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How Do Service Automation and National ICT Development Affect International Trade in Services?

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Research Motivation

- Advances in automation technologies
 - AI, big data, IoT, Cloud, robotics
 - Automation of services (e.g., RPA)
- Prior studies focus on
 - Manufacturing sector
 - Job displacement (Frey & Osborne; OECD)
 - Survey data, expert opinions
- Knowledge gaps
 - Impact on service sector?
 - Impact on international trade?
 - Economic data

Research Questions

- Does service automation reduce international trade in services?
- How do service automation and national ICT development interact in affecting international trade in services?

Data

- **U.N. Comtrade data**
 - 2007-2017 trade data for 236 countries in 62 industries
- **Occupational Information Network (O*NET) database**
 - degree of automatability in each service industry
- **ITU's ICT Development Index (IDI)**
 - level of a country's ICT development (infra, use, skills)
- **World Bank Open Data**
 - control variables (population, GDP, unemployment rate)

Regression Model 1

- $Y = \beta_E \text{Exporter ICT} + \beta_I \text{Importer ICT} + \beta_{YH} \text{Year} \times \text{HighAuto} + \beta_{YL} \text{Year} \times \text{LowAuto} + X\beta_X + \varepsilon$
 - Y : log-transformed volume of services trade in USD
 - *Exporter (Importer) ICT: the IDI of the exporting (importing) country*
 - *Year: year ranging from 7 to 17 (7 for 2007 and 17 for 2017)*
 - *HighAuto =1 and LowAuto =0 for highly automatable service industries (financial services, information services, professional services)*
 - *HighAuto =0 and LowAuto =1 for less automatable service industries*
 - X : a covariate matrix for control variables
 - ε is a random error term

Control Variables

Variables	Definitions
Exporter Population	Log(population)
Exporter GDP	GDP per capita (US \$1,000)
Exporter Service Ind.	% of service sector GDP to total GDP
Exporter FDI	Net foreign direct investments per capita (US \$1,000)
Exporter R&D	% of R&D investments to total GDP
Exporter Education	% of government education spending to total GDP
Exporter Service Emp.	% of employment in the service sector
Exporter Unemployment	Unemployment rates (%)
Importer Population	Log(population)
Importer GDP	GDP per capita (US \$1,000)
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Importer R&D	% of R&D investments to total GDP
Importer Education	% of government education spending to total GDP
Importer Service Emp.	% of employment in the service sector
Importer Unemployment	Unemployment rates (%)
Good Trades	<u>Log</u> (total good trade values between the same exporter and importer in the same year in US\$)

Regression Model 2

- $Y = \beta_E \text{ Exporter ICT} + \beta_I \text{ Importer ICT} + \beta_{YE} \text{ Year} \times \text{High ICT Exporter} + \beta_{YI} \text{ Year} \times \text{High ICT Importer} + X\beta_X + \varepsilon$
 - *High ICT Exporter = 1 if the IDI of the exporting country is greater than the median of the IDI of all countries in a given year*
 - *High ICT Importer = 1 if the IDI of the importing country is greater than the median of the IDI of all countries in a given year*

