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Modelling the impact of intellectual property protection and spillovers on attracting foreign direct investment

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ABSTRACT

Previous studies yield ambiguous results from using country-level indices of intellectual property rights (I.P.R.) protections to test their relation to foreign direct investment (F.D.I.). This study develops a simple model featuring vertically linked stages of production to show that country-level I.P.R. indices might cause the ambiguity by ignoring differences in I.P.R. protection strength across industries. We demonstrate that industry-level I.P.R. indices resolve ambiguity over the empirical nexus between I.P.R. protections and F.D.I.

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1. Introduction

Numerous factors influence decisions by multinational enterprises (M.N.E.s) to invest abroad. For example, market-oriented foreign direct investment (F.D.I.) considers market size, gross domestic product and population as key determinants. Cost-oriented F.D.I. considers factor quality and prices. Host country considerations – tariffs, government stability and business policies – affect F.D.I. significantly. Among important F.D.I.-related issues, intellectual property rights (I.P.R.) protections have attracted decades of studies (Kukharsky, 2020; Maskus, 1998, 2015; Noon et al., 2019). From an *ex ante* perspective, I.P.R. protections incentivise innovation. From an *ex post* perspective, open access to knowledge is socially optimal. Optimal I.P.R. protections balance both perspectives. Therefore, preferences for strong I.P.R. protections may vary among countries and across industries within one country. Whether laws and enforcement protect intellectual property is pivotal to a firm's competitiveness.

Globalisation magnifies the complexity of I.P.R. issues and their scholarly following. How a country's I.P.R. protections affect F.D.I. is a prominent research question and important to policymakers, but empirical findings remain ambiguous. The mainstream hypothesis claims that stronger I.P.R. protections in host countries attract

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F.D.I. because M.N.E.s invest more willingly where risk of knowledge leaks is small. Empirical studies test this hypothesis using country-level measures such as I.P.R. indexes by Rapp and Rozek (1990) and Park and Ginarte (1997) and the Global Competitiveness Report by the World Economic Forum (W.E.F.). Empirical studies that support a positive relation between I.P.R. and F.D.I. include Lee and Mansfield (1996); Maskus (1998); Smith (2001); Nicholson (2007); Awokuse and Yin (2010) and Branstetter et al. (2011). In contrast, Ferrantino (1993), Mansfield (1993), Maskus and Konan (1994), Braga and Fink (2000) and Mayer and Pfister (2001) find no evidence of a positive correlation.

Using industry-level data, Park and Lippoldt (2003) find that effects of strengthening I.P.R. protections on F.D.I. vary with host countries' economic development. Positive effects are most apparent among least-developed economies and less apparent among higher-income countries. Nunnenkamp and Spatz (2004) find that I.P.R. reform in developed economies exerts little effect on F.D.I. by M.N.E.s headquartered in the United States, but the effect is positive and significant for developing economies. Javorcik (2004) finds a positive correlation in high-tech sectors but no significant correlation in others.

We re-examine the mainstream hypothesis and show it could be misleading. We offer a new perspective and theoretical foundation to show why a country-level I.P.R. index may generate ambiguous empirical relations between F.D.I. inflows and I.P.R. reform. Literature regarding F.D.I. flows and I.P.R. protections assumes there is only one stage in production of final goods. We believe the vertical link between upstream and downstream industrial tiers is fundamental to deciphering relations between I.P.R. and F.D.I. inflows. We develop a simple model featuring n local upstream firms and m local downstream firms that respectively produce an intermediate and a final good. An M.N.E. with sophisticated technology establishes a subsidiary in the host country to produce and sell a final good there. An intermediate good is needed to produce the final good. To obtain it the M.N.E. can self-source by establishing an upstream affiliate or outsource from a local upstream firm. Downstream local firms cannot produce the intermediate good and must buy it from local upstream firms. Firms within the same tier compete on the basis of quantity.

We assume further that the M.N.E.'s entry into a production tier is accompanied by technology spillovers to local firms within that tier. By considering technology spillovers within different production tiers, we confirm empirical findings by Park and Lippoldt (2003) and Nunnenkamp and Spatz (2004) of a positive correlation between I.P.R. and F.D.I. inflows only in developing economies. In addition, the strength of I.P.R. protections correlates strongly and positively with national income, as Maskus (2015) argues. Lemma 1 shows that when the host country's I.P.R. protections are weak, I.P.R. reform is associated with encouraging F.D.I. inflows. This result explains the positive correlation between I.P.R. and F.D.I. in developing economies.

Our results also explain why the positive correlation between I.P.R. and F.D.I. may not hold for developed economies. Lemma 2 shows that international technology gaps alongside I.P.R. protection strength among production tiers jointly determine relations between I.P.R. and F.D.I. inflows. If the technology gap between local firms and M.N.E.s is sufficiently large within the upstream tier relative to downstream,

bolstering I.P.R. protections encourages F.D.I. If M.N.E.s enjoy significant cost advantages within the downstream tier relative to upstream, differing degrees of I.P.R. protection across production tiers may encourage or discourage F.D.I. inflows. In particular, if protection applies primarily to the upstream tier, stronger I.P.R. protections attract F.D.I. by incentivising M.N.E.s to build an upstream affiliate (i.e., self-sourcing). If I.P.R. protection applies primarily downstream, stronger protections raise the likelihood M.N.E.s will outsource and discourages F.D.I.

