phi(v)} \right]^{(\sigma^s - 1) \lambda_j^s}.$$
Theoretical framework (cont’d)

- Firms in country \( i \) draw their efficiency level from a Pareto distribution with support \([b_i^s, +\infty)\) and shape parameter \( k_j^s > \sigma^s - 1\).

- The probability that a firm \( v \) with productivity \( \phi(v) \) is active in providing a variety of sector \( s \) out of country \( i \) to market \( j \) is given by

\[
1 - \Pr[\phi(v) < \phi_{ij}^s] = \left( \frac{b_i^s}{\phi_{ij}^s} \right)^{k_j^s}.
\]

- With Pareto-distributed firms’ efficiencies, average sales per selling firm can be written as

\[
\bar{x}_{ij}^s = \sigma^s c_i^s f_{ij}^s \Theta_j^s,
\]

with \( \Theta_j^s = \frac{\theta_j^s \lambda_j^s}{(1-\theta_j^s)[1-\theta_j^s(1-\lambda_j^s)]} \) and \( \theta_j^s = \frac{\sigma^s-1}{k_j^s} \).

- Average sales of firms whose efficiency is greater than \( \phi(v) \) over average sales is given by

\[
\frac{\bar{x}_{ij}^s(v)}{\bar{x}_{ij}^s} = \left( \frac{\phi_{ij}^s}{\phi(v)} \right)^{-(\sigma^s-1)} \left\{ \frac{1 - \theta_j^s}{\theta_j^s \lambda_j^s} \left[ 1 - \left( \frac{\phi_{ij}^s}{\phi(v)} \right)^{(\sigma^s-1)\lambda_j^s} \right] + 1 \right\}.
\]
Elasticity of substitution, $\sigma^s$

- Firm $v$’s operating profits from rendering sector-$s$ output in market $j$ is given by a constant fraction of its respective sales, i.e. $x_{ij}^s(v)/\sigma^s$.

- Using information on firms’ profit and loss accounts, we measure $\sigma^s$ as the sum of firms’ sales belonging to sector $s$ over all destination markets divided by the sum of their corresponding operating profits.

<table>
<thead>
<tr>
<th>Sector</th>
<th>$\hat{\sigma}^s$</th>
<th>Obs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>5.164 (0.418)</td>
<td>179</td>
</tr>
<tr>
<td>Construction Services</td>
<td>5.997 (0.280)</td>
<td>675</td>
</tr>
<tr>
<td>ICT Services</td>
<td>3.915 (0.244)</td>
<td>282</td>
</tr>
<tr>
<td>Other Business Services</td>
<td>4.512 (0.219)</td>
<td>590</td>
</tr>
<tr>
<td>Other Services</td>
<td>3.273 (0.078)</td>
<td>3836</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>4.855 (0.036)</td>
<td>6934</td>
</tr>
<tr>
<td>Other Sectors</td>
<td>7.647 (0.102)</td>
<td>7558</td>
</tr>
</tbody>
</table>

Note: Bootstrapped standard errors are in parentheses.
Market penetration cost (\(\lambda^s_j\)) and productivity distribution (\(\hat{k}^s_j\)) parameters

- A lower value of \(\lambda^s_j\) means that relatively fewer customers are reached.
- A smaller value of \(\hat{k}^s_j\) means that the density of small productivity levels of firms is relatively low compared to high productivity levels.
Data vs. model

![Graph showing sales over mean sales in logs vs. quantile, with data and model curves.]

Note: Due to the confidential nature of the data, each dot corresponds to the mean of three adjacent firms.
Data vs. model (cont’d)

Note: Due to the confidential nature of the data, each dot corresponds to the mean of three adjacent firms.
When bringing the model to general equilibrium, we acknowledge the importance of services in the value added of modern economies.

We follow Caliendo and Parro (2015) in implementing this input-output structure:

- In each country $i$ and sector $s$ there is a unit measure of perfectly competitive firms which bundle a composite good that is a CES-basket of individual varieties belonging to sector $s$ from $J$ countries.
- Firms combine labour and intermediate inputs of each sector $s$ using a Cobb-Douglas technology.
- Labour is immobile across sectors.

We solve the model in changes as in Dekle, Eaton and Kortum (2008).
Counterfactual analysis

➢ To assess the quantitative consequences of associated reductions in fixed and ad valorem trade costs, we shut down preferential trade-agreement membership for selected countries.

