The impact of 3D printing on trade and FDI

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9th FIW Research Conference, December 2016

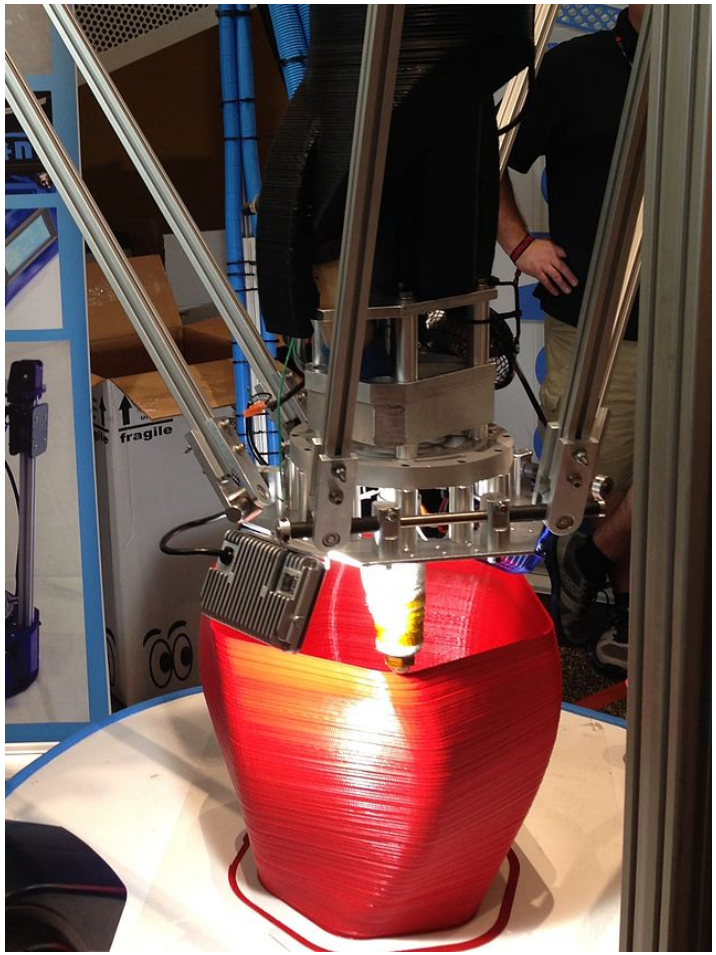
What is 3D printing?

- It is a synonym for Additive Manufacturing (AM)
  $\rightarrow$ And, what is AM?

- It refers to a process by which digital 3D design data is used to build up a component in layers by depositing material. (*International Committee F42 for Additive Manufacturing Technologies, ASTM*).

  $\rightarrow$ Instead of milling a workpiece from a solid block, for example, AM builds up components layer by layer using materials which are available in fine powder form. A range of different metals, plastics and composite materials may be used.

Figure: 3D printing in action



Source: Wikipedia

3D Printing has received a lot of attention from the media in recent years

- The Economist: "The printed world" (2011), "Print me a Stradivarious" (2011), "3D printing scales up" (2013), "Bioprinters: Printing a bit of me"(2014)
- The Guardian: "How 3D printing is set to shake up manufacturing supply chains" (2014), "3D-printed cities: is this the future?" (2015), "Smile! Meet the 3D printer churning out teeth, nerves and gums for dentists" (2015)
- The New York Times: "3-D Printing Aims to Rewrite the Script on Cooking and Tech" (2014), "Will 3-D Printers Change the World?" (2014), "3-D Printers to Make Things You Need or Like" (2013)

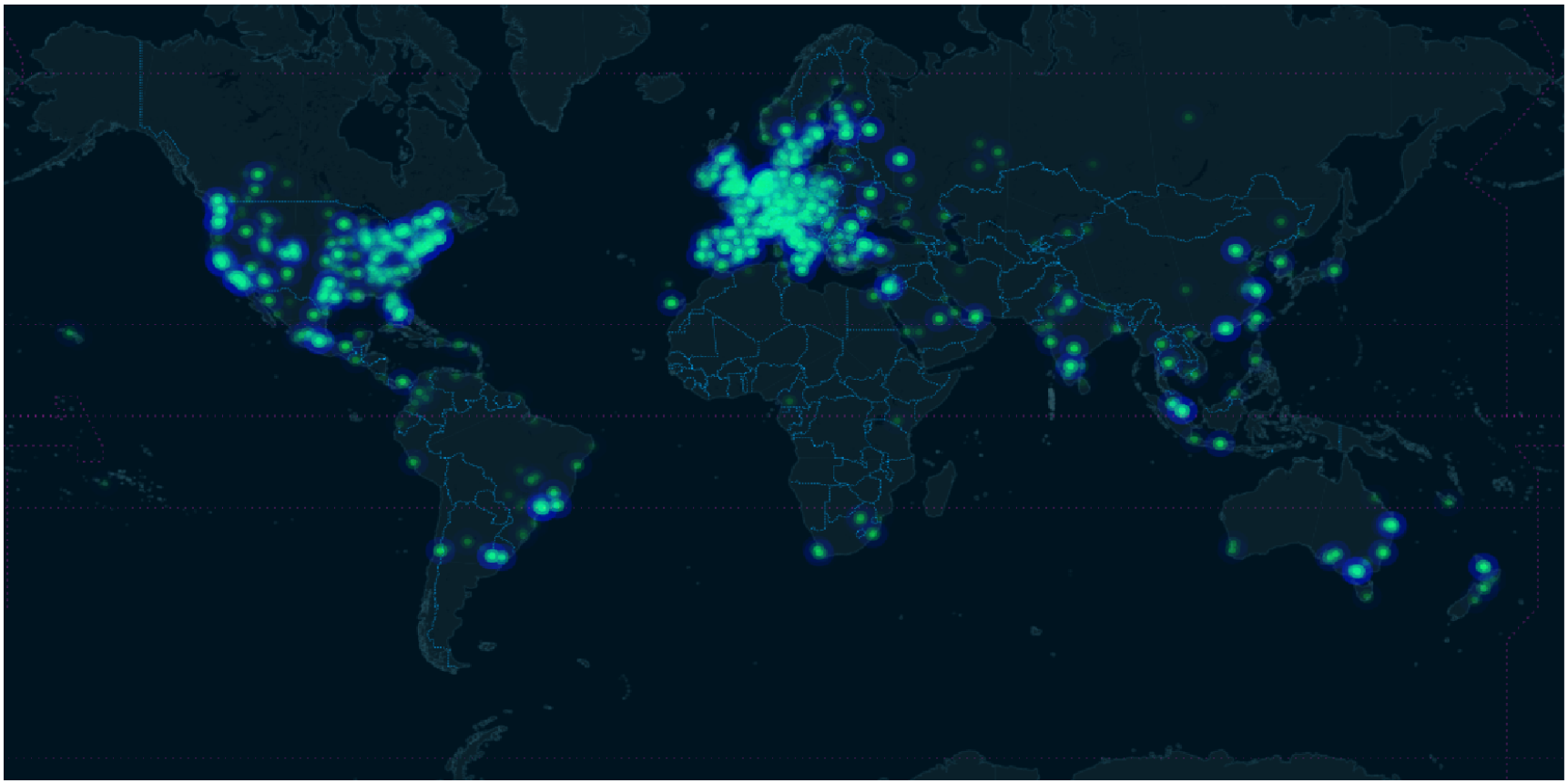
...among many others!!!!

