Substitution in Bilateral FDI: Theory and Evidence from Global FDI Firm Data

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Abstract

This paper builds a theory to characterize the impact of institutional quality on productivity and profitability of firms. MNEs headquartered in countries of poorer state institutions are shown to invest more in 'informal institutions'. Firms from countries of good "formal" institutions tend to invest in countries with "not so good" institutions to save on production cost since those host countries tend to have lower wage levels. On the contrary, their counterparts from countries with "not so good" institutions tend to invest in countries of "good" institutions to save on fixed cost which is partly composed by invests in "informal institutions". For the most productive firms, MNEs on average generate more net profits in countries of better institutions, the poorer the institutional environment at home. The above proposition is confirmed using global firm level FDI data.

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1. Introduction

Studies on determinants of FDI has been accumulated and provided us a good understanding on this issue. Helpman (2006) reviewed relevant literature on this research question. The decision at firm level to undertake FDI depends on firm-level characteristics such as productivity, and potential host country features. For example, firms tend to choose lower-cost countries to create export platforms. In addition, firms also have to consider problems of outsourcing or integration in fragmented production.

Although vertical FDI decisions are often assumed to be cost-saving, other factors can affect vertical FDI as well. According to IMF, Developing countries' share in total FDI inflows rose from 26 percent in 1980 to 37 percent in 1997, and their share in total outflows rose from 3 percent in 1980 to 14 percent in 1997. Firms based in industrial countries are still the primary source of FDI, but direct investment originating in developing countries has more than doubled since the mid-1980s. Industrial countries as a group also attract the greater proportion of such investment. From this point, firms from South countries undertaking FDI can be motivated by other factors.

This paper incorporate the institutional factors in firms' choosing host countries. The institutional quality at the origin country will affect the firm's productivity, in line with earlier studies on positive effect of institutions on growth. Worse institution will discount firm productivity more. This "discounted" productivity will finally affect profit whenever the firm produce at home or carry out vertical FDI. So, for two firms of the same productivity, the one from a country of good institution quality will not have its productivity discounted so much and earn a higher profit than the one from a country of bad institution quality that if they produce in the same host country.

Therefore, firms choose their host countries considering institutions both at home and the host country. Firms from countries of worse institutions tend to invest in countries of higher institutional quality and vice versa. The rationale behind is that countries from countries of better governance quality are motivated by cost-saving considerations since wage levels there are lower. Their counterparts from countries of worse governance qualities seeks to reduce their fixed costs since it's well recognized that worse institutions implies higher entry costs. That mechanism is confirmed using firm-level data on FDI.

The study is connected to prevalent research on institutional determinants of FDI and research using firm-level data on FDI. For example, Du et al. (2008) examines the impacts of economic institutions, including property rights protection and contract enforcement, on the location choice of foreign direct investment of US firms. They find that US multinationals prefer to invest in those regions that have better protection of intellectual property rights, lower degree of government intervention. Similar findings are also present in Bénassy-Quéré et al. (2007) and Jensen (2008). The contribution of the paper is that a mechanism through which bilateral institutional difference can affect FDI is proposed. Also, the data used in the paper is firm-level FDI data across more than 100 countries, which enable the deep investigation in the issue. Additionally, firm-level characteristics are exploited.

The paper is organized as the following. Section 2 provide the theoretical framework of the paper. Section 3 discusses and summarize data used here. Section 4 presents empirical studies. Section 5 concludes.

2. Model

The model is intended to show the conditions under which positive or negative sorting in institutions occur in FDI. Theoretical predictions focus on showing the 'direction' of impacts. Particularly, I focus on vertical FDI where production is composed of headquarter and subsidiary components and profit is affected by both home and host countries.

2.1. Setup

The world is populated by a unit measure of consumers. Here homothetic preference is assumed, with utility function of each consumer as

$$U = \left(\int_{\omega \in \Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where $\sigma > 1$ is the elasticity of substitution and Ω is the set of available varieties.

Each variety ω requires a headquarter service component and a manufactured (subsidiary) component using a Cobb-Doublas production function, following Antras and Helpman (2004). Each component has a unit labor requirement equal to one, without loss of generality. In addition, more productive firms have lower marginal costs.

Institutional quality of the home country can affect firm productivity. This is supported in prior studies in governance and economic development. The importance of institutional quality as a basic determinant of economic growth and TFP in the long term is illustrated by many authors: the seminal paper by Mankiw et al. (1992) emphasizes the importance of the impact of institutions on investment in human and physical capital and thus in turn on per capita income. In the same vein, Eicher et al. (2004) and Rodríguez-Pose and Ketterer (2012) point out that institutions have a large impact on human and physical capital accumulation, which in turn affects firms' productivity. Besides, institutions exert an impact on TFP and output through other channels. Acemoglu and Robinson (2010) have shown how better institutions create a favorable business environment and a legal structure which directs investments toward activities able to ensure higher and more rapid growth. Good institutions encourage firms to use better technology, invest in knowledge creation and transfer (Loayza et al. 2005).

