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Multinational Firm Innovation and Affiliate Sourcing Decisions*

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Abstract

The paper studies the effect of R&D investments by parent multinational corporations (MNC) and their affiliates on the decisions of those affiliates to purchase intermediate inputs across different locations. We first develop a theoretical model of R&D and sourcing decisions to provide potential mechanisms and to guide our empirical analysis. Our fixed-effects regression results imply that, first, higher affiliate R&D expenditures are associated with a higher share of the affiliate's purchases from local firms. Second, higher R&D expenditures by affiliates in other countries (i.e., those under the same parent firm but located in a different foreign country) are associated with a higher share of affiliate purchases from those countries. Third, we find that the affiliate's R&D expenditures are negatively correlated with the purchase share from the parent home country and from the parent firm.

Keywords: Multinational firms, input sourcing, R&D investment

JEL classification: F23, D22, O30, F14

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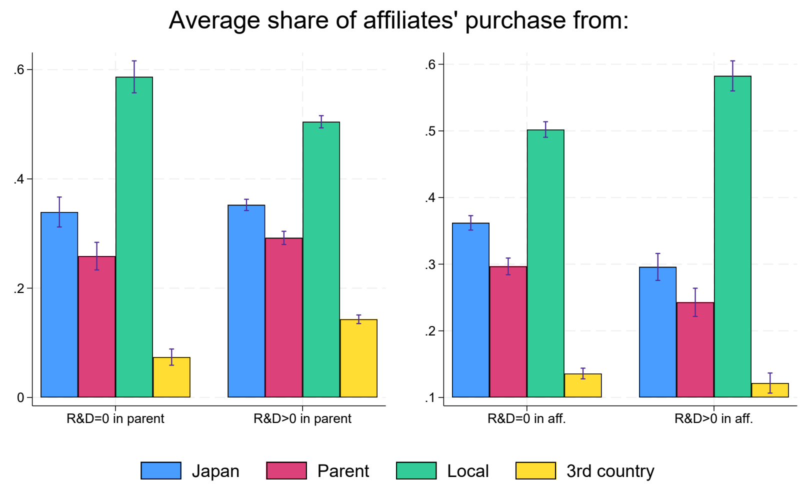
1 Introduction

When firms operate in multiple countries, innovation in one location can affect trade flows in other locations. This paper focuses on the intra-firm effect of multinational corporation (MNC) innovation on foreign affiliates' decisions to import intermediate inputs. On the one hand, parent companies' innovation can improve affiliates' productivity through technology transfer as in Brantstetter, Fisman, Foley, et al. (2006) and Keller and Yeaple (2013), or provide better inputs through intra-firm trade. This in turn allows affiliates to incur the costs to import from other countries (scale effect). On the other hand, parent firms' innovation might decrease affiliate's imports by reducing the need to access foreign technologies through imported inputs (substitution effect). Thus, the impact of parent firms' innovation on affiliates' input import decision is ambiguous.

To study the effect of MNC innovation on affiliate sourcing, we use a sample of Japanese MNCs and their foreign affiliates from 1995 to 2020. We find that higher affiliate performance in terms of sales, firm size, and value-added is positively associated with both parent R&D and affiliates' own R&D. Furthermore, parent and affiliate R&Ds are correlated with higher input purchases by affiliates. Interestingly, when we look at the composition of input purchases by source locations, we find that while parent R&D is associated with a higher share of purchase from parent firms, but a lower share from local firms, affiliate R&D is associated with a lower share from parent firms, but a higher share from local firms. Figure 1 summarizes these patterns. Comparing the two figures on the left, foreign affiliates whose parent firms have positive R&D investment tend to purchase a smaller share of products from the local market than those whose parent firms have zero R&D investment. Similarly from the two figures on the right, foreign affiliates that have positive R&D investment tend to source a smaller share of products from Japan than those that have zero R&D investment. The difference in the level and composition of purchases highlights the importance of disentangling the scale versus substitution effects.

Figure 1: Average share of affiliates' purchase from different locations



Note: The figure shows the average share of affiliates' purchase from different locations (Japan, a parent firm in Japan, local market, or third countries) for different groups of affiliates. Foreign affiliates are grouped into (1) affiliates whose parents have zero R&D investment, (2) those whose parents have positive R&D investment, (3) those that have zero R&D investment, and (4) those that have positive R&D investment.

Motivated by these facts, we present a model of R&D and sourcing decisions. Each affiliate firm follows standard Cobb-Douglas production, using labor, capital, and materials to produce output. MNC and affiliate innovation affects affiliate sourcing through two channels. First, it enters the Hicks-neutral productivity term, thus affect sourcing from all locations (scale effect). Second, materials are subject to source-specific productivity, which is influenced by the choice of R&D by the parent firms and their affiliates, thus reflecting the substitution effect.

The model also provides guidance on the source to identify the effect of R&D on affiliate sourcing. In particular, we derive an estimation equation that stipulates the relationship between the share of affiliates' purchase and R&D. Our regression results imply that higher affiliate R&D expenditures are associated with a higher share of the affiliate's purchases from local firms. Similarly, higher R&D expenditures by affiliates in third-party countries (i.e., those under the same parent firm but located in a different foreign country) are associated with a higher share of affiliate purchases from third-party countries. However, we find that the affiliate's R&D expenditures are negatively correlated with purchase share from home country and from the parent firm.