... but also from Academia

- There is a special journal for research on 3D printing called "Additive Manufacturing" (published by Elsevier)
- Benson and Magee (2015) - 3D printing is among the most innovative sectors (analyzing patent data)
- "Additive Manufacturing is one of the 10 breakthrough technologies of 2013" (MIT Technology Review, 2013)
- Over half a million articles on Google Scholar

- Companies are also traded in big Stock Exchanges
  - Stratasys (SSYS) trades in NASDAQ. Stocks rose 120% in 2013 (source:CNBC)
  - 3D Systems (DDD) trades in the NYSE Stocks rose 98% in 2013 (source:CNBC)
- There is also a mutual fund dedicated to 3D printing: "3D Printing Fund LLC"
- A survey conducted by PWC (2014) in US firms indicates that
  - Small companies: 59% are adopting 3D printing in some way, while 29% plan to adopt it in the future in some way
  - Large companies (over 500 employees): 75% are using it in some way, while 23% plan to in the future

Snapshot: consumer and services of 3D printers



Benefits of using 3D printers

- Reduction of inventory costs
- Easy customization
- Less energy use
- Reduction of waste
- Elimination of supply chains and assembly lines

Limitations of 3D printers

- Substantial printing times
- Quality of materials
- Cost of printers and materials
- Quality standards
- Environmental conditions and exact replicability

What we do

- First theoretical application to consider the introduction of this technology, within a firm heterogeneity framework (based on Helpman, Melitz and Yeaple (2004))
- We model, predict and find that:
  - Countries with higher demand buy more printers
  - Countries subject to higher transport costs buy more printers
  - Anecdotal evidence suggests that companies already engage in FDI with the use of 3D printers

Consumer side

- Identical households (across economies) with CES utility function.

  $\epsilon = 1/(1-\alpha) > 1$ is the elasticity of substitution.

- Demand of variety j : $x(j) = Ap(j)^{-\epsilon}$ where

  $x(j)$ is the quantity of good j

  $p(j)$ its price

  A the demand level (determined by household's income).

