Business Travel and International Technology Diffusion

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Introduction

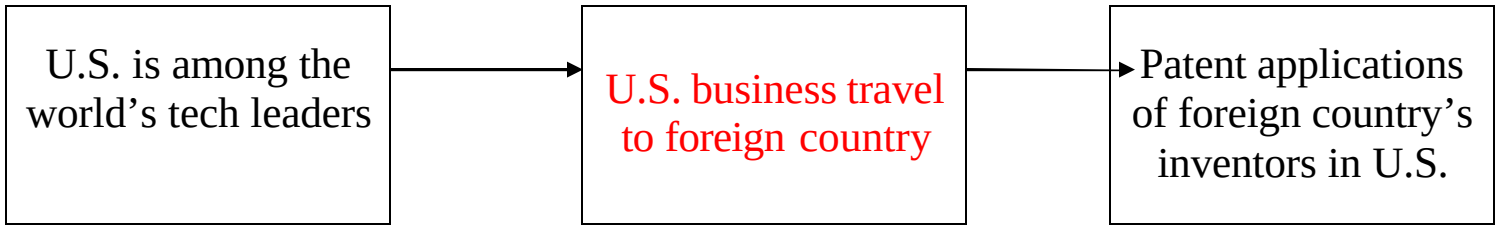
- Technology creation is mainly concentrated in advanced economies
- Technology transfer from leaders to followers is necessary for economic development and convergence
- Literature emphasized trade and FDI as important channels of international technology transfer
- International labor mobility and networks may also be important conduit for tech transfer
- Role and extent of **international travel** for international technology diffusion

Why international travel- anecdotal evidence

- Exchange of ideas through communication and travel is an important source of income convergence (Frankel and Romer, 1999)
- Informal exchange of information and ideas that takes place at a personal level is a crucial foundation of knowledge transfer (Krugman and Obstfeld, 2006)
- Technology is tacit and not easily codifiable: role of face-to-face meetings is crucial
- International travel overcomes informational and communication barriers in technology diffusion
- Might also explain why knowledge spillovers are geographically localized (Keller, 2002)

Main Hypothesis

- Outward business travel from U.S. can be used for tech transfer to foreign persons and corporations



- Countries with more access to U.S. technology and ideas through business travel will innovate more (as measured by the number of U.S. patents) controlling for various other factors
- **Identification:** Business and professional travel vs. travel unrelated to economic profit interests

Related Literature I

1. Travel triggers productivity

Dowrick and Tani (2008): business travel impacts positively industry level productivity in Australia

Andersen and Dalsgaard (2008): intensity of travel (arrivals+ departures from WDI) predicts productivity in cross-section of 72 countries

Gambardella et. al. (2003): average annual travel affects regional labor productivity in Europe

2. International migration impacts international technology diffusion

Le (2008): worker migration impacts knowledge flows bi-directionally, panel of 19 OECD countries

Kim et al (2006): foreign research personnel of U.S. firms triggers tech. transfer to U.S.

Oettl and Agrawal (2008): "patenting inventors" who move internationally influence bi-directional knowledge flows

Related Literature II

3. Business travel fosters international trade

Poole (2008), Cristea (2009): business travel serves as an input to international trade

4. Social and personal relationships ease technology transfer

Kerr (2008): larger ethnic research community in U.S. affects industry level productivity in foreign countries

Agrawal et. al. (2008): social proximity can substitute spatial proximity in the probability of knowledge flows

Singh (2005), Agrawal et.al. (2006): collaborative networks act as conduit for interregional and interfirm tech transfer

Contribution

Goal: Empirically analyze the extent of face-to-face communication in the diffusion of international knowledge flows

- Business travel posits an explicit and observable knowledge transmission channel
- Novel panel dataset of U.S. outward and inward travel 1993-2003 with destination country, **purpose of the trip** (business, professional, vacation, visit, etc.) and **occupations**
- Novel analysis of **fractional** patent counts utilizing the geographic location of multiple inventors per patent, and extensive country and time coverage

Empirical Specification

$$E[P_{ct} / Z_{ct}] = \exp(\beta * \ln T_{ct} + \mu \ln X_{ct} + \gamma_t + \phi_c)$$

Conditional Fixed-Effects Poisson Regression, where

- indexes are *c* for country, *t* for time
- P_{ct} is count of patent applications of foreign country *c* in the U.S in year *t*
- T_{ct} is U.S. resident outward travelers to country *c* in year *t*
- X_{ct} is controls (e.g. GDP per capita, R&D expenditures, exports, FDI)

Expect: $\beta > 0$

Identification: Business and professional travel

(a) conditional on all travel, (b) compare to visitor and clerical/sales

Data

International Travel Data: U.S. Department of Commerce, International Trade Administration (OTTI)

- Quarterly survey (1993-2003) of international outbound air travel from U.S.
- Distinguish between yearly outbound travel by U.S. residents and inbound travel by U.S. non-residents
- Main country of destination, purpose of the trip (business/professional, convention/conference, vacation/holiday, visit friends/relatives, study, etc) and occupation

U.S. Patent Data: United States Patent and Trademark Office, Custom Data Extracts

- Individual inventor data with U.S. and foreign locations
- Bibliographic and patent citations data