Based on that, the marginal cost function of a firm with productivity ϕ and headquarter intensity η from home country h carrying on vertical FDI in host country d is

$$c = \frac{w_h^{\eta} w_d^{1-\eta}}{r_h^{\frac{1}{1-\sigma}} \phi}$$

where r_h is the (formal) governance quality in country d. Higher r_d, the poorer the institutional quality, and therefore the higher marginal cost for a firm from h investing in d. with CES preference mentioned above, the profit function of the firm is

$$\pi = B \frac{\tilde{\phi}}{r_h} (w_h^{\eta} w_d^{1-\eta})^{1-\sigma} \tag{2}$$

where $B = \frac{1}{\sigma} X_j^{\sigma(\mu-1)+1} (\frac{\sigma}{\sigma-1})^{1-\sigma}$,$\tilde{\phi} = \phi^{\sigma-1}$ and $w_h(w_d)$ is the wage at home(host) country.

In the above model, labor endowment is assumed to be fixed and large enough in each country. The wage level w is determined by labor productivity. It's assumed that countries with better formal institutional quality have higher labor productivity and hence a higher wage: $w^{'}(r) = dw/dr < 0$

2.2. Choice of Informal Institution

To produce at home or initiate vertical FDI, a fixed cost should be incurred. The fixed cost of producing at home country only is $f(r_h, I)$. This fixed cost depends on r_h, the formal institution at home country, and I, the informal institution the firm invests in. If the firm carries out vertical FDI, the fixed cost should be $f(r_h, I) + f(r_d, I)$, i.e. the additional fixed cost depends on both informal institution the firm invests and the formal institutional quality in the host country d.

The following key assumptions on the fixed cost is made. These assumptions follows Chang (2015). Firstly, the fixed cost increases with r_h and r_d, i.e. higher fixed costs are required, the worse institutional quality at home and host countries. Secondly, fixed cost decreases with informal institution investment, i.e. higher informal institutional investment reduces such fixed cost. Thirdly, higher informal institutional investment is more effective in reducing fixed costs in countries with poorer governance quality (higher r_h, r_d), as Equation (3) shows:

$$\frac{\partial}{\partial r}\left(\frac{\partial f(r, I)}{\partial I}\right) < 0 \tag{3}$$

Note here that the informal institution I can reduce the fixed cost of both producing at home and vertical FDI. In addition, investing informal institution at level I requires the cost of $k(I)$, which is increasing and convex in I.

One aspect of the firm's problem is to minimize its fixed costs. If the firm only produces at home, its problem is

$$\min_I F(r_h, I) = f(r_h, I) + K(I)$$

If the firm carry out vertical FDI, its problem is

$$\min_I F^{FDI}(r_h, r_d, I) = f(r_h, I) + f(r_d, I) + K(I)$$

According to Chang (ibid.), the above setup have several implications[1]. Firstly, investment in informal institutions are higher if a firm decide to initiate FDI and fixed cost associated with FDI is higher than producing at home. Related to that, the poorer institutional quality both at home and host countries, the higher fixed costs of FDI. Intuitions are that FDI impose additional fixed cost threshold for firms and firms carrying out FDI have higher incentives to reduce such fixed costs, thus informal institution investment is higher for FDI. Poorer institutional quality raise fixed costs through both increasing $f(r_h, I)$, $f(r_d, I)$ and informal investment $k(I)$.

The second implication is related to the above. Multinationals located in home countries with poorer formal institutions invest more in informal institutions. For a given destination, multinationals from home countries with poorer informal institutions are more effective in reducing the fixed costs. The intuition is that firms headquartered in countries of poorer informal institution have higher incentive to invest in informal institution due to assumption (3). This high investment in informal institution in turn benefits the multinational by reducing the fixed cost in the host country d.

Formally, the following implications are yielded.

$$I^{FDI,*}(r_h, r_d) > I^*(r_h)$$

[1]For mathematical proof of these implications, refer to Chang (2015) Proposition 1 and Proposition 2

$$F^{FDI,*}(r_h, r_d) > F^*(r_h)$$

$$\frac{dF^{FDI,*}(r_h,r_d)}{dr_d} > 0$$

$$\frac{dF^{FDI,*}(r_h,r_d)}{dr_h} > 0$$

$$\frac{\partial I^{FDI,*}(r_h,r_d)}{\partial r_h} > 0$$

$$\frac{df(r_d,I)}{dr_h} < 0$$

2.3. Optimal FDI Destination

This section characterize the optimal choice of host countries by firms of different productivity levels $\tilde{\phi}$ and different home countries r_h. Producing locally yields the profit of

$$\Pi^D = \pi^D - F_h^* = B\frac{\tilde{\phi}}{r_h} w_h^{1-\sigma} - f(r_h, I^*) - k(I^*) \tag{4}$$

