Technology transfers, foreign investment and productivity spillovers: Evidence from Vietnam

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Motivation

- Attracting FDI is a policy priority in many developing countries
- Aside from providing jobs and capital, FDI firms also bring new technology and knowledge
- Argument is that FDI firms are likely to be technologically superior to domestic firms
- Through their interactions, knowledge/new technology can be transferred to domestic sector leading to productivity improvements
- This can happen through many different mechanisms but these are difficult to disentangle empirically
- While the topic has received a lot of attention in the literature there is conflicting empirical evidence on the nature of spillovers and limited evidence on the underlying mechanisms

What we do in this paper….

- Using rich firm-level panel data for Vietnam 2009-2011 we analyze various mechanisms for spillovers from foreign-invested firms to the domestic sector

  - Examine horizontal, forward and backward spillovers
  - Disentangle contractual technology transfers from FDI externalities using a firm-specific measure
  - Consider whether competition effects dominate positive externalities from FDI
  - Examine spillovers from joint-venture vs. wholly-foreign owned firms
  - Explore the role of absorptive capacity of firms in determining the extent of technology spillovers

Preview of findings

- Forward linkages lead to productivity spillovers while backward linkages negatively impact the productivity of domestic firms

  This is contrary to other empirical studies
- Contractual technology transfers play a small role in explaining forward spillovers

  A large part of the positive spillovers we observe are unexplained
- Forward FDI externalities are from joint venture foreign firms
- Contracted technology transfers are productivity enhancing when they are linked with wholly foreign-owned upstream firms
- Increased competition from imports explains most (but not all) of the negative backward spillover from downstream FDI firms
- Absorptive capacity can cushion firms from negative backward spillovers

Conceptual framework

- **Horizontal or intra-sector spillovers** (Caves, 1996):

  FDI firm has firm-specific asset with a public good characteristic (e.g. knowledge or superior technology)

  Cannot prevent it from being transferred to competing firms

  E.g. through worker mobility, business or other networks, etc.

- **Vertical or inter-sector spillovers** (Rodriguez-Clare 1996):