This article extends the literature in three respects. First, it proposes evidence-oriented theories that two circumstances create ambiguous correlations between I.P.R. and F.D.I. inflows: host country protections are not prohibitively weak, and the technology gap between M.N.E.s and local firms is greater downstream relative to the upstream tier. Both circumstances likely hold in developed economies and less so in developing economies, corroborating empirical findings such as those of Nunnenkamp and Spatz (2004). Second, it shows that inappropriate I.P.R. indices explain the empirical ambiguity between F.D.I. inflows and I.P.R. in previous studies. Instead, an industry-level analysis of I.P.R. reform is needed for empirical examination of how I.P.R. affects F.D.I. Third, our results inform policymakers by showing they should consider cost structures and industry-level I.P.R. protection when seeking to encourage F.D.I.

The study proceeds as follows. Section 2 constructs our model and enumerates the profits from up upstream and downstream investment. Section 3 analyses how changes in I.P.R. protection affect F.D.I. inflows. Section 4 provides a welfare analysis and Section 5 summarises with implications for I.P.R. policies and future research.

2. Model

Suppose that before entry of the M.N.E., there are $n \geq 1$ identical upstream local firms and $m \geq 1$ identical downstream local firms in a host country. The setup of two production tiers is standard in earlier studies such as Lin and Saggi (2011). Host country demand for final good y is given by $p(y) = a - y$, where a is a market size parameter assumed to be sufficiently large for all firms to earn profits after the M.N.E. enters. One unit of intermediate good x is required to produce one unit of final good y . Goods produced by each firm within the same tier are homogeneous, and the M.N.E.'s subsidiary enjoys superior production technology within both tiers. In the first stage of the game, the M.N.E. determines how to obtain the intermediate good. Given its sourcing decision during the first stage, firms within the same tier compete on quantity during the second stage.

Let c_A^u and c_I^u denote unit production cost of the M.N.E.'s upstream subsidiary and a local upstream firm. Let c_A^d (c_J^d) be the M.N.E.'s (local downstream firm's) unit process cost of transforming the intermediate good into the final good. As such, we have $0 \leq c_A^u < c_I^u$ and $0 \leq c_A^d < c_J^d$.

In line with De Meza and Lockwood (2004) and Gattai and Natale (2016), we assume F.D.I. by the M.N.E. generates technology spillovers. If the M.N.E. invests in the upstream tier, local upstream firm i 's ($i=1, \dots, n$) unit cost becomes $c_i^u = c_I^u - s^u(c_I^u - c_A^u)$. Similarly, local downstream firm j 's ($j=1, \dots, m$) unit process cost

reduces to $c_j^d = c_j^d - s^d (c_j^d - c_A^d)$ after the M.N.E. enters downstream. Here, $s^u \in [0, 1]$ and $s^d \in [0, 1]$ measure the degree of technology spillover.

We further assume the strength of host country’s I.P.R. influences spillover effects. Stronger protections lower technology spillover. Consequently, we have $s^u = f(\delta^u)$ ($s^d = g(\delta^d)$) with $f'(\delta^u) < 0$ ($g'(\delta^d) < 0$), where $\delta^u \in [0, 1]$ ($\delta^d \in [0, 1]$) represents the strength of I.P.R. protections upstream (downstream). Larger values of δ^u (δ^d) are associated with stronger protections.

2.1. Outsourcing

Suppose the M.N.E. builds a subsidiary only downstream and outsources the intermediate good from local upstream firms. Then there are $m + 1$ firms downstream and n firms upstream. Let π_A^o be the M.N.E.’s profit when it outsources the intermediate good. Its profit maximisation problem becomes

$$\max_{\{y_A\}} \pi_A^o = \left(a - y_A - \sum_{j=1}^m y_j \right) y_A - \left(c_A^d + w \right) y_A - F^d. \tag{1}$$

Here, y_A (y_j) is the final good produced by the M.N.E.’s downstream subsidiary (local downstream firm j) in the host country, w is the price of the intermediate good and F^d denotes the fixed costs of F.D.I. With the M.N.E. entry downstream, spillover effects reduce the unit process cost of local downstream firms. Consequently, local downstream firm j faces this profit maximisation problem:

$$\max_{\{y_j\}} \pi_{dj}^o = \left(a - y_A - \sum_{j=1}^m y_j \right) y_j - \left(w + c_j^d - s^d (c_j^d - c_A^d) \right) y_j. \tag{2}$$