Producing in the form of vertical FDI yields the profit of

$$\Pi^{FDI} = \pi^{FDI} - F^{FDI,*} = B\frac{\tilde{\phi}}{r_h}\left(w_h^{\eta} w_d^{1-\eta}\right)^{1-\sigma} - f(r_h, I^{FDI,*}) - f(r_d, I^{FDI,*}) - k(I^{FDI,*}) \tag{5}$$

The problem of a firm in vertical FDI is to choose host country r_d to maximize overall profit Π^{FDI}:

$$\max_{r_d} \Pi^{FDI} = \pi^{FDI} - F^{FDI,*} = B\frac{\tilde{\phi}}{r_h}\left(w_h^{\eta} w_d^{1-\eta}\right)^{1-\sigma} - f(r_h, I^{FDI,*}) - f(r_d, I^{FDI,*}) - k(I^{FDI,*}) \tag{6}$$

where the total fixed cost $F^{FDI,*}$ takes into account of the optimal choice of $I^{FDI,*}$ discussed in prior subsection.

The first-order condition (FOC) for optimal choice of r_d^* satisfies the following

$$\frac{\partial \pi^{FDI}}{\partial w_d^*} w^{'}(r_d^*) = \frac{\partial f(r_d^*, I^{FDI,*})}{\partial r_d^*} \tag{7}$$

Proposition 1. *(i)* ***Substitution in Institutional Qualities*** *With the assumption on the wage elasticity of governance quality:* $-\frac{dw_h/w_h}{dr_h/r_h} > \frac{1}{\eta(\sigma-1)}$. *The following can be obtained:*
All else being equal, all firms with productivity above certain threshold ϕ^* *will choose to undertake FDI in countries of poorer institutional qualities, the better the institution quality at home, i.e.* $\frac{\partial r_d^*}{\partial r_h^*} < 0$*; (ii) All else being equal, a firm will choose to undertake FDI in countries of poorer institutions, the more productive the firm is* $\frac{\partial r_d}{\partial \tilde{\phi}} > 0$*; (iii) All else being equal, a firm will choose to undertake FDI in countries of poorer institutional qualities, the larger world demand is* $\frac{\partial r_d^*}{\partial B} > 0$*; (iv) All else being equal, if host country wage is lower than the home country wage, a firm will choose to carry out FDI in countries of poorer institutions, the less headquarter intensive the sector is* $\frac{\partial r_d^*}{\partial \eta} < 0$

Proof. (i) $\frac{\partial^2 \pi^{FDI}}{\partial r_d^2} < 0$ by second-order condition for profit-maximization on r_d^*. Differentiating (7) with respect to r_h attains:

$$\frac{\partial^2 \Pi}{\partial r_d \partial r_h} = \frac{\partial^2 \pi}{\partial r_d \partial r_h} - \frac{\partial^2 f(r_d, I^{*,FDI})}{\partial r_d \partial I} \frac{\partial I^{*,FDI}}{\partial r_h} \tag{8}$$

where

$$\frac{\partial^2 \pi}{\partial r_d r_h} = B(1-\sigma)(1-\eta)\tilde{\phi} w_d^{(1-\eta)(1-\sigma)-1} \frac{w_h^{\eta(1-\sigma)-1}}{r_h} w'(r_d)((1-\sigma)\eta w'(r_d) - \frac{w_h}{r_h})$$

Given the (absolute value of) wage elasticity w.r.t r is larger than $\frac{1}{\eta(\sigma-1)}$, i.e. $-\frac{dw_h/w_h}{dr_h/r_h} > \frac{1}{\eta(\sigma-1)}$, $\frac{\partial^2 \pi}{\partial w_d w_h} < 0$

For the second part of Equation (8), the assumption implies that $\frac{\partial^2 f(r_d, I^{*,FDI})}{\partial r_d \partial I} < 0$. According to last subsection, $\frac{\partial I^{*,FDI}}{\partial r_h} > 0$

Thus, it can be inferred that $\frac{\partial^2 \Pi}{\partial r_d \partial r_h} < 0$ if and only if $\tilde{\phi} > \tilde{\phi}^*$

where $\tilde{\phi}^* = \frac{\partial f(r_d, I^{FDI})}{\partial r_d \partial I} \frac{\partial I^{FDI}}{\partial r_h} [B(1-\sigma)(1-\eta) w_d^{(1-\eta)(1-\sigma)-1} \frac{w_h^{\eta(1-\sigma)-1}}{r_h} w'(r_d) w'(r_h)((1-\sigma)\eta - \frac{w_h}{r_h} w'(r_h)^{-1})]^{-1}$

For firms with high productivity, $\frac{\partial r_d}{\partial r_h} < 0$ holds.