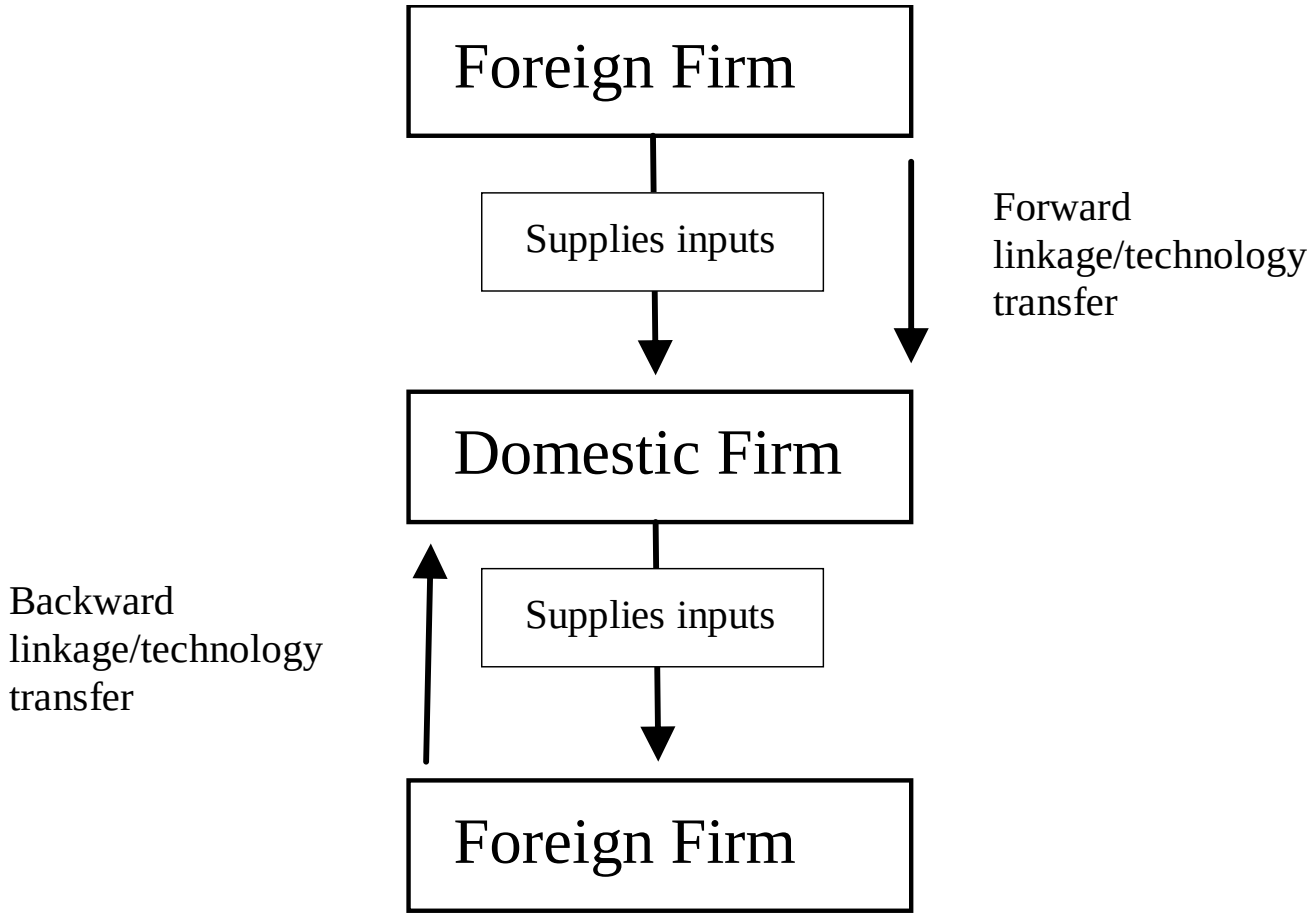
  Through the supply chain

  Backward: from foreign firms to domestic input suppliers

  Forward: from foreign intermediate input suppliers to domestic producers

  To illustrate…..

Conceptual framework



Conceptual framework

Backward spillovers:

- Positive:
  - Deliberate knowledge transfer e.g. technical assistance, management experience, quality assurance (Moran 2001)
  - Incentives for suppliers to improve quality of inputs (Javorcik 2004)
  - Scale economies
- Negative:
  - Asymmetric bargaining power (Girma et al. 2008)
  - Domestic firms not suited to producing input varieties demanded by foreign firms (Rodriguez-Clare 1996)
  - Increased competition from other foreign firms supplying inputs (Aitken and Harrison 1999) or from imported inputs

Conceptual framework

Forward spillovers:

- Positive:
  - Embodied technologies (Girma et al 2008)
  - Accompanying services (Javorcik 2004)
  - Competition effects
- Negative:
  - 'Lock-in' to using inputs purchased from FDI firms
  - Asymmetric bargaining power possible if FDI firms gain dominant position upstream
  - Cultural factors
- Forward spillovers have been very little attention in the literature…

Empirical Evidence

- Horizontal spillovers:
  - Very little empirical evidence that they exist
  - Foreign-invested firms compete with domestic firms in the same sector – incentive to prevent their technology from leaking (Javorcik 2004)
  - Barrios et al. (2011), Blalock and Gertler (2008), Bwalya (2006), Damijan et al. (2008), Javorcik (2004) and Kugler (2006) - none find evidence for horizontal spillovers
- Backward spillovers:
  - Javorcik (2004)- Luthuania
  - Blalock and Gertler (2008) – Indonesia
  - Kugler (2006) - Columbia
- Forward spillovers:
  - No evidence that we can find