Data cont'd

Controls

- GDP per capita, population, openness etc- Penn World Table 6.2
- Labor force, R&D expenditures, world patent applications - World Development Indicators
- Distance and language- CEPII
- U.S. exports- U.S. Census Bureau
- FDI- Bureau of Economic Analysis

Descriptive Statistics

	Obs	Mean	Std. Dev.
Patent Count	2149	377.33	2629.18
Business/Visit	2149	0.37	0.82
Professional/Clerical	2149	1.51	0.81
Total Travel	2149	3.48	2.01
Population	1894	8.66	1.95
GDP per Capita	1862	8.49	1.14
World Pat. Appl, non- resident	949	5.83	2.43
World Pat. Appl, resident	949	5.34	2.66
US Exports	2118	18.93	2.65
US FDI, majority owned MNE total sales	1105	21.26	2.67
R&D Expenditures	640	8.53	1.85
Openness	1848	4.32	0.61

All variables, except patent counts are in natural logarithms

- Unbalanced panel, 1993-2003 for around 200 countries

Benchmark Results: Poisson with Fixed Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Travel	**0.0180**	**0.0730**	**0.0882**	0.000661	**0.0238**	**0.0805**	**0.0745**
Business/Visit		**0.0611**	**0.0733**	**0.0251**	**0.0569**	**0.0446**	**0.0535**
Professional/Sales		**0.264**	**0.0864**	**0.0557**	**0.0737**	**0.0443**	
Population			**4.945**	**3.897**	**3.363**	**3.834**	**3.884**
GDP per Capita			**1.250**	**0.979**	**0.628**	**0.140**	**0.222**
Patents, non-res.				**0.0453**	**0.0295**	0.00212	0.00637
Patents, res				**0.194**	**0.189**	**0.254**	**0.255**
US Exports					**0.0495**	**-0.221**	**-0.234**
US FDI					**0.225**	**0.121**	**0.110**
R&D Expenditures						**0.500**	**0.522**
Openness						**1.090**	**1.083**
Observations	1613	1613	1434	851	631	417	417
Number of countries	150	150	133	93	79	69	69

All data in logs. Statistically significant coefficients in bold.

Results: OLS with Fixed Effects

	(1)	(2)	(3)	(4)	(5)	(Poisson)
Travel	**0.0756**	**0.0995**	0.00300	0.0259	**0.0886**	**0.0805**
Business/Visit	**0.117**	**0.110**	**0.0556**	**0.0930**	**0.0596**	**0.0446**
Professional/Sales	**0.284**	**0.0896**	**0.0634**	**0.0826**	**0.0501**	**0.0443**
Population		**4.852**	**4.136**	**3.521**	**4.158**	**3.834**
GDP per Capita		**1.352**	**0.995**	**0.597**	0.173	**0.140**
Patents, non-res.			**0.0413**	0.0188	-0.00712	0.00212
Patents, res			**0.198**	**0.193**	**0.213**	**0.254**
US Exports				0.00326	**-0.250**	**-0.221**
US FDI				**0.254**	**0.142**	**0.121**
R&D expenditures					**0.532**	**0.500**
Openness					**1.088**	**1.090**
Observations	2149	1862	929	655	426	417
R-squared	0.752	0.852	0.868	0.892	0.859	
Number of countries	214	183	120	92	74	69

All data in logs. Statistically significant coefficients in bold.

Alternative Specification: Weighted Travel

- Outward travel from state *s* to country *c* year *t*
- Weight travel by the U.S. patent stock

$$Adjusted\_Travel_{ct} = Travel_{ct} \sum_{ct} \frac{Travel_{sct}}{Total\_travel_{ct}} \frac{Pat\_count_{st}}{Average\_pat\_count_{t}}$$

- This procedure adjusts for travel from high-patenting states

Results: Weighted Travel –Poisson

	(1)	(2)	(3)	(4)	(5)
Travel	**0.0666**	**0.0911**	**0.0192**	**0.0136**	**0.0525**
Business/Visit	**0.116**	**0.0766**	**0.0313**	**0.0412**	**0.0211**
Professional/Sales	**0.173**	**0.0714**	**0.0646**	**0.0504**	**0.0136**
Population		**4.633**	**3.742**	**3.238**	**3.684**
GDP per capita		**1.333**	**0.998**	**0.723**	**0.268**
Patents, non-res.			**0.0400**	**0.0311**	0.00186
Patents, res			**0.192**	**0.195**	**0.262**
US exports				**0.0428**	**-0.209**
US FDI				**0.195**	**0.0855**
R&D expenditures					**0.492**
Openness					**1.050**
Observations	1613	1434	851	631	417
Number of countries	150	133	93	79	69

All data in logs. Statistically significant coefficients in bold.

Future Work

- Timing : adding lags
- Quarterly data
- Industry level analysis
- Outward vs. inward travel (spillovers vs. sourcing)
- First vs. second purpose of trip: Additional margin of identification
- Sample composition changes
- Patent citations as measure of quality?

Conclusions

- Present evidence that international travel can help explain international technology diffusion

- Traveler purpose of the trip and occupation allow to estimate a more precise impact of travel on tech diffusion

- Future work