This paper makes three major contributions to existing literature. First, it builds on existing research on the relationship between parent innovation on affiliate performance. Bilir and Morales (2020) find that the median US firm realizes abroad 20 percent of return to its U.S. R&D investment by improving affiliates' productivity[1]. We are the first to study the impact of parent firms' innovation on affiliates' import of intermediate goods.

Second, this study contributes to the literature on the relationship between imported intermediate inputs and innovation. Bøler, Moxnes, and Ulltveit-Moe (2015) show evidence that R&D and international sourcing are complementary activities through scale effects. Exploiting the introduc-

[1] Todo and Shimizutani (2008) analyzes the opposite; that is, the effect of an affiliate's R&D investment on the Japanese parent's productivity growth using the same dataset as ours. They find a positive effect only from the affiliate's innovative R&D investment.

tion of an R&D tax credit in Norway in 2002, they find that cheaper R&D stimulated not only R&D investments but also imports of intermediates. Similarly, Chen, Zhang, and Zheng (2017) show that intermediate imports increase Chinese firms' R&D intensity. By contrast, Liu and Qiu (2016) find that input tariff cut results in less innovation undertaken by Chinese firms, measured by patent filings. In the context of MNCs, innovation in different locations may affect affliates' import decisions through different channels, i.e., scale and substitution effects. Our theoretical and empirical framework allows us to include both mechanisms.

Third, this work contributes to the literature on the effect of MNCs activities on global trade. MNCs account for a large share of global trade and their operations across national borders imply that trade policies in one country can affect trade in other countries through MNC activities. Existing studies examine the effects of MNC innovation on export decisions and choice of production location (Tintelnot, 2017; Gumpert, Li, Moxnes, Ramondo, & Tintelnot, 2020). This paper provides a novel channel for the third market effect: innovation by parent companies can affect import decisions of foreign affiliates.

The remainder of this paper is organized as follows. Section 2 explains the data and provides their descriptive statistics. Section 3 introduces a theoretical model that clarifies the mechanism and guides our empirical analysis. Section 4 provides our empirical specifications and estimation results. Finally, Section 5 presents some concluding thoughts.

2 Data and Descriptive Statistics

Our data come from two sources. First, we use the parent-affiliate-level data of the Basic Survey on Overseas Business Activities (BSOBA) provided by the Ministry of Economy, Trade and Industry, available from 1995 to 2020. This survey covers two types of overseas subsidiaries of Japanese MNCs: (1) direct subsidiaries with share of equity by Japanese enterprises being 10% or higher as of the end of the fiscal year, (2) second-generation subsidiaries with the share of equity by Japanese subsidiaries of 50% or higher as of the end of the fiscal year. This survey is conducted annually via a questionnaire based on self declaration survey forms (one for the parent firm and another one for each foreign affiliate) sent to the parent firm at the beginning of a fiscal year. The survey provides key information, such as affiliates' locations, R&D investment by affiliates, and import values by affiliates, including intra-firm trade.

The second data set comes from the Basic Survey of Japanese Business Structure and Activities (BSJBSA) that covers 1994 to 2020. The BSJBSA is an annual survey that provides detailed information about parent firm activities such as sales, employment, capital stock, intermediate purchases, R&D investment, and industry affiliation. It covers the full population of manufacturing and non-manufacturing firms with more than 50 employees and with capital of more than 30 million yen.

Using parent and affiliate identification numbers and a BSJBSA-BSOBA converter provided by the RIETI, which enables precise conversion between the datasets, we construct a panel dataset of parents and foreign affiliates from 1995 to 2020 that includes both manufacturing and non-manufacturing firms. Among the matched sample, we further focus on the manufacturing parent firms and their foreign affiliates. Table 1 shows the number and the fraction of Japanese parent firms that have foreign affilaites (i.e., being a MNC). MNCs account for 16.6% of the total number of Japanese firms in 2010, but account for 58.5% of sales and 47.6% of employment in Japan. Among MNCs, approximately 76% conduct R&D, while only 40% of non-MNC parents have positive R&D investments.

Table 1: R&D investment in parents and having MNC affiliates in 2010

	In parent		
	R&D=0	R&D>0	Total
w/o affiliates	7487	4999	12486
	(59.96)	(40.04)	(100)
w/ affiliates	597	1896	2493
	(23.95)	(76.05)	(100)
Total	8084	6895	14979
	(53.97)	(46.03)	(100)

Note: The table shows the number of Japanese parent firms that have foreign affiliates and have positive R&D expenditures in 2010. The parentheses below shows the fraction of firms in each category.

Table 2 shows descriptive statistics for the MNC parent firms. Overall, compared to firms without R&D, firms that conduct R&D are more likely to export and import, employ more workers, have higher sales and value added, and higher labor productivity (i.e., employment to sales). These results are consistent with previous findings on R&D and productivity and international trade participation.