(ii) Similarly, taking the total differentiation of (7) w.r.t. $\tilde{\phi}$ obtains

$$\frac{\partial r_d^*}{\partial \tilde{\phi}} = -\frac{\frac{\partial^2 \pi^{FDI}}{\partial \tilde{\phi} \partial w_d} w'(r_d)}{\frac{\partial^2 \Pi^{FDI}}{\partial r_d^2}} > 0 \tag{9}$$

Since $\frac{\partial^2 \pi^{FDI}}{\partial \tilde{\phi} \partial w_d} = (1-\sigma)(1-\eta)\pi^{FDI}/(w_d \tilde{\phi}) > 0$

(iii) Using the same method as above, the same implication can be reached, since B and $\tilde{\phi}$ affects π^{FDI} in the same direction.

(iv) Finally, similar derivations as the above yields:

$$\frac{\partial r_d^*}{\partial \eta} = -\frac{\frac{\partial^2 \pi^{FDI}}{\partial \eta \partial w_d} w'(r_d)}{\frac{\partial^2 \Pi^{FDI}}{\partial r_d^2}} < 0, \text{ if } w_h > w_d$$

Since $\frac{\partial^2 \pi^{FDI}}{\partial \eta \partial w_d} = (1-\sigma)\left[(1-\eta)(1-\sigma)\ln(\frac{w_h}{w_d}) - 1\right] \frac{\pi^{FDI}}{w_d} > 0$ if $w_h > w_d$; Otherwise, the sign is ambiguous. QED

The above theoretical model is different from previous studies in the following aspects. Firstly, the theoretical model identifies the effect of home country institutional quality on productivity, which is not considered in Chang (2015); Secondly, unlike Chang (ibid.) which identifies complementarity in institutional quality choice universally, the model here analyzes the conditions under which substitution/complementarity can occur in terms of host country institution choice. Finally, the model here does not exclude the case of $w_h < w_d$, i.e. a firm with very high productivity can carry out vertical FDI in a host country with higher wage than the domestic country because the institutional quality at home is very low.

2.4. Discussion on the Model

I discuss the rationales behind this model and some further extensions on it. The model predicts that when the wage is very elastic to institution quality, for very productive firms, the poorer the institutional quality at home country is, the better the host country institutional quality, and vice versa. The intuition behind is that, if the home country has a very good governance, a firm does not care about much of its productivity; rather, it will consider investing in a host country with low wage to save production costs. However, the poorer the governance quality, the lower the wage and higher the additional fixed costs as is argued in the setup of the model. The better the institutional quality at home, the lower the informal institution investment I, thus the higher fixed cost for a given host country. According to Helpman et al. (2004), only the subset of most productive firms choose to initiate FDI due to its high fixed cost. From this point, for a subset of most productive firms, the better institution at home induces them to carry out vertical FDI in institutionally poorer host countries.

Conversely, firms from countries of poor institutional quality have different motivations. Firms headquartered in these countries cares more about their productivity since it's heavily "discounted" by poor governance at home.The poorer home country institution, the more productivity is "discounted", the lower the cost of headquarter service is, the more the firm is concerned about reducing fixed effects to remedy the loss in operating profit. Only the subset of the most productive firms can offset the higher wage in host countries of better governance.

The model can be extended in the following way. Firstly, a firm can make informal institution investment separately in the home and host countries. Secondly, more productive firms (or larger firms) have closer connection with the governments and this is especially true in developing countries (Cai et al. 2011). Finally, assumptions can be made on functional forms of $w(r)$, $f(r, I)$ and $k(I)$ to derive the aggregate pattern.

3. Data

This section discusses how firm-level data is processed, along with descriptive evidence on this. The primary dataset is the listed firms data provided by Bureau van Dijk. The reason is that listed firms are mostly highly productive.

3.1. Firm-level Data and Productivity Estimation

I construct the firm-level measures based on the OSIRIS enterprise database of Bureau van Dijk (BvD). This dataset provides comprehensive information on listed, and major unlisted/delisted companies around the world. I use two subsets of the database: the financial module and the ownership module. The former provides firm-level financial report items including total revenues, employment, total assets, and research and development (R&D) expenses.[2] The latter reports for each firm its name, location, industry, and its domestic/foreign affiliates, as well as the information on each of its affiliates (name, location, and industry).[3] The percentage of ownership stake in an

[2]Data are downloaded in US dollars.

[3]The dataset reports a firm's sector at the 4-digit NAICS 2012 level. Financial-type firms (such as banks, financial company, insurance company, mutual/pension fund, or private equity firm) are excluded from the analysis.

affiliate by its parent firm is also recorded. This allows us to identify FDI activity (Kalemli-Ozcan et al. 2015). The financial module allows the user to retrieve historical data for up to 10 recent periods. The ownership module however reports only the latest ("as of date") ownership information. I downloaded the data on November 24th, 2016. See ibid. for a discussion of the issues involved in downloading/assembling a similar database ORBIS of BvD.

