Cross-Border Investment & Digital Technology Adoption: Firm-level Evidence from Korea

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Motivation

- Recent decades have witnessed strong worldwide growth in digitalization (OECD 2020).
  - From computerization and automation to the provision of internet services and use of robotics in production and service delivery to advances in big data, cloud storage technologies, and artificial intelligence.
  - In fact, the use of and reliance on digital technologies have spread to virtually every sector of the economy, from agriculture to manufacturing to services (UNCTAD 2025).

- Digitalization contributes to economy-wide growth through advancements in productivity (ADB 2025) and employment opportunities (Park and Shin 2025).

- How best can the Asia-Pacific region position itself in this new digital global economy?
  - As a major hub in global value chains (WTO 2023), the region serves as both host economy and source country for global investment flows.
  - International investment in the digital economy is growing disproportionately fast (UNCTAD 2025), with Asia being a key part of the story.

- What role do cross-border investments play in adoption of new technologies?

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This Paper: Contributions

- Does foreign direct investment support the Asia-Pacific region's digital economic development?

- We emphasize the role of outward FDI on technology adoption
  - across income levels, regions, and sectors

- We assess the role of investment on digitalization for those firms engaging in cross-border investment activities and also assess the potential spillovers to purely domestic firms without FDI.
  - consider different potential mechanisms

- Rich micro-level data on different types of digital technologies (e.g., AI, robotics, cloud computing) allows for deeper investigations

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Conceptual Framework

- A long and well-established literature exists on the role of foreign direct investment in transferring technology around the globe, enhancing local productivity in *host countries*.
  - Aitken, Hanson, and Harrison (1997); Aitken and Harrison (1999); Bloom and van Reenen (2010); Javorcik (2004); Keller (2004); Kee (2015); Poole (2013); Gong (2023).

- In contrast, the literature remains more open regarding the impact of *outward* foreign investment on local (*source country*) technology adoption.
  - Grossman and Rossi-Hansberg (2008) posit theoretically that offshoring allows firms to specialize in different tasks, thus increasing productivity and supporting technology-upgrading at home.
  - Ebenstein, et al (2014) demonstrate that the positive productivity and employment effects of U.S. foreign affiliates is concentrated among vertically-integrated firms. Relocation of U.S. activity abroad offers ability to reallocate internal resources.

- Technology diffusion may weaken source country technological advantage. On the other hand, task specialization may encourage enhanced productivity-upgrading. This is an inherently empirical question that we take to the data.

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Data

- Survey of Business Activities, *Statistics Korea*, 2017-2023
  - Covers firms in virtually all sectors of the Korean economy
  - With at least 50 employees and at least KRW 300 million (~$200,000) in capital
  - Does not exclusively rely on self-reporting
  - Between 12,000 and 14,000 unique firms per year
  - Restrict analysis to manufacturing and services firms—totaling over 80,000 firm-year observations

- Detailed firm-level information, as in classic databases (e.g., assets, revenues, employees), but also extends well beyond typical firm-level balance sheet data
  - Firms domestic & foreign network: subsidiaries and parent company, including detailed subsector and location
  - Indicators for digital technology development and use for a range of technologies from internet and big data to artificial intelligence, cloud computing, robotics, and 3D printing.

- Park, et al (2022); Cho, et al (2023); DeStefano, et al (2023); Park and Shin (2025) among other recent studies relying on this data.

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Why Korea?

- Korea offers a prime setting to assess the impacts of cross-border investment on technology adoption in the Asia-Pacific region.
  - From aid-dependent nation in 1960s to high-income, innovation-driven, state-led, export-oriented growth strategy, light manufacturing to heavy industry and technology.

- Korea serves as a top source of outward FDI to the region (a net capital exporter)
  - 11th largest in 2024, over $48 billion (UNCTAD 2024)
  - Especially toward Asia-Pacific, with 22% of total outward FDI going to the region, second only to North America (Korea Ministry of Finance and Economy 2025)
  - Among top ICT companies: Samsung Electronics (3rd), LG Electronics (16th), SK Hynix (48th).