Local upstream firm i ’s profit function in this case is $\pi_{ui}^o(x_i) = wx_i - c_i^u x_i$. Substituting $\pi_{ui}^o(x_i)$ with $w = \frac{((1+m)a - m(c_j^d - s^d(c_j^d - c_A^d)) - c_A^d - (2+m)(\sum_{i=1}^n x_i))}{(m+1)}$, which is derived from the first-order conditions of Equations (1) and (2), we have the following profit maximisation problem:¹

$$\max_{\{x_i\}} \pi_{ui}^o = \left(\frac{\left((1+m)a - m(c_j^d - s^d(c_j^d - c_A^d)) - c_A^d - (2+m)(\sum_{i=1}^n x_i) \right)}{(m+1)} \right) x_i - c_i^u x_i. \tag{3}$$

In equilibrium, the price of the intermediate good is $w^o = \frac{((1+m)a - m(c_j^d - s^d(c_j^d - c_A^d)) - c_A^d + (n+mn)c_i^u)}{(1+m)(1+n)}$. Total host country output of the final good is $y^o = y_A + \sum_{j=1}^m y_j = \frac{n((1+m)a - m(c_i^u + c_j^d - s^d(c_j^d - c_A^d)) - c_A^d - c_i^u)}{(2+m)(1+n)}$. The MNE’s profit is

$$\pi_A^o = (a - y^o - c_A^d - w^o)^2 - F^d. \tag{4}$$

2.2. Self-sourcing

The M.N.E. invests in both tiers of the host country by establishing a vertically integrated unit. To avoid double marginalisation, it is reasonable to assume the upstream unit offers the intermediate good to the downstream unit at a price equal to unit production cost. We first stipulate that the upstream unit does not sell the intermediate good to local downstream rivals (see proof in the Appendix). In this case, n local upstream firms provide the intermediate good to m local downstream firms. The M.N.E. and m local downstream firms compete in selling the final good. The M.N.E. faces this profit maximisation problem:

$$\max_{\{y_A\}} \pi_A^s = \left(a - y_A - \sum_{j=1}^m y_j \right) y_A - (c_A^u + c_A^d) y_A - F^u - F^d, \quad (5)$$

where F^u denotes the fixed cost of building an upstream unit. The similar profit maximisation problem faced by local downstream firm j is:

$$\max_{\{y_j\}} \pi_{dj}^s = \left(a - y_A - \sum_{j=1}^m y_j \right) y_j - \left(c_j^d - s^d(c_j^d - c_A^d) + w \right) y_j. \quad (6)$$

The best response functions for the MNE and the downstream firms are respectively:

$y_A = \frac{1}{2} \left(a - \sum_{j=1}^m y_j - c_A^d - c_A^u \right)$ and $y_j = \frac{1}{m+1} \left(a - y_A - (c_j^d - s^d(c_j^d - c_A^d)) - w \right)$. By substituting $w = \frac{1}{2} \left(a + c_A^u + c_A^d - 2(c_j^d - s^d(c_j^d - c_A^d)) - (m+2)y_j \right)$ into upstream firms' profit functions, we obtain the equilibrium price of the intermediate good:

$$w^s = \frac{\left(a + c_A^d + c_A^u - 2 \left(c_j^d - s^d(c_j^d - c_A^d) \right) + 2n \left(c_I^u - s^u(c_I^u - c_A^u) \right) \right)}{2(1+n)}.$$

Consequently, the MNE's profit from this mode of investment equals:

$$\pi_A^s = \frac{\left((2+m+2n)(a - c_A^d - c_A^u) + 2mn \left((1-s^d)(c_j^d - c_A^d) \right) + (1-s^u)(c_I^u - c_A^u) \right)^2}{4(2+m)^2(1+n)^2} - F^u - F^d. \quad (7)$$

3. I.P.R. protections and sourcing decisions

Based on the profit from each mode of investment, we now discuss how spillover effects, which depend on the strength of I.P.R. δ^u or δ^d , affect the M.N.E.'s sourcing decision. Let $\Omega = \pi_A^o - \pi_A^s$ be the difference in profits between outsourcing and self-sourcing. The following propositions show relations between sourcing decisions and spillover effects.

Proposition 1. *Ceteris paribus, the M.N.E. more likely outsources when technology spillovers within the upstream tier increase.*

Proof. Define $\Delta^u = c_I^u - c_A^u > 0$ and $\Delta^d = c_J^d - c_A^d > 0$. The proof follows by checking:

$$\frac{\partial \Omega}{\partial s^u} = \frac{mn\Delta^u \left((2 + m + 2n)(a - c_J^d - c_I^u) + \Delta^d \theta_1 + \Delta^u \theta_2 \right)}{(2 + m)^2(1 + n)^2} > 0, \tag{8}$$

where $\theta_1 = 2 + m + 2n + 2mn(1 - s^d)$ and $\theta_2 = 2 + m + 2n + 2mn(1 - s^u)$. ■

The intuition behind **Proposition 1** is straightforward. The M.N.E.’s entry upstream reduces price of the intermediate good, which benefits its downstream rivals. Therefore, strong technology spillovers upstream reduce the M.N.E.’s incentive to enter the upstream tier.

