Downstream foreign MNEs and local suppliers' innovation in a dynamic environment: The moderating effect of network diversity[1]

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Abstract

This study investigates how the presence of foreign multinational enterprises (MNEs) in downstream sectors influences innovation in upstream local suppliers via backward linkages. Analysis using Korean Innovation Surveys shows backward linkages of foreign MNEs to have negative effects on local suppliers. While local suppliers operating in dynamic environments can avert negative effects, those locked in extant innovation networks continue to experience adverse effects. Our findings show that the effect of MNE presence on local firms should be evaluated in conjunction with given industrial changes and heterogeneous firm strategies.

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1. Introduction

When a multinational enterprise (MNE) conducts foreign direct investment (FDI) to establish foreign subsidiaries, they transfer knowledge assets to host countries (Buckley & Casson 2002). Some firm-specific assets then leak out, enlarging public knowledge pools for local firms and triggering endogenous chains of knowledge externalities (Caves 1974; Jaffe 1986; Lee et al. 2016). Following theoretical arguments, policymakers have sought to attract inward FDI and MNE activities with a view to promoting innovation performance in local industries.

With the degree of 'hard sell' surrounding FDI promotion, studies have sought to assess the effect of FDI on local firms and have identified different channels of externalities between foreign MNEs (origin) and local firms (recipient). In within-industry channels, FDI horizontally affects local firms via competition, demonstration and imitation, and labor turnover within the same industries (Blomström & Kokko 1998; Meyer 2004). In inter-industry channels, FDI vertically affects local firms through backward linkages from MNE subsidiaries (through purchasing inputs from upstream local suppliers) and forward linkages (through supplying inputs to downstream local customers) (Blalock & Gertler 2008; Girma et al. 2008; Orlic et al. 2018). Theoretically, local firms' gain from FDI is understood as learning opportunities via pecuniary and knowledge externalities from the channels (Breschi & Lissoni 2001; Zhang et al. 2010).

In this study, we specifically focus on the effect of FDI in the downstream sector via backward linkages on upstream local suppliers. Previous research has shown that inter-industry effects of downstream FDI via backward linkages are more evident than alternative intra-industry effects (Havranek & Irsova 2011; Iwasaki & Tokunaga 2016). Suppliers' innovation then has knock-on effects on technological competitiveness in the entire industry, supporting the key objective of FDI promotion (Terjesen et al. 2011). The direction of effects, however, is inconsistent; some studies report positive effects (Amendolagine et al. 2019; Blalock & Gertler 2008; Herrigel et al. 2013; Jude 2016; Mariotti et al. 2015; Spencer 2008), others negative (Girma et al. 2008; Matusik et al. 2019; Stojčić & Orlić 2020; Xu & Sheng 2012; Yamashita et al. 2014). Such inconsistency has generated calls for more research into the effect of FDI via backward linkages under heterogeneous conditions (Rojec & Knell 2018).

Our first objective is to examine whether the effect of downstream FDI via backward linkages can vary according to environmental dynamism, either high (dynamic environment) or low (stable environment). The strategic management literature shows that industrial conditions affect firms' strategy-making (Lawrence & Lorsch 1967; Miller & Friesen 1983). Likewise, MNEs adopt different strategies when environmental dynamism entails fast-paced and discontinuous industrial change (Chirico et al. 2011; Schilke 2014; Schmidt & Keil 2013; Sirmon et al. 2007). We will propose that in dynamic environments MNEs increase local embeddedness, strengthening backward linkages, mitigating the typical caveats of MNEs' local sourcing strategies and therefore offering more learning opportunities to upstream local suppliers. Past studies have attended to the differential effects of MNE presence by such industrial conditions as the host country's level of economic and institutional development (Alfaro et al. 2004; Meyer & Sinani 2009), an industry's technology intensity (Buckley et al. 2007; Keller & Yeaple 2009), the performance gap between MNE subsidiaries and local firms, and rivalry in the industry (Blomström & Woffle 1989; Findlay 1978; Kokko 1994; Perri et al. 2017) as factors that adversely affect local firms' motivation and capability to capture learning opportunities in the light of foreign MNE presence. Yet little attention has been paid to conditions regarding the rate and direction of industrial change and the implications for heterogeneity in MNE strategies.

We will also explore the moderating effect of network diversity. We will show how the effect of FDI in the dynamic environment may vary with a local supplier's ability to simultaneously align extant resources with new opportunities extracted from backward linkages (Ahuja & Katila 2004; Lavie 2007; Phelps 2010; Radosevic & Yoruk 2018; Zaheer & Bell 2005). Previous studies have suggested a local firm needs absorptive capacity to recognize, integrate and exploit FDI externalities (Blalock & Simon 2009; Girma 2005; Javorcik & Spatareanu 2008; Keller & Yeaple 2009). Recent empirical studies, however, have contradicted this (Jin et al. 2019; Marin & Sasidharan 2010), implying that extant resources and capabilities can represent a source of myopia, keeping local firms from learning new knowledge. Given that suppliers rely on network resources, we will explore whether extant network ties in particular can countervail positive effects of downstream FDI (Terjesen et al. 2011; Yan et al. 2017).

Our empirical analysis is based on four waves of the Korean Innovation Survey conducted in 2002-2010, combined with firm-level patenting data in 2002-2012. The survey records innovation activities in both foreign MNEs and local firms over a three-year period prior to survey, including the level of environmental dynamism. Its information about supply activities furthermore allows us to more precisely capture how FDI amongst local firms can bring greater exposure to backward linkages with potential foreign-owned customers. Our main analysis will use two matching samples – treatment group and control group – extracted based on propensity scores in order to address endogeneity bias. Further analysis will demonstrate the stability of the main result after applying instrumental variable estimation and alternative measurements of key explanatory variables.

This research makes several contributions. First, we will suggest that FDI in the downstream sector can have a negative influence on local firms, but that local firms operating under high environmental dynamism experience less negative effect. Reporting dynamic industrial changes as a boundary condition of FDI's effects is a new finding.

Second, we will propose a conceptual explanation that external dynamic industrial changes will trigger heterogeneous choices on firm strategy, such as different modes of MNE operation, which in turn will affect the degree of backward linkages that MNEs embed locally and the opportunities for local firms to learn through them.

Our third contribution is related to our finding of a potential lock-in effect for local firms in an extant network, where they may resist the learning opportunities in backward linkages. This contributes to our discussion of how a local firm can avert negative effects and capture positive effects from FDI to develop dynamic capabilities for survival in dynamic industrial changes.

The paper is structured as follows. The next section reviews the literature on interactions between FDI and local firms in host countries and develops hypotheses. Following the data and methodology section come the empirical results. We conclude with further discussion of findings, research contributions, and future research agendas.