➢ It turns out that changes in the fixed component of market entry and variable trade costs in general equilibrium affect aggregate outcomes as

\[ \zeta_{ij}^s = \left( \tau_{ij}^s \right)^{-k_j^s} \left( f_{ij}^s \right)^{1 - \frac{1}{\theta_j^s}}. \]

➢ The market share of country \( i \) exporting varieties of sector \( s \) to country \( j \) is given by

\[ \mu_{ij}^s = \frac{X_{ij}^s}{E_j^s} = \frac{X_{ij}^s}{\sum_{l=1}^J X_{lj}^s} = \frac{\mathcal{M}_i \left( b_i^s \right)^{k_j^s} \left( c_i^s \right)^{1 - \frac{1}{\theta_j^s} - k_j^s} \zeta_{ij}^s}{\sum_{l=1}^J \mathcal{M}_l \left( b_l^s \right)^{k_j^s} \left( c_l^s \right)^{1 - \frac{1}{\theta_j^s} - k_j^s} \zeta_{lj}^s}. \]

➢ We can solve for \( \zeta_{ij}^s \) as the residual from the regression of \( \ln \mu_{ij}^s \) on \( i \)- and \( sj \)-specific fixed effects as well as our estimates for \( k_j^s \) and \( \theta_j^s \).
Counterfactual analysis

- We exploit variation in $\hat{\zeta}_{ij}^s$ to investigate the role of major factors of influence behind services trade costs, such as geography or services trade policy.

- We run the following regression

$$\ln(\hat{\zeta}_{ij}^s) = Z_{ij} \beta_{s,Z} + u_{ij}^{s,Z},$$

where $Z_{ij}$ contains observable components of trade costs as well as a dummy for membership in preferential trade agreements and $u_{ij}^{s,Z}$ measures all unobservable components of $\hat{\zeta}_{ij}^s$.

- We then shut down preferential trade-agreement membership for selected countries and assess the change in $\hat{\zeta}_{ij}^s$ and its general equilibrium effects.
Impact of service trade agreements on $\hat{\zeta}_{ij}^s$

As $\hat{\zeta}_{ij}^s$ is inversely related to obstacles to cross-border trade, we would expect the coefficient on a dummy for membership in preferential trade agreements to be positive.

<table>
<thead>
<tr>
<th>Sector</th>
<th>$\hat{\beta}_{s,STA}$</th>
<th>Decrease in $\hat{\zeta}_{ij}^s$</th>
<th>Distance Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>0.311 (0.033)</td>
<td>-26.716</td>
<td>477.140</td>
</tr>
<tr>
<td>Construction Services</td>
<td>0.204 (0.022)</td>
<td>-18.484</td>
<td>374.339</td>
</tr>
<tr>
<td>ICT Services</td>
<td>0.343 (0.039)</td>
<td>-29.062</td>
<td>520.841</td>
</tr>
<tr>
<td>Other Business Services</td>
<td>0.338 (0.021)</td>
<td>-28.675</td>
<td>534.635</td>
</tr>
<tr>
<td>Other Services</td>
<td>0.219 (0.043)</td>
<td>-19.694</td>
<td>398.157</td>
</tr>
</tbody>
</table>

*Note: Bootstrapped standard errors in parentheses.*
Counterfactual analysis

The welfare loss due to removing preferential market access for services for each individual country is measured as the percentage change in real consumption.

<table>
<thead>
<tr>
<th>Country</th>
<th>Change in Welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Individual removal of STAs</td>
</tr>
<tr>
<td>Austria</td>
<td>-0.482</td>
</tr>
<tr>
<td>Belgium</td>
<td>-0.875</td>
</tr>
<tr>
<td>Canada</td>
<td>-0.114</td>
</tr>
<tr>
<td>France</td>
<td>-0.243</td>
</tr>
<tr>
<td>Germany</td>
<td>-0.281</td>
</tr>
<tr>
<td>Netherlands</td>
<td>-0.699</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>-0.330</td>
</tr>
<tr>
<td>United States of America</td>
<td>-0.018</td>
</tr>
</tbody>
</table>
## Counterfactual analysis – UK

<table>
<thead>
<tr>
<th>Change in</th>
<th>Impact on the United Kingdom</th>
<th>Impact on Other Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min</td>
<td>p10</td>
</tr>
<tr>
<td>Real Consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Sectors</td>
<td>-0.330</td>
<td>-3.143</td>
</tr>
</tbody>
</table>

| Real Wages |     |     |     |     |     |
| Transport | -0.262 | -2.251 | -0.470 | -0.075 | 0.006 |
| Construction | -0.150 | -1.648 | -0.142 | -0.031 | 0.001 |
| ICT Services | -0.806 | -3.296 | -0.300 | -0.059 | 0.004 |
| Other Busi. Serv. | -0.929 | -2.330 | -0.241 | -0.062 | 0.005 |
| Other Services | -0.384 | -4.087 | -0.151 | -0.034 | 0.001 |
| Manufacturing | -0.085 | -0.924 | -0.076 | -0.015 | -0.001 |
| Other Sectors | -0.122 | -1.422 | -0.071 | -0.013 | -0.001 |