Proposition 2. *An increase in technology spillovers within the downstream tier has ambiguous effects on the M.N.E.’s sourcing decision. If technology spillovers downstream are sufficiently large, stronger spillovers downstream raise the likelihood of outsourcing. With sufficiently small technology spillovers downstream, stronger spillovers downstream raise the likelihood of self-sourcing if Δ^d is sufficiently large and Δ^u is sufficiently small.*

Proof.

$$\frac{\partial \Omega}{\partial s^d} = \frac{\Delta^d m(\Psi - \Phi)}{((1 + m)(2 + m)(1 + n))^2} \tag{9}$$

where $\Psi(\Delta^u) = n(1 + m)[\phi_1 + (1 + m)\theta_2\Delta^u] > 0$, and $\phi_1 = (m^2 + m - 2)(a - c_I^u - c_J^d) \geq 0$; $\Phi(\Delta^d) = (2 + m)\phi_2\Delta^d$ and $\phi_2 = n + 4m(1 + n)(1 - s^d) + m^2(2 + 3n - (2 + 4n)s^d)$. $\Phi(\Delta^d)$ is negative if $s^d > \underline{s}^d \equiv \frac{(n+4m(1+n)+m^2(2+3n))}{2m(2+m+2n+2mn)}$. Otherwise, it is positive. If $s^d > \underline{s}^d$ such that $\Phi(\Delta^d) < 0$, then $\frac{\partial \Omega}{\partial s^d} > 0$. This completes the proof of the first part of **Proposition 2**.

For the second part, if $s^d < \underline{s}^d$ such that $\Phi(\Delta^d) > 0$, the sign of $\frac{\partial \Omega}{\partial s^d}$ depends on the values of Δ^d and Δ^u given the number of firms within the local market. For a sufficiently large Δ^d ($\Delta^d > \Phi^{-1}(\Psi(0))$) and small Δ^u such that $\Psi(\Delta^u) - \Phi(\Delta^d) < 0$, we have $\partial \Omega / \partial s^d < 0$.² ■

It is evident that an increase in s^d is detrimental to both π_A^o and π_A^s :

$$\frac{\partial \pi_A^o}{\partial s^d} = \frac{2\Delta^d m T_1 (-n(1 + m)(a - c_I^u - c_J^d) + \Delta^d (m T_1 s^d - (n + m(1 + n)(2 + m))))}{(2 + m)^2(1 + m)^2(1 + n)^2} < 0, \tag{10}$$

$$\frac{\partial \pi_A^s}{\partial s^d} = \frac{-\Delta^d mn((T_2 - 2mn)(a - c_I^u - c_J^d) + \Delta^d (T_2 - 2mns^d) + \Delta^u (T_2 - 2mns^u))}{(2 + m)^2(1 + n)^2} < 0, \tag{11}$$

where $T_1 = 2 + m + n + mn$ and $T_2 = 2 + m + 2n + 2mn$.

We can further verify that $\frac{\partial^2 \pi_A^o}{\partial (s^d)^2} > \frac{\partial^2 \pi_A^s}{\partial (s^d)^2} > 0$. This means that the marginal effect of downstream spillover on the M.N.E.'s profit decreases under either mode. In addition, $\frac{\partial^2 \pi_A^o}{\partial (s^d)^2} > \frac{\partial^2 \pi_A^s}{\partial (s^d)^2}$ indicates that as downstream spillover s^d increases, the extra damage to the M.N.E. decreases faster under outsourcing than it does under self-sourcing. There exists a threshold value, \underline{s}^d , such that when $s^d > \underline{s}^d$, we have $\frac{\partial \pi_A^s}{\partial s^d} < \frac{\partial \pi_A^o}{\partial s^d} < 0$. That is to say, with sufficiently large downstream spillover, an additional increase in s^d favours outsourcing.

Proposition 2 indicates that when $\Phi(\Delta^d) > 0$, the sensitivity of the M.N.E.'s profits to downstream spillover under both sourcing modes depends on the technology gap within the upstream tier. However, sensitivity differs across the two sourcing modes. To simplify analysis, we keep Δ^d constant and analyse how Δ^u affects sourcing decisions given downstream technology spillovers. In outsourcing mode, given the unit cost of domestic suppliers, the change in π_A^o due to downstream technology spillovers is insensitive to potential cost gaps within the upstream tier (Δ^u) because the M.N.E. does not enter upstream.³

In self-sourcing mode local downstream firms buy the intermediate good at price w , which increases in Δ^u . Therefore a large Δ^u is associated with large cost differences between the M.N.E. and local downstream rivals to obtain the intermediate good. An increase in s^d engenders a catch-up effect for local downstream firms. The catch-up effect is beneficial (detrimental) to downstream rivals (the M.N.E.), but the marginal effect is decreasing. In other words, the catch-up effect on profits correlates positively with the cost gap but diminishes as firms' cost structures draw closer. As a result, with an increase in s^d , the M.N.E.'s profits decline more (less) when Δ^u is large (small). The negative cross-derivative of π_A^s with respect to s^d and Δ^u validates this result.⁴

Now we define $SS = \{(s^d, s^u) | \Omega = 0\}$. Since $\frac{\partial \Omega}{\partial s^u} > 0$, the slope of SS is positive (negative) if and only if $\frac{\partial \Omega}{\partial s^d} < 0$ ($\frac{\partial \Omega}{\partial s^d} > 0$).⁵ Therefore, we establish **Lemmas 1** and **2**.