2. Theory and Hypothesis Development

2.1. Backward Linkages of FDI

A firm's innovation builds on a public knowledge pool which includes other firms' innovation outcomes within an industry (Griliches 1992). As such, the presence of foreign MNEs can strengthen local knowledge pools by introducing new technological ideas, managerial practices and sales know-how to host countries (Blomström & Kokko 1998; Xia & Liu 2018; Zhang et al. 2014). Prior studies have examined how FDI by foreign MNEs can affect productivity in local firms in the short term (Chang & Xu 2008; Crescenzi et al. 2015; Fosfuri et al. 2001; Fu 2012; Zhang et al. 2014), and knowledge spillovers and management know-how can also boost local firms' innovation in the longer term (Cappelli et al. 2014; Conti et al. 2014; Herrigel et al. 2013; Weigelt & Sarkar 2009).

Recent studies have focused on the effect of FDI through backward linkages, where foreign MNEs are downstream buyers and local firms are upstream suppliers (Rojec & Knell 2018). By purchasing from local suppliers, MNEs can increase downstream knowledge pools for local firms to access (Crone & Roper 2001; Herrigel et al. 2013; Weigelt & Sarkar 2009). In addition to technological knowledge, MNEs can disseminate knowledge about international marketing and the know-how of coordinating marketing with commercialization of innovation output, design and production (Yam et al. 2011). Local firms can further tap into collective MNE-led oligopolistic networks to leverage innovation outputs (Dacin et al. 2007; De Propris & Driffield 2005; Gibbon et al. 2008; Morrison et al. 2008; Sako 2004).

The advantages from foreign presence can be summarized as a positive agglomeration effect leading to opportunities to learn how to innovate and commercially scale up innovation output (Driffield & Love 2007; Ivarsson & Alvstam 2010; Motohashi & Yuan 2010; Spencer 2008). The presence of foreign MNEs boosts new demands for locally-produced intermediate goods, opening the way for local suppliers to attain increasing returns to new product innovation (Puga 2010). Using marketing knowledge spillovers, local suppliers can better control uncertainty in the innovation process (Chadwick et al. 2015; Fu 2012; Siegel et al. 2019; Xin-gang et al. 2019). A local firm may no longer need to bind itself to home-domestic buyers: they can first become local suppliers for MNEs, and then pursue further buyer diversification to access international marketing opportunities.

The above prediction is made on the assumption that the operational mode of MNEs is fully embedded in local industries. However, this assumption does not always hold. MNEs can use a global production network, purchasing key components from strategic global partners, thereby dampening the potential for equivalent local sourcing (Girma et al. 2008; Motohashi & Yuan 2010; Rodriguez-Clare 1996; Xu & Sheng 2012). The propensity for global production networks has increased with preferential international trade agreements (Javorcik & Spatareanu 2011; Njikam & Leudjou 2019). Moreover, to prevent unwanted diffusion of their proprietary technology to local peers, MNEs locate their operations in locations remote from local-firm clusters (Alcácer & Chung 2007), and majority ownership is the establishment mode preferred for foreign operations (Javorcik & Spatareanu 2008). Limited local embeddedness can bring negative effects on upstream local suppliers' innovation if foreign MNEs increase competitive pressures amongst upstream suppliers, motivating suppliers to pursue short-term strategic gains such as cost reduction and imitation without serious organizational learning (Aitken & Harrison 1999; Xia & Liu 2018).

Further concerning the limitations of MNEs' backward linkages, other studies point out the intrinsic barriers to inter-firm knowledge transfer arising from a stickiness of knowledge from foreign origins. Even with close interactions with local counterparts via backward linkages, foreign MNEs can face difficulties in transferring the knowledge and management know-how imprinted in the MNE's home institutions (Spencer 2008). Adverse effects from imprinting are more acute in tacit and undocumented types of knowledge unless recipient and sender share organizational foundations (Kogut 1991). Knowledge stickiness increases learning costs in recipients of sophisticated knowledge from foreign sources, causing insignificant or even negative effects of FDI via backward linkages (Matusik et al. 2019).

The above review shows that the effect of FDI via backward linkages can be positive or negative. The next section will identify the heterogeneous environment of backward linkages from FDI (namely, environmental dynamism – stable or dynamic); until that point is established, we cannot determine whether positive or negative is likely to prevail. Thus, two alternative hypotheses are proposed:

Hypothesis 1a: *Downstream presence of foreign MNEs has a positive effect on the innovation performance of local suppliers in upstream sectors.*

Hypothesis 1b: *Downstream presence of foreign MNEs has a negative effect on the innovation performance of local suppliers in upstream sectors.*

2.2. Environmental Dynamism

To resolve the inconsistent effect of FDI, it is necessary to carefully specify a firm's heterogenous behavior in response to environmental contingencies (Rojec & Knell 2018). To further decompose the main effect, we now explore the effect of downstream presence of foreign MNEs on local suppliers as contingent on environmental dynamism.

Environmental dynamism is a concept addressing high-frequency changes and uncertainty about directions of change in a firm's external environments. A high velocity of change cascades serial opportunities and challenges, destabilizing a firm's information-setting and strategy-making (Fine 2000; McCarthy et al. 2010; Wirtz et al. 2007). For that reason, dynamism has been considered a key boundary condition to test a firm's dynamic capabilities (Girod & Whittington 2017), and is pertinent to the long-term effect of foreign MNEs on local suppliers' sustained growth (McCarthy et al. 2010). Prior studies, based on a knowledge-based approach, have assumed a short lifecycle as a cue for dynamism in other dimensions of external environments, such as markets, competition, regulations and institutions (Fine 2000; Jones 2003; Nadkarni & Narayanan 2007). This paper adopts this narrow definition of environmental dynamism, as our goal is to explain the effect of downstream FDI on a specific outcome of innovation performance.

Earlier, we discussed how the negative (positive) effect of downstream FDI is related to MNEs' local embeddedness and the way backward linkages operate. Environmental dynamism is an antecedent of an MNE's strategic choice on its degree of local embeddedness. When low environmental dynamism entails slow-paced and stable technological changes, MNEs use modular strategies based on extreme fragmentation and specialization across dispersed value-chain partners (Crone & Roper 2001; Gereffi

& Lee 2012). Local suppliers may be involved in standardized tasks of re-assembling intermediate goods with high-technology content imported from an MNE's other global suppliers (Javorcik & Spatareanu 2011).

Shallow local embeddedness of MNEs in a stable environment is illustrated in structured and directed formats of collaboration with local suppliers. In a stable environment, MNEs focus on regulating how to communicate pre-planned standardized tasks to suppliers, as the slow tempo of emergent challenges and opportunities do not require continuous fine-tuning of tasks. Supplier participation in problem identification and solution development is limited (Von Krogh et al. 2012). Suppliers are often expected to have already completed the 'learning-before-doing' process on their own before joining the MNE's value network (Alcacer & Oxley 2014; Pisano 1994). The features of collaboration in stable environments resonate with previous studies about when backward linkages have negative effects (Girma et al. 2008; Mariotti et al. 2015; Merlevede et al. 2010; Motohashi & Yuan 2010).