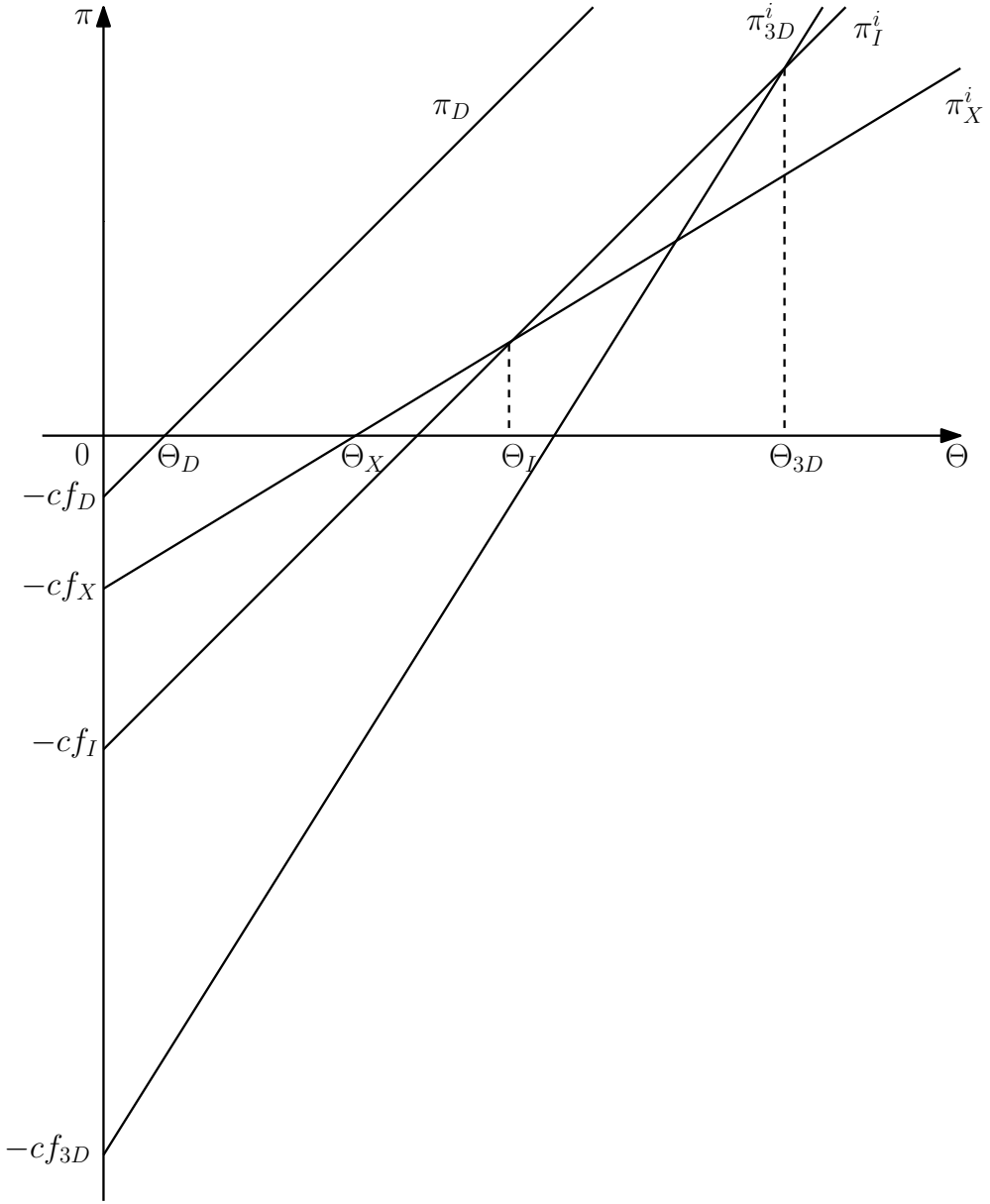
Production side

- World comprised of $i \in [1, n+1]$ open economies
- 1 factor of production (L), that earns ω
- Firms produce a continuum of manufactured goods $j \in (0, 1)$
- Each firm draws a productivity level $\theta(j)$ from the distribution $G(\theta) \rightarrow$ variable cost: $w/\theta(j)$
- Productivity determines which markets they serve and how
- Besides variable costs, firms also face different fixed costs depending on their type of activity
  cf_D (domestic production) ; $cf_X > cf_D \cdot \tau^{1-\epsilon}$ (exporting) ;
  $cf_I > cf_X \cdot \tau^{\epsilon-1}$ (FDI) ; $cf_{3D} > cf_I$ (FDI with 3D printing)

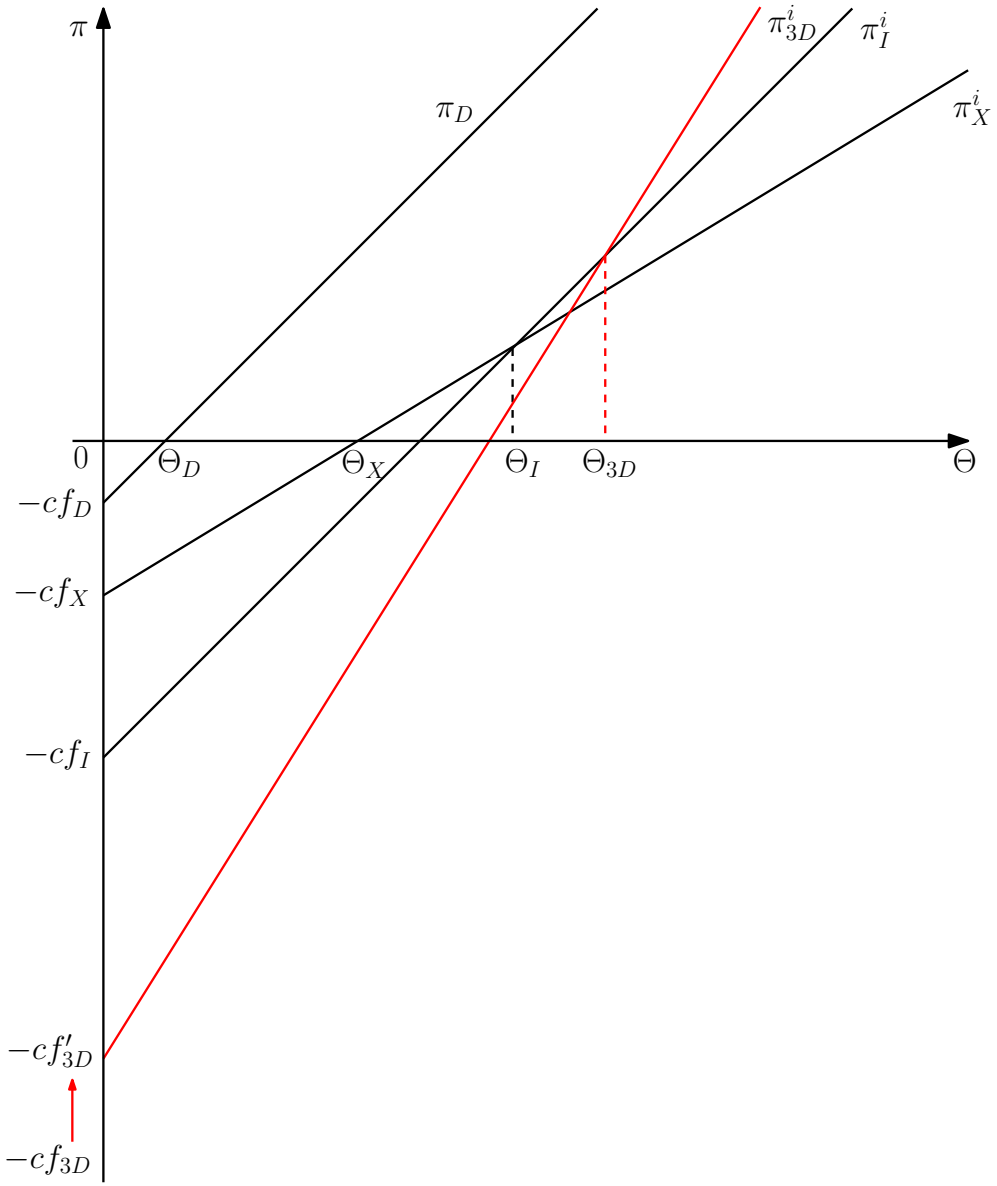
In this setting, firms charge a mark-up over marginal cost in the destination market, which leads to the following prices:

- $p(j)_D = w/[\alpha\theta(j)]$ (domestic production)
- $p(j)_X = w\tau/[\alpha\theta(j)]$ (via exporting)
- $p(j)_I = w/[\alpha\theta(j)]$ (via FDI)
- $p(j)_{3D} = w/[(1+\xi)\alpha\theta(j)]$ (via 3D printing FDI)

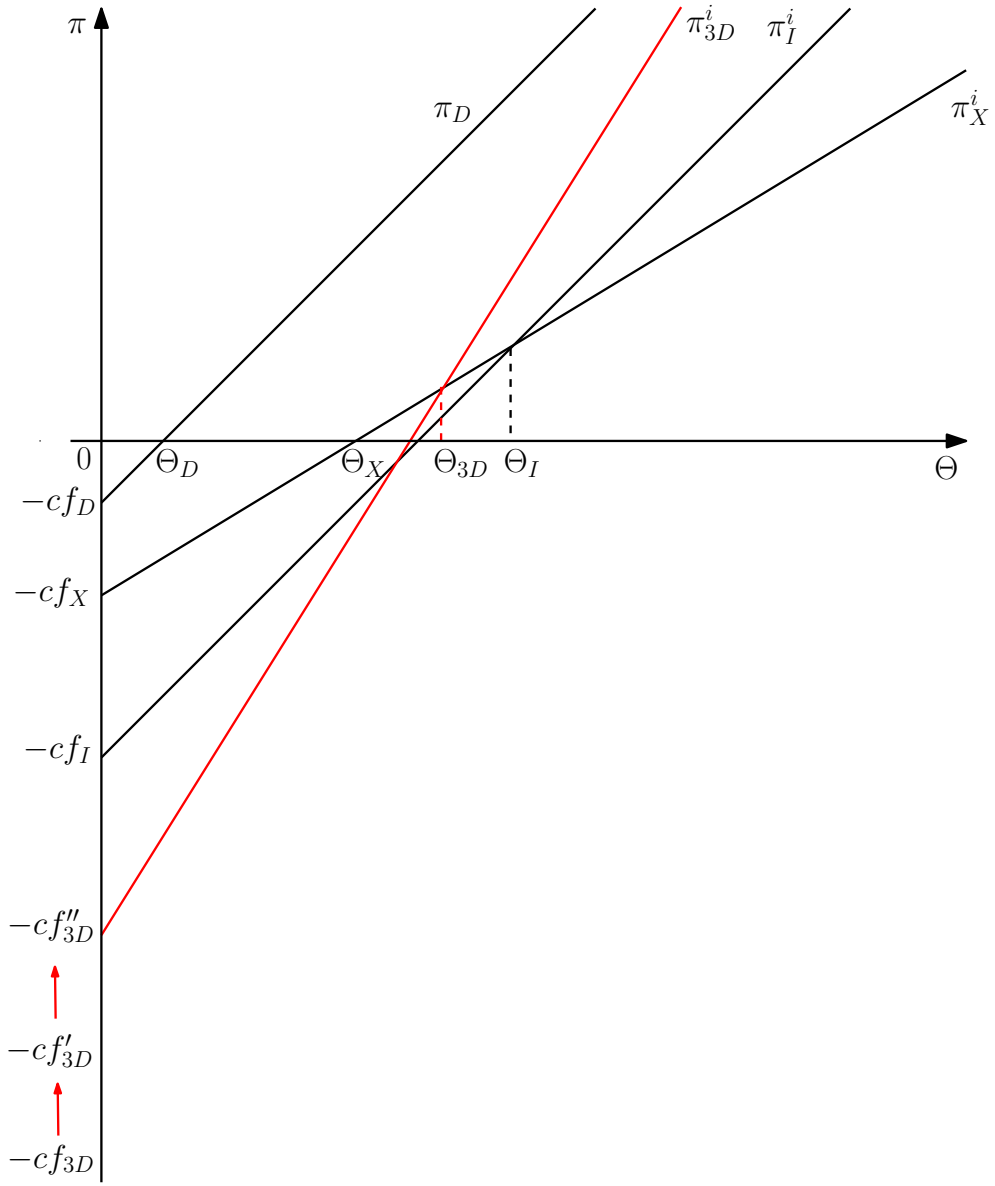
Graph I


π
π^i_{3D}
π^i_I
π_D
π^i_X
0
Θ_D
Θ_X
Θ_I
Θ_{3D}
Θ
$-cf_D$
$-cf_X$
$-cf_I$
$-cf_{3D}$

Graph II - FDI with AM replaces traditional FDI



Graph III - FDI with AM replaces exports



Model predictions

- 3D Printing first occurs in areas with high economic activity and subject to high transport costs
- Gradually, technological progress leads to 3D Printing FDI replacing traditional FDI
- Later, when 3D printers are widely used, trade will be gradually replaced

In a nutshell: "Companies are re-imagining supply chains: a world of networked printers where logistics may be more about delivering digital design files- from one continent to printer farms in another- than about containers, ships and cargo planes"

—PWC report (2014), *3D printing and the new shape of industrial manufacturing*

Data

- Since it is a fairly new industry, data is scarce
- 3D printers do not have a specific HS code already → research on classification is required