Table 3 shows the descriptive statistics for affiliates. The first two

Table 2: R&D investment in parents and their performance in 2010

	In parent		
	R&D=0	R&D>0	All
Parent export prob.	63.48	82.84	77.94
Parent import prob.	56.11	71.26	67.63
Parent export share	0.10	0.16	0.14
Parent import share	0.07	0.08	0.07
Parent employees	412	1370	1141
Parent sales	18579	89411	72449
Parent value added	3963	15790	13014
Parent log labor productivity	1.86	2.12	2.05

Note: The table shows the summary statistics for the matched parent firms in 2010, for the parent firms with no R&D investment (column 1), those with positive R&D investment (column 2), and all (column 3).

columns compare the statistics for affiliates whose parent firms conduct R&D and affiliate whose parent firms do not conduct R&D. Similar to the previous table, we find that parent R&D is associated with higher employment, sales, value added, and labor productivity. Nonetheless, affiliates with parent R&D are unlikely to export/import more than affiliates without R&D. In columns 3-4, we compare affiliates with and without their own R&D. Here, we find that affiliates with R&D are more likely to export and import than those without R&D. Affiliates with R&D also have higher sales, employment, and labor productivity than those without R&D.

Table 3: R&D investment in parents and affiliates' performance in 2010

	In parent		In affiliate		
	R&D=0	R&D>0	R&D=0	R&D>0	All
Aff. export prob.	57.58	55.29	52.06	77.37	55.57
Aff. import prob.	52.23	52.48	49.76	69.17	52.44
Aff. export share	0.35	0.30	0.30	0.33	0.31
Aff. import share	0.21	0.28	0.28	0.25	0.27
Aff. employees	291	469	408	668	447
Aff. sales	4391	11788	9568	19168	10896
Aff. value added	433	1122	804	2168	1037
Aff. log labor productivity	0.29	0.98	0.83	1.18	0.89

Note: The table shows the summary statistics for the matched affiliates in 2010, for affiliates whose parents have no R&D investment (column 1), those whose parents have positive R&D investment (column 2), affiliates that have no R&D investment (column 3), those that have positive R&D investment (column 4), and all (column 5).

In Table 4, we show the patterns of sourcing by affiliates, that is the focus of our paper. In general, parent and affiliate R&D are associated with larger purchases from all sources and higher probability of buying from each source. Nonetheless, looking at the composition of purchases by source, we find that parent R&D and affiliate R&D have different effects. While parent R&D is associated with a higher share of purchase from parent firms but a lower share from local firms, affiliate R&D is associated with a lower share from parent firms but a higher share from local firms. The difference in the level and composition of purchases highlights the importance of disentangling the scale versus substitution effects.

3 Model

We begin with a production function similar to that of Bilir and Morales (2020). The affiliate production function has a Cobb-Douglas structure between materials and value-added can be written as

$$Q_{ij} = A_{ij} H(L_{ij}, K_{ij})^{1-\alpha_M} M_{ij}^{\alpha_M} \tag{1}$$

where the i indexes the parent company and j the affiliate. We abstract from uncertainty and the problem of zeros for R&D throughout the following discussion to simplify. The A_{ij} parameter is the productivity of the affiliate, which reflects Hicks-neutral technical progress. Letting a ˆ over a variable denote a rate of change, we assume that the growth rate of affiliate productivity is given by

$$\hat{A}_{ij} = \sum_{k \in \{a,p,o\}} a_k \hat{R}_{ik} \tag{2}$$

where R_{ij} is affiliate R& D, R_{ip} is parent R&D, and R_{io} is R&D at other affiliates of parent i. Productive R&D from location k means $a_k > 0$.

Our model differs from (Bilir & Morales, 2020) in that we assume that material inputs from different sources are imperfect substitutes. The aggre-

Table 4: R&D investment and the affiliates' sourcing in 2010

	In parent		In affiliate		
	R&D=0	R&D>0	R&D=0	R&D>0	All
Aff. log total purchase	6.12	7.20	6.90	8.00	7.07
Aff. log purchase from local	5.45	6.27	5.92	7.16	6.16
Aff. log purchase from 3rd countries	4.83	5.40	5.28	5.63	5.35
Aff. log purchase from Japan	4.66	5.81	5.51	6.34	5.66
Aff. log purchase from Japanese parents	4.55	5.67	5.39	6.17	5.54
Aff. prob. purchase from local	59.86	52.17	50.04	72.11	53.10
Aff. prob. purchase from 3rd countries	17.84	29.26	25.42	43.18	27.88
Aff. prob. purchase from Japan	50.45	48.76	46.32	65.37	48.96
Aff. prob. purchase from Japanese parents	43.41	43.48	41.01	58.81	43.48
Share of purchase from local	0.59	0.50	0.50	0.58	0.52
Share of purchase from 3rd countries	0.07	0.14	0.14	0.12	0.13
Share of purchase from Japan	0.34	0.35	0.36	0.30	0.35
Share of purchase from Japanese parents	0.26	0.29	0.30	0.24	0.29

Note: The table shows the summary statistics for the pattern of sourcing by affiliates in 2010, for affiliates whose parents have no R&D investment (column 1), those whose parents have positive R&D investment (column 2), affiliates that have no R&D investment (column 3), those that have positive R&D investment (column 4), and all (column 5).

gate material input M_{ij} for firm i's affiliate in location j in (1) is assumed to be given by a constant returns to scale aggregator of the material input purchases from the respective source locations, $H(X^a_{ij}, X^p_{ij}, X^o_{ij})$, corresponding to affiliate (a), parent (p) and other (o).