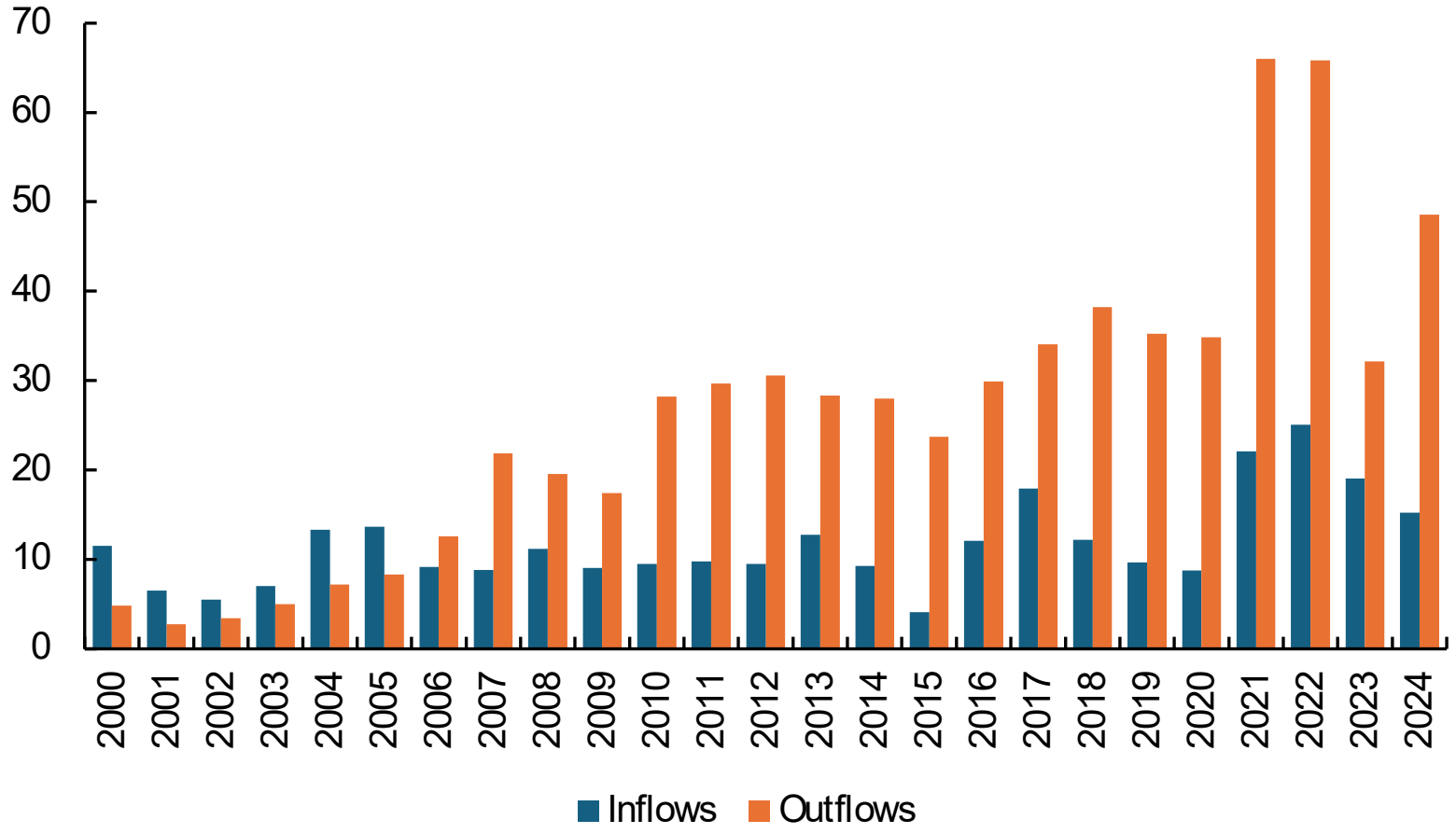
- Korea is one of the world's most digitally connected economies
  - with broadband penetration above 99%, while adoption of AI, cloud services, big data, and industrial robotics is among the highest in the world providing a rich environment to study firm-level digital technology use

- Developing Asia can learn from Korean experience.

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Korean Investment Flows

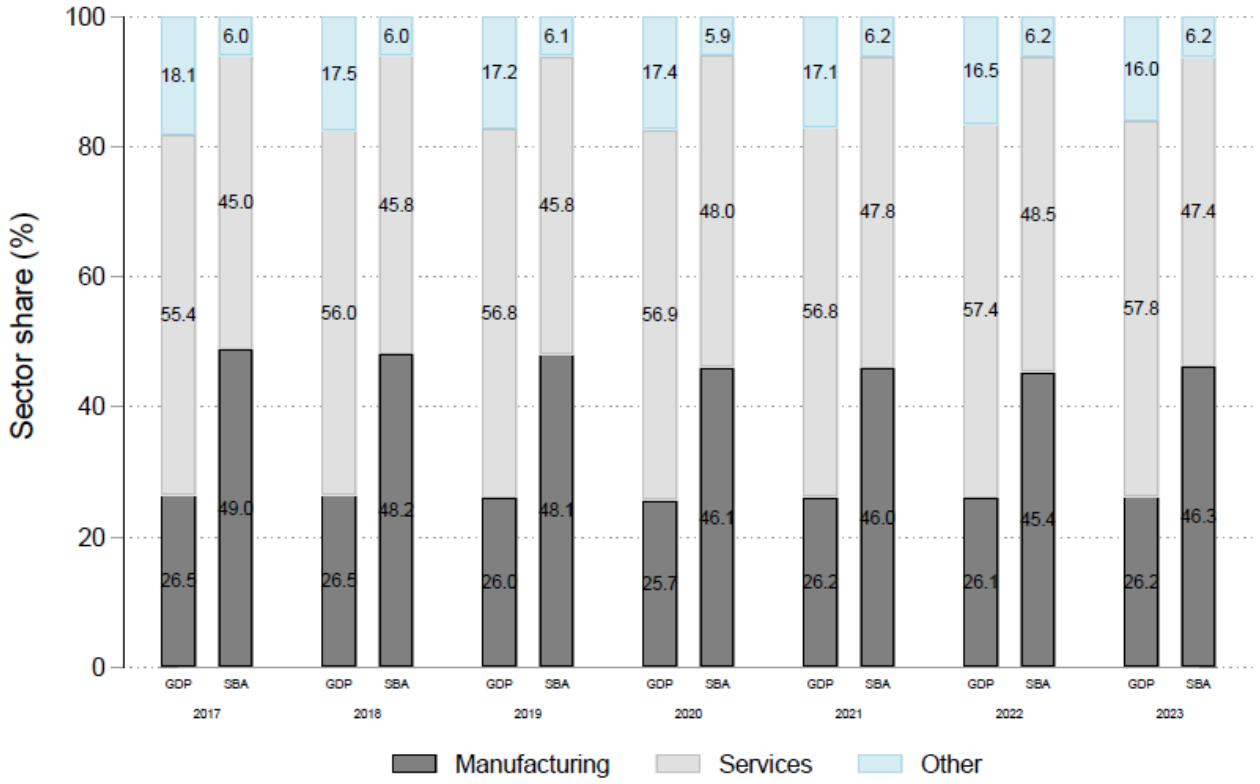
Korea: Inflows and Outflows, 2000-2024
($ Billion)



Source: ADB calculations using data from UNCTAD, World Investment Report 2025 Statistical Annex Tables.