Country	Code	Source
United States	8443.32.1090	Flexport (http://learn.flexport.com/import-3d-printers)
Spain	8443.32.10.90	SICNOVA3D and Valencia Port authority
United States	8443.99.5050	Flexport (http://learn.flexport.com/import-3d-printers)
Argentina	8477.20.10	Kikai Labs
United States	8477.59.01.00	U.S. Census Bureau - Foreign Trade Schedule B (2015) (https://uscensus.prod.3ceonline.com/)
Hong Kong	8477.59.10	Trade and Industry Department of Hong Kong (http://www.tid.gov.hk/english/cepa/tradegoods/files/mainland_2014.pdf
United States	8477.80.00	Hodes & Mohseni (2014)
Germany	8474.80.90	German Federal Statistical Office
Argentina	8477.80.90.000W	Trimaker
Germany	8477.80.99	German Federal Statistical Office
United States	8479.89.98	Hodes & Mohseni (2014)

Table: Collected information on tariff lines considered for the trade of 3D printers

HS code description

Variables and sources

- Trade (of printers): UN-COMTRADE
- GDPs: World Development Indicators
- Free trade agreements: De Sousa (2012, plus updates)
- Gravity controls such as distance, common language, former colony: CEPII
- Trade cost: OECD chapter 84, 87 and 90

Empirical strategy

We use the Gravity Model

$$X_{ij} = \frac{Y_i \cdot Y_j}{Y_w} \cdot \left(\frac{t_{ij}}{P_i \cdot P_j} \right)^{1-\sigma}$$

where

$$P_i = \left(\sum_{j=1}^{N} \Theta_j \cdot \left(\frac{t_{ij}}{P_j} \right)^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \qquad P_j = \left(\sum_{i=1}^{N} \Theta_i \cdot \left(\frac{t_{ij}}{P_i} \right)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$$

Applying logs we obtain

$$\ln X_{ij} = \alpha_1 \ln Y_i + \alpha_2 \ln Y_j - \alpha_3 \ln t_{ij} + \alpha_4 \ln P_i + \alpha_5 \ln P_j + \epsilon_{ij}$$

Cross-section: OECD measure of transport cost (Ch. 84)

Dependent variable: (ln) trade quantity

	OLS		OLS - BV	PPML	PPML - BV
	(1)	(2)	(3)	(4)	(5)
lntcoecd	0.605	0.738	1.401	0.563	1.069
	(0.248)**	(0.333)**	(0.250)***	(0.277)**	(0.359)***
lngdpi	1.120		0.795	1.491	0.811
	(0.098)***		(0.102)***	(0.113)***	(0.071)***
lngdpj	0.721		0.627	1.082	1.074
	(0.093)***		(0.095)***	(0.135)***	(0.103)***
lndist	-1.034	-1.591	-1.033	-1.427	-0.986
	(0.218)***	(0.224)***	(0.357)***	(0.154)***	(0.629)
comlang_off	0.594	1.053	0.720	0.124	0.787
	(0.279)**	(0.339)***	(0.314)**	(0.185)	(0.290)***
colony	-0.126	0.491	0.770	0.469	1.224
	(0.414)	(0.421)	(0.200)**	(0.200)**	(0.537)**
rta	0.296	-0.357	0.286	0.661	0.664
	(0.201)	(0.386)	(0.271)	(0.166)***	(0.587)
(Pseudo)R^2	0.43	0.72	0.38	0.70	0.47
N	359	359	359	885	885
Dummy Var.	Continent	Countries	-	Continent	-

Cross-section: OECD measure of transport cost (Ch. 87)

Dependent variable: (ln) trade quantity

	OLS		OLS - BV	PPML	PPML - BV
	(1)	(2)	(3)	(4)	(5)
lntcoecd	0.617***	0.510*	0.936***	0.379**	0.389*
	(0.164)	(0.273)	(0.232)	(0.167)	(0.203)
lngdpi	1.173***		0.785***	1.458***	0.775***
	(0.101)		(0.101)	(0.105)	(0.077)
lngdpj	0.745***		0.582***	1.118***	1.045***
	(0.099)		(0.112)	(0.139)	(0.094)
lndist	-1.303***	-1.741***	-1.451***	-1.335***	-0.533
	(0.207)	(0.246)	(0.441)	(0.163)	(0.491)
comlang	0.298	0.855**	0.242	0.069	0.705**
	(0.235)	(0.335)	(0.499)	(0.172)	(0.322)
colony	0.001	0.611	1.107*	0.605***	1.544***
	(0.398)	(0.461)	(0.587)	(0.149)	(0.527)
rta	0.382*	-0.324	-0.213	0.710***	0.614
	(0.209)	(0.407)	(0.357)	(0.168)	(0.405)
N	339	339	339	755	755
(Pseudo)R^2	0.453	0.721	0.356	0.718	0.411
Dummy Var.	Continent	Countries	-	Continent	-

Cross-section: OECD measure of transport cost (Ch. 90)

Dependent variable: (ln) trade quantity

	OLS		OLS - BV	PPML	PPML - BV
	(1)	(2)	(3)	(4)	(5)
lntcoecd	0.512***	0.385**	0.938***	0.351**	0.333
	(0.182)	(0.170)	(0.222)	(0.175)	(0.251)
lngdpi	1.146***		0.809***	1.442***	0.766***
	(0.091)		(0.089)	(0.108)	(0.074)
lngdpj	0.774***		0.563***	1.097***	1.044***
	(0.096)		(0.101)	(0.128)	(0.099)
lndist	-1.110***	-1.573***	-1.236***	-1.228***	-0.402
	(0.212)	(0.245)	(0.387)	(0.175)	(0.509)
comlang	0.314	0.826***	0.406	0.154	0.683**
	(0.229)	(0.298)	(0.466)	(0.198)	(0.321)
colony	-0.071	0.593	0.910	0.534***	1.407**
	(0.418)	(0.469)	(0.612)	(0.190)	(0.568)
rta	0.331*	-0.442	-0.286	0.692***	0.581
	(0.183)	(0.334)	(0.312)	(0.170)	(0.399)
N	339	339	339	714	714
(Pseudo)R^2	0.453	0.721	0.356	0.718	0.411
Dummy Var.	Continent	Countries	-	Continent	-

Further robustness checks

- Panel setting Results
- Alternative measure of transport cost Fedex Results
- Placebo regressions with total trade Placebo Results

Selected anecdotal evidence: hearing aid industry

Starkey and Phonak

- About 90% of the plastic shells for customized hearing aids produced in the world are 3d printed
- 3D printing has changed production: from several steps to only 3
- Has used the technology for over 10 years
- Starkey has printers in 7 facilities worldwide, while Phonak has 14

Conclusions

- Heterogeneous firm model that includes the introduction of 3D printers.
- Though it is too early to properly assess the predictions of the model, we observe
  - 3D printing takes place in locations with higher domestic demand
  - transport costs are positively associated with the amount of printers traded
  - there is already some FDI from MNE using this technology (Starkey and Phonak, for example).