Under the assumption of constant returns to scale for $H(.)$ and the separability of M_{ij} in the production function, the firm's cost minimization problem can be treated as a two stage problem in which the firm chooses material inputs to minimize the unit cost of M_{ij} given input prices P^k from source $k \in \{a, p, o\}$. We assume that the unit cost function for materials takes the translog form

$$\log C_{ij} = \gamma^0_{ij} + \sum_{k \in \{a,p,o\}} \gamma^k_{ij} logP^k_j + \frac{1}{2} \sum_{m \in \{a,p,o\}} \gamma^{km} logP^k_j logP^m_j \tag{3}$$

The parameters γ^k_{ij} represent taste parameters for inputs from the respective sources and the parameter γ^0_{ij} is a productivity parameter for material inputs, which we allow to be affiliate specific. The parameters for substitution effects between sources, γ^{km}, we assume to be common across all firms.

Differentiating (3) with respect to P^k_j yields the cost shares of materials purchased from location k

$$\mu_{ij} = \gamma^k_{ij} + \sum_{m \in \{a,p,o\}} \gamma^{km} \log P^m_j \tag{4}$$

The assumption that the cost function is homogeneous of degree 1 in prices and that cost shares are homogeneous of degree 0 in prices yields the parameter restrictions $\sum_k \gamma^k_{ij} = 1$, $\gamma^{km} = \gamma^{mk}$ and $\sum_m \gamma^{km} = 0$ for all $k \in \{a, p, o\}$

We assume that R&D in the firm can affect the firm in two ways: through its impact on productivity of material inputs and through its impact on tastes for material inputs from respective locations. Letting R_{il} denote the amount of R&D done by multinational firm i in location l, we capture the impact of R&D on the taste parameters by assuming that $\gamma_{ij}^{k} = g_{ij}^{k} + \sum_{l\in\{a,p,o\}} b_{l}^{k} f(R_{il})$, where $f(.)$ is an increasing function and $b_{l}^{k} > 0$ means that R&D in location l within the firm leads the affiliate to place a higher valuation on material imports from location l. Such a complementarity might arise if R&D results in the creation of new inputs that the affiliate sources from the innovating location. If R&D is neutral in its impact on material sourcing, $b_{l}^{k} = 0$ for all l, k. The requirement that cost shares add to 1 yields the restriction that $\sum_{k} b_{l}^{k} = 0$ for all $l \in \{a, p, o\}$.

With this specification of the impact of R&D within the firm on material sourcing, we can write the cost shares for materials as

$$\mu_{ij} = g_{ij}^{k} + \sum_{l} b_{l}^{k} f(R_{il}) + \sum_{m\in\{a,p,o\}} \gamma^{km} \log P^{m} \tag{5}$$

For the productivity parameter, we assume that $\gamma_{ij}^{0} = g_{ij}^{0} + \sum_{l\in\{a,p,o\}} b_{l}^{0} f(R_{il})$. R&D expenditures from location l are neutral between value added and materials if $b_{l}^{0} = 0$, while $b_{l}^{0} > (<)0$ arises if technical progress raises (lowers) the unit cost of materials relative to value added.

4 Regression Analysis

We estimate a version of the material share demand equation in (5):

$$\begin{aligned}\mu_{ijt} = {} & \alpha + \beta_1 \text{R\&D}_{i0t-1} + \beta_2 \text{R\&D}_{ijt-1} + \beta_3 \text{R\&D}_{i-jt-1} \\ & + \beta_4 (log(p_{t-1}^{local}) - log(p_{ijt-1}^{third})) + \beta_5 (log(p_{t-1}^{japan}) - log(p_{ijt-1}^{third})) + \boldsymbol{\eta}' X_{ijt} + \epsilon_{ijt}\end{aligned} \tag{6}$$

where $\mu_{ijt} = \{\frac{local_{ijt}}{total_{ijt}}, \frac{third_{ijt}}{total_{ijt}}, \frac{japan_{ijt}}{total_{ijt}}\}$ is the expenditure share of purchases from local, third country, or Japan. $\text{R\&D}_{i0t-1}$, $\text{R\&D}_{ijt-1}$, and $\text{R\&D}_{i-jt-1}$ are log (R&D

expenditures +1) in parent, affiliate j, and all other manufacturing affiliates $-j$, respectively.

X_{ijt} includes, depending on the specifications, affiliate's current and lag nominal capital constructed by the perpetual inventory method, current and lag employment in affiliate, lag value-added, country-sector-year fixed effects, affiliate fixed effects, and parent fixed effects. For example, the relationship between R&D investment and the composition of input purchases from each source region may simply be because of an association between innovation and affiliate inputs. Capital and employment information control for such a spurious correlation.