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Data: Sectoral Composition



Note: The composition of firms is derived from the Survey of Business Activities (2017–2023), and GDP value-added shares are from Statistics Korea (KOSTAT). "Other" includes: Agriculture, forestry, fishing, mining, construction, utility sectors.

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Key Definitions

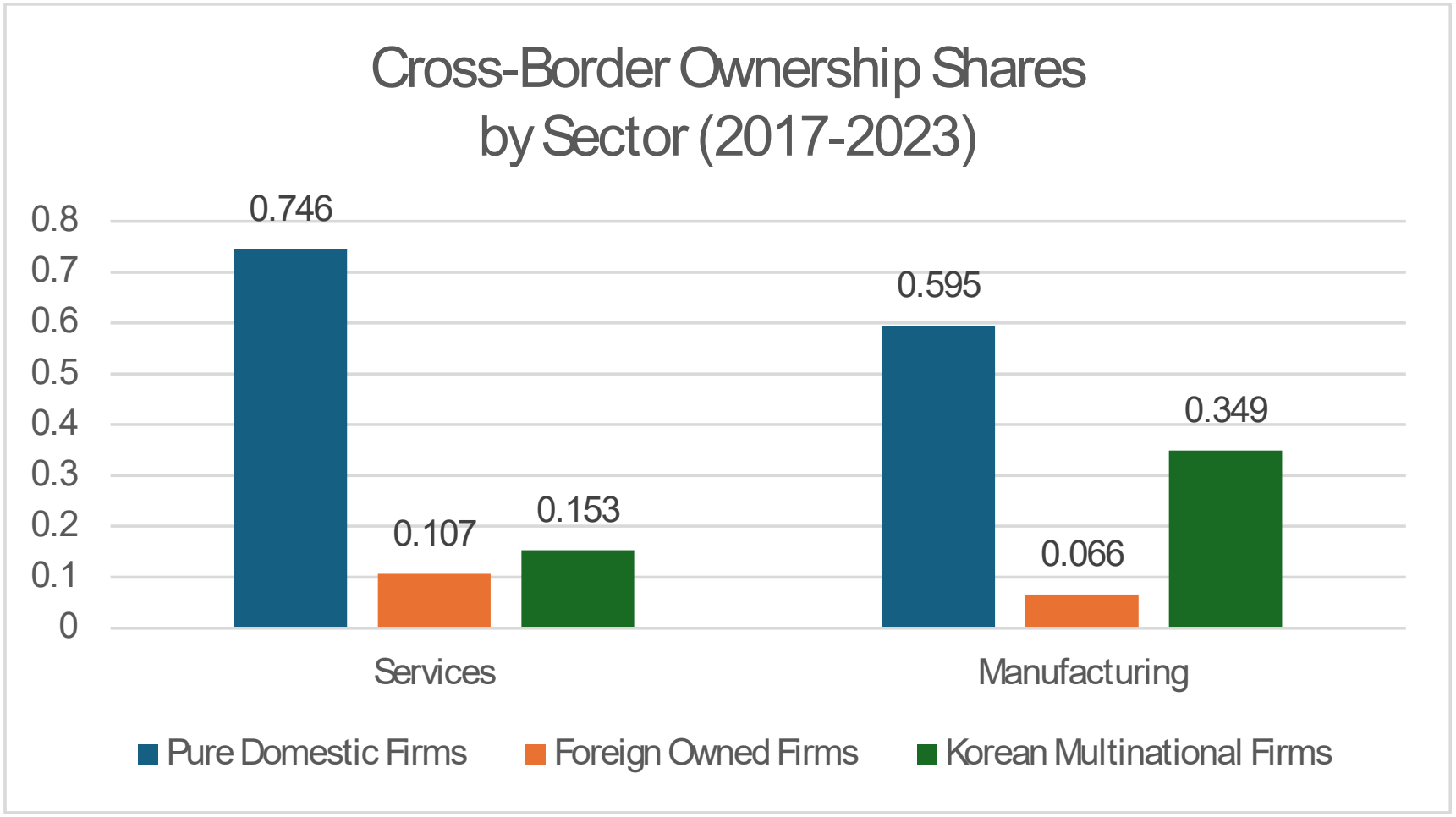
- The *Survey of Business Activities* offers detailed information on each firm's corporate structure.
  - whether the surveyed firm is >50% owned by a parent company (foreign or domestic)
  - whether the surveyed firm maintains >50% ownership share in a subsidiary (foreign or domestic)

- We rely on these two binary indicator variables to classify surveyed firms into *pure domestic* firms, *foreign-owned* firms, and *Korean multinational* firms.

