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IP risks as a Deterrent for Foreign R&D Investments: IP strategy, tacitness, complexity, and technological capabilities

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Motivation

- Significant growth in cross-border R&D investments by MNEs
  (Athukorala and Kohpaiboon, 2010; Atkinson, 2007; Branstetter et al., 2018)
- Emerging countries become important locations for foreign R&D
  - ➢ BRICS account for 34.4% of the total foreign R&D worldwide from 2003 to 2011
    (OECD, 2016)
- MNEs perceive IPR protection as incomplete in those countries
  (USTR, 2017; Potter et al, 2017; EIU, 2004)
- Weak IPR protection in the host country discourages R&D investments of MNEs
  (e.g. Branstetter et al., 2006; Belderbos et al., 2008, 2013; Park and Belderbos, 2018).
- Yet firms still invest: IPR risk has a heterogeneous effect on R&D investment, depending on firm and technology characteristics?
  - ➢ R&D location choices of 120 global leading MNEs in 67 countries, 2003 to 2014

Theoretical framework

- Foreign R&D increase the probability of unwanted knowledge spillovers to foreign competitors

- Strength of spillovers due to collocation is likely to be heterogeneous across R&D investors :

➢ Measures firms put in place to reduce spillovers

➢ Knowledge asymmetry between foreign investors and local firms (Shaver and Flyer, 2000)

➢ Charecteristics of knowledge embodied in firm technologies

Hypothesis 1. IP strategy

- **Intra-firm cross-country inventor collaboration** : R&D activities for a technology are segmented and distributed across multiple locations, as indicated by cross-country internal inventor linkages
- This IP strategy reduces local spillovers to collocated rivals (Alcácer and Zhao, 2012; Belderbos and Somers, 2015; Zhao, 2006)
- Firms with such IP strategy can reduce IP risk in R&D host, making them less concerned about weak IPR there

- H1: The strength of firms' IP strategies based on cross-country internal inventor linkages weakens the negative effect of the host country weak IPR on the probability that foreign R&D investors locate in the country

Hypothesis 2. Complex versus discrete technologies

- Technologies with numerous separately patentable elements (**Complexity**) vs technologies for which a single patent can be the bases of commercialization (**Discreteness)** (Cohen et al., 2000)
- **Complexity** (e.g. ICT): commercialization requires combinations of many other components Patenting is mainly for increasing negotiation power during the cross-licensing deals (Hall and Ziedonis, 2001).
  - ➢ Leakage of single component may not cause serious damage
- **Discreteness** (e.g. Chemicals): a single technology tends to be sufficient to develop a commercializable product itself.
  - ➢ IPR protection is more important

- H2: The degree to which firms' patent portfolio is dominated by complex technology weakens the negative effect of the host country weak IPR on the probability that foreign R&D investors locate in the country.

Hypothesis 3. Tacit versus codified knowledge

- Transferring **tacit knowledge** is difficult and requires close interaction and collocation (Nooteboom, 2000)
  - ➢ Engaging in foreign R&D in countries with high IPR risk runs the risk of transfer of this tacit knowledge, e.g. through inventor mobility
  - ➢ Patent enforcement can reduce tacit knowledge transfer to rivals by mitigating inventor mobility (Ganco et al., 2015), but this is unlikely in weak IPR host countries
  - ➢ Firms with tacit knowledge are more sensitive to IPR protection in the R&D host
- **Codified knowledge** transfer and spillovers can occur over longer distances regardless of foreign R&D

- H3: The degree to which firms’ patent portfolio is dominated by tacit technology amplifies the negative effect of the host country weak IPR on the probability that foreign R&D investors locate in the country.

Hypothesis 4. Relative technology capability

- Technology leaders may not collocate with other firms while technology laggards enjoy benefits of technology spillovers
  (Alcácer and Chung, 2007; Belderbos et al., 2008; Shaver and Flyer, 2000)
- If R&D investors have more knowledge to protect but less knowledge to source in the host country, IPR protection is more important
- If MNEs have more advanced technology capabilities than local firms in host countries, the MNEs are more sensitive to IPR protection

- H4: The degree of relative technological firm capability to host country amplifies the negative effect of the host country weak IPR on the probability that foreign R&D investors locate in the country.

Data and sample

- 165 leading MNEs (top 5 firms in EU markets across manufacturing and high-tech IT service sectors) from Europe, US, and Japan

- 120 firms recorded foreign R&D investments from 2003 to 2014 according to *the FDI market* database

- Patent families of 120 firms extracted from PATSTAT 2016

- 1,799 cross-border R&D project location decisions, 2003 – 2014, in 67 countries. We consider a choice set of 106 countries

Conditional Logit Model

- Widely used for location choice studies
  (e.g. Alcácer and Chung, 2007; Alcácer and Delgado, 2016; Head et al., 1995; Shaver and Flyer, 2000)
- Firms select a one R&D location (county) which provides the maximum utility in comparison with other alternatives.
- DV=1 if a certain country is actually chosen for R&D location by the focal firm, otherwise zero
- Firm characteristics do not vary across potential location choices: they are interacted with host country attributes (weak IPR) to test hypotheses

Measurement 1. Weak IPR in host

- Based on Ginarte and Park's patent right index (GP)
- The GP relies on statutory information for each country but actual implementation of IPR policy is not considered
- We multiply GP with *Impartial courts* scores (IC) from *the Global Competitiveness Report* to take into account de jure and de facto protection of patents (Hu and Png, 2009; Maskus and Yang, 2013)
- GP and IC are normalized by the max values respectively, ranging from 0 to 1