In dynamic environments, however, MNEs focus on continuous knowledge creation, and thus apply spontaneous and interactive processes of collaborations with local suppliers. In dynamic environments, tasks need to be updated continuously to address the fast-moving nature of problems and solutions. Returns from innovation can come in short bursts of commercial success; hence, returns from spontaneous knowledge creation and continuous innovation should increase (Hambrick, 1983). MNEs need to preempt their rivals in technology changes (Mendelson & Pillai 1999). These changes motivate MNEs to apply spontaneous collaboration, which invites local suppliers to tackle urgent problems in a creative manner (Eisenhardt & Martin 2000). The transition from a structured to a spontaneous approach to local supplier engagement may entail decentralized leadership in MNEs, meaning that MNEs' local units may be able to forge spontaneous local collaboration autonomously (Beugelsdijk & Jindra 2018; Von Krogh et al. 2012). The positive effects of backward linkages, as illustrated in previous research. are realized through such a collaboration process in dynamic environments.

Greater local embeddedness resulting from the transition from structured to spontaneous local collaboration in a dynamic environment can mitigate the negative effect of backward linkages. Owing to a need for greater flexibility, MNEs offer greater interactive learning opportunities for suppliers in a dynamic environment; they stop demanding learning-before-doing and favor spontaneous learning-by-doing (Pisano 1994). Suppliers can acquire greater bargaining power over MNEs, enabling a supply-pushing rather than demand-pulling strategy (Jones 2003). In the light of MNEs' increased engagement of suppliers, suppliers can attain increasing returns to production of new technology and application to new products (Godart & Görg 2013; Puga 2010). In summary, we propose a positive moderating effect of environmental dynamism on the effect of FDI via backward linkages:

Hypothesis 2: *Positive effect from downstream presence of foreign MNEs is increased in a dynamic environment.*

2.3. Network Diversity

We have discussed how the negative effect of FDI via backward linkages is related to MNEs' local embeddedness and knowledge stickiness. The former can be addressed in a dynamic environment; but even in a dynamic environment, knowledge stickiness can remain an issue if local firms are locked in an infertile context that impedes the process of knowledge transfer from downstream foreign MNEs (Szulanski 1996).

Network diversity refers to how having different types of network partners can have a significant impact on a supplier's innovation processes. When key knowledge is unevenly distributed across different sources, a diverse network allows a supplier to access useful knowledge, such as products in a buyer's portfolio, pricing information in competitors, solutions for customer needs in other suppliers, and market information from professional service providers and other institutional partners such as research centers, universities, or business associations (Sofka et al. 2014; Terjesen et al. 2011; Yan et al. 2017). Thus, the extent to which they can tap into different networks simultaneously and leverage complementarity and compatibility is related to suppliers' cumulative relational capabilities (Eapen 2012; Gulati 1995).

Network diversity positively influences absorptive capacity to absorb and apply acquired knowledge for innovation activities (Tsai 2001). At the same time, network diversity is a source of inertia in a supplier's motivation and capacity to accept and retain knowledge transferred from downstream MNE customers. We predict the latter's effect will be stronger than the former in dynamic environments where fast-moving nature of challenges and opportunities in an industry increases managers' tendency to use heuristics to quickly judge the value of knowledge. According to imprinting-effect theory, the founding network conditions can cause managerial bias towards choosing knowledge accumulated within existing networks rather than external alternatives (McEvily et al. 2012). When knowledge passed on by foreign MNEs comes from outside the network and is imprinted with its origins in different cultural institutional and organizational contexts, such managerial bias can initiate a 'not-invented-here' attitude that rejects the alien knowledge (Antons & Piller 2015). The reduced motivation can lead a recipient's cognitive system to filter out promising new knowledge and the incentive to capture it. Aside from the cognitive factor, the imprinting factor can constrain a supplier's capacity to implant new knowledge acquisition within its extant knowledge creation system (Spencer 2008). In a dynamic environment, such investment decisions involve high risk, given the lack of time to assess information asymmetries and opportunism in forging collaboration with the knowledge's source (Haeussler et al. 2012). In this case, it is more valuable for a local supplier to focus on exploiting existing network-based resources. Collaboration with existing network partners who share common practices in learning and exploration can be a more reliable way to address rapid change or resource gaps in dynamic environments (Dacin et al. 2007; De Propris & Driffield 2005; Gibbon et al. 2008; Morrison et al. 2008; Sako 2004); local suppliers need not bother to address knowledge stickiness and instead focus on aligning extant networks with dynamic industrial changes (Gorodnichenko et al. 2014).

Based on preferences for familiar knowledge from extant network resources over foreign sophisticated knowledge, we propose a negative moderating effect of extant network diversity, as follows:

Hypothesis 3: *The positive effect of downstream presence of foreign MNEs in a dynamic environment is attenuated if local suppliers have developed diverse network ties.*

3. Methodology

3.1. Data

This study uses data from South Korea, where inward FDI flows have been rising recently. Following the 1997-98 Asian financial crisis, proactive incentives were introduced to attract inward FDI, such as tax reductions, cash grants and industrial clusters for foreign MNEs. As a result, the share of inward FDI stocks in gross domestic product returned to pre-crisis levels in 2002, and continued to rise during our observation period, according to UNCTAD FDI Statistics. In annual reports by Korea's Ministry of Trade, Industry and Energy (MOTIE), the ratio of foreign-invested firms in total manufacturing R&D expenditures reached 8.3% in 2004 before declining to 5.7% in 2018 (MOTIE Various). While the level of foreign presence in South Korea is low compared with other non-triad economies, previous studies have reported statistically significant effects of backward linkages between foreign MNEs and local firms in South Korea, although some results have been mixed (Matusik et al. 2019; Sun et al. 2017).

South Korea is a pertinent context in which to examine backward linkage effects contingent on dynamic industrial changes. Matusik et al. (2019) found the country displays idiosyncrasies in the mechanism of backward-linkage effects that were not detectable in other countries they considered. This is because South Korean suppliers are highly motivated to capture learning opportunities in global value chains (Mathews 2006). At the same time, South Korean firms have recently increased their bargaining power in relationships with foreign counterparts (Gereffi 2014), and thus can consider various options in the light of dynamic industrial changes. South Korean suppliers are also increasingly diversifying target customers as a growth strategy to address high environmental dynamism (Jones & Lee 2018).

For data construction, we combined various sources. The Korean Innovation Survey, published every two or three years by Korea's Science and Technology Policy Institute on behalf of Statistics Korea, records firm-level factors of innovation in manufacturing industries for the three years preceding each survey. Its questionnaire design and data collection follow the format of the EU's Community

Innovation Survey and the OECD Oslo Manual. We use four waves of the survey, conducted in 2002, 2005, 2008 and 2010.

To identify the potential local beneficiaries of backward FDI spillovers, we specifically extracted local firms that had generated sales from transactions with any downstream buyers, and were under domestic ownership. Both sets of information were obtained from firms' responses to survey questions. As a result, the initial sample is based on 2,852 usable observations.

We also gathered individual firms' patent counts from the Korea Institute of Patent Information (KIPO). Additional data, pertaining to the innovation environment in the region and the industry of local suppliers, were extracted from the OECD database.