Further related research

- Related analysis with 3D Hubs and Wohlers data
- Extend the number of countries in the robustness analysis for the different transport costs measures
- Extend the model to allow firms to reap benefits from customization and product complexity by using 3D printers
- Analyze potential implications in the labor market

Thanks for your attention!

Questions, suggestions?

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HS Code description

Country	Code	Description
Most common 6 digits	8443.32	Other printers, copying machines and facsimile machines, whether/not combined , excluding the ones which perform two/more of the functions of printing, copying/facsimile transmission; capable of connecting to an automatic data processing machine to a network
Most common 6 digits	8477.80	Machinery for working rubber/plastics/for the manufacture of products from these materials, not specified /incld. elsewhere in this Ch., Other machinery, n.e.s. in 84.77
Argentina	3909.50.19.000A	Amino-resins, phenolic resins and polyurethanes, in primary forms. Plastics and articles of plastic; Polyurethanes; others
United States	8443.32.1090	Other, capable of connecting to an automatic data
Spain	8443.32.1090	Other, capable of connecting to an automatic data; Printer units; Other
United States	8443.99.5050	Printing machinery used for printing by means of plates, cylinders and other printing components of heading 8442; other printers, copying machines and facsimile machines, whether or not combined; parts and accessories thereof; Parts and accessories;other;other;other
Argentina	8477.20.10	Machinery for working rubber or plastics or for the manufacture of products from these materials, not specified or included elsewhere in this Chapter; Extruders; for thermoplastics, with a screw diameter not exceeding 300 mm
United States	8477.59.01.00	Machinery for working rubber or plastics or for the manufacture of products from these materials, not specified or included elsewhere in this chapter, parts thereof; other machinery for molding or otherwise forming; other
Hong Kong	84775910	Three-dimensional printer (3D printer)
United States	8477.80.00	Machinery for working rubber or plastics or for the manufacture of products from these materials, not specified or included elsewhere in this chapter, parts thereof; Other machinery
Germany	8474.80.90	Machinery for sorting, screening, separating, washing, crushing, grinding, mixing or kneading earth, stone, ores or other mineral substances, in solid (including powder or paste) form; machinery for agglomerating, shaping moulding solid mineral fuels, ceramic paste,unhardened cements, plastering materials or other mineral products or in powder or paste molds of sand;other form; machines for forming foundry machinery; other
Argentina	8477.80.90.000W	Machinery for working rubber or plastics or for the manufacture of products from these materials, not specified or included elsewhere in this Chapter;other machinery; other
Germany	8477.80.99	Machinery for working rubber or plastics or for the manufacture of products from these materials, not specified or included elsewhere in this chapter;other machinery;other
United States	8479.89.98	Machines and mechanical appliances having individual functions, not specified or included elsewhere in this chapter; parts thereof; Other: Electromechanical appliances with self-contained electric motor;Other

Table: Collected information on tariff lines considered for the trade of 3D printers with description

Back to data and issues

Alternative cost measure: Fedex

	Large package				Hearing aids package			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lnfedex	0.137	1.213***	-0.140	0.793*	0.152	1.153**	0.008	1.147**
	(0.410)	(0.432)	(0.414)	(0.430)	(0.546)	(0.533)	(0.569)	(0.554)
lndist	-0.231	-0.579**	-0.412*	-0.330	-0.246	-0.430**	-0.454**	-0.238
	(0.196)	(0.226)	(0.212)	(0.221)	(0.190)	(0.192)	(0.217)	(0.200)
comlang	0.116	0.685**	-0.048	0.617**	0.120	0.523	0.000	0.576**
	(0.329)	(0.338)	(0.361)	(0.247)	(0.312)	(0.367)	(0.352)	(0.270)
colony	0.585	0.351	0.981**	0.771**	0.553	0.437	0.984**	0.859**
	(0.371)	(0.363)	(0.427)	(0.387)	(0.364)	(0.396)	(0.419)	(0.391)
rta	1.317***	2.033***	0.979***	1.712***	1.203***	1.902***	0.859***	1.715***
	(0.279)	(0.294)	(0.297)	(0.338)	(0.280)	(0.320)	(0.311)	(0.336)
lngdpj	0.843***	0.779***	0.810***	0.757***	0.837***	0.676***	0.824***	0.722***
	(0.064)	(0.062)	(0.065)	(0.055)	(0.057)	(0.047)	(0.058)	(0.057)
usa	-2.850***	-2.293***	-2.860***	-2.242***	-2.951***	-3.087***	-2.827***	-2.860***
	(0.255)	(0.312)	(0.243)	(0.273)	(0.256)	(0.461)	(0.271)	(0.377)
N	174	207	174	207	177	211	177	211
(Pseudo) R-squared	0.690	0.699	0.721	0.752	0.683	0.677	0.716	0.770
Dummy Var.	-	-	Cont. (d)	Cont. (d)	-	-	Cont. (d)	Cont. (d)
Origin	USA and China							

Back

Panel: OECD measure of transport cost (Ch. 84)