Lemma 1. *Bolstering I.P.R. protections encourages F.D.I. inflows when $\Psi > \Phi$.*

Figure 1 depicts the SS curve when $\Psi > \Phi$.⁶ In such a case, it slopes downward. The area above (below) the SS curve indicates the region where $\pi_A^o > \pi_A^s$ ($\pi_A^o < \pi_A^s$). Bolstering I.P.R. protections engenders movement from a given point (s^d, s^u) toward the origin. With $\Psi > \Phi$ and sufficiently strong I.P.R. protections, therefore, the M.N.E. enters the upstream tier. The intuition is as follows. The value of Ψ (Φ) indicates how Δ^u (Δ^d) affects sensitivity of the M.N.E.'s profits from the two sourcing modes due to an increase in s^d . As **Proposition 2** suggests, large values for Ψ associated with large Δ^u causes a strong marginal catch-up effect under self-sourcing.

In other words, Ψ measures the degree to which the M.N.E. prefers outsourcing to self-sourcing when facing increases in s^d . Given an increase in s^d , a large Δ^d amplifies technology spillovers, derived demand and price of the intermediate good. This effect favours self-sourcing. Therefore, Φ can indicate the degree of preference for self-sourcing over outsourcing. When $\Psi > \Phi$, an increase in s^d raises the likelihood of outsourcing. In addition, **Proposition 1** shows that an increase in s^u also raises the likelihood of outsourcing. Namely, with the strengthening of I.P.R. protection, less

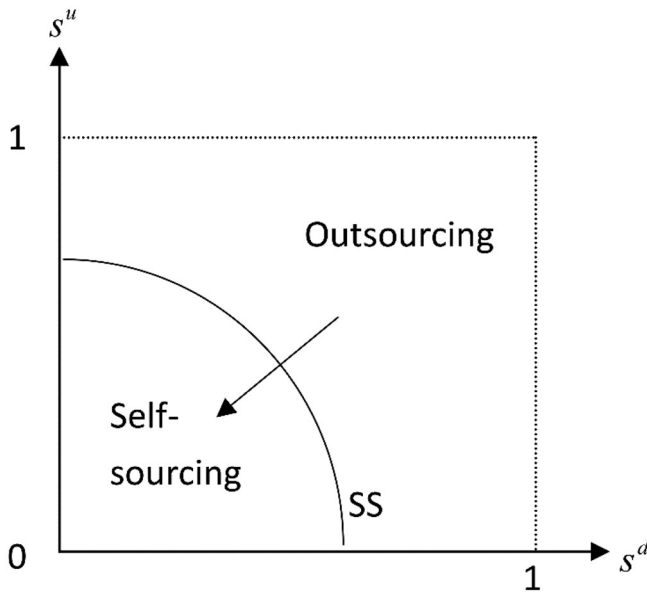


Figure 1. Bolstering I.P.R. protections encourages F.D.I. inflows when $\Psi > \Phi$.
Source: this study.

technology spillover within either production tier raises the likelihood of self-sourcing.

Lemma 2. *I.P.R. protection creates ambiguous effects on F.D.I. inflows when $\Psi < \Phi$.*

Figure 2 shows an upward-sloping SS curve when $\Psi < \Phi$. We find that bolstering I.P.R. does not necessarily encourage F.D.I. In Figure 2, for example, movement from A to B and from C to D indicates heightened I.P.R. protections. However, they entail differing investment consequences. The former (A→B) shows a shift from outsourcing to self-sourcing, and the latter (C→D) shows the opposite result. Intuition behind this result is as follows. When I.P.R. protection is mainly placed upstream (A→B), weak upstream spillovers increase the M.N.E.'s incentive to enter the upstream tier because the ensuing price reduction in the intermediate good used by downstream rivals is small. In contrast, when I.P.R. protection centres on the downstream tier (C→D), weak spillovers downstream suppress derived demand for the intermediate good and its price. Outsourcing is more appealing in this case.

Table 1 shows the correlation coefficients between inward F.D.I. flows and I.P.R. strength for several developed and developing countries for the 2007–2015 period. The data for F.D.I. flows were collected from the Organisation for Economic Co-operation and Development (OECD, 2020) and I.P.R. indices were adopted from the W.E.F. Table 1 is consistent with the work of Nunnenkamp and Spatz (2004), who found a positive correlation between I.P.R. reform and F.D.I. flows within developing economies and an insignificant correlation within developed economies. Lemmas 1 and 2 might explain this finding. As Fadinger and Fleiss (2011) point out: ‘Within lower income countries, productivity differences relative to the U.S. are systematically larger within human capital intensive sectors, but within richer countries this effect

Table 1. Correlation between I.P.R. and inward F.D.I. flows.

