The impact of international trade and foreign investment on a nation's domestic innovation

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Introduction

This project is an empirical investigation of the role of international trade in determining the rate of innovation in leading innovative and emerging innovative countries. Previous research reveals strong and positive relation between trade and innovation rates. This project focuses on (1) measuring the impact of imports of high-technology goods and the impact of foreign direct investment(FDI) as well as (2) finding out their heterogenous effects on leading innovative and emerging innovative countries. A panel data of 20 countries from 2000 to 2016 is used and they are mainly compiled from sources including World Intellectual Property Organization(WIPO), World Development Indicators(WDI), The Organization for Economic Co-operation and Development Indicators(OECD).

Methods

(i) Panel vs time series

Number of observations is relatively large and the time period is short; autocorrelation can arise; more focus on individual components; panel preferred

(ii) Fixed effect vs random effect

Highly possible to exist unobservable variables that affected innovation level systematically differently across countries in the panel data. Even if there are control variables, still difficult to avoid omitted variables bias. Fixed effects method would solve part of the problem here however it gives away much variation in the data. If enough relevant control variables included and the omitted variables bias is believed to not exist, random effect approach is better in terms of yielding smaller standard errors.

(iii) Control variables selection

Principal Component Analysis and randomized decision trees applied. Potential control variables include percentage of urban population, national labor force composition and etc.

Current Results

- Out of eight potential control variables, the urban population percentage revealed high feature importance combining the result of PCA and randomized decision.
- FE and RE methods are both tested in the model (including the urban population control variable) on two samples of leading and emerging innovative countries as well as on all countries
- For all samples, the results of FE and RE methods are quite similar, with an overall R-squared being about 0.4 and joint F-statistic very significant. When applied to all countries, only FDI are significant at a 5% α level among all variables.
- When the model are applied to leading or emerging country samples, GDP, education expenditure, scientific journals and articles become significant at 5% level.

Model

(i) Model in closed economy by Furman & Hayes(2004)

$$I_{i,t} = (X_{i,t}^{INF}, Y_{i,t}^{CLUS}, Z_{i,t}^{LINK}) H_{i,t} A_{i,t}$$

$X_{i,t}^{INF}$: a nation's innovation infrastructure

$Y_{i,t}^{CLUS}$: the environment for innovation in a country's industrial clusters

$Z_{i,t}^{LINK}$: strength of linkage between common infrastructure and a nation's industrial clusters

$H_{i,t}$: human capital stock in a nation

$A_{i,t}$: stock of knowledge in a nation

(ii) Model in open economy

$$I_{i,t} = (X_{i,t}^{INF}, Y_{i,t}^{CLUS}, Z_{i,t}^{LINK}) H_{i,t} A_{i,t} M_{i,t} F_{i,t} C_{i,t}$$

$M_{i,j}$: international trade flows

$F_{i,j}$: foreign direct investment

$C_{i,j}$: other relevant control variables

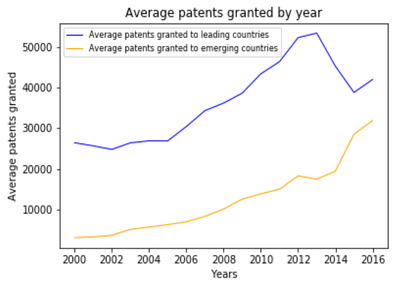
(iii) Natural log transformation

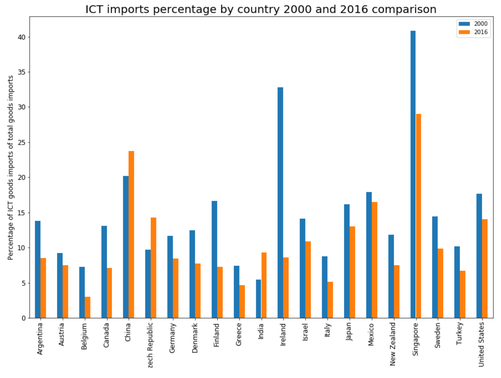
$$lnI_{i,t} = \beta_0 \, lnC_{i,t} + \beta_1 lnX_{i,t}^{INF} + \beta_2 lnY_{i,t}^{CLUS} + \beta_3 lnZ_{i,t}^{LINK} + \beta_4 lnH_{i,t} + \beta_5 lnA_{i,t} + \beta_6 lnM_{i,t} + \beta_7 lnF_{i,t}$$

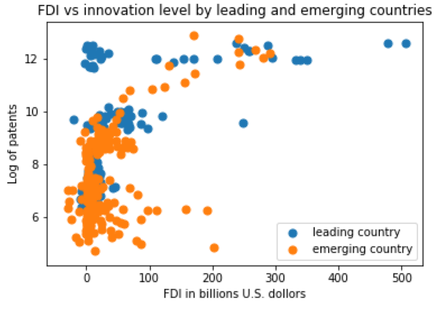
Comment: better interpreted in terms of elasticity; less sensitive to outliers.

Data

Category		Variable	Description	observations	mean	STD
Innovation rate	$I_{i,t}$	patents	Log of patents granted	340	8.210543	1.984444
Common innovation Infrastructure	$X_{i,t}^{INF}$	GDP	Log of GDP (in billions U.S. dollars)	340	6.539503	1.316195
		EDU	Education expenditure (% of GDP)	244	5.188383	1.355753
		journal	Log of number of scientific journals and articles	280	9.997718	1.243082
Cluster-specific Innovation environment	$Y_{i,t}^{CLUS}$	R&D_P	Percentage of R&D expenditure by business sector	286	52.522829	14.087389
Quality of Linkage	$Z_{i,t}^{LINK}$	R&D_G	Percentage of R&D expenditure by government	285	34.330683	13.790983
Trade flows	$M_{i,j}$	import	Imports of services and goods (% of total GDP)	340	43.612720	35.660670
		ICT	ICT goods import (% of goods imports)	340	11.559839	6.769082
Foreign direct Net inflows	$F_{i,j}$	FDI	Foreign direct net inflows (in billions U.S. dollars)	338	40.087137	73.994754







Discussion

- The significant impacts of GDP, education expenditure and scientific publications on a nation's innovation conforms to economic intuition.
- The current results deviate from expectation. The variables of interest, FDI and ICT imports, are not significant in explaining domestic innovation. Besides, the results don't show significant differences between leading and emerging innovative countries.
- Potential improvements include: balance the data by filling missing values or increase sample size; apply machine learning tools to select more potential control variables to mitigate omitted variables bias problem ; choose better variables to operationalize theoretical constructs.
- Hausman test and other methods including matching will be applied for comparison.

Work Cited

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