Furthermore, the literature on MNCs' location choices for R&D activities predicts that R&D investments are influenced by host-country and firm-specific factors, which may also correlate with affiliates' sourcing patterns, potentially leading to spurious correlations (e.g., Shimizutani and Todo (2008); Siedschlag, Smith, Turcu, and Zhang (2013)). These host-country factors (e.g., market size, distance from headquarters, and knowledge levels in the host country) are accounted for by including country-sector-year fixed effects. Firm-specific factors (e.g., the parent's knowledge base, the affiliate's size, and the affiliate's entry motives) are controlled for using lagged values of the affiliate's value-added, employment, and capital, as well as parent and affiliate fixed effects. For instance, changes in an affiliate's managerial quality or brand value, which likely influence both R&D investments and sourcing patterns, are partially captured by these input variables, as such changes are reflected in adjustments to labor and physical capital investments.

However, some time-varying unobservable factors may still influence both parent and affiliate R&D investments and the affiliate's sourcing patterns. For example, a shift in the motives for establishing an affiliate in the host country could simultaneously affect R&D investments and sourcing decisions, potentially biasing the estimation results.

We add $log(p^{local}_{t-1}) - log(p^{third}_{ijt-1})$ and $log(p^{japan}_{t-1}) - log(p^{third}_{ijt-1})$, which control for the price terms suggested by the theoretical model. To measure them, we use the price level in each country, "pl_gdpo", constructed in the Penn World Table version 10.01[2]. Feenstra, Inklaar, and Timmer (2015) call this as the real exchange rate. This price level is equal to the PPP exchange rate relative to the US, divided by the nominal exchange rate relative to the US. Thus, this captures differences in (1) production costs (in the denominator) and (2) the nominal exchange rates (in the numerator) across countries over time. Grieco, Murry, and Yurukoglu (2023) uses the similar price level from Penn World Table as an instrument for prices.

p^{local}_{t-1} is the price level in an local country and therefore there is no variation across firms within host countries. Also, p^{japan}_{t-1} is the price level in Japan, and as a result, common for all firms. However, p^{third}_{ijt-1} can be an affiliate-level variable depending on affiliate's purchase. In particular, p^{third}_{ijt-1} is defined as:

$$p^{third}_{ijt-1} = \sum_{k \in Asia,EU,NA,Other} \underbrace{\frac{\text{purchase from } k_{ij}}{\sum_{l \in Asia,EU,NA,Other} \text{purchase from } l_{ij}}}_{\equiv w_{ij}} p^{k}_{t-1}. \tag{7}$$

Note that the weight w_{ij} is defined by the sum of purchase from region k for all years, divided by the sum of total purchase from third countries (no subscript t). Therefore, there are a smaller number of observations with 0-denominator than before.Another thing to notice is that $log(p^{local}_{t-1}) - log(p^{third}_{ijt-1})$ and $log(p^{japan}_{t-1}) - log(p^{third}_{ijt-1})$ are perfectly collinear once we control for host

[2]It covers from 1995 to 2019, and therefore our 2020 data is dropped.

country times year fixed effects, because p_{t-1}^{local} and p_{t-1}^{japan} are constant within a country-year. Therefore, we include only one of them in these specifications.

We focus on affiliates that have a manufacturing parent, are categorized as manufacturing at some point in their sample period, and are located in non tax-heaven countries.

Tables 5-8 report the results. In each table, columns 1 to 6 are the results from regression without price terms. Columns 7 to 10 report the same regression results as columns 3 to 6 but including the price terms.

Three sets of results are noteworthy. First, from Table 5, we can see that higher affiliate R&D expenditure is associated with higher share of materials purchased from local firms. This result is robust across different specifications. Second, affiliate R&D, however, is associated with a lower share of imports coming from the home country (Japan) as seen in Table 6. We obtain similar findings for imports from parent firms as the dependent variable in Table 8. Finally, we find that R&D conducted by affiliates in third-party countries is associated with a higher import share from those countries.

Interestingly, the coefficients on parent R&D are not significant, regardless of outcome variables, once we control for either parent or affiliate fixed effects. This pattern suggests the presence of time-invariant, firm-level unobservable factors that influence both the parent's R&D investments and the affiliate's sourcing strategies. For example, a Japanese MNC with significant R&D investments might establish an affiliate in an advanced country to acquire cutting-edge knowledge while simultaneously sourcing more inputs from the local market for the same reason. Such time-invariant confounding factors are mitigated by the inclusion of affiliate or parent fixed effects, and the main results discussed above remain robust.

In terms of the magnitude of the coefficients, the result suggests, for example for column (8) in Table 5, that if there is a 10% increase in the affiliate's R&D expenditure, then it would increase the purchase share from the affiliate's hosting country by 0.16 in a 0-100 scale (the median value of the purchase share from local in 2010 is 45.3, and thus this is a 0.35% increase). This is on top of scale effect, i.e., an increase in total purchase. In terms of JPY values, because the median value of total purchase is 2,037 million JPY ($\approx$ 14.22 million USD), a 10% increase in the affiliate's R&D expenditure implies a 3.26 million JPY increase in the purchases from local ($= 2,037$ million JPY $\times 0.0016$), given the level of total purchase. The economic magnitudes look slightly small, although Bilir, Chor, and Manova (2019) show a similar magnitude in their Table 4 when they use a sales share in each destination region as an outcome variable (their main RHS variable is the interactions of dummies: a dummy of the financial development in a host country, and a dummy of the external finance dependency in a sector, thus the focus is different).