Developing economy		Developed economy	
Country	Correlation coefficient	Country	Correlation coefficient
CHN	0.433	NLD	0.672
IND	0.242	USA	0.656
BRA	0.040	JPN	0.165
IDN	0.700	AUS	-0.764
MEX	0.608	CZE	-0.499
TUR	0.462	GBR	-0.106

Data source: OECD and W.E.F. Correlation coefficients are calculated by the author.

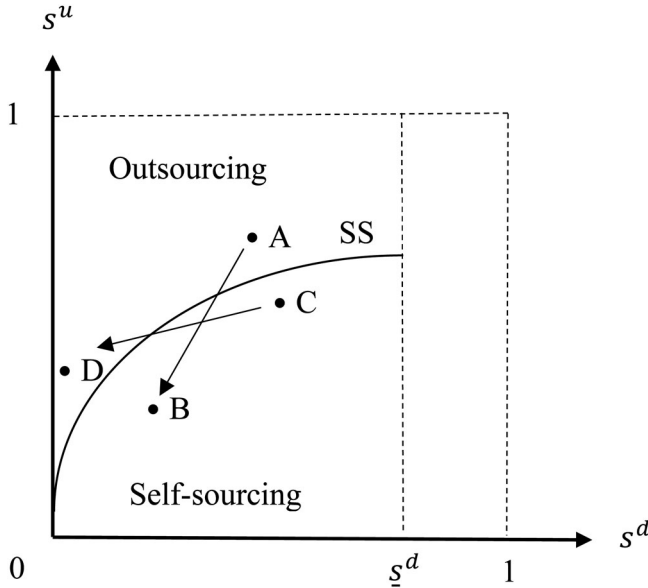


Figure 2. I.P.R. protection creates ambiguous effects on F.D.I. inflows when $\Psi < \Phi$. Source: this study.

disappears.’ Electronic product manufacturing is an example. Assembling electronic products (downstream tier) is less human capital intensive than within the upstream tier, which engages mainly in R&D and producing an intermediate good (integrated circuits).

In line with Fadinger and Fleiss (2011), therefore, $\Delta^d < \Delta^u$ should be common in developing economies. In other words, $\Psi > \Phi$ more likely occurs in developing economies, and bolstering I.P.R. protections in those countries tends to encourage F.D.I. inflows per Lemma 1. In contrast, the relative sizes of Δ^d and Δ^u are less clear for developed economies. Thus, mixed results might appear in developed economies, as Table 1 shows and Lemma 2 predicts.

4. Sourcing decisions and welfare

Let WF^s and WF^o respectively denote the local welfare under mode s (i.e., self-sourcing) and mode o (i.e., outsourcing). $WF^s = CS^s + \Pi_u^s + \Pi_d^s$ and $WF^o = CS^o + \Pi_u^o + \Pi_d^o$, where CS^k denotes the consumer surplus under mode k ($k = s, o$). Similarly, Π_l^k

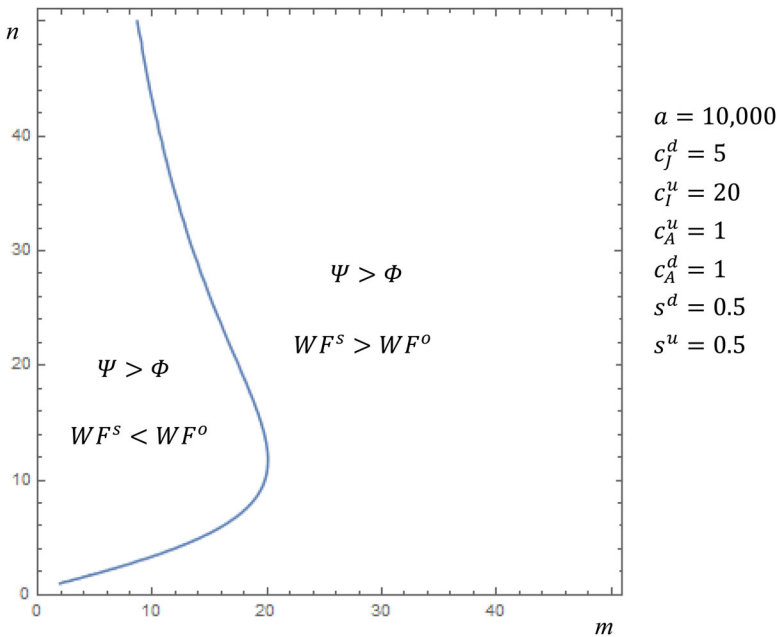


Figure 3. Welfare under self-sourcing is higher when m is large. ($\Psi > \Phi$).
Source: this study.