Regression Model 3

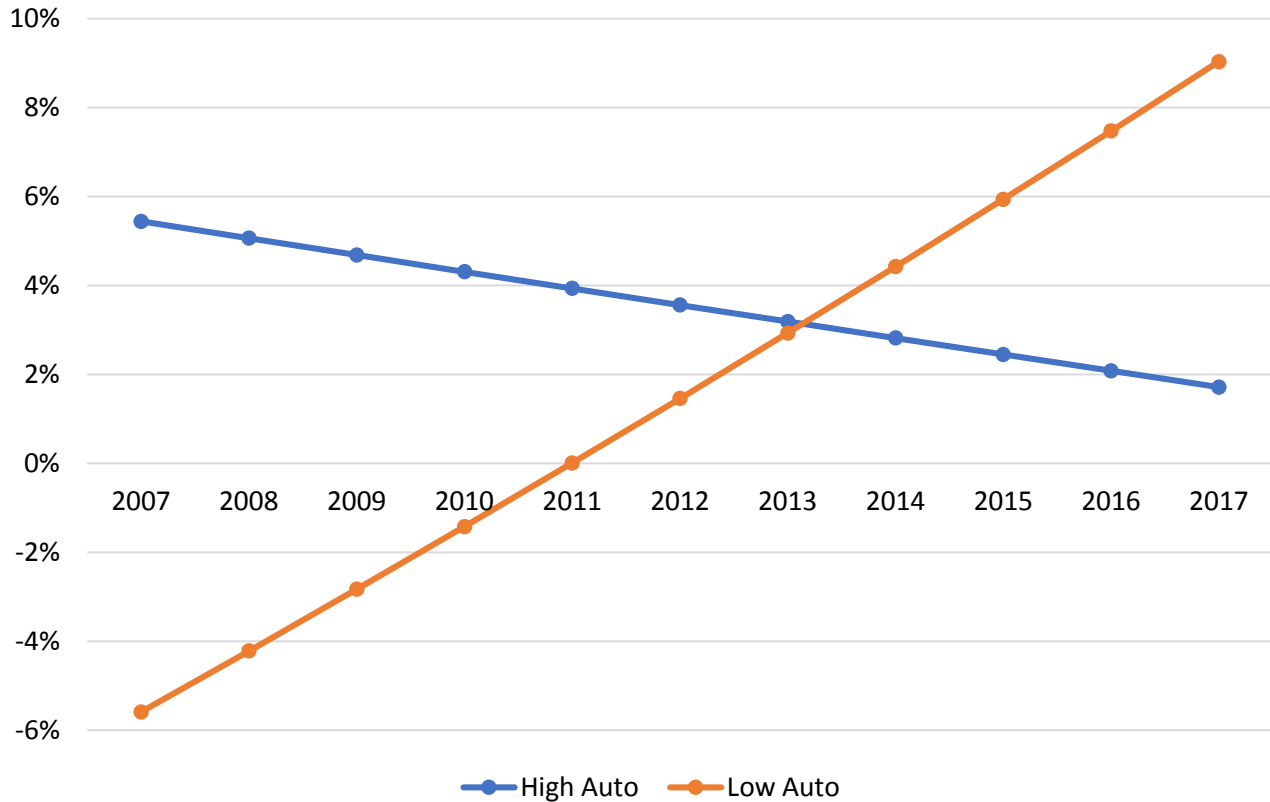
- $$Y = \beta_E \text{Exporter ICT} + \beta_I \text{Importer ICT} + \beta_{YH} \text{Year} \times \text{HighAuto} + \beta_{YL} \text{Year} \times \text{LowAuto} + \beta_{YHE} \text{Year} \times \text{HighAuto} \times \text{High ICT Exporter} + \beta_{YHI} \text{Year} \times \text{HighAuto} \times \text{High ICT Importer} + X\beta_X + \varepsilon$$

Results: Model 1

Dependent Variables	Trades in Service		
	(1)	(2)	(3)
Exporter ICT	0.0213** (0.0109)	0.0270** (0.0109)	0.0415*** (0.0113)
Importer ICT	-0.1214*** (0.0133)	-0.1135*** (0.0133)	-0.0996*** (0.0138)
Year	0.0316*** (0.0037)		
Year × High Auto		0.0462*** (0.0038)	0.0782*** (0.0166)
Year ² × High Auto			-0.0018*** (0.0006)
Year × Low Auto		0.0104*** (0.0038)	-0.1583*** (0.0165)
Year ² × Low Auto			0.0072*** (0.0006)
Exporter FE	YES	YES	YES
Importer FE	YES	YES	YES
Industry FE	YES	YES	YES
Observations	328,062	328,062	328,062
R^2	0.8883	0.8885	0.8886
Adjusted R^2	0.859	0.860	0.860
F	70.22***	86.14***	87.40***
Root MSE	1.155	1.154	1.153

Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Growth Rate in Trade in Highly Automatable and Less Automatable Service Industries



Results: Model 2

Dependent Variables	Trades in Service		
	(1)	(2)	(3)
Trade in Goods	0.0641*** (0.0070)	0.0642*** (0.0070)	0.0639*** (0.0070)
Exporter ICT	0.0147 (0.0108)	0.0203* (0.0108)	0.0133 (0.0108)
Importer ICT	-0.1189*** (0.0133)	-0.1189*** (0.0131)	-0.1159*** (0.0131)
Year	0.0212*** (0.0040)	0.0356*** (0.0041)	0.0256*** (0.0044)
Year × High ICT Exporter	0.0073*** (0.0010)		0.0075*** (0.0010)
Year × High ICT Importer		-0.0028*** (0.0010)	-0.0033*** (0.0010)
Exporter FE	YES	YES	YES
Importer FE	YES	YES	YES
Industry FE	YES	YES	YES
Observations	328,062	328,062	328,062
R^2	0.8883	0.8883	0.8883
Adjusted R^2	0.859	0.859	0.859
F	68.60***	66.98***	65.63***
Root MSE	1.154	1.155	1.154

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Control variables are omitted for brevity.

Results: Model 3

Dependent Variables	Trades in Service		
	(1)	(2)	(3)
Trade in Goods	0.0642*** (0.0070)	0.0642*** (0.0070)	0.0640*** (0.0070)
Exporter ICT	0.0247** (0.0108)	0.0260** (0.0109)	0.0236** (0.0108)
Importer ICT	-0.1125*** (0.0133)	-0.1116*** (0.0132)	-0.1104*** (0.0132)
Year × High Auto	0.0384*** (0.0043)	0.0533*** (0.0044)	0.0456*** (0.0047)
Year × High Auto × High ICT Exporter	0.0056*** (0.0014)		0.0059*** (0.0014)
Year × High Auto × High ICT Importer		-0.0051*** (0.0014)	-0.0054*** (0.0014)
Year × Low Auto	0.0102*** (0.0038)	0.0105*** (0.0038)	0.0104*** (0.0038)
Exporter FE	YES	YES	YES
Importer FE	YES	YES	YES
Industry FE	YES	YES	YES
Observations	328,062	328,062	328,062
R^2	0.8885	0.8885	0.8885
Adjusted R^2	0.860	0.860	0.860
F	82.52***	83.60***	80.25***
Root MSE	1.154	1.154	1.154

Summary of Findings

- The marginal year-by-year growth rates of trade in highly automatable services decreased in 2007-2017, whereas those of trade in less automatable services have increased
- The level of ICT development in the exporting country is positively associated with the volume of its service exports
- The level of ICT development in the importing country is negatively associated with the volume of its service imports

Summary of Findings

- Countries with advanced ICT development demonstrate a higher growth rate of service exports than other countries
- Countries with advanced ICT development demonstrate a lower growth rate of service imports than other countries
- The growth rate of trade in highly automatable services is lower for importing countries with advanced ICT development
- The growth rate of trade in highly automatable services is higher for exporting countries with advanced ICT development

Policy Recommendations

- Workforce reskilling and retraining for less automatable jobs
- Educating future workforce for high-demand skills and knowledge
- Matching employees and employers through digital platforms
- Providing transition support
- Creating jobs by promoting entrepreneurship and innovation
- Restructuring domestic service industries to the next level
- Investing in new network infrastructure
- Facilitating public-private partnership

Policy Recommendations for APEC

- Develop regional strategies for APEC member economies
- Create APEC joint research programs
- Develop an APEC online education platform for reskilling and retraining
- Create regional certifications for digital skills
- Develop a regional center of excellence for innovation and entrepreneurship
- Create an APEC working group to facilitate policy dialogue and cooperation