	Foreign Parent=0	Foreign Parent=1
Foreign Subsidary=0	Pure Domestic	Foreign-Owned
Foreign Subsidiary=1	Korean MNE	

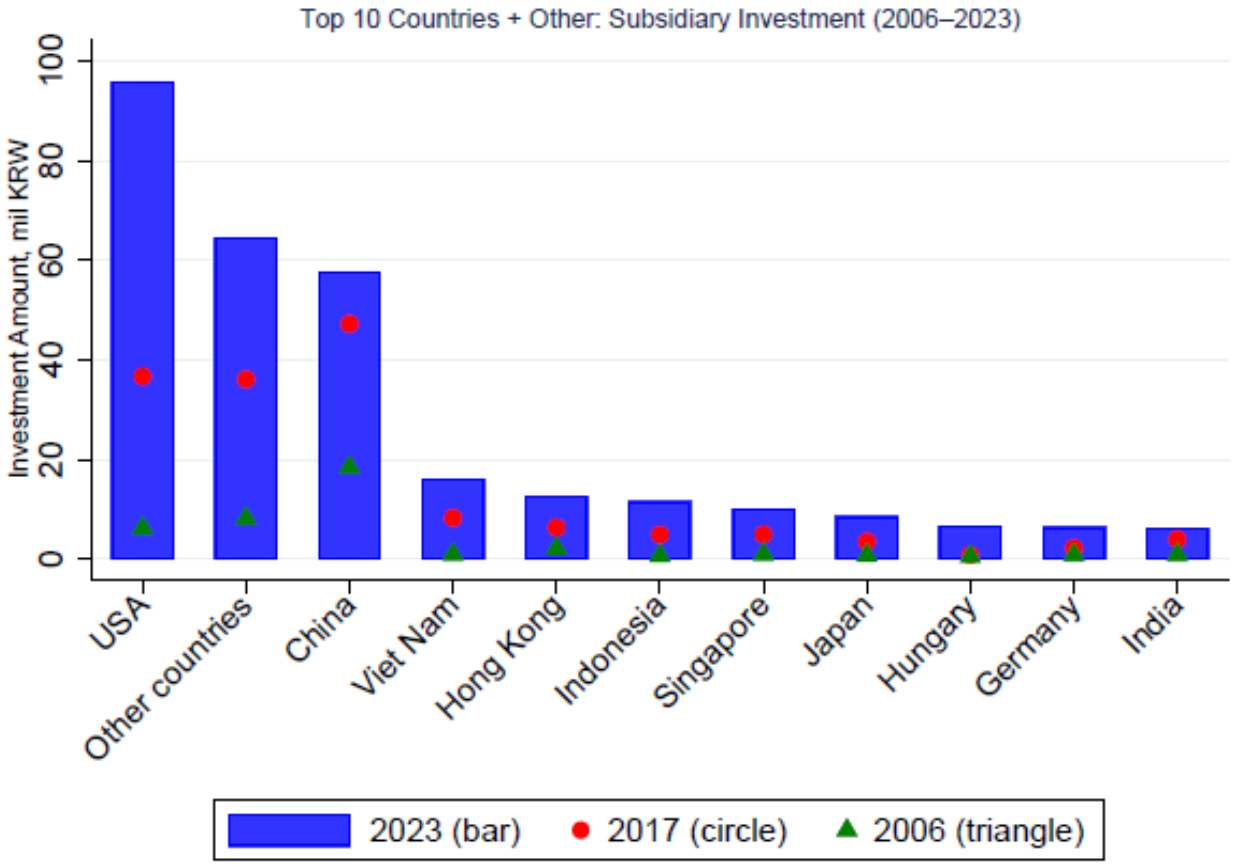
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Descriptives: Ownership



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Descriptives: Ownership Hosts



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Key Definitions

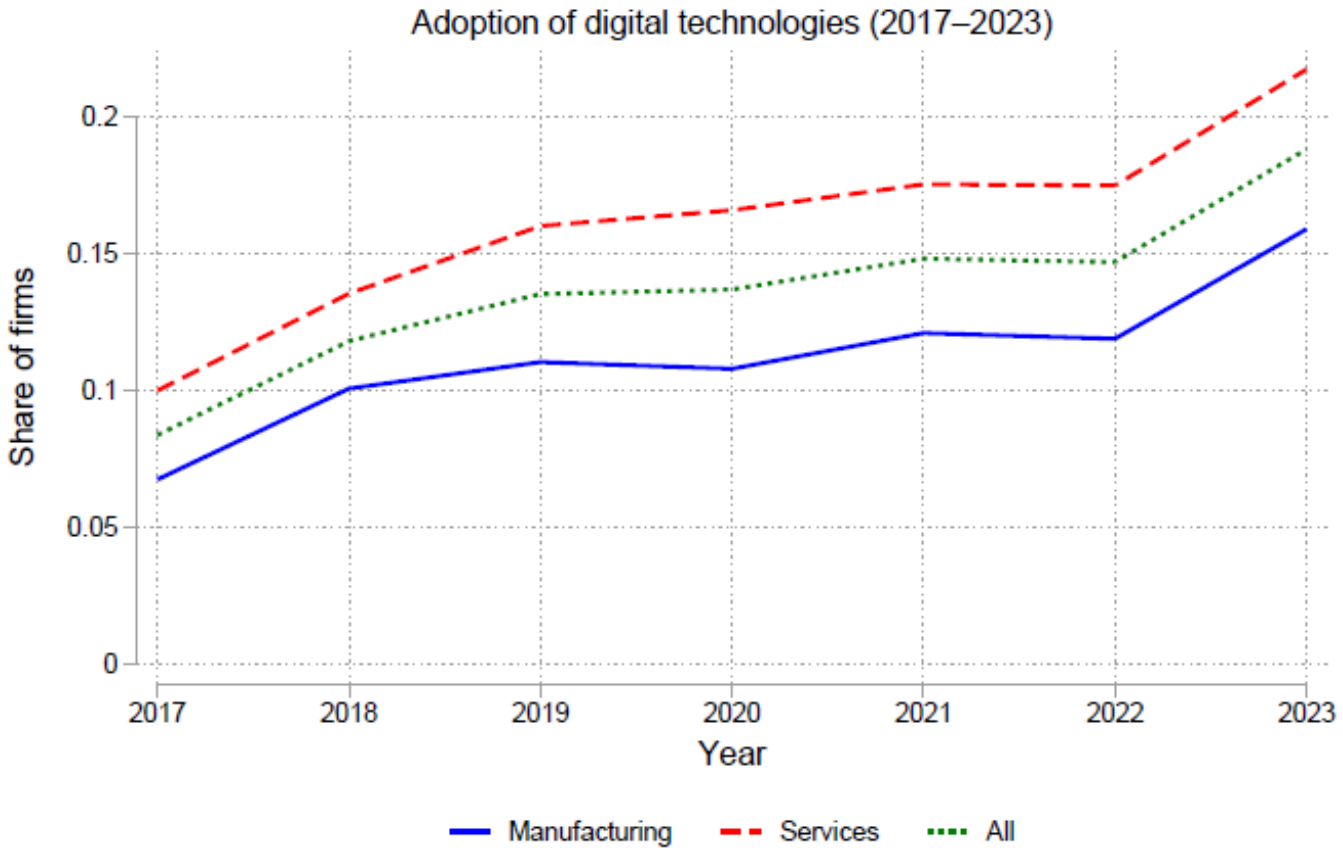
- The *Survey of Business Activities* offers detailed information on each firm's development and use of 9 different digital technologies.
- We consider digital technology adoption in the aggregate, and also follow OECD-G20 (2020), UNCTAD (2025), and Cho, et al (2023) to categorize functionally.