($l = u, d$) represents total profits of local firms in production tier l under mode k . $CS^k = \int_0^{y^{k*}} (a - q - p^{k*})dq$, where y^{k*} and p^{k*} , respectively, represent the equilibrium level of the total quantity and price of final goods under mode k . Under the self-sourcing mode, with the M.N.E.'s upstream entry, spillover exists in tier u . Thus, $\Pi_u^s = \sum_{i=1}^n \pi_{ui}^s = n(w^s - (c_l^u - s^u \Delta^u))x_i^{s*}$, where x_i^{s*} is the equilibrium output of an upstream firm under the self-sourcing mode. $\Pi_u^o = \sum_{i=1}^n \pi_{ui}^o = n(w^o - c_l^u)x_i^{o*}$, with x_i^{o*} denotes a local upstream firm's equilibrium output under outsourcing. Similarly, the total profits of downstream firms in the two modes can be calculated by $\Pi_d^k = \sum_{j=1}^m \pi_{dj}^k = m(a - p^{k*} - (w^s + c_j^d - s^d \Delta^d))y_j^{k*}$, where y_j^{k*} is the equilibrium output of a downstream firm with $y^{k*} = my_j^{k*}$.

Under both modes, it is obvious to see that local welfare is increasing in either s^d or s^u because local firms benefit from cost reduction by taking advantage of technology spillover and consumers benefit from the resultant lower price of final goods. However, this does not imply that the local government should abandon all I.P.R. protections just because local firms and consumers can benefit from spillover only when the M.N.E. enters. Weak I.P.R. protections might instead deter the M.N.E.'s entry into the market (Chen, 2015).

The above analysis implies that the local welfare is associated with firm entry, which can be sensitive to I.P.R. protection. If the local government intends to set welfare-enhancing I.P.R. protection policy, understanding the nexus between sourcing modes and welfare consequences is necessary. Therefore, another problem may arise: if the M.N.E. has entered downstream, is the local welfare necessarily higher with the

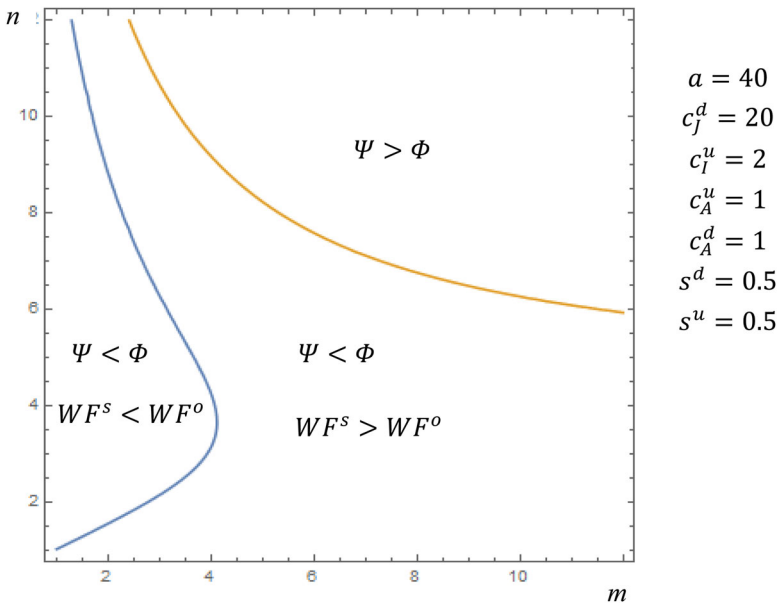


Figure 4. Welfare under self-sourcing is higher when m is large. ($\Psi < \Phi$). Source: this study.

M.N.E.’s entry upstream? Let $DW = WF^s - WF^o$ be the difference in welfare between the self-sourcing and outsourcing modes. It is tedious to derive the conditions for $DW > 0$. We will use simulation and provide a contour analysis in Figures 3 and 4. Figure 3 (Figure 4) offers the simulation result for $\Psi > \Phi$ ($\Psi < \Phi$). We discover that given unit costs and spillover effects, local welfare is higher under self-sourcing than it is under outsourcing if the number of downstream firms (m) is sufficiently large. The intuition underlying this result is as follows. With the M.N.E.’s entry upstream, local upstream firms are better off because, as shown in the Appendix, the M.N.E. does not compete with them. However, the impact of the M.N.E.’s entry upstream on local downstream firms can be ambiguous. On the one hand, local downstream firms benefit from the lower price of intermediate goods because of upstream spillover. On the other hand, however, self-sourcing enlarges the cost difference between local downstream firms and the M.N.E. It should be noted that a large m implies a high level of derived demand for intermediate goods. When m is large, with the M.N.E.’s entry upstream, the upstream welfare gain will outweigh the potential downstream welfare loss. Consequently, local welfare increases with the M.N.E.’s upstream entry provided m is sufficiently large.