These findings have implications for the structural parameters, b_l^k, in Section 3. In particular, these results suggest that b_j^j and b_o^o are larger than the average of R&D effects on local sourcing and third-party sourcing, respectively, but b_j^p is below the average of R&D effects on parent sourcing. Therefore, R&D in each location within MNCs is unlikely to be neutral, but have biased effects on input sourcing from certain locations.

Table 5: Local inputs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES						$\frac{local_{ijt}}{total_{ijt}}$				
log R&D$_{ijt-1}$	0.0264***	0.0171***	0.0222***	0.0155***	0.00251*	0.0124***	0.0245***	0.0162***	0.00279*	0.0143***
	(0.00183)	(0.00227)	(0.00246)	(0.00234)	(0.00142)	(0.00215)	(0.00260)	(0.00250)	(0.00153)	(0.00234)
log R&D$_{i0t-1}$	-0.0177***	-0.0190***	-0.0173***	-0.00992***	-0.000853	-0.00196	-0.0167***	-0.0106***	-0.00108	-0.00153
	(0.00106)	(0.00153)	(0.00170)	(0.00171)	(0.00116)	(0.00139)	(0.00192)	(0.00187)	(0.00134)	(0.00161)
log R&D$_{i-jt-1}$	-0.00127	-0.00502***	-0.00648***	-0.00203	-0.00250**	-0.00496***	-0.00595***	-0.00168	-0.00150	-0.00424***
	(0.00117)	(0.00142)	(0.00154)	(0.00148)	(0.00114)	(0.00138)	(0.00159)	(0.00154)	(0.00116)	(0.00138)
log p^{local}_{t-1} - log p^{other}_{ijt-1}							-0.0549***	-0.0553*	0.0212	-0.0669**
							(0.0134)	(0.0298)	(0.0438)	(0.0299)
log p^{Japan}_{t-1} - log p^{other}_{ijt-1}							-0.0131			
							(0.0231)			
log capital		0.00651	0.0134***	-0.00497	0.000717	-0.00130	0.0163***	-0.00303	0.00149	-0.00105
		(0.00452)	(0.00506)	(0.00569)	(0.00408)	(0.00489)	(0.00521)	(0.00608)	(0.00460)	(0.00529)
log capital_lag		0.0242***	0.0301***	0.0182***	0.00747*	0.0155***	0.0222***	0.0160***	0.00680	0.0134**
		(0.00426)	(0.00490)	(0.00545)	(0.00384)	(0.00457)	(0.00524)	(0.00596)	(0.00432)	(0.00521)
log value-added_lag			-0.0331***	-0.0163***	0.00337*	-0.00945***	-0.0243***	-0.0144***	-0.000318	-0.00816**
			(0.00354)	(0.00376)	(0.00190)	(0.00307)	(0.00422)	(0.00425)	(0.00216)	(0.00328)
log employment		0.00417*	0.00867***	0.00533	-0.00290	-0.000883	-0.0117***	-0.00910**	-0.00911***	-0.0115***
		(0.00244)	(0.00267)	(0.00336)	(0.00259)	(0.00309)	(0.00322)	(0.00401)	(0.00306)	(0.00357)
log employment_lag		0.00996***	0.0185***	0.0175***	0.00400	0.0126***	0.0407***	0.0376***	0.0192***	0.0285***
		(0.00256)	(0.00300)	(0.00389)	(0.00271)	(0.00347)	(0.00656)	(0.00728)	(0.00597)	(0.00689)
Observations	94,402	54,890	42,279	39,613	38,810	39,493	33,134	30,781	30,379	30,700
R-squared	0.032	0.071	0.101	0.349	0.810	0.587	0.122	0.374	0.800	0.593
Country-sector-year FE	No	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Affiliate FE	No	No	No	No	Yes	No	No	No	Yes	No
Parent FE	No	No	No	No	No	Yes	No	No	No	Yes

Note: The table reports the results of estimating equation (10) using the share of purchases from the local country as the dependent variable. Clustered standard errors at the affiliate level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Inputs from home country