| Real Dividends |     |     |     |     |     |
| Transport | -0.632 | -1.954 | -0.373 | -0.033 | 0.004 |
| Construction | -0.150 | -1.630 | -0.170 | -0.028 | 0.001 |
| ICT Services | -0.500 | -3.404 | -0.470 | -0.110 | 0.007 |
| Other Busi. Serv. | -0.661 | -2.459 | -0.426 | -0.100 | 0.005 |
| Other Services | -0.337 | -5.050 | -0.276 | -0.039 | 0.002 |
| Manufacturing | -0.083 | -0.910 | -0.076 | -0.015 | -0.001 |
| Other Sectors | -0.121 | -1.419 | -0.070 | -0.013 | -0.001 |
Conclusion

- Abandoning STA membership reduces real consumption
  - Smaller and less remote countries suffer bigger losses
  - Non-trivial detrimental spillover effects to manufacturing through Input-output relationships
  - Effect on partner countries and third countries may be larger than for STA-abandoning economies
- Effects should be understood as a lower bound as preferential service provisions rarely come in isolation and are often tied to goods-market provisions
APPENDIX
Data sources

- Firm-level data compiled by the Deutsche Bundesbank (Cross-section for 2014)
  1. Statistics on International Trade in Services (SITS)
     - Transaction-level data on population of German service exporters (reporting threshold 12,500 €)
     - 18,646 firms, 228 foreign destinations, 133 types of services
  2. Data on firms’ financial statement (Ustan)
     - Domestic sales, operating profits, and total exports of German firms
     - 6,961 firms in Services sectors, 7,903 in manufacturing, and 8,431 in other (non-services) sectors

- World-Input-Output-Database (WIOD, 2016 vintage)
- World Trade Organization’s RTA database (services trade agreements)
- CEPII database (trade barriers)
Pattern of entry differs across service category

- Set of top-6 destinations and their rank vary across service types
- True both in terms of share of total exports by service or by destination and in terms of number of firms exporting to a destination.
Estimating the fundamental parameters $\sigma^s, \lambda_j^s$ and $k_j^s$

1. Estimation of $\sigma^s$
   - Exploiting information on firm sales and operating profits

2. Estimation of $\lambda_j^s$ and $k_j^s$
   - The probability that a firm has higher efficiency than $\phi(v)$ can be written as $1 - \Pr_{i,j}^s(v) = \left(\frac{\phi^s_{i,j} \cdot \theta_k}{\phi(v)}\right)^{k_j^s} = \frac{\text{rank}^s_{i,j}(v)}{M^s_{i,j}}$
   - Using $\hat{\sigma}^s$, firms' sales percentile $\Pr_{i,j}^s(v)$, and a guess about $\theta_j^s \lambda_j^s$, compute the fraction of buyers reached $n_{i,j}^s(v)$ and the cumulative average of sales per fraction of buyers reached, $\tilde{x}_{i,j}^s(v)$
   - For each $\{s,j\}$, regress $\ln \tilde{x}_{i,j}^s(v)$ on a constant and on $\ln \left[1 - \Pr_{i,j}^s(v)\right]$, where the estimated parameter on the latter is $\hat{\theta}_j^s$
   - Using the obtained $\hat{\theta}_j^s$ and an expression for average sales we can estimate $\theta_j^s \lambda_j^s$, and iterate until convergence
Distribution of $\ln \hat{\zeta}_{i,j}^s$, by Sector

- **Transport Services**: Std. Dev.: 1.909
- **Construction Services**: Std. Dev.: 2.150
- **ICT Services**: Std. Dev.: 1.832
- **Other Business Services**: Std. Dev.: 1.953
- **Other Services**: Std. Dev.: 1.794
Definition of services trade and modes of supply (GATS)

Mode 1: Cross-border trade
- service suppliers resident in one country provide services in another country (without producer or consumer moving)
- consultancy, distance training, architectural drawings (delivered through telecom. or postal network)

Mode 2: Consumption abroad
- consumer moves to the location of the supplier to consume the service
- tourists, international students, patients

Mode 3: Commercial presence
- firms move to the location of the consumer to sell services locally through a foreign affiliate or branch
- foreign-owned and controlled bank, hotel group, construction company, etc.

Mode 4: Presence of natural persons
- individuals (temporary) move to the country of the consumer to provide the service
- foreign national providing services as an independent supplier or employee of a foreign company