3.2. Variable specification

3.2.1. Dependent Variable

This study uses the local supplier's innovation performance as the dependent variable. This is measured by the total number of patents filed in South Korea and foreign countries. Patents can be counted based on patent applications or patents that are granted after passing inspection. While the record of patent grants allows research to focus on valuable patents, it can also omit rejected patent applications, i.e. early-stage output to be later upgraded (Gittelman 2008). Thus, this study considered patent application as a proxy for innovation output, to avoid underestimating the actual level of innovation activities that are not patented (Nagaoka et al. 2010). As the Korean Innovation Survey covers a firm's innovation activities over a three-year period, we counted patent applications in three-year periods.

Through patent counts, we focus on innovation outcomes concerning the number of innovation projects that are completed, successful delivery of managerial attention to innovation, and the extent of strategic choice in protecting self-created intangible assets in a firm (Fu et al. 2011; Salomon & Shaver 2005; Vanhaverbeke et al. 2015). We acknowledge that there are other aspects of innovation outcomes, such as new-to-market knowledge and commercial success of the firm's inventions, which are better measured by full patents granted, sales shares based on new inventions, and other alternative measures (Guellec & de la Potterie 2000; Lee 2013; Radosevic & Yoruk 2016). Furthermore, patent is hardly a perfect measure, as many innovations are pursued without patents. Thus, it is noted that our results should not be extrapolated beyond the scope of our research motivation.

3.2.2. Independent Variables

To estimate the effect of foreign presence in a local firm's downstream sectors via backward linkages, we adopt the measurement by Javorcik (2004). This measure captures the sum of downstream foreign presence in all other industries which purchase outputs from the local firm's own industry, after weighting it by the degree of backward linkages between other industries and the local firm's own industry. This indicator has become a standard measure of spillovers from downstream FDI in the literature (Jude 2016; Stojčić & Orlić 2020). The use of a measure consistent with the literature allows comparison of our findings with prior research.

The step-by-step of derivation of our main measurement is explained as follows. The first step was to calculate horizontal foreign presence within individual industries as the ratio of foreign MNEs within the sector (See Eq. 1). It captures the ratio of MNEs' local activities that are direct sources of knowledge externalities for local firms (Barrios et al. 2011; Gorodnichenko et al. 2014). We calculated foreign presence in terms of innovation activities, as innovation is more associated with knowledge spillovers than employment and sales or other operational activities (Knott et al. 2009).

$$Horizontal\ Foreign\ Presence_{kt} = \sum_{i=1}^{m}(Dummy\ for\ Foreign\ \times R\&D\ Expenditures_{it}) \Bigg/ \sum_{i=1}^{m} R\&D\ Expenditures_{it} \tag{1}$$

Next, the total presence of foreign MNEs in industries that are downstream to a local supplier *i*'s industry was weighted by backward linkage coefficients (See Eq. 2). The backward-linkage coefficient is derived from the OECD's input-output data and refers to the ratio of the local supplier's industry *j* in the total purchases made in industry *k*. The higher that foreign MNEs' total R&D activities are within *k* industries in the given year *t*, and the greater the industries' linkage coefficients are with industry *j*, the more that local firms are exposed to the impact of downstream foreign-MNE activities.

$$Downstream\ Foreign\ Presence_{it} = \sum_{k,k \neq j}^{n} (BackwardLinkages_{jkt} \times\ Horizontal\ Foreign\ Presence_{kt}\quad)$$

(2)

To estimate network diversity in a local supplier (*Network*), we counted the types of ties with which the local firm had developed tight relationships (Laursen & Salter 2006). More specifically, we first referred to the innovation survey's question, 'During the past three years, how important to your firm's innovation activities were each of the following information sources?', concerning eight network ties: (1) competitors or other firms in the same industry, 2) suppliers, 3) customers, 4) private research centers or business-service providers, 5) new skilled workers, 6) universities, 7) public research centers, 8) business associations for innovation performance. The responses were recorded based on a five-point Likert scale (zero being not relevant, five the most important, and one the least important). We counted the ties that received a score of five within each firm. Firms with the most diverse network ties were assigned eight, and those with no network ties zero.

We also measured whether a local firm operates in a dynamic environment (*Dynamism*) based on the average lifespan of a firm's new knowledge (Fine 2000; Jones 2003; Nadkarni & Narayanan 2007). Data is based on self-reported responses by firm managers to a question in the Korean Innovation Survey: 'what is the average lifespan of new knowledge the firm has developed from innovation activities?'. The longer the lifespan, the more years the knowledge remains useful. Following Nadkarni and Naryanan (2007), those reporting a knowledge lifespan of less than three years were classified as operating in a dynamic environment, those reporting three years or longer as operating in a stable environment. Our measure is subjective perception of environments, as a firm's response to environmental dynamism depends on managers' subjective interpretation of various market information (Carillo 2005; Duncan 1972).

3.2.3. Control Variables

R&D Intensity is R&D expenditure per employee and captures a local supplier's internal resource profile. *Regional Spillovers* is the rate of inter-firm co-patenting activities in the firm's region. *Competition* is the Herfindhal index and captures industry characteristics in terms of industry-level competition.

3.3. Estimation Strategy

This study notes potential endogeneity bias. First of all, there could be a bias due to latent factors simultaneously correlating with the moderating variable (Dynamism) and dependent variables (Local Supplier Innovation). For instance, there could be an influx of companies strategically selecting stable (dynamic) sectors, and this could bias our report of the moderating effect of environmental dynamism on downstream foreign-MNE presence. Therefore, we use a matched sample composed of two equally-sized groups of firms – one in a dynamic environment (treatment group, where the effect of environmental dynamism is delivered) and the other in a stable environment (control group, where the effect of environmental dynamism is not delivered), to control for any systematic differences between firms in stable and dynamic environments. The matching process is based on the one-to-one nearest-neighbor matching (Guo & Fraser 2014). The main regression analysis for the hypothesis testing will be based on the matched sample.

The detailed process is managed by STATA's *psmatch2* code. In Step 1, the STATA code derives the propensity scores for each individual case, using a logistic regression model about a firm's allocation to a stable or dynamic environment. The logistic regression contains the covariates of a firm's employment, industry affiliation, horizontal foreign-MNE presence and R&D capacity (R&D personnel divided by total staff), as reported in Table A.1 (See Appendix). This matching criteria is developed based on Estrin et al. (2016). From this process, propensity scores are obtained. In Step 2, in order to address potential systematic differences between the two environments, STATA identified pairs which have close propensity scores but are assigned to different groups, i.e. treatment group (Dynamism=1 for a dynamic environment) or control group (Dynamism=0 for a stable environment). As a result, a matched sample is formed, containing 373 in a dynamic and 373 in a stable environment. In Step 3, we check that the profiles of the two groups are well balanced, by generating the balancing table in Figure A1 (See Appendix).