	OLS		OLS - BV	PPML	PPML - BV
	(1)	(2)	(3)	(4)	(5)
lntcoecd	0.348***	0.210*	0.430**	1.816***	0.231
	(0.130)	(0.119)	(0.169)	(0.406)	(0.310)
lndist	-0.893***	-1.085***	-0.813***	-1.259***	-0.991
	(0.143)	(0.117)	(0.229)	(0.243)	(0.744)
comlang	0.394**	0.878***	0.609**	0.644*	0.723*
	(0.188)	(0.169)	(0.238)	(0.337)	(0.398)
colony	-0.456*	0.215	0.366	-0.739***	-2.795
	(0.248)	(0.205)	(0.333)	(0.284)	(2.893)
rta	0.526**	0.410**	0.347	1.090**	-0.575
	(0.233)	(0.194)	(0.338)	(0.454)	(1.358)
lngdpi	0.987***	0.711***	0.687***	1.187***	0.746***
	(0.053)	(0.191)	(0.047)	(0.136)	(0.073)
lngdpj	0.551***	0.581***	0.440***	1.136***	0.773***
	(0.062)	(0.182)	(0.045)	(0.186)	(0.088)
N	3,894	3,894	3,894	12,531	12,531
(Pseudo)R^2	0.376	0.575	0.318	0.272	0.030
Dummy Var.	Continent	-	-	Continent	-

Panel: OECD measure of transport cost (Ch. 87)

Dependent variable: (ln) trade quantity

	OLS		OLS - BV	PPML	PPML - BV
	(1)	(2)	(3)	(4)	(5)
lntcoecd	0.446***	0.151*	0.315***	1.113***	-0.116
	(0.105)	(0.082)	(0.119)	(0.246)	(0.250)
lndist	-1.023***	-1.168***	-0.887***	-1.194***	-0.773
	(0.149)	(0.139)	(0.256)	(0.247)	(0.748)
comlang	0.354*	0.889***	0.542**	0.262	0.559
	(0.199)	(0.190)	(0.262)	(0.300)	(0.484)
colony	-0.403	0.253	0.447	-0.123	-2.838
	(0.260)	(0.214)	(0.352)	(0.344)	(3.038)
rta	0.622**	0.431**	0.434	1.055**	-0.387
	(0.248)	(0.213)	(0.372)	(0.471)	(1.385)
lngdpi	1.025***	0.679***	0.697***	1.062***	0.736***
	(0.055)	(0.195)	(0.049)	(0.125)	(0.074)
lngdpj	0.557***	0.528***	0.445***	1.071***	0.757***
	(0.066)	(0.184)	(0.046)	(0.179)	(0.083)
N	3,650	3,650	3,650	10,717	10,717
(Pseudo)R^2	0.386	0.577	0.316	0.238	0.033
Dummy Var.	Continent	-	-	Continent	-

Panel: OECD measure of transport cost (Ch. 90)

Dependent variable: (ln) trade quantity

	OLS		OLS - BV	PPML	PPML - BV
	(1)	(2)	(3)	(4)	(5)
lntcoecd	0.412***	0.072	0.273*	1.014***	-0.313
	(0.108)	(0.096)	(0.141)	(0.243)	(0.299)
lndist	-0.912***	-1.122***	-0.850***	-1.047***	-0.663
	(0.155)	(0.143)	(0.254)	(0.256)	(0.665)
comlang	0.384*	0.876***	0.587**	0.357	0.473
	(0.197)	(0.185)	(0.256)	(0.314)	(0.442)
colony	-0.467*	0.251	0.374	-0.548**	-2.818
	(0.256)	(0.214)	(0.350)	(0.268)	(3.019)
rta	0.585**	0.408*	0.374	1.563***	-0.377
	(0.241)	(0.212)	(0.359)	(0.580)	(1.219)
lngdpi	1.024***	0.662***	0.712***	1.140***	0.740***
	(0.057)	(0.196)	(0.050)	(0.120)	(0.076)
lngdpj	0.586***	0.538***	0.442***	1.151***	0.754***
	(0.069)	(0.184)	(0.046)	(0.199)	(0.081)
N	3,639	3,639	3,639	10,308	10,306
(Pseudo)R^2	0.386	0.577	0.318	0.216	0.036
Dummy Var.	Continent	-	-	Continent	-

Back

Placebo regressions: cross-section

	(1)	(2)	(3)	(4)	(5)	(6)
lntcoecd	-0.102	-0.224*	-0.022	-0.183	-0.036	0.070
	(0.213)	(0.122)	(0.159)	(0.155)	(0.156)	(0.096)
lndist	-0.803***	-0.670***	-0.755***	-0.675***	-0.799***	-0.748***
	(0.203)	(0.066)	(0.184)	(0.047)	(0.211)	(0.047)
comlang_off	0.261	-0.462	0.374	-0.343	0.226	-0.426
	(0.226)	(0.313)	(0.294)	(0.257)	(0.257)	(0.264)
colony	0.133	-0.251	0.113	-0.381	0.152	-0.241
	(0.182)	(0.223)	(0.189)	(0.276)	(0.188)	(0.251)
rta	0.314	1.333***	0.283	1.374***	0.182	1.494***
	(0.441)	(0.296)	(0.468)	(0.218)	(0.484)	(0.287)
lngdpi	0.839***	0.926***	0.808***	0.941***	0.841***	0.910***
	(0.062)	(0.085)	(0.055)	(0.091)	(0.063)	(0.075)
lngdpj	0.771***	0.955***	0.762***	0.977***	0.767***	0.965***
	(0.059)	(0.084)	(0.057)	(0.089)	(0.057)	(0.098)
N	359	856	339	755	339	714
(Pseudo) R-squared	0.747	0.786	0.742	0.779	0.741	0.756
Chapter	84	84	87	87	90	90