Other issues

- Characteristics of foreign and domestic firms may matter:
  - Javorcik (2004) – backward spillovers only evident from partially-owned foreign firms
  - Giroud et al (2012), Marin and Bell (2006) – spillovers more likely from firms that are technologically/knowledge intensive
  - Crespo and Fontoura (2007) – absorptive capacity of domestic firms matters
    - Blomstrom and Sjoholm (1999) – export status of firm
    - Aitken and Harrison (1999) – firm size
    - Marin and Bell (2006) – investments in technology and training

- Distinction between externalities and actual technology transfers:
  - Giroud et al. (2012) and Zanfei (2012) critique literature on this point
  - Smeets (2008) – technology transfers and spillovers are distinct concepts that should be considered as such in empirical analysis
  - **This is one of our key points of departure…..**

What we test in this paper:

- Test for horizontal, forward and backward spillovers in Vietnamese case
- Test to what extent FDI spillovers are due to contract related technology transfers or externalities
- Test whether there are negative competition effects from increased imported inputs associated with FDI
- Test whether spillovers are more likely from joint-venture FDI firms and wholly-foreign owned firms
- Test whether absorptive capacity of firms plays a role in determining extent of technology spillovers

Empirical Approach

- **Measurement of spillovers (Javorcik, 2004)**

- Horizontal spillovers: the proportion of total revenue, R, within each 4-digit sector, j, accounted for by k foreign-owned firms (firms denoted with subscript i and time with t).

$$H_{jt} = \sum_{i=1}^{k} R_{ijt} \Big/ \sum_{i=1}^{n} R_{ijt}$$

- Forward spillovers: the proportion of total revenue in upstream sectors accounted for by foreign-owned firms

$$F_{jt} = \sum_{u=1}^{J-1} \alpha_{ut} H_{ut}$$

α_{ut} is the proportion of inputs into sector j that are purchased from sector u in time t and H_{ut} is the proportion of foreign-owned firms in upstream sector u.

Empirical Approach

- Backward spillovers: the proportion of total revenue in downstream sectors accounted for by foreign-owned firms

$$B_{jt} = \sum_{d=1}^{J-1} \alpha_{dt} H_{dt}$$

α_{dt} is the proportion of output from sector j that is sold to sector d in time t and H_{dt} is the proportion of foreign-owned firms in downstream sector d.

Empirical Approach

- **Baseline model (Javorcik, 2004): detecting spillovers**

$$lnY_{ijt} = \alpha_i + \beta_l \, ln\, L_{ijt} + \beta_k \, ln\, K_{ijt} + \delta_H H_{jt} + \delta_F F_{jt} + \delta_B B_{jt} + s_j + \tau_t + e_{ijt}$$

Y: value added
L: total labor input
K: capital inputs

α_i: firm fixed effects
s_j: 4-digit sector fixed effects
τ_t: time fixed effects

- How productivity of firm is correlated with foreign dominance within sectors (H), in upstream sectors (F) and in downstream sectors (B)

Empirical Approach

- **Detecting technology transfers:**

$$\begin{aligned} ln\,Y_{ijt} &= \alpha_i + \beta_l\, ln\, L_{ijt} + \beta_k\, ln\, K_{ijt} + \delta_H H_{jt} + \delta_B B_{jt} + \delta_F F_{jt} \\ &+ \beta_{TB} tech\_back_{ijt} + \beta_{TF} tech\_for_{ijt} \\ &+ \varphi_B tech\_back_{ijt} \times B_{jt} + + \varphi_F tech\_for_{ijt} \times F_{jt} \\ &+ s_j + \tau_t + e_{ijt} \end{aligned}$$

tech_back: firm received a technology transfer from a downstream firm
tech_for: firm received a technology transfer from an upstream firm

Two Marginal Effects of interest:

$$\frac{\partial ln Y_{ijt}}{\partial B_{jt}} = \delta_B + \varphi_B tech\_back_{ijt}$$

$$\frac{\partial ln Y_{ijt}}{\partial F_{jt}} = \delta_F + \varphi_F tech\_for_{ijt}$$