We follow long-established methods of estimating firm productivity as a residual of Cobb-Douglas production function. In this regard, both methodologies proposed by Olley and Pakes (1996) (OP) and Levinsohn and Petrin (2003) (LP) are possible candidates given the current dataset. I choose to estimate firm productivity based on LP, because the LP approach relies on intermediate inputs as a proxy rather than on investment, whose level may be non-positive and depends on the assumption of the depreciation rate. On the other hand, it is common that firms record positive use of materials/energy so that we preserve as many observations as possible.[4]

I choose to download the five latest available years of financial data for each firm. The latest account update year ranges between 1987 and 2016. i use only firms whose latest account update year falls in 2014, 2015 or 2016. Thus, this is an unbalanced panel with up to 5 years of financial data (the latest account update year t, $t-1$, ..., $t-4$) with $t \in \{2014, 2015, 2016\}$. The procedure to estimate productivity is as follow. First, gross output, capital and total inputs are proxied by total revenues, total assets, and Costs of Goods Sold (COGS), respectively. The cost of material/energy (in short, material, henceforth) is calculated by COGS minus total wage payable, by the accounting definition of COGS. Second, these values are deflated to obtain the quantity counterpart.[5] The number of employees are directly observable from the data. Given the observations on gross output, labor, material, and capital, we estimate the production function based on the Stata program *levpet* using as instruments current capital, lagged material, lagged labor, lagged two year material and lagged capital. Because industries can vary in their production technologies, the estimation is done separately for each 3-digit NAICS sector.

Another key firm-level variable used in our empirical analysis is research and development (R&D) intensity. This is constructed as the ratio of R&D expenditure to total sales revenues. I use this variable to measure the complexity of a firm's headquarter intensity. R&D intensity is used as proxy of headquarter intensity in FDI literature Godart et al. (2009). R&D activities are the skill intensive activity of a multinational and is generally assumed to be carried out at the headquarter. Patents or trademarks generated by R&D at the parent firms can be easily transferred to foreign affiliates and foreign subsidiaries can use those in combination with local factor inputs to contribute to production and distribution.

[4]We also use OP as a robustness check and estimated productivities are similar.

[5]The total sales revenues are deflated by Consumer Price Index (CPI), the total assets deflated by the index of fixed asset investment deflator, and the material normalized by Producer Price Index (PPI). Currently, we use the US CPI (Total All Items) and PPI (for All Commodities), and construct the index of fixed asset investment deflator from gross fixed investment flows. They are retrieved from the US Federal Reserve Bank of St. Louis website, https://fred.stlouisfed.org/.

3.2. Vertical and Horizontal FDI

As introduced above, I use the ownership module of OSIRIS to identify FDI activity. In particular, the ownership module provides data on the ownership stake of a firm in its affiliates.[6] I replace special codes "BR" (Branch) and "WO" (Wholly Owned) as 100% ownership stake, "MO" (majority owned) with 50.01%, and "JO" (jointly owned) with 50%.

As noted above, the ownership module provides the firm-affiliate information "as of date", that is, at the latest account update of each firm. Without accessing the historical vintage release, by implication, I have only a cross-section (and not a panel data) on FDI activity. I keep only the ownership observations that are updated in the three year span of 2014–2016 and drop the older observations. Given that firms are unlikely to withdraw their foreign affiliates in a short time frame due to large sunk and fixed costs Helpman et al. (2004), it's supposed that the FDI relations reported in 2014/2015 remain active in 2016.

Given the industry classification of a firm, we classify a FDI relationship as horizontal FDI if the parent and its affiliate are in the same industry (at 4-digit NAICS level). The identification of vertical FDI is relatively complicated because the literature has approached it in various ways. For example, Godart et al. (2009) identifies vertical link by affiliates' shipments to parent firms. In contrast, Alfaro and Charlton (2009) identify the relationship based on sectoral linkages. I follow the latter approach and use the Input-Output (IO) table of the US economy complied by Bureau of Economic Analysis (BEA). For firm-affiliate FDI relationship in 2014, the IO table of 2014 is used and for that in 2015-2016, the IO table in 2015 (the latest year available) is used. The US table is used because the IO tables are not readily available for every country at highly disaggregate levels. A vertical FDI relationship is identified as follows. Suppose the parent firm belongs to industry s_p and its foreign affiliate industry s_a. The parent and its foreign affiliate are classified as in a vertical FDI relation if the following criteria are met:

(a) sector s_p's use of inputs from s_a exceeds 1% of s_p's total intermediate input purchase,[7] or
(b) sector s_a's use of inputs from s_p exceeds 1% of s_a's total intermediate input purchase, and
(c) sector s_p is not equal to s_a at 4-digit NAICS level.

Note that with this definition, both the use of inputs by the parent firm from foreign affiliates (Alfaro and Charlton (ibid.)) and the use of inputs by foreign affiliates from the parent firm are considered.