Another bias is reverse causality. Unobserved factors can disturb the main causality by simultaneously affecting the dependent variable of local suppliers' innovation and the independent variable of downstream FDI. The effect of MNEs' managerial insight about the future outlook is a well-known example of such a bias: MNEs selectively operate in a sector where they expect local firms will actively innovate or industry-wide trends will drive innovation. Without addressing such reverse causality, supplier innovation and level of FDI in the same year can be associated without causal interactions. To address this, we inserted the growth of local suppliers' innovation outputs from the preceding period as a control variable to consider any unobserved unit-level initial trend, as well as fixed effects by year and industry ('a_{it}') to address macro-level trends (Brancati et al. 2018). We also used the lagged value of the dependent variable over the three years after FDI activities, to allow for a delay of backward linkages' effect on local-firm innovation and reduce the reverse effect from the dependent to the independent variable (Crescenzi et al. 2015; Haskel et al. 2007). As a result, our model is summarized as Eq. 3, where t is a three-year period of each survey wave.

$$\text{LocalSupplierInnovation}_{it+1} = b_0 + b_1\text{InnovationGrowth}_{it} + b_2\text{DownstreamForeignPresence}_{it} + b_n\Sigma\ \text{ControlVariables}_{nit} + a_{it} + e_{it} \quad (3)$$

The main regression is with the dependent variable of the count of patents filed. Thus, models are estimated by a negative binomial regression with robust standard error. All regression results show that over-dispersion parameters are significantly greater than zero. In this case, an alternative estimation based on a Poisson regression would suffer from an over-dispersion issue, and this reaffirms that the negative binomial regression is appropriate.

4. Results

4.1. Main Analysis

Table 1 shows descriptive statistics and a correlation matrix. Low-correlation coefficients indicate that the penultimate models do not have a multicollinearity problem.

Insert Tables 1 and 2 about here

Table 2 reports the regressions against a local firm's innovation performance. In Model 1, which is the baseline model, *R&D Intensity* has a positive and significant effect on a local firm's innovation, while *Network* does not. This means that in the matched sample, their differential innovation performance is primarily explained by internal rather than external resources. The negative effects of *Competition* and *Dynamism* indicate increasing barriers to innovation in highly competitive and dynamic environments. *Regional Spillovers* is positive and significant, implying that geographical proximity to external knowledge source is critical to a firm's innovation strategy.

H1a and H1b suggested positive and negative effects of foreign MNEs through backward linkages. From Model 2, we find *DFP* to be negative and statistically significant (b=-1.538, p<0.01). This finding suggests that increasing foreign-MNE presence in the downstream sector is associated with a reduction in local suppliers' innovation. Therefore, H1a cannot be accepted, and H1b is supported.

H2 is about the backward linkage effect in dynamic environments. In Model 3, the coefficient for *DFP* x *Dynamism* is positive and statically significant (b=1.844, p<0.05). In the same regression, the coefficient of *DFP* now represents the effect of backward linkages in a stable environment, and it is negative and statistically significant (b=-2.137, p<0.01). This indicates that in a dynamic environment foreign MNEs generate more positive effects than negative ones via backward linkages. Thus, H2 can be supported.

H3 concerns the effect of backward linkages in a dynamic environment, given high network diversity. According to Dawson and Richter (2006), the three-way interaction model requires three two-way interaction terms.[2] Thus, we entered *DFP x Network* and *Network x Dynamism* as two additional control variables. In Model 4, we find the coefficient for *DFP x Dynamism x Network* is negative and significant (*b*=-3.013, *p*<0.01). Thus, H3 can be accepted, meaning that under high environmental dynamism the drawbacks of backward linkages from foreign MNEs increase if the local firm has already established sufficient network diversity.

4.2. Further Analysis

We tried an alternative remedy for endogeneity bias arising from omitted factors, by estimating the main model after instrumentalizing *DFP*. An instrumental variable should be correlated with *DFP* but not with the model's dependent variable. Following other studies, we used the growth rate of net FDI inflows in the US as the instrumental variable, as FDI in the US can be correlated with that in South Korea via MNEs' global strategy, but cannot be correlated with local firm performance in South Korea (Jordaan 2011; Xu & Sheng 2012). For the model estimation, we followed Wooldridge's (2015) control-function approach, as our negative binomial function is a nonlinear endogenous model. In Table 2, Model 5 reports the directions of coefficients to be consistent with those of the main model.

We also tested main variables using alternative measurements. In Model 6 we tested the model using the growth rate of *DFP*, in place of the original measure of its level. The result is still consistent with the main result. In Model 7 *Network* is measured by the count of all ties in a local firm regardless of the ties' strength, while our original measure counted only ties with tight relationships. All other results are the same, but *DFP x Dynamism x Network* is no longer significant. This means that the moderating effect of *Network* may be sensitive to how network diversity is measured. Moreover, local

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[2] When Z is an independent variable, W is the first moderator and X the second moderator, and the three-way interaction regression is expressed as $Y = (b_0 + b_2Z + b_3W + b_6ZW) + (b_1 + b_4Z + b_5W + b_7ZW) X + e$. This means the model requires three two-way interaction terms.

Regressions containing multiple interaction terms commonly have issues due to potentially high multicollinearity. There are remedies (such as the use of mean-centered, z-standardized values) but then interpretation of results will be difficult (Dawson 2014). Therefore, we acknowledge a potential multicollinearity issue as our design of a three-way interaction regression.

firms with diverse and shallow networks can escape the knowledge stickiness issue to benefit from backward linkages in a dynamic environment, while those with diverse and deep networks experience a negative effect due to a learning myopia. In Model 8, we measured the dependent variable using the count of patents granted instead of patent applications. The directions of coefficients in the main variables are consistent with those in our main result.

In order to more precisely interpret the interaction terms in the main model, we drew graphs (Figures 1 and 2). The figures depict the effect of FDI in downstream sectors via backward linkages in stable and dynamic environments. The x-axis is levels of DFP, where values are expressed, following Zhang et al. (2014), as Low DFP (the mean minus a standard error) and High DFP (the mean plus a standard error). The y-axis is the predicted innovation performance of a local supplier. In Figure 1, the line is flattened in dynamic environments, while it has a steep negative slope in stable environments.

Insert Figures 1 and 2 about here

In Figure 2, the four lines represent the four types of local suppliers by scope of network and level of environmental dynamism. "Dynamic, High Network" is a flatter, less negative slope than "Stable, High Network". In other words, there is a positive moderating of environmental dynamism that offsets negative standalone effects from downstream foreign presence when network's effect is controlled. "Dynamic, High Network" has a steeper negative slope than "Dynamic, Low Network". This means there is a negative moderating effect of network of DFP's effect in a dynamic environment. Overall, we conclude that all graphs are consistent with the regression coefficients of the key interaction terms.

5. Discussion and Conclusion

5.1. Discussion of Findings

This study examines the effect of FDI in the downstream sector on local suppliers' innovation via backward linkages. We consider the contingency effects of environmental dynamism, which can cause shifts in MNE strategy and local embeddedness, and the extent of a local firm's network, which can affect its motivation to accept and learn from knowledge rooted in incompatible organizational foundations.