φ_B: backward FDI spillovers due to direct technology transfers
φ_F: forward FDI spillovers due to direct technology transfers

δ_B: backward FDI spillovers due to externalities
δ_F: forward FDI spillovers due to externalities

Empirical Approach

- Netting out competition effects
  - Add interaction term between Backward Linkages and level of imports into the sector to control for extent of upstream competition
  - Marginal effect can be computed for different levels of imports

$$\frac{\partial \ln Y_{ijt}}{\partial B_{jt}} = \delta_B + \varphi_B tech\_back_{ijt} + \delta_{imp} imports$$

- Disaggregation by type of ownership
  - Disaggregate B and F into proportion of foreign firms that are 100% foreign owned and proportion that are joint ventures.

- Absorptive capacity of domestic firms
  - Add interaction terms between spillovers, technology transfers and measures of absorptive capacity

Vietnamese Context

- The opening up of the Vietnamese economy began in 1986 with the adoption of a range of policy measures under *doi moi* (renovation) in particular relating to trade liberalisation and the promotion of foreign direct investment (FDI)

- FDI promotion a gradual process with successive revisions to investment laws between late 1980s and mid-2000s.

Table 1: Regional and sector level contribution of foreign investors to output and employment

	2009	2010	2011
		Output contribution (%)	
All manufacturing	43.02	44.51	47.31
15: Food products and bev.	32.91	30.84	33.84
19: Tanning/dressing leather	80.06	80.92	84.15
20: Wood and wood products	18.67	17.97	18.13
33: Medical, precision and opt.	93.11	88.25	86.11
		Employment contribution (%)	
All manufacturing	43.77	44.97	48.71
15: Food products and bev.	17.22	17.65	19.49
19: Tanning/dressing leather	71.90	73.52	77.70
20: Wood and wood products	12.31	12.03	13.73
33: Medical, precision and opt.	80.78	81.74	86.71

Data

- Technology and Competitiveness Survey (TCS) 2009-2011
- Sample of more than 7,500 firms

- Vietnamese Enterprise Survey 2002- 2011
- Population of all registered enterprises in Vietnam with 30 employees or more and representative sample of smaller firms
- TCS implemented by GSO as part of Vietnam Enterprise Survey and so data can be combined

- Supply Use Tables for Vietnam in 2007 to measure proportion of inputs/outputs traded between sectors
- Export and import data at 4-digit level taken from COMTRADE – control variables

Results

Baseline model: detecting spillovers

Dependent Variable: lnY	
lnlab	0.518***
lncap	0.223***
FDI Spillovers:	
Horizontal	-0.0001
Forward	0.0048***
Backward	-0.0073***
R^2	0.803
Firms	7,767
Obs	17,497

Detecting technology transfers:

Dependent Variable: lnY		
FDI Spillovers:		
Horizontal	-0.0001	-0.0001
Forward	0.0047***	0.0043***
Backward	-0.0074**	-0.0074***
Tech Transfers:		
Tech_for	0.0244***	-0.0019
Tech_back	0.0036	-0.0225
Interactions:		
FDI For*Tech_for		0.0009**
FDI Back*Tech_back		0.0007
R^2	0.803	0.803
Firms	7,767	7,767
Obs	17,497	17,497

Large part of spillover still unexplained……

Detecting technology transfers:

Dependent Variable: lnY		
FDI Spillovers:		
Horizontal	-0.0001	-0.0001
Forward	0.0047***	0.0043***
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Tech Transfers:		
Tech_for		
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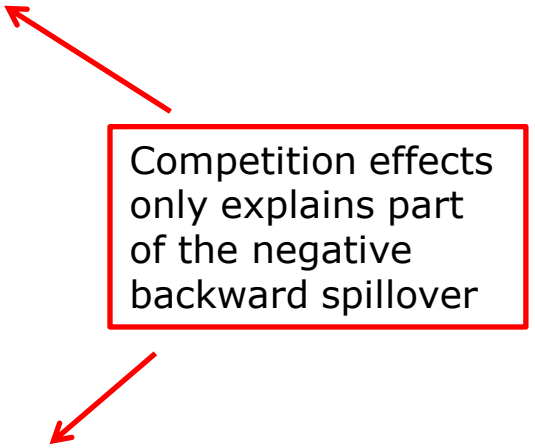
Interactions:		
FDI For*Tech_for		0.0009**
FDI Back*Tech_back		0.0007
R^2	0.803	0.803
Firms	7,767	7,767
Obs	17,497	17,497

Netting out competition effects:

Dependent Variable: lnY	
FDI Spillovers:	
Horizontal	-0.0001
Forward	0.0039**
Backward	-0.0055**
Tech Transfers:	
Tech_for	-0.0024
Tech_back	0.0038
Interactions:	
FDI For*Tech_for	0.0009**
FDI Back *imports	-0.0001**
R^2	0.803
Firms	7,767
Obs	17,497



Disaggregation by type of ownership:
Joint ventures vs. Wholly foreign-owned

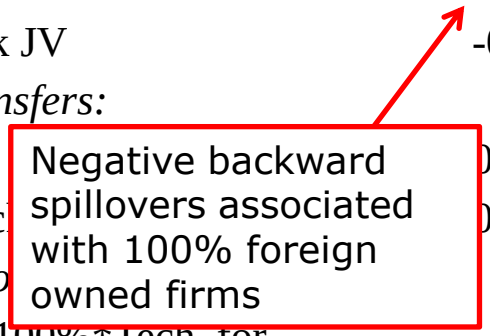
Dependent Variable: lnY		
FDI Spillovers:		
FDI Horizontal	-0.00001	-0.0000
FDI For 100%	0.0025	0.0018
FDI For JV	0.0116***	0.0125***
FDI Back 100%	-0.0088***	-0.0090***
FDI Back JV	-0.0031	-0.0036
Tech Tr		
Tech_for	0.0235***	0.0045
Tech_back	0.0036	-0.0265
Interactions:		
FDI For 100%*Tech_for		0.0014***
FDI For JV*Tech_for		-0.0029
FDI Back 100% *Tech_back		0.0005
FDI Back JV*Tech_back		17
R^2	0.802	0.803
Firms	7,767	7,767
Obs	17,497	17,497

Externalities associated with joint ventures

Tech transfers associated with 100% foreign owned firms

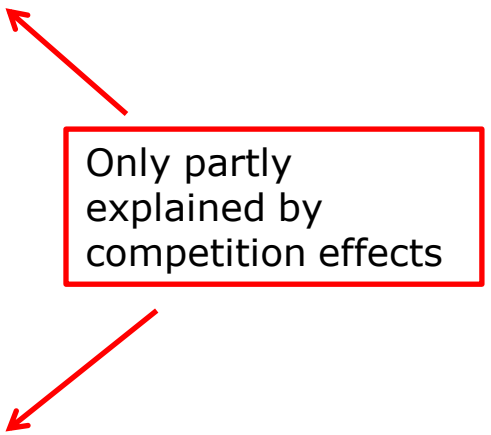
Disaggregation by type of ownership:
Joint ventures vs. Wholly foreign-owned

Dependent Variable: lnY		
FDI Spillovers:		
FDI Horizontal	-0.00001	-0.0000
FDI For 100%	0.0025	0.0018
FDI For JV	0.0116***	0.0125***
FDI Back 100%	-0.0088***	-0.0090***
FDI Back JV	-0.0031	-0.0036
Tech Transfers:		
Tech_for	0.0235***	0.0045
Tech_bac	0.0036	-0.0265
Interactio		
FDI For 100%*Tech_for		0.0014***
FDI For JV*Tech_for		-0.0029
FDI Back 100% *Tech_back		0.0005
FDI Back JV*Tech_back		0.0017
R^2	0.802	0.803
Firms	7,767	7,767
Obs	17,497	17,497