Placebo regressions: cross-section with Fedex data

	Larger package				Hearing aid package			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lnfedex	-0.477**	-0.340*	-0.539**	-0.287*	-0.281	0.100	-0.172	-0.320
	(0.214)	(0.193)	(0.212)	(0.156)	(0.319)	(0.346)	(0.285)	(0.265)
lndist	-0.488***	-0.378***	-0.653***	-0.333***	-0.548***	-0.491***	-0.706***	-0.370***
	(0.128)	(0.098)	(0.133)	(0.081)	(0.120)	(0.079)	(0.125)	(0.076)
comlang_off	0.485***	-0.125	0.348**	-0.165	0.581***	-0.084	0.471***	-0.096
	(0.159)	(0.281)	(0.164)	(0.230)	(0.166)	(0.278)	(0.172)	(0.207)
colony	-0.293	-0.418**	0.099	-0.078	-0.260	-0.383*	0.141	-0.114
	(0.207)	(0.212)	(0.234)	(0.259)	(0.205)	(0.204)	(0.232)	(0.247)
rta	0.888***	1.008***	0.462***	0.787***	0.907***	1.182***	0.491***	0.866***
	(0.162)	(0.232)	(0.149)	(0.175)	(0.166)	(0.256)	(0.149)	(0.188)
lngdpj	0.782***	0.875***	0.791***	0.801***	0.810***	0.921***	0.829***	0.827***
	(0.038)	(0.062)	(0.036)	(0.033)	(0.038)	(0.058)	(0.035)	(0.029)
usa	-0.613***	-0.290*	-0.560***	-0.227*	-0.397**	-0.218	-0.361**	-0.057
	(0.155)	(0.157)	(0.136)	(0.134)	(0.181)	(0.211)	(0.162)	(0.147)
N	174	207	174	207	177	211	177	211
(Pseudo) R-squared	0.780	0.881	0.829	0.944	0.775	0.891	0.822	0.947
Dummy Var.	-	-	Cont. (d)	Cont. (d)	-	-	Cont. (d)	Cont. (d)
Origin	US and China							

Placebo regressions: panel OECD data

	(1)	(2)	(3)	(4)	(5)	(6)
lntcoecd	-0.322***	-0.257	-0.206**	-0.111	-0.221***	-0.002
	(0.088)	(0.194)	(0.083)	(0.102)	(0.079)	(0.120)
lndist	-0.580***	-0.418**	-0.500***	-0.451***	-0.559***	-0.472***
	(0.142)	(0.198)	(0.164)	(0.170)	(0.172)	(0.157)
comlang_off	0.307	-0.328	0.387*	-0.215	0.328	-0.280
	(0.212)	(0.317)	(0.227)	(0.293)	(0.235)	(0.290)
colony	0.108	-0.251	0.052	-0.327	0.091	-0.250
	(0.215)	(0.242)	(0.218)	(0.256)	(0.222)	(0.248)
rta	0.754***	1.656***	0.748**	1.757***	0.724**	1.799***
	(0.286)	(0.349)	(0.314)	(0.341)	(0.323)	(0.344)
lngdpi	0.670***	0.837***	0.676***	0.838***	0.684***	0.819***
	(0.033)	(0.048)	(0.034)	(0.049)	(0.034)	(0.051)
lngdpj	0.756***	0.923***	0.751***	0.944***	0.758***	0.944***
	(0.028)	(0.059)	(0.030)	(0.066)	(0.030)	(0.065)
Observations	3,894	12,531	3,650	10,717	3,639	10,308
R-squared	0.732	0.793	0.739	0.783	0.741	0.782
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Chapter	84	84	87	87	90	90

Back

Profits are of the following form

- When firms serve the domestic market

$$\begin{aligned}\pi_D &= \theta^{\epsilon-1}(1-\alpha)A\left(\frac{w}{\alpha}\right)^{1-\epsilon} - cf_D \\ &\equiv \Theta B - cf_D, \end{aligned} \tag{1}$$

Where $\Theta = \theta^{\epsilon-1}$ and $B = (1-\alpha)A\,(w/\alpha)^{1-\epsilon}$

- Firms that also export

$$\begin{aligned}\pi_D + \pi_X &= \theta^{\epsilon-1}(1-\alpha)A\left(\frac{w}{\alpha}\right)^{1-\epsilon} - cf_D + \tau^{1-\epsilon}\theta^{\epsilon-1}(1-\alpha)A^i\left(\frac{w}{\alpha}\right)^{1-\epsilon} - cf_X \\ &\equiv \Theta B - cf_D + \tau^{1-\epsilon}\Theta B^i - cf_X, \end{aligned} \tag{2}$$

- Firms with Greenfield FDI

$$\begin{aligned}\pi_D + \pi_I &= \theta^{\epsilon-1}(1-\alpha)A\left(\frac{w}{\alpha}\right)^{1-\epsilon} - cf_D + \theta^{\epsilon-1}(1-\alpha)A^i\left(\frac{w}{\alpha}\right)^{1-\epsilon} - cf_I \\ &\equiv \Theta B - cf_D + \Theta B^i - cf_I \end{aligned} \tag{3}$$

- Firms with 3D Printing FDI

$$\begin{aligned}\pi_D + \pi_{3D} &= \theta^{\epsilon-1}(1-\alpha)A\left(\frac{w}{\alpha}\right)^{1-\epsilon} - cf_D + \theta^{\epsilon-1}(1-\alpha)A^i\left[\frac{w}{(1+\xi)\alpha}\right]^{1-\epsilon} - cf_{3} \\ &\equiv \Theta B - cf_D + \Theta(1+\xi)^{\epsilon-1}B^i - cf_{3D}. \end{aligned} \tag{4}$$

We control for multilateral resistance (P_i and P_j) with:

- Continental dummies
- Country dummies
- (Unweighted) Bonus Vetus OLS (Baier and Bergstrand, 2009)

$$\ln(t_{ijt}*) = \ln(t_{ijt}) + \frac{1}{N}\sum_{j=1}^{N}\ln(t_{ijt}) - \frac{1}{N^2}\sum_{i=1}^{N}\sum_{j=1}^{N}\ln(t_{ij}) + \frac{1}{N}\sum_{i=1}^{N}\ln(t_{ijt})$$