Our first finding is that without taking environmental contexts into consideration, the overall effect of FDI via backward linkages on local supplier innovation is negative. Most prior studies predict a positive effect, given that direct and indirect ties of downstream buyer-upstream suppliers serve as a route of knowledge dissemination (Spencer 2008). A smaller number of studies predict a negative effect in a host country with an advanced local manufacturing base (Havranek & Irsova 2011). Our finding conforms with the latter. As a theoretical analysis, we suggest that the negative effect is related to limited local embeddedness of MNEs and stickiness of sophisticated knowledge. Limited local embeddedness is related to MNEs' global production strategies, which substitute local sourcing with global sourcing, and require local suppliers to learn-before-doing to service MNE contracts, rather than offering opportunities for learning-by-doing to absorb sophisticated knowledge. The knowledge that suppliers in advanced host countries will seek is often tacit and undocumented and heavily imprinted with foreign contexts, hence causing stickiness in the international knowledge transfer process.

Our second finding shows that the effect of backward linkages varies with the level of environmental dynamism, whether high (dynamic) or low (stable). Previous studies have focused on industries' static characteristics − such as the distance of local firms from technology frontiers being too far or too narrow − as contingency factors (Buckley et al. 2007). Our analysis is different, but can complement those studies by proposing that not just the presence of foreign MNEs but also the nature of industrial change can affect take-up (Eisenhardt & Martin 2000; Pisano 1994). We suggest dynamic industrial changes can reduce the negative effect of foreign presence on local suppliers, as environmental dynamism is a key antecedent of MNEs' decisions on supplier engagement. In dynamic environments MNEs spontaneously define tasks in response to fast-moving external environments and invite their local suppliers to participate in the identification of novel solutions. Thus, in a dynamic environment MNEs increase local embeddedness to provide more opportunities of learning-by-doing for their local suppliers.

We also found that the negative effect of backward linkages can be increased, even in a dynamic environment, if a local supplier relies on extant network ties for innovation. Prior studies have reported difficulties for local firms in acquiring foreign knowledge, despite linkages and the firm’s internal absorptive capacity (Jin et al. 2019; Matusik et al. 2019). We are in agreement with these, by reporting that the negative effect of FDI increases when a local supplier operates networks that are tightly connected. In line with our earlier explanation, we propose that local suppliers develop myopia from an imprinting effect of initial conditions in tight networks and are weakly motivated to overcome the stickiness of alien knowledge, and this can impede acquisition and integration of new knowledge from outside the current network.

5.2. Contributions

This study makes the following contributions. First, our findings contribute to the literature by investigating conditions under which FDI via backward linkages positively (negatively) affects local suppliers’ performance. In previous studies, FDI effect varies according to static industrial conditions, such as an industry’s technological intensity or the level of institutional development, neglecting dynamic industrial changes. By identifying industrial change as a key context, we can discuss FDI’s role in shaping dynamic capabilities for sustainable growth in local firms (Schilke 2014). As many countries attract FDI while simultaneously undergoing industrial changes in terms of both rate and direction, our study contributes an empirical analysis addressing a timely topic.

Our second contribution is to complement knowledge about firm heterogeneity in the mechanism of FDI effects. FDI effect is related to the operational modes of foreign MNEs that require differing degrees of local embeddedness (Havranek & Irsova 2011; Rojec & Knell 2018). After contrasting different levels of MNEs’ local embeddedness according to environmental dynamism, we could zoom in on the type of learning opportunities that foreign MNEs offer and how these may or may not fit into learning requirements that are diversifying as local suppliers climb the ladder of industrial upgrading. Thus, our contribution is towards ongoing efforts to understand firm-level heterogeneity in the mechanism of FDI's role in local firms' dynamic learning (Chang & Xu 2008; Crescenzi et al. 2015), striking a balance with the macro-perspective.

We also draw attention to myopia that can reduce local firms' motivation to learn from new, tacit and undocumented knowledge from outside familiar local networks. While previous research has focused on internal absorptive capacity as a condition for local firms to benefit from FDI spillovers (Jin et al. 2019), supplier innovation literature has revealed that an external network's structure influences supplier performance, complementing poor internal resources and also locking a firm in the network. Our result further extends this proposition, by highlighting that dynamic capability-building in dynamic environments involves complex alignment of knowledge learned from FDI, internal and external resources (Girod & Whittington 2017).

5.3. Practical Implications

In manufacturing clusters, local suppliers used to enjoy exclusive relationships with focal firms in home-grown value chains. However, recent examples show that home-grown focal firms lose competitiveness or diversify their supply chains in a global context, rendering obsolete the value of exclusive relationships in supplier growth. Regulations may also change, in classifying exclusive relationships between buyer and supplier as vertical collusion. In this context, a local supplier may pursue customer diversification, incorporating foreign MNEs in the downstream sector. Our finding implies that this strategy is more likely to work in industries experiencing dynamic change. Furthermore, a local firm needs to avoid over-reliance on a diverse knowledge network for telescopic learning and exploration.

For MNEs purchasing locally, any resulting supplier innovation can have a knock-on effect on MNE performance. Suppliers are increasingly involved in buyer-firms' innovation and product development. In this context, supplier innovation has received increasing attention in recent studies due to its role in downstream buyers' strategies to generate competitive advantages (Weigelt & Sarkar 2009).

As our findings show, an MNE can positively affect supplier innovation by offering opportunities for learning-by-doing, while learning-before-doing can dampen it. Thus, we suggest that MNEs flexibly switch from traditional structured supplier supports to supplier-integration strategies, highlighting spontaneity and dynamic learning-by-doing.

This study also has a policy implication in that governments may differentiate promotional policies for downstream activities of foreign MNEs in the light of different industrial changes. The conventional classification of firms by industry neglects variance within an industry (Rumelt 1991). Thus, this study proposes that policy-makers should look into the heterogeneous effects of foreign MNEs on local firms by a novel classification of firms, e.g. the surrounding technological environment and network structures within industries. For instance, policy-makers may give priority to FDI projects in fast-paced industries, while giving incentives for proactive supplier engagement if FDI is made in slow-paced industries.

5.4. Research Limitations

We acknowledge research limitations and suggest a couple of research agendas. This study has measured environmental dynamism, focusing on technological changes. Future research may engage more fully with complexity in the environmental context of innovation by addressing dynamism in multiple dimensions (McCarthy et al. 2010). Furthermore, we have focused on local firms' network diversity, but not on network structure or trade-offs amongst them. In network research, both network composition and structure affect a firm's innovation performance (Phelps 2010). Thus, future research could conduct additional analysis of the effect of network structure. We also agree with critiques on the use of inter-industry backward linkages as a proxy of the extent of inter-industry externalities. Thus, future research might consider using detailed firm-level survey data about MNEs' local sourcing strategies. Finally, we call for qualitative case studies to document the mechanism of FDI effects, both positive and negative, given firm heterogeneity.