Disaggregation by type of ownership:
Joint ventures vs. Wholly foreign-owned
Netting out competition effects:

Dependent Variable: lnY	
FDI Spillovers:	
FDI Horizontal	0.0001
FDI For 100%	0.0020
FDI For JV	0.0108***
FDI Back 100%	-0.0070***
FDI Back JV	-0.0034
Tech Transfers:	
Tech_for	0.0067
Tech_back	0.0039
Interactions:	
FDI For 100%*Tech_for	0.0014***
FDI For JV*Tech_for	-0.0032
FDI Back 100% * imports	-0.0001*
FDI Back JV * imports	-0.0001
R^2	0.803
Firms	7,767
Obs	17,497



Absorptive capacity

- Include interaction terms between indicators of absorptive capacity of firms and spillover measures
  - New Machinery
  - New ICT
  - Process Innovation
  - Quality Innovation
  - Expand Variety
  - Expand Product
  - Switch Sector
  - Tech Adaptation
  - R&D

- No evidence of any impact of absorptive capacity on spillovers through forward linkages
- For backward linkages 3 measures emerge as potentially important for lessening negative impact
  - Investment in ICT, Variety innovation, Technology Adaptation

Absorptive capacity: investment in ICT

Dependent Variable: lnY		
FDI Spillovers:		
Horizontal	-0.0001	-0.0001
Forward	0.0047***	0.0046***
Backward	-0.0074***	-0.0074***
Absorptive capacity:		
ICT investment	-0.0030	-0.0215
Interactions:		
FDI For*ICT		-0.0004
FDI Back*ICT		0.0008**
R^2	0.803	0.803
Firms	7,767	7,767
Obs	17,497	17,497

Absorptive capacity: Variety Innovation

Dependent Variable: lnY		
FDI Spillovers:		
Horizontal	-0.0002	-0.0002
Forward	0.0047***	0.0046***
Backward	-0.0074***	-0.0077***
Absorptive capacity:		
Process Innovation	0.0045	-0.0037
Interactions:		
FDI For*Process Innov		0.0001
FDI Back*Process Innov		0.0010*
R^2	0.803	0.803
Firms	7,767	7,767
Obs	17,497	17,497

Absorptive capacity: Technology Adaptation

Dependent Variable: lnY		
FDI Spillovers:		
Horizontal	-0.0001	-0.0002
Forward	0.0047***	0.0045***
Backward	-0.0074***	-0.0074***
Absorptive capacity:		
Process Innovation	-0.0011	-0.0382
Interactions:		
FDI For*Process Innov		-0.0002
FDI Back*Process Innov		0.0012*
R^2	0.803	0.803
Firms	7,767	7,767
Obs	17,497	17,497

Robustness checks

- Estimate productivity using Olley and Pakes (1996) approach and use two-stage approach
- Estimate model removing outliers
- Estimate model for balanced panel
- Control for the sector level concentration (Amiti and Konings, 2007)
- This allows us disentangle real productivity effects from changes in mark-ups

Conclusions

- There are FDI spillovers in the case of Vietnam that provide benefits beyond those internalized through market transactions
- These occur through forward spillovers from foreign input-suppliers based in Vietnam to domestic Vietnamese firms
- There is a distinction between *externalities* and *technology transfers* but even after controlling for technology transfers a large part of FDI spillovers remains unexplained
- Specifically:
  - <u>Forward spillovers:</u>
  - JVs create productivity *externalities* that filter along the supply chain
  - Wholly foreign-owned projects only enhance the productivity of domestic customers where there is a contractual obligation to transfer knowledge
  - <u>Backward spillovers:</u>
  - Negative spillovers are due to wholly foreign-owned firms
  - Only part of this is explained by negative competition effects
  - Domestic firms that invest in ICT, new varieties or technology adaptation experience less of a negative backward spillover

Thank you

Questions and comments most welcome