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
					$\frac{japan_{ijt}}{total_{ijt}}$					
log R&D$_{ijt-1}$	-0.0186***	-0.00992***	-0.0157***	-0.0139***	-0.00430***	-0.0110***	-0.0167***	-0.0142***	-0.00468***	-0.0118***
	(0.00164)	(0.00210)	(0.00219)	(0.00225)	(0.00149)	(0.00208)	(0.00234)	(0.00240)	(0.00163)	(0.00230)
log R&D$_{i0t-1}$	0.0128***	0.0138***	0.0112***	0.00740***	-0.00113	0.000734	0.0104***	0.00752***	-0.00127	-0.000380
	(0.000997)	(0.00145)	(0.00162)	(0.00166)	(0.00112)	(0.00139)	(0.00185)	(0.00184)	(0.00132)	(0.00159)
log R&D$_{i-jt-1}$	-0.00907***	-0.00639***	-0.00589***	-0.00607***	-0.000858	-0.000339	-0.00625***	-0.00600***	-0.00194	-0.00155
	(0.00112)	(0.00140)	(0.00153)	(0.00155)	(0.00136)	(0.00150)	(0.00163)	(0.00167)	(0.00143)	(0.00156)
log p^{local}_{t-1} - log p^{other}_{ijt-1}							0.0157			
							(0.0131)			
log p^{Japan}_{t-1} - log p^{other}_{ijt-1}							0.0837***	-0.0167	-0.00980	0.0324
							(0.0225)	(0.0309)	(0.0459)	(0.0318)
log capital		0.00515	-0.00106	0.00781	-0.00290	0.00477	-0.00335	0.00573	-0.00581	0.00363
		(0.00447)	(0.00509)	(0.00588)	(0.00453)	(0.00517)	(0.00543)	(0.00646)	(0.00525)	(0.00585)
log capital_lag		-0.0252***	-0.0280***	-0.0173***	-0.0105***	-0.0154***	-0.0179***	-0.0127**	-0.0106**	-0.0129**
		(0.00422)	(0.00495)	(0.00565)	(0.00404)	(0.00478)	(0.00542)	(0.00628)	(0.00457)	(0.00558)
log value-added_lag			0.0264***	0.0153***	-0.00377**	0.00785**	0.0308***	0.0157***	-0.00158	0.00665**
			(0.00343)	(0.00367)	(0.00187)	(0.00305)	(0.00400)	(0.00425)	(0.00210)	(0.00332)
log employment		-0.00378*	-0.00800***	-0.00816**	0.00299	0.00161	0.0130***	0.0112***	0.00598**	0.0113***
		(0.00227)	(0.00247)	(0.00324)	(0.00248)	(0.00303)	(0.00297)	(0.00405)	(0.00297)	(0.00351)
log employment_lag		-0.0151***	-0.0220***	-0.0243***	-0.00149	-0.0111***	-0.0516***	-0.0460***	-0.00702	-0.0189***
		(0.00238)	(0.00275)	(0.00373)	(0.00263)	(0.00339)	(0.00586)	(0.00695)	(0.00568)	(0.00652)
Observations	94,402	54,890	42,279	39,613	38,810	39,493	33,134	30,781	30,379	30,700
R-squared	0.018	0.049	0.068	0.274	0.798	0.538	0.073	0.295	0.792	0.540
Country-sector-year FE	No	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Affiliate FE	No	No	No	No	Yes	No	No	No	Yes	No
Parent FE	No	No	No	No	No	Yes	No	No	No	Yes

Note: The table reports the results of estimating equation (10) using the share of purchases from Japan as the dependent variable. Clustered standard errors at the affiliate level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Inputs from parents

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES						$\frac{Jparent_{ijt}}{total_{ijt}}$				
log R&D$_{ijt-1}$	-0.0145***	-0.00543**	-0.0110***	-0.0108***	-0.000471	-0.00905***	-0.0134***	-0.00994***	-0.000840	-0.00943***
	(0.00186)	(0.00275)	(0.00272)	(0.00294)	(0.00192)	(0.00268)	(0.00290)	(0.00316)	(0.00213)	(0.00299)
log R&D$_{i0t-1}$	0.0106***	0.0135***	0.00774***	0.00399*	0.000865	0.00165	0.00825***	0.00543**	-0.000259	0.000133
	(0.00140)	(0.00272)	(0.00200)	(0.00216)	(0.00141)	(0.00182)	(0.00222)	(0.00231)	(0.00168)	(0.00214)
log R&D$_{i-jt-1}$	-0.0105***	-0.00771***	-0.00743***	-0.00509**	-0.00210	0.00178	-0.00873***	-0.00640***	-0.00268	0.000637
	(0.00156)	(0.00240)	(0.00193)	(0.00205)	(0.00188)	(0.00204)	(0.00206)	(0.00221)	(0.00195)	(0.00219)
log p^{local}_{t-1} - log p^{other}_{ijt-1}							0.0907***			
							(0.0189)			
log p^{Japan}_{t-1} - log p^{other}_{ijt-1}							-0.0237	-0.00758	-0.0115	0.0633
							(0.0274)	(0.0404)	(0.0860)	(0.0423)
log capital		0.0199	0.0159	0.0206	0.0120	0.0146	0.0164	0.0209	0.0296**	0.0266*
		(0.0193)	(0.0138)	(0.0139)	(0.00932)	(0.0116)	(0.0165)	(0.0168)	(0.0126)	(0.0144)
log capital_lag		-0.0405**	-0.0425***	-0.0290**	-0.0148*	-0.0270**	-0.0386**	-0.0298*	-0.0175*	-0.0421***
		(0.0177)	(0.0135)	(0.0135)	(0.00821)	(0.0112)	(0.0164)	(0.0166)	(0.0103)	(0.0140)
log value-added_lag			0.0323***	-0.00179	-0.00791***	0.000869	0.0259***	-0.00142	-0.00590**	0.00421
			(0.00448)	(0.00495)	(0.00250)	(0.00395)	(0.00516)	(0.00595)	(0.00286)	(0.00455)
log employment		-0.0120***	-0.0170***	-0.00404	0.00119	0.00211	0.00825***	0.00918**	-0.000170	0.00574
		(0.00259)	(0.00277)	(0.00365)	(0.00255)	(0.00326)	(0.00298)	(0.00435)	(0.00296)	(0.00356)
log employment_lag		-0.0147***	-0.0224***	-0.00639	-0.00259	-0.000257	-0.0418***	-0.0225**	-0.0101	-0.000481
		(0.00272)	(0.00298)	(0.00406)	(0.00264)	(0.00354)	(0.00710)	(0.00917)	(0.00867)	(0.00892)
Observations	55,595	24,406	20,392	19,063	18,665	18,990	15,694	14,569	14,290	14,513
R-squared	0.007	0.020	0.076	0.265	0.837	0.609	0.098	0.293	0.845	0.616
Country-sector-year FE	No	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Affiliate FE	No	No	No	No	Yes	No	No	No	Yes	No
Parent FE	No	No	No	No	No	Yes	No	No	No	Yes