3.3. Firm-level Summary Statistics

I include in the sample the firms who have at least one foreign affiliate and meet the above criteria for vertical/horizontal FDI and with recent account update years (2014–2016). This results in more than 309,000 firm-affiliate FDI relationships. Note that a firm can have multiple foreign affiliates each in vertical or horizontal FDI relationship. Consequently, I obtain more than 23,000 headquarter firms. These firms are linked to their firm characteristics and estimated productivity levels of year 2013 as constructed from the financial module.

More firms conduct horizontal FDI than vertical FDI. Comparing firm variables in the two types, the table shows that they do not differ to very large extent. In general, firms undertaking vertical

[6] In the ownership module, information on both the direct ownership stake and total ownership stake are provided. In this study, I choose to use the information on the direct ownership stake as the benchmark in identifying FDI

[7] As robustness checks, higher threshold of 5% and 10% are also used. Results are robust to changes in the threshold.

FDI are slightly larger, more productive, more capital/R&D intensive than their horizontal FDI counterparts. Furthermore, vertical FDI firms have slightly higher sales and use more intermediate inputs.

3.4. Country-level Measures

In Table 2, I characterize the home countries of multinationals and the destination countries of their foreign affiliates, in terms of institutional qualities. A country's institutional quality is measured based on the Worldwide Governance Indicators (WGI), 2015 Update, in six dimensions: voice and accountability (VA), political stability and absence of violence (PV), government effectiveness (GE), regulatory quality (RQ), rule of law (RL), and control of corruption (CC). This practice follows Kaufmann et al. (2011). For each governance indicator, a country receives both a point estimate, ranging from approximately -2.5 (weak) to 2.5 (strong), and a percentile ranking among all countries. We use the point estimate here. The data on GDP per capita (in current USD) is from the World Bank.

As indicated by Table 2, multinationals are based in a narrower set of countries than their affiliates (eg. 125 versus 199). They are on average from countries of better governance institutions (positive values), and not surprisingly, the standard deviations of governance measures of home countries are smaller. In comparison, affiliates are located pretty much everywhere with an average institutional quality close to the population's mean (0).

A detailed comparison is made on different home countries. Only vertical FDI are focused on. Home countries are separated based on whether the country has a good governance quality (any of the 6 measures being above 0.02) or a poor quality (any of the 6 measures being below 0.02). As is observed from Table 3, generally, firms from poor governance quality countries tend to choose host countries of better governance quality than firms from good governance quality countries do. For example, on average, firms from poor governance countries choose to undertake vertical FDI in countries with RQ index of 0.21 while the average host country RQ of good governance country firms' destinations is 0.12.

In empirical analysis, bilateral country characteristics of FDI origin and destination are considered. These include bilateral distance, contiguity (contig), common language (comlang), whether a country pair have ever had a colonial relationship (colony), a common colonizer after 1945 (comcol), are currently in a colonial relationship (curcol), or were/are the same country (smctry). These variables are retrieved from the CEPII website. In addition, we will also control for regional trade agreements (rta), common currency (comcur), and bilateral investment treaty (bit). The former two variables are retrieved from de Sousa's website, while the information on bilateral investment treaties are obtained from UNCTAD. We construct the 'bit' dummy variable for year 2013 such that it equals one if a BIT enters into force between a country pair before July 2013 and zero otherwise.

4. Empirics and Results

This section uses the data described above to examine the theoretical model. The contribution in the empirical study is that I use firm-subsidiary level disaggregated data and focus particularly on vertical FDI while prior studies such as Chang (2015) uses aggregate data and does not separate horizontal and vertical FDI. Furthermore, the firms in the sample are listed and major de-listed

companies, indicating that the productivity of them are high enough to examine the model predictions.

4.1. Empirical Specification

According to Proposition 1, for very productive firms, if a multinational from a country with institutional quality poorer than another multinational corporation (MNC), it's likely to invest in a destination with a better governance quality than the other MNC does. Following Chang (2015), the following empirical specification is used

$$\begin{aligned}\ln(FDI_{ihads}) &= \beta_0 + \beta_1 TFP_i + \beta_2 TFP_i * G_d + \beta_3 RD_i + \beta_4 RD_i * G_d + \beta_5 \mid \ln(GDPPC_d) - \ln(GDPPC_o) \mid \\ &\quad + \beta_6 (G_o * G_d) + \gamma X_{od} + \lambda_h + \delta_d + \alpha_s + \epsilon_{ihads} \end{aligned} \tag{10}$$

where FDI_{ihads} denotes FDI undertaken by firm i of sector s headquartered in country h to affiliate a located in country d ($d \neq i$). Here I measure the "FDI to affiliates" as the percent of shares the headquarter owns its affiliates, from year 2014 to 2016. On the other hand, if firm i does not have affiliate in country d, then $\ln(FDI_{ihads}) = 0$. Since this variable measures the percentage of ownership, the maximum value of FDI_{ihads} is 100. Tobit estimation is appropriate for this.