Tables & Figures

Table 1
Correlation and descriptive statistics

		1	2	3	4	5	6	7	8
1	Local Supplier Innovation	1.000							
2	Innovation growth	0.346***	1.000						
3	Downstream Foreign presence (DFP)	-0.028	-0.011	1.000					
4	Network	-0.031	-0.026	0.107***	1.000				
5	Dynamism	-0.018	-0.011	0.061*	0.089**	1.000			
6	R&D Intensity	-0.039	-0.017	-0.288***	0.056	-0.051	1.000		
7	Competition	-0.047	-0.028	0.008	-0.073**	0.026	-0.389***	1.000	
8	Regional Spillovers	0.035	0.014	-0.120***	-0.070*	0.019	0.336***	-0.182***	1.000
	Observations	746	746	746	746	746	746	746	746
	Mean	20.681	8.086	0.230	2.267	0.302	0.054	0.500	0.569
	Standard Deviation	295.906	208.289	0.395	2.863	0.761	0.052	0.500	0.118

Note: *** p<0.01, ** p<0.05, * p<0.1

Table 2
Empirical results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variables: Local Supplier Innovation								
Key Variables								
H1: DFP		-1.538***	-2.137***	-2.386***	-12.07***	-6.082***	-3.663***	-1.155**
		(0.398)	(0.432)	(0.446)	(3.679)	(1.381)	(0.801)	(0.497)
H2: DFP x Dynamism			1.844**	3.097***	2.888***	7.298***	2.471**	2.552**
			(0.899)	(1.027)	(0.998)	(1.670)	(1.145)	(1.052)
H3: DFP x Dynamism x Network				-3.013***	-2.610**	-7.571**	-0.0917	-1.245**
				(1.123)	(1.060)	(3.303)	(0.224)	(0.505)
Control Variables								
Innovation growth	0.000147	7.43e-05	9.55e-05	8.13e-05	0.000161	-0.000141	7.49e-05	0.0003
	(0.000189)	(0.000193)	(0.000191)	(0.000191)	(0.000191)	(0.000217)	(0.000202)	(0.0002)
R&D Intensity	0.242***	0.247***	0.221***	0.176***	0.200***	0.138***	0.224***	0.0632
	(0.0609)	(0.0599)	(0.0593)	(0.0513)	(0.0525)	(0.0488)	(0.0620)	(0.0441)
Network	0.266	0.269	0.280	-0.147	-0.154	0.173	0.00859	-0.448***
	(0.354)	(0.336)	(0.312)	(0.400)	(0.413)	(0.562)	(0.0989)	(0.165)
Competition	-30.24***	-31.31***	-32.17***	-31.50***	-34.07***	-23.33***	-32.58***	-21.24***
	(4.996)	(4.992)	(5.014)	(4.887)	(4.808)	(4.386)	(4.806)	(3.964)
Dynamism	-1.151***	-1.230***	-1.631***	-1.924***	-1.699***	-1.355***	-1.441**	-1.252***
	(0.393)	(0.393)	(0.443)	(0.463)	(0.457)	(0.391)	(0.667)	(0.345)
Regional Spillovers	3.019**	3.415**	2.880**	2.556**	2.589**	1.926*	2.812**	1.596
	(1.459)	(1.476)	(1.280)	(1.208)	(1.211)	(1.133)	(1.276)	(0.996)
DFP x Network				0.729	0.664	3.440	0.269**	0.204
				(0.627)	(0.636)	(2.693)	(0.126)	(0.301)
Network x Dynamism				1.330*	1.002	0.616	-0.0484	0.693**

				(0.719)	(0.653)	(0.689)	(0.125)	(0.328)
Technology dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.871*	1.608	2.300**	2.548***	4.614***	1.714*	2.430**	3.869***
	(1.117)	(1.122)	(1.026)	(0.982)	(1.170)	(0.948)	(1.099)	(0.781)
R2	0.0589	0.0629	0.0651	0.0679	0.0695	0.072	0.063	0.050
Log Likelihood	-1371.83	-1366.08	-1362.74	-1358.76	-1343.62	-1352.77	-1361.07	-1887.60
Wald Chi2	91.13	92.53	91.5	93.78	99.99	98.52	107.45	93.18
Observations	746	746	746	746	728	746	746	746