Note: The table reports the results of estimating equation (10) using the share of purchases from Japanese headquarters as the dependent variable. Clustered standard errors at the affiliate level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 8: Inputs from third-party countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES					$\frac{third_{ijt}}{total_{ijt}}$					
log R&D$_{ijt-1}$	-0.00776***	-0.00714***	-0.00645***	-0.00160	0.00179	-0.00138	-0.00772***	-0.00195	0.00189	-0.00242
	(0.00130)	(0.00160)	(0.00181)	(0.00167)	(0.00114)	(0.00150)	(0.00204)	(0.00192)	(0.00131)	(0.00176)
log R&D$_{i0t-1}$	0.00487***	0.00519***	0.00605***	0.00252**	0.00199**	0.00123	0.00625***	0.00306**	0.00236*	0.00191
	(0.000642)	(0.000922)	(0.00102)	(0.00105)	(0.00101)	(0.00107)	(0.00127)	(0.00136)	(0.00130)	(0.00135)
log R&D$_{i-jt-1}$	0.0103***	0.0114***	0.0124***	0.00810***	0.00335***	0.00530***	0.0122***	0.00768***	0.00344***	0.00579***
	(0.000808)	(0.00103)	(0.00117)	(0.00108)	(0.00108)	(0.00114)	(0.00132)	(0.00129)	(0.00122)	(0.00133)
log p^{local}_{t-1} - log p^{other}_{ijt-1}							0.0391***	0.0720***	-0.0114	0.0345
							(0.0106)	(0.0205)	(0.0389)	(0.0235)
log p^{Japan}_{t-1} - log p^{other}_{ijt-1}							-0.0705***			
							(0.0181)			
log capital		-0.0117***	-0.0123***	-0.00284	0.00219	-0.00347	-0.0130***	-0.00269	0.00432	-0.00258
		(0.00326)	(0.00386)	(0.00406)	(0.00354)	(0.00386)	(0.00462)	(0.00511)	(0.00452)	(0.00487)
log capital_lag		0.00101	-0.00216	-0.000934	0.00304	-9.27e-05	-0.00429	-0.00325	0.00382	-0.000529
		(0.00306)	(0.00370)	(0.00388)	(0.00296)	(0.00357)	(0.00452)	(0.00497)	(0.00373)	(0.00462)
log value-added_lag			0.00670***	0.000980	0.000403	0.00160	-0.00651**	-0.00131	0.00189	0.00151
			(0.00244)	(0.00220)	(0.00144)	(0.00204)	(0.00300)	(0.00285)	(0.00183)	(0.00262)
log employment		-0.000394	-0.000678	0.00284	-9.25e-05	-0.000732	-0.00133	-0.00210	0.00313	0.000114
		(0.00164)	(0.00180)	(0.00223)	(0.00205)	(0.00230)	(0.00252)	(0.00326)	(0.00263)	(0.00310)
log employment_lag		0.00514***	0.00352*	0.00677***	-0.00251	-0.00149	0.0109**	0.00842*	-0.0122**	-0.00956*
		(0.00175)	(0.00206)	(0.00246)	(0.00231)	(0.00253)	(0.00462)	(0.00509)	(0.00534)	(0.00534)
Observations	94,402	54,890	42,279	39,613	38,810	39,493	33,134	30,781	30,379	30,700
R-squared	0.032	0.037	0.045	0.285	0.753	0.463	0.045	0.286	0.743	0.470
Country-sector-year FE	No	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Affiliate FE	No	No	No	No	Yes	No	No	No	Yes	No
Parent FE	No	No	No	No	No	Yes	No	No	No	Yes

Note: The table reports the results of estimating equation (10) using the share of purchases from the third countries as the dependent variable. Clustered standard errors at the affiliate level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

5 Conclusion

In this paper, we study the effect of R&D decisions by MNCs and their affiliates on an affiliate's decision to purchase intermediate inputs across different locations. To do so, we develop a theoretical model of R&D and sourcing decisions, where innovation in the MNC and affiliate affects affiliate sourcing through Hicks-neutral productivity and also the biased productivity toward individual input sources. then, we use a panel of Japanese MNCs and their affiliates from 1995 to 2020. Our regression results imply that higher affiliate R&D expenditures are associated with a higher share of affiliate purchases from local firms. Similarly, higher R&D expenditures by affiliates in third-party countries (i.e., those under the same parent firm but located in a different foreign country) are associated with a higher share of affiliate purchases from third-party countries. However, we find that affiliate R&D expenditures are negatively correlated with purchase share from home country and from the parent firm.

For future work, a dynamic model is needed to solve for the optimal R&D decisions.

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