Additionally, dummy variable of FDI is run on the same set of regressors as:

$$\begin{aligned}\ln(FDI_{ihds}) &= \beta_0 + \beta_1 TFP_i + \beta_2 TFP_i * G_d + \beta_3 RD_i + \beta_4 RD_i * G_d + \beta_5 \mid \ln(GDPPC_d) - \ln(GDPPC_o) \mid \\ &\quad + \beta_6 (G_o * G_d) + \gamma X_{od} + \lambda_h + \delta_d + \alpha_s + \epsilon_{ihads} \end{aligned} \tag{11}$$

where FDI_{ihds} equals 1 of firm i of sector s headquartered in country h has at least one affiliate located in country d ($d \neq i$), 0 otherwise.

In the specification (10) and specification (11), both firm-level and bilateral country level variables are included. TFP is the firm-level productivity estimated using LP method as discussed in the previous section. This firm-level variable is interacted with host country governance quality G_d; Also, firm-level $R\&D$ intensity is interacted with G_d. To evaluate Linder hypothesis in FDI proposed by Fajgelbaum et al. (2015), the absolute value of difference in GDP per capita between home and host countries are included here. To examine whether the substitution effect in Proposition 1 hold, the interaction between home and host countries are included here. Other bilateral variables are added. These include bilateral distance, dummy of contiguity, dummy of common language, dummy of colony relation, dummy of regional trade agreements, dummy of common currency and dummy of bilateral investment treaty. Those variables are typically used in most gravity models in international trade. Finally, fixed effects of home country, host country and sector are controlled.

According to Proposition 1, the signs of coefficients are examined. Intuitively, $\beta_1 > 0$ is expected, i.e. more productive firms have higher propensity to invest. $\beta_2 < 0$ is expected by Proposition 1 (ii), and G is larger the better institutional quality. $\beta_4 > 0$ is expected if conditions of Proposition 1(iv) hold. $\beta_5 < 0$ holds if Linder hypothesis of FDI applies to vertical FDI. $\beta_6 < 0$ by Proposition 1 (i). All those regressors are in 2013 values (if time variant).

4.2. Results

Equation (10) is estimated using Tobit. As further robustness checks, PPML estimation is also used on this specification. The signs and significance are similar to the ones presented here. Table

4 presents the tobit estimation results of Equation 10, As shown in the table, the coefficient on $G_o{*}G_d$ is negative across all governance indicators except VA. This generally supports the theoretical predictions. In addition, interaction terms $TFP * G_d$ and $R\&D * G_d$ are negative (except VA) and positive, respectively. These estimated coefficients generally supports Proposition 1.

Most of these coefficients are in line with ex ante theoretical predictions. More productive firms are more likely to undertake vertical FDI. Focusing on gravity model variables, variables of regional trade agreement (rta), bilateral investment treaties (bit), contiguous (contig), sharing a common language (comlang), common colonizer or being (were) in colony relation, and being (were) the same country all have significant and positive effect on the propensity to undertake vertical FDI. The (log) distance (lnDist) between a pair of countries has a negative effect on tendency of vertical FDI.

Apart from the the above results, extensive margin is studied. Here, the dependent variable of specification 10 becomes binary: it equals 1 if firm i of sector s from country h has at least one (vertical type) affiliate in destination country d ($h \neq d$); it equals 0 otherwise. Regressors and fixed effects are the same as the tobit estimation before. Here the probit estimation is employed. the purpose of this practice is to check whether Proposition 1 still holds when it comes to deciding whether to produce in a country or not.

Table 5 summarizes probit estimations of respective regressors. For bilateral country-level regressors, the signs and significance remain the same to some extent, except common colonizer (comcol) dummy. When checking Proposition 1, $G_o * G_d$ stays relative stable, with negative sign carrying on (except GE). However, Proposition (ii) and Proposition (iv) does not hold here as their coefficients are insignificant. Therefore, the factors affect differently when it comes to 'whether to enter or not' rather than 'how much shares to own'.

4.3. Robustness Checks

In order to check whether the above hypothesis still holds if samples vary, robustness checks are done in this section. Empirical specification is the same as Equation 10. The sample of firms changes in robustness checks. Specifically, 4 samples are used: all firms, all multinationals, all vertical FDI firms with domestic firms and all vertical FDI firms only. Only the governance measure RQ is selected in estimations, but similar findings are yielded using other governance measures. The criteria of vertical FDI varies in using each of the above 4 samples.

Table 6 presents results using all firms in the dataset. Different vertical FDI definitions apply to different columns. Column (1), (3) and (5) defines vertical FDI as the headquarters owning the subsidiary and headquarter sector requires more than 1%, 5% and 10% output of the subsidiary sector and vice versa, respectively. For Column (2), (4) and (6), the vertical FDI is defined as headquarters owning more than 10% shares of the subsidiary and headquarter sector requires more than 1%, 5% and 10% output of the subsidiary sector and vice versa, respectively. If a headquarter-subsidiary relation does not meet the respective criteria for vertical FDI, the $\ln(FDI_{ihads}) = 0$. Coefficients on $G_o{*}G_d$ remains negative and significant for most governance measures. Furthermore, Proposition 1 (ii) and 1 (iv) hold as coefficients on $TFP * G$ and on $RD * G$ are negative/positive and significant. Finally, coefficients on most bilateral country variables and firm-level TFP preserve their signs.