Mapping of UNCTAD (2025) Definition of Digital Economy to Survey of Business Activities Indicators

UNCTAD (2025)	Survey of Business Activities	This Paper
CORE		
ICT Infrastructure	Internet of Things	*Data Creation*
Telecommunications	5G Mobile	
ICT Equipment Manufacturing		
Foundational Technologies, software		
Data Centers	Big Data	
NARROW		
E-commerce		*Data Use*
Digital services and solutions	Blockchain	
Platform and Sharing Economy	Cloud Computing	
AI and automation services	AI	
BROAD		
Digitalized Agriculture		*Application of Technology*
Digitalized Manufacturing	3D Printing & Robotics	
Digitalized Services	AR/VR	

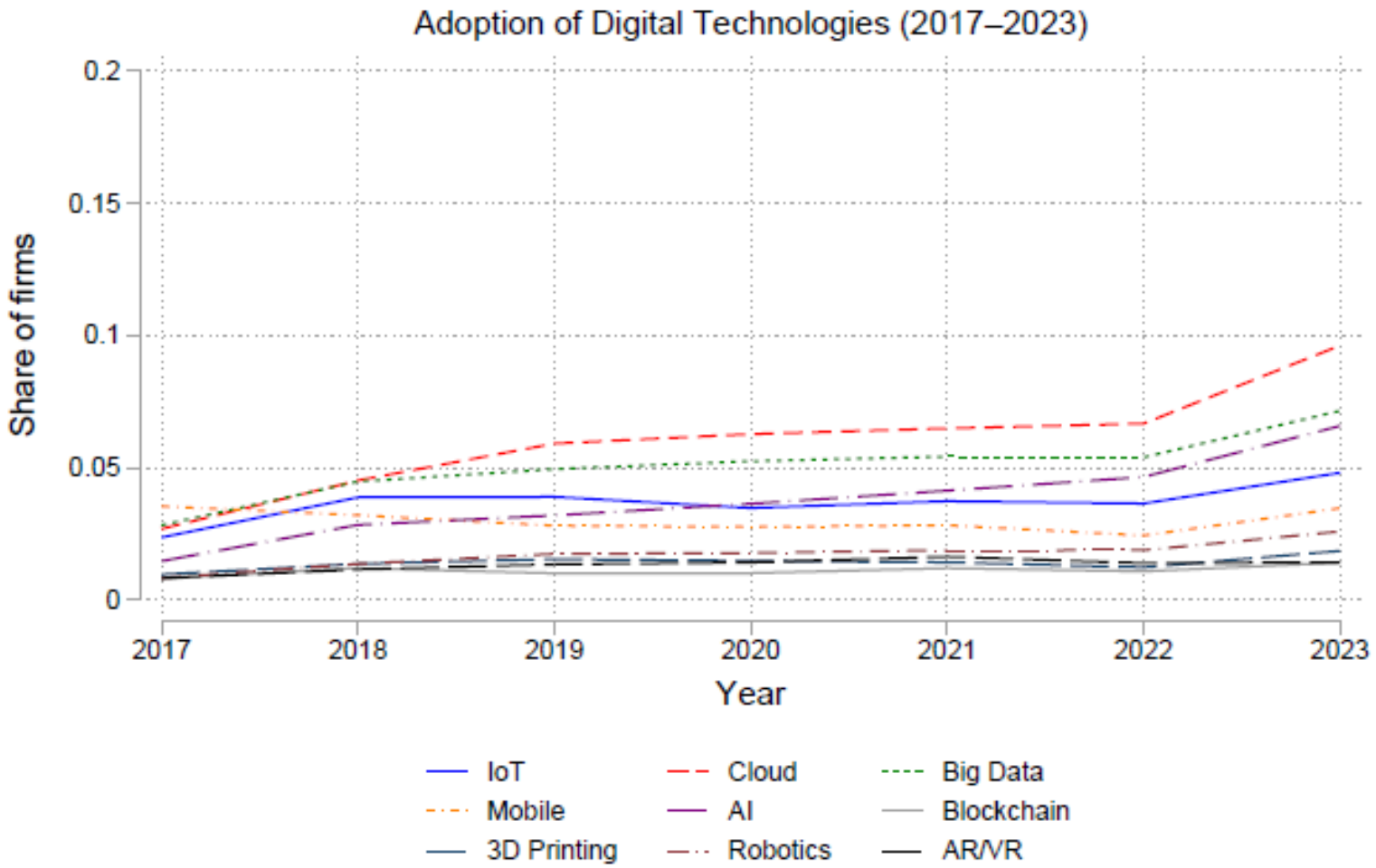
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Descriptives: Technology Adoption