5. Conclusions and implications for I.P.R. policy and future empirical research

Ours is the first study that employs vertically related production stages to address the ambiguity between I.P.R. protections and F.D.I. inflows in earlier studies. As stated in Lemma 2, the consequence for F.D.I. inflows from bolstering I.P.R. protections depends on two factors: the technology gap between the M.N.E. and local firms

within two production tiers and I.P.R. protection within different tiers. **Lemma 2** underpins theoretically the empirical findings in Nunnenkamp and Spatz (2004). This result further implies that using an aggregate I.P.R. index to investigate the nexus between I.P.R. protections and F.D.I. inflows likely will yield mixed results. As such, researchers should re-examine correlations between I.P.R. and F.D.I. inflows using industry-level I.P.R. indices. Although industry-level I.P.R. indices are not publicly available, it is possible to construct them. The W.E.F. constructs current country-level I.P.R. indices from its annual Executive Opinion Survey. Accessing W.E.F. surveys is a cost-conscious way to develop industry-level I.P.R. indices.

Our results bear implications for I.P.R. policy. Host countries striving to encourage F.D.I. inflows by reforming I.P.R. must consider both the technology gap and I.P.R. protection across industries. If an M.N.E. enjoys a huge technology advantage within the downstream tier (large Δ^d and small Δ^u), host countries should assure strong protection upstream relative to downstream; otherwise I.P.R. reform will backfire and discourage F.D.I. inflows. In short, when attempting to encourage F.D.I. host countries should evaluate the technology gap between local firms and foreign investors in different industries and erect appropriate I.P.R. rules and enforcement for each.

This article follows the Structure–Conduct–Performance (S.C.P.) paradigm. That is to say, given the market structure, we analyse firms' strategic interactions and then derive the equilibrium outcome for each firm. However, although the S.C.P. paradigm is widely utilised in industrial organisational analysis, the S.C.P. paradigm has also been criticised for overemphasising the importance of a current/given market structure and ignoring industrial dynamics (Anderson, 2020; Berry & Compiani, 2021). It provides little explanation regarding the evolution of industries. An interesting potential extension for future study could be for researchers to consider the 'endogenous market structure' in their analysis.

Notes

1. Second-order conditions also hold in the model.
2. We have imposed nonnegative output constraints and verified that $\frac{\partial \Omega}{\partial s^d} < 0$ is not an empty set.
3. This result can be verified mathematically by $\frac{\partial^2 \pi_A}{\partial s^d \partial \Delta^u} = 0$ from (10).
4. From (11), we have $\frac{\partial^2 \pi_A}{\partial s^d \partial \Delta^u} = \frac{-\Delta^d mn(T_2 - 2mns^u)}{(2+m)(1+n)^2} < 0$.
5. The second derivative shows the SS curve is concave, but our analysis does not require it to be.
6. For some parameter values, $SS \cap \{(s^d, s^u) | 0 \leq s^d \leq 1, 0 \leq s^u \leq 1\}$ may be empty. Nevertheless, that does not undermine our argument because such instances imply the sourcing decision is irrelevant to I.P.R. protections and too trivial to produce a visible impact.

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Appendix

The M.N.E. will not offer intermediate goods to downstream rivals with linear demand.

Proof. Given price w for intermediate goods, the quantity purchased by a local downstream firm and the M.N.E. respectively equals

$$y_j = (a + c_A^d + c_A^u - 2(w + c_j^d - s^d(c_j^d - c_A^d)))/(m + 2) \text{ for } j = 1, 2, \dots, m.$$

$$y_A = (a - (m + 1)(c_A^d + c_A^u) + m(w + c_j^d - s^d(c_j^d - c_A^d)))/(m + 2)$$

Let x_A and x_{-A} respectively be the quantity of intermediate goods offered by the M.N.E. and local upstream firms. Derived demand becomes:

$$w = (a + c_A^u + c_A^d - 2(c_j^d - s^d(c_j^d - c_A^d)))/2 - (m + 2)(x_A + x_{-A})/2m$$

The M.N.E.'s profit becomes

$$\begin{aligned} \pi_A^u + \pi_A^d &= (w - c_A^u)x_A + (p - c_A^u - c_A^d)y_A \\ &= \left[(a + c_A^u + c_A^d - 2(c_j^d - s^d(c_j^d - c_A^d)))/2 - c_A^u - (x_A + x_{-A})/(m+2)/2m \right] x_A \\ &\quad + [a - x_A - x_{-A} - y_A - c_A^u - c_A^d] y_A \end{aligned}$$

Substituting $w = (a + c_A^u + c_A^d - 2(c_j^d - s^d(c_j^d - c_A^d)))/2 - (m+2)(x_A + x_{-A})/2m$ into y_A derives

$$\frac{\partial(\pi_A^u + \pi_A^d)}{\partial x_A} = -\frac{2m(c_j^d - c_A^d)(1 - s^d) + (4 + m)x_A + 2x_{-A}}{2m} < 0$$

Thus, the M.N.E. sets the optimal quantity of intermediate goods $x_A = 0$