- $\text{Weak IPR(t)} = -\text{Log(GPIC)}$

$$\text{with Patent protecton (GPIC)} = \frac{\text{GP(t)}}{Max\ GP(t)} * \frac{\text{IC(t)}}{Max\ IC(t)}$$

Measurement 2. IP strategy of firm

- IP strategy based on cross-country inventor collaboration
- Average degree of geographic dispersion of inventors of the MNEs' patents in terms of their countries of residence (Alcácer & Zhao, 2012; Zhao, 2006)

- IP strategy $(IPS)_{it} = Average\left(CCC_{ip}\right)_{it}$ $with\ CCC_{ip} = 1 - \sum_c Share_c{}^2$
- *i= firm, p= patent, c=inventor country, t=year, share= share of inventor country c in all inventor countries in a patent*

- If the firms have many patents invented by cross-country inventor collaboration, this indicator goes up

Measurement 3. Complexity of firm technology

- Following von Graevenitz et al. (2011)
- In complex sectors, there are many interactions across components so cross citiations occur more frequently
- Based on all patent families from 2000, we counted N. assignees pairs who cite each other for each 4 digit IPC
- Weighted average of class complexity w.r.t a firm's patent share for each IPC

- $Class\ complexity\ score_c = \frac{N.cross\ citing\ assignee\ pairs_c}{Total\ assignees_c}$
- $Firm\ complexity\ _{it} = \sum_c [(\frac{patents\ in\ class_{ict}}{Total\ patents_{it}}) * Class\ complexity\ score_c]$

  with i=firm, t=time, c=IPC

Measurement 4. Tacitness of firm technology

- Knowledge spillovers are highly localized and country borders restrict international knowledge transfer: Tacit knowledge spillovers are more geographically restricted

  (Almeida and Kogut, 1999; Belenzon and Schankerman, 2013; Morescalchi et al, 2015)

- For each IPC, we calculated average citation distance between inventors (Morrison et al., 2017)

- $Class\ tacit\ score_c = Average(\frac{max\ distance}{citataion\ distance_r})_c$

- $Firm\ tacitness_{it} = \sum_c [(\frac{patents\ in\ class_{ict}}{Total\ patents_{it}}) * Class\ tacit\ score_c]$

With r= inventor pairs in citations, i=firm, t=time, c=IPC class

Measurement 5. Relative technological capability

- Defining the core tech fields of each firm as top 10 IPC classes in term of patent application volume
- Counting N. patent applications of each potential host country issued in these top 10 IPCs

- $Realtive\ capability(RC)_{ist} = \log(\frac{1+patent\ count\ in\ the\ core\ fields_{it}}{1+patent\ count\ in\ the\ same\ fields_{st}})$
- *with i=firm, t=time, s=host country*
- The higher RC, the stronger firm capability compared to host countries

- **Control variables**: GDP, Wage, Openness (trade, FDI, capital), Corporate tax, Prior investments, geo-distance, Language proximity, Tertiary education, R&D agglomeration

	(1)	(2)	(3)	(4)	(5)	(6)
Weak IPR	-0.25**	-0.42***	-0.81***	-0.37***	0.05	-1.88***
	(0.11)	(0.16)	(0.27)	(0.12)	(0.12)	(0.34)
Weak IPR*IP strategy		1.26				**2.54*** **
		(0.80)				(0.92)
Weak IPR*Complexity			1.52**			**3.93*** **
			(0.64)			(0.79)
Weak IPR*Tacitness				-0.50***		**-0.77*** **
				(0.11)		(0.14)
Weak IPR*RC					-0.22***	**-0.23*** **
					(0.02)	(0.02)
Relative capability (RC)	-0.02	-0.02	-0.02	-0.02	-0.09***	-0.10***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
GDP	0.55***	0.55***	0.54***	0.55***	0.56***	0.53***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
R&D wage	-0.96***	-0.97***	-0.96***	-0.98***	-0.88***	-0.91***
	(0.16)	(0.16)	(0.16)	(0.16)	(0.17)	(0.17)
FDI open	0.16***	0.16***	0.16***	0.16***	0.21***	0.21***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)
Capital open	0.14	0.14	0.14	0.14	0.36**	0.39**
	(0.14)	(0.14)	(0.14)	(0.14)	(0.16)	(0.16)
Trade open	0.49***	0.49***	0.48***	0.49***	0.36***	0.34***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Corporate tax	-0.01***	-0.01***	-0.01***	-0.01***	-0.01	-0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Prior investments	1.29***	1.29***	1.29***	1.30***	1.21***	1.23***
	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
Language proximity	0.32*	0.35*	0.31*	0.34*	0.38**	0.44**
	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)	(0.18)
Geo distance	-0.01	-0.00	-0.01	-0.00	0.01	0.02
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Tertiary education	0.44***	0.44***	0.44***	0.45***	0.43***	0.42***
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
R&D agglomeration	0.41***	0.41***	0.41***	0.41***	0.44***	0.44***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
N.firms	120	120	120	120	120	120
N.host country(max)	105	105	105	105	105	105
N.project	1,799	1,799	1,799	1,799	1,799	1,799

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

Conclusion and implications

- IP strategy and complexity weaken the deterrence effect of weak IPR on R&D investments while tacitness and relative capability amplify it

➢ MNEs may benefit from conducting R&D in low IPR countries and avoid knowledge spillovers if they have the right IP strategy in place, and if R&D have the right technological characteristics. Helps to explain growth in R&D investment in emerging economies

➢ Weak IPR may especially deter R&D investments by technology leading firms and MNEs whose technology domains are more tacit and discrete.

- Future research: are R&D spillovers to local firms indeed affected by those four factors?

Thank you!

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