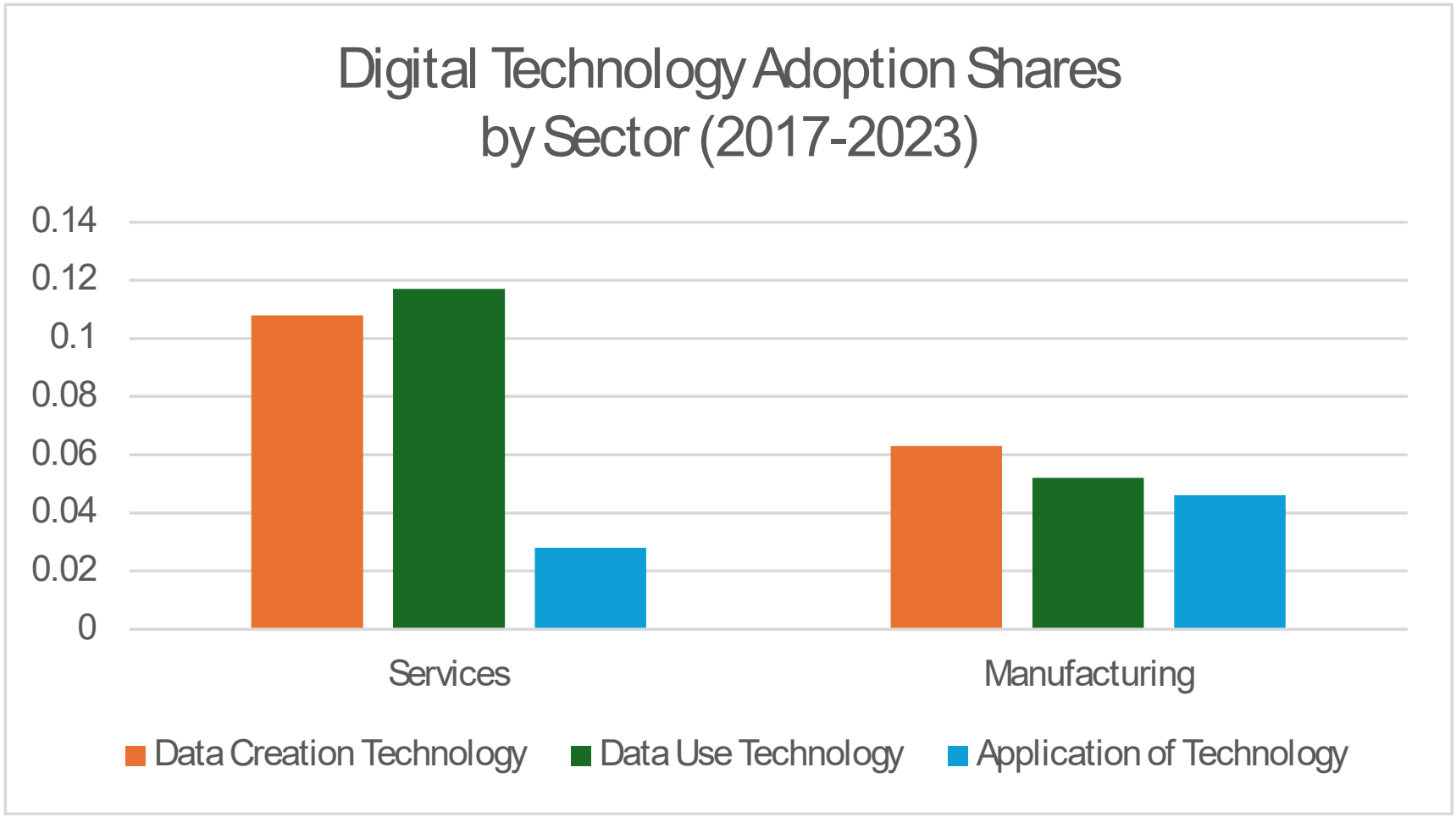
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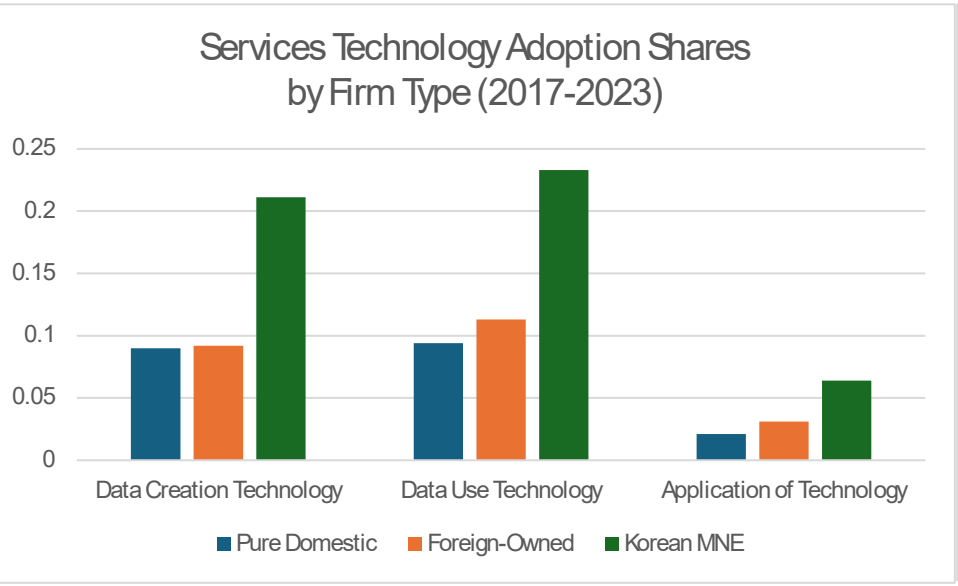
Descriptives: Digital Technologies