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

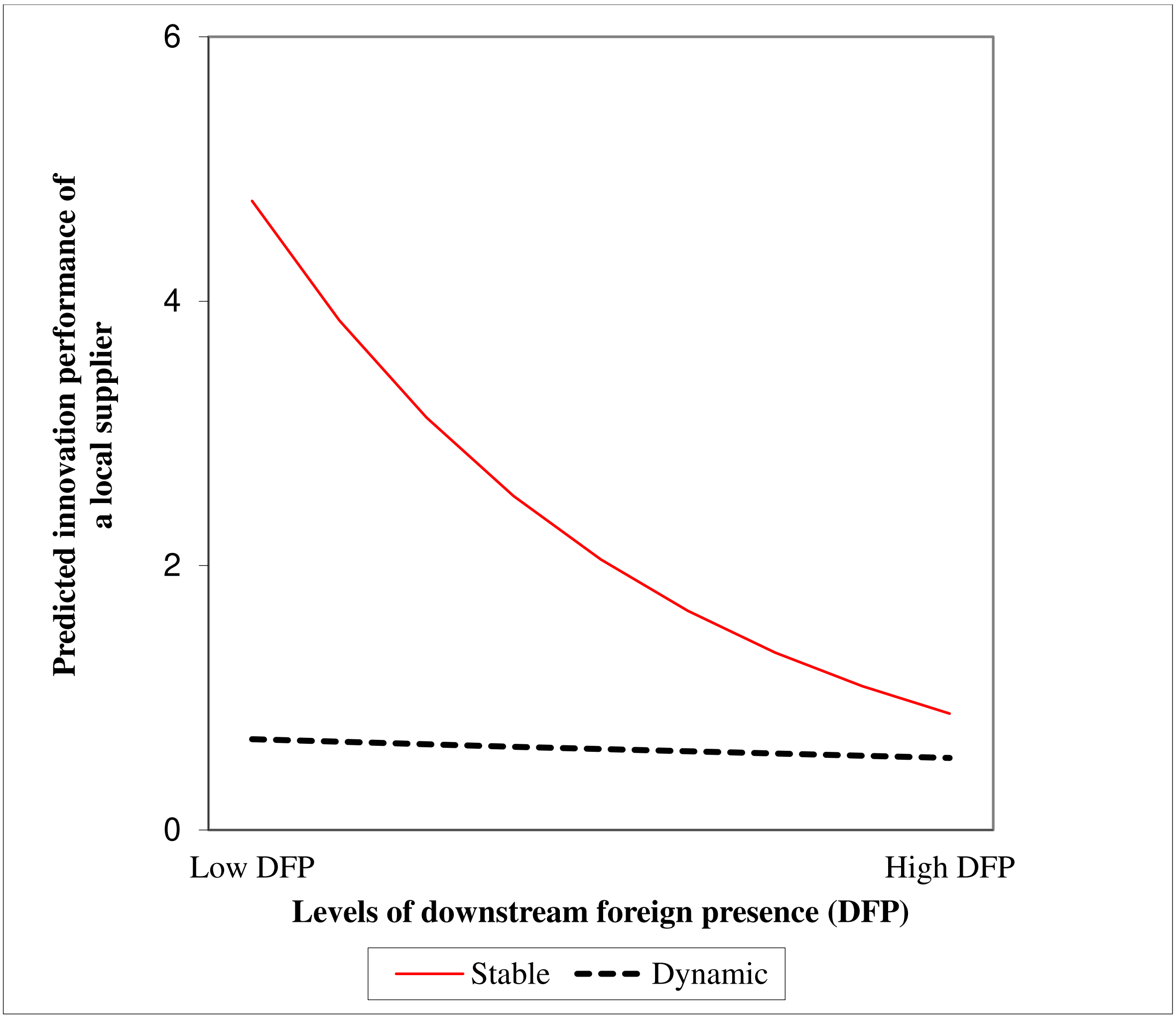

Figure 1
The effect of downstream foreign presence in dynamic environments

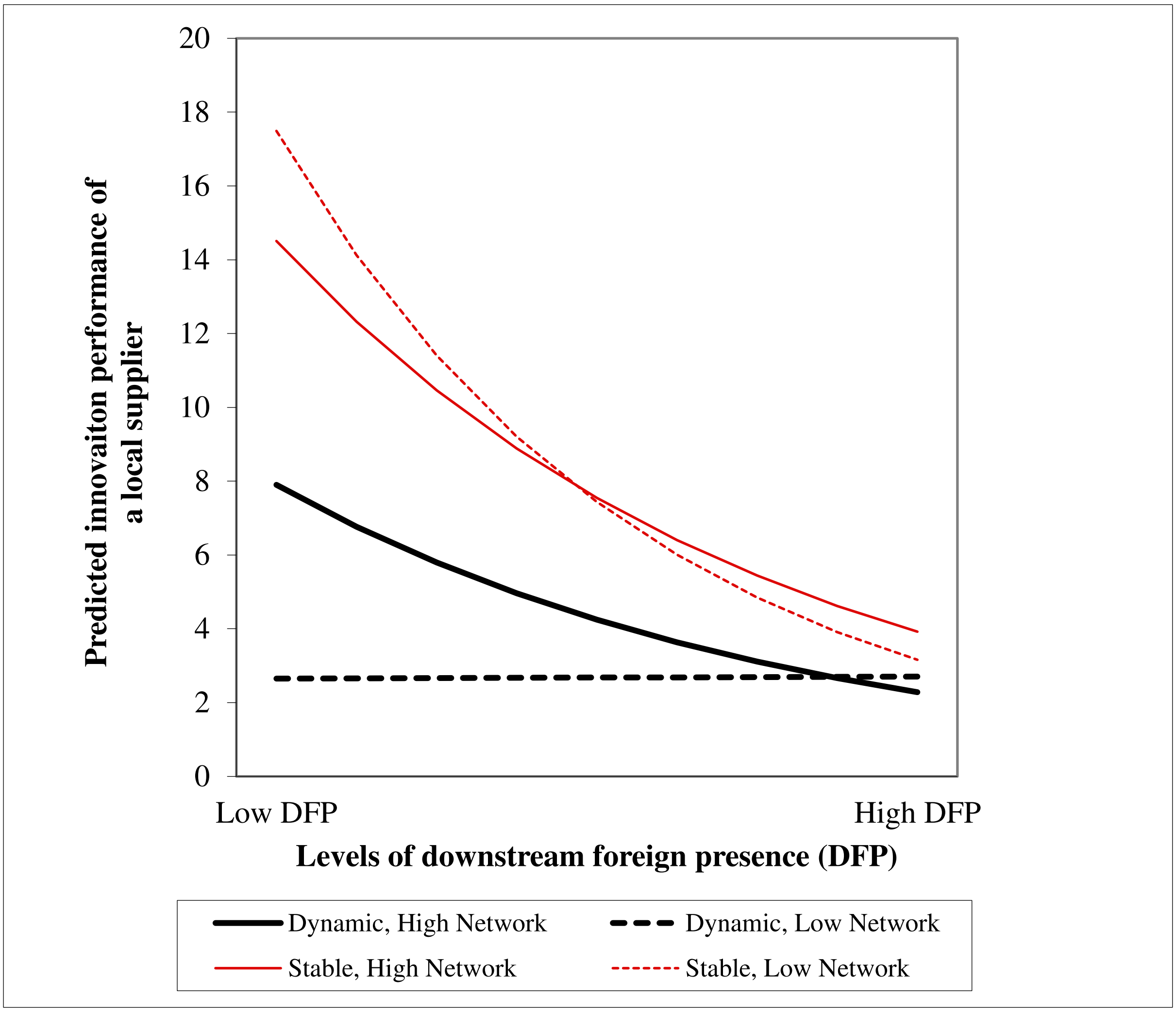

Figure 2
The effect of downstream foreign presence in dynamic environments contingent on network diversity

Appendix

Table A.1
Logistic estimation

	Coefficient	Standard error	P> |z|
R&D Capacity	1.480	0.478	0.002
Employment	0.000	0.000	0.015
Horizontal Foreign Presence	1.578	0.385	0.000
Industry effect	*Included*		
Constant	-2.283	0.236	0.000
Number of observations	3,255		
Chi2 (d/f)	252.05 (21)		
Prob > Chi2	0.000		
Pseudo R2	0.109		

Note: The dependent variable is probability of Dynamism=1 in the treatment group.

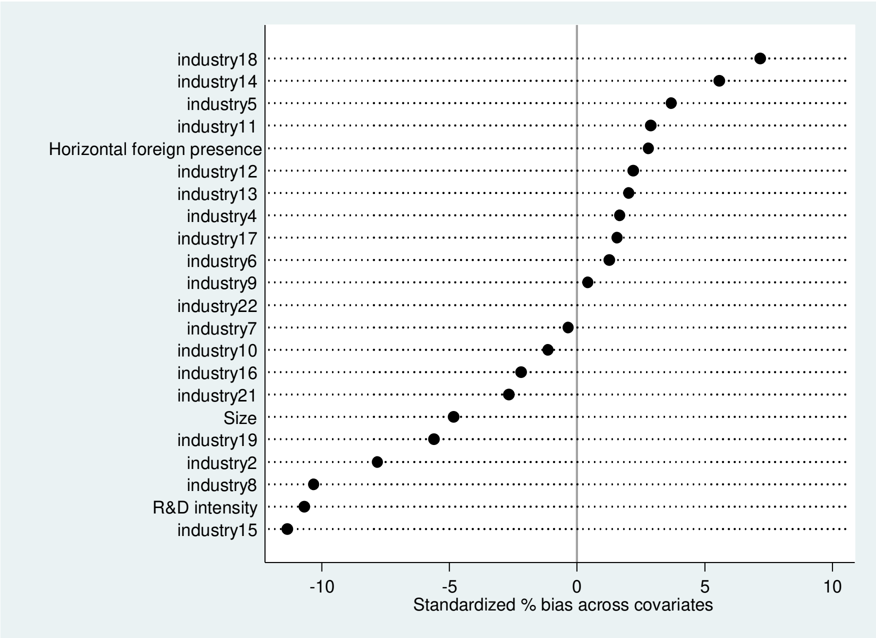

Figure. A.1
Balancing between treatment and control groups

Note: Bias across covariates refers to the % difference of the sample means in the treated (Dynamism=1) and non-treated (Dynamism=0). Based on individual t-tests on covariates as well as overall Chi^2 test, we report that the treated and controlled have equal means and that all groups are reasonably balanced.

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