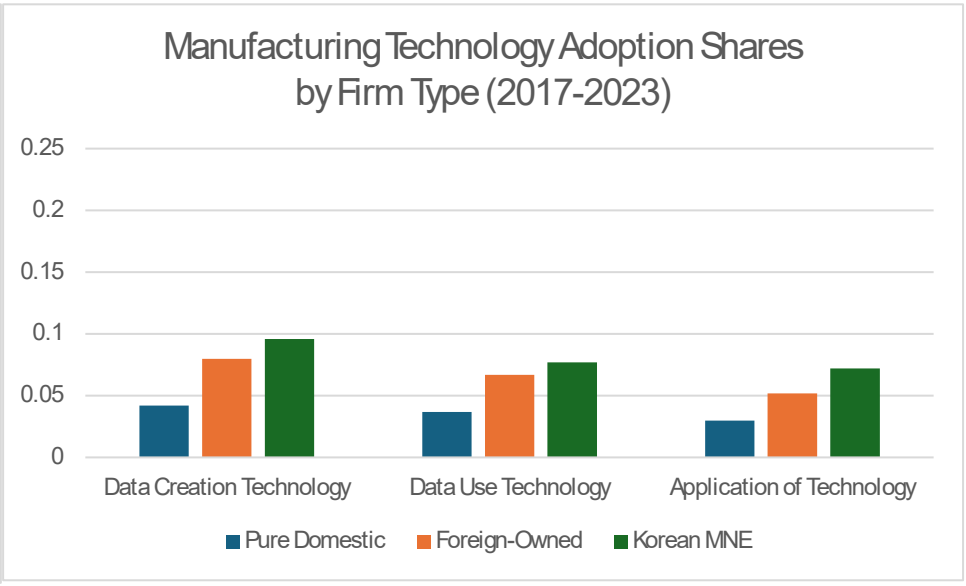


Note: *Data creation* technologies include: internet of things, 5G mobile, and big data. *Data use* technologies include: AI, cloud computing, and blockchain. *Application of technology* includes: robotics, 3D printing, and augmented/virtual reality.

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Descriptives: Technology Adoption by Firm Type





Note: *Data creation* technologies include: internet of things, 5G mobile, and big data. *Data use* technologies include: AI, cloud computing, and blockchain. *Application of technology* includes: robotics, 3D printing, and augmented/virtual reality.

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Empirical Strategy

- **Step 1**: assess the extent to which the adoption of digital technology is influenced by cross-border investment flows (across firms)

$$y_{jt} = \beta_1 KMNE_{jt} + \theta X_{jt} + \delta_{kt} + \varepsilon_{jt}$$

  - $KMNE_{jt}$: dummy for Korean multinational firm
  - X_{jt}: firm-size, foreign-ownership
  - y_{jt}: digital technology adoption, across 3 categories of digital economy
  - Include (subsector-by) year fixed effects; cluster standard errors at firm level

- Multinational firms are different from domestic firms in terms of size, productivity, average wages, and skill composition (Helpman, Melitz, and Yeaple 2004).

- We first assess *whether* foreign-owned and Korean MNEs are also different in terms of their technology adoption, once controlling for sector-specific trends.

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International investment and digital technology adoption: Results

Firm Type and the Likelihood of Technology Adoption

	(1) All Firms	(2) Manufact. Firms	(3) Services Firms	(4) Digital Sectors	(5) Non-Digital	(6) Digital Manufact.
			Adopted any technology (=1)			
Korean MNE =1	0.057***	0.031***	0.094***	0.079***	0.051***	0.036**
	(0.005)	(0.006)	(0.010)	(0.014)	(0.005)	(0.015)
			Adoption of AI (=1)			
Korean MNE =1	0.019***	0.006**	0.041***	0.025***	0.017***	-0.0001
	(0.003)	(0.003)	(0.007)	(0.009)	(0.003)	(0.007)
			Adoption of robotics (=1)			
Korean MNE =1	0.009***	0.002	0.010***	0.006	0.010***	0.009
	(0.002)	(0.003)	(0.003)	(0.004)	(0.002)	(0.007)
Sub-sector × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	86,232	43,128	43,104	14,940	71,292	7,521

Standard errors, clustered at the firm level, are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

- Korean MNEs are 5.7% more likely to adopt digital technologies, compared to purely Korean-operating firms
- Positive association is stronger
  - In services than manufacturing
  - In digital sectors than non-digital
- Positive association between firms investing abroad and AI adoption, esp. in services
- No difference between domestic and Korean MNEs in adoption of robotic technologies.

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Empirical Strategy

- **Step 2:** Can exposure to foreign direct investment encourage digitalization by pure domestic firms with no cross-border investment?

$$y_{jt} = \beta ShKMNE_{kt} + \theta_1 X_{jt} + \theta_2 X_{kt} + \delta_t + \varepsilon_{jt}$$

  - $ShKMNE_{kt}$: share of Korean MNEs in firm *j*'s subsector *k*
  - X_{jt}: firm-size, foreign-ownership
  - X_{kt}: control for 'traditional' foreign investment spillovers
  - y_{jt}: digital technology adoption, across 3 categories of digital economy
  - Include year fixed effects; cluster standard errors at sub-sector level

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Empirical Strategy

- Identification: Limit the sample to only those (always) pure domestic firms

- Typically—do foreign firms locate in sectors where productive firms are present? That is, productivity of domestic firms drives foreign (inward) investment.

- Our setting is different: we ask whether the (outward) investment of Korean MNEs influences the digital technology adoption of other Korean (purely domestic) firms
  - Possible scenario: MNEs are pushed to invest abroad if they are present in industries where Korean domestic firms are strong adopters of digital technology (competition effect)
  - That is, the digital technology adoption of domestic Korean firms is driving the MNE presence abroad. [not impossible, but less plausible]

- Future work: include lagged MNE presence, employ 'China shock'-esque instruments for outward investment.

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Digital technology spillovers to domestic firms: Results

	(1) All Firms	(2) Manufact. Firms	(3) Services Firms	(4) Digital Sectors	(5) Non-Digital	(6) Digital Manufact.
			Adoption of any technology (=1)			
Share of Korean MNEs	0.156**	0.268***	1.416***	-0.866**	0.088**	0.521
	(0.070)	(0.083)	(0.387)	(0.294)	(0.043)	(0.235)
			Adoption of AI (=1)			
Share of Korean MNEs	0.044	0.088**	0.600***	-0.382**	0.012	0.325
	(0.031)	(0.039)	(0.169)	(0.121)	(0.016)	(0.166)
			Adoption of Robotics (=1)			
Share of Korean MNEs	0.056***	0.048***	0.056***	0.021	0.060***	0.124
	(0.010)	(0.010)	(0.017)	(0.015)	(0.014)	(0.053)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Sub-sector×Year Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	53,624	23,194	30,430	8,237	45,387	3,304

Standard errors, clustered at the sub-sector level, are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

- Across all firms, a strong presence of Korean MNEs within the domestic firm's subsector is associated with increased digital technology adoption
- Presence of MNEs is more likely to support digital adoption in sectors that enhance production application, such as robotics.

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Digital technology spillovers to domestic firms: Results

	(1) All Firms	(2) Manufact. Firms	(3) Services Firms	(4) Digital Sectors	(5) Non-Digital	(6) Digital Manufact.
			Adoption of any technology (=1)			
Share of Korean MNEs	0.007	0.085	0.105	0.331	-0.040	0.771
	(0.109)	(0.084)	(0.228)	(0.183)	(0.081)	(0.490)
			Adoption of AI (=1)			
Share of Korean MNEs	0.076	0.020	0.164	0.281*	0.040	0.432
	(0.079)	(0.030)	(0.171)	(0.134)	(0.036)	(0.224)
			Adoption of Robotics (=1)			
Share of Korean MNEs	0.020	0.065**	0.032	0.076**	0.016	0.386
	(0.015)	(0.031)	(0.021)	(0.029)	(0.017)	(0.168)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time-Varying Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time-Varying Sub-sector Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	51,845	22,240	29,522	7,919	43,861	3,138

Standard errors, clustered at the sub-sector level, are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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Digital technology spillovers to domestic firms: Results

	(1) All Firms	(2) Manufact. Firms	(3) Services Firms	(4) Digital Sectors	(5) Non-Digital	(6) Digital Manufact.
			Adoption of any technology (=1)			
Share of Korean MNEs	0.113	0.146	0.212	0.371**	0.039	0.419*
	(0.111)	(0.108)	(0.212)	(0.149)	(0.069)	(0.142)
			Adoption of AI (=1)			
Share of Korean MNEs	0.037	0.019	0.085	0.158*	-0.001	0.100
	(0.056)	(0.030)	(0.124)	(0.080)	(0.031)	(0.047)
			Adoption of Robotics (=1)			
Share of Korean MNEs	0.012	0.041	0.025	0.094*	0.027	0.093*
	(0.029)	(0.077)	(0.041)	(0.049)	(0.031)	(0.029)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Time-Varying Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time-Varying Sub-sector Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,261	10,829	13,382	3,856	20,369	1,421

Standard errors, clustered at the sub-sector level, are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

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Conclusions & Next Steps

- When Korean firms invest abroad, local firms learn about new technologies and upgrade
  - This is particularly true for small firms in the digital sector
- Explore mechanisms further
  - Upstream versus downstream
  - Urban versus rural firms
- Across income and regional analyses (where investment occurs)
- Value of investment rather than binary indicator
- Number of distinct technologies adopted
- Attempts toward a deeper causal mechanism
  - Lagged FDI
  - quasi-exogenous shocks in exchange rates or tariff rates or ‘China-shock’
  - sibling identification following Kee (2015)

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