Similar practice is also applied to th sample of all multinational firms. In the Table 7, the same criteria of vertical FDI as in Table 6 is applied and the dependent variable is also defined in

respective columns as in Table 6. Coefficients are present. The results carries on for interaction terms. Besides, Proposition 1 (ii) and 1 (iv) hold in this subsample. Finally, bilateral gravity variables and TFP have their signs and significance roughly unchanged.

The last two robustness checks use subsets of firms. Table 8 use vertical firms and domestic firms. Column (3) and (5) define vertical FDI as headquarters owning the subsidiary and headquarter sector requires more than 5% and 10% output of subsidiary sector, and vice versa, respectively. Column (2), (4) and (6) define vertical FDI as headquarters owning more than 10% shares of the subsidiary and headquarter sector requires more than 1%, 5% and 10% output of subsidiary sector, and vice versa, respectively. Tale 9 has the same definition of vertical FDI in respective columns as in Table 6 and 7 and use vertical FDI firms only. Generally, robustness checks using different samples of firms supports hypothesis.

5. Conclusion

To summarize, the paper recognize a theory of substitution between FDI home and host countries. In the study, conditions under which such substitution relationship is proposed. A cross-country firm level dataset is applied to confirm such mechanism. When wage elasticity is large enough, the most productive firms from better institutional quality countries tend to invest in institutionally worse countries. They are motivated by marginal and fixed cost-saving considerations. Further, more headquarter intensive firms tend to invest in better institutions.

The model is stylized and can be extended to shed light on further research. For example, at the aggregate level, whether complementarity or substitution relationship hold is worth exploring. Additionally, the framework can be extended to horizontal FDI to explore whether the same mechanism hold.

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Table 1: Summary Statistics of Firms

	Vertical FDI			Horizontal FDI		
	Mean	Std.	Obs	Mean	Std. Dev.	Obs
(log) Productivity	4.16	4.05	2,488	3.98	3.97	3,820
R&DIntensity	0.39	7.01	6,618	0.36	9.94	12,443
(log) Employment	7.63	2.14	5,531	7.21	2.21	9,184
(log) Capital	13.25	2.40	7,147	12.64	2.73	13,186
(log) Material	11.95	2.54	3,475	11.53	2.63	6,099
(log) Sales	12.94	2.63	7,009	12.24	2.98	12,523

This table summarize firm-level characteristics. The firm here refers to the headquarter firm.

Table 2: Summary Statistics of Country Governance Measures

	FDI Home Countries			FDI Host Countries		
	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs
VA	0.22	0.92	126	-0.02	1.01	201
PV	0.09	0.94	126	-0.02	0.99	201
RL	0.25	0.97	126	-0.03	0.99	201
RQ	0.34	0.92	125	-0.02	1.00	199
GE	0.34	0.94	125	-0.01	1.00	199
CC	0.26	1.02	125	-0.02	1.01	199

Table 3: Comparison of Vertical FDI Destinations

	Poor Governance Quality			Good Governance Quality		
	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs
VA	0.0172967	0.9701287	129	-0.0046605	0.9821376	153
PV	-0.0457731	0.954553	129	-0.0409124	0.9657981	153
RL	0.0966728	1.005613	129	0.0526759	0.9955881	153
RQ	0.2094784	0.9699894	129	0.12356	0.9799615	152
GE	0.18549	0.987671	129	0.1179053	0.9984494	152
CC	0.0931511	1.050381	129	0.0569713	1.04891	152

Table 4: Baseline Results with Tobit

	VA	PV	GE	RQ	RL	CC
TFP_i	0.0947***	0.102***	0.119***	0.118***	0.120***	0.112***
	(0.010)	(0.010)	(0.011)	(0.011)	(0.010)	(0.010)
$TFP_i * G_d$	-0.000451	-0.0172**	-0.0241***	-0.0246***	-0.0270***	-0.0186***
	(0.008)	(0.008)	(0.007)	(0.008)	(0.007)	(0.007)
$R\&D_i$	-2.267***	-0.433***	-1.932***	-1.469***	-2.300***	-1.236***
	(0.061)	(0.042)	(0.062)	(0.056)	(0.056)	(0.057)
$R\&D_i * G_d$	1.563***	0.377***	1.151***	0.893***	1.355***	0.657***
	(0.038)	(0.033)	(0.034)	(0.031)	(0.030)	(0.026)
$G_o * G_d$	0.288***	-1.150***	-0.187***	-0.662***	-0.574***	-0.396***
	(0.046)	(0.050)	(0.039)	(0.040)	(0.036)	(0.030)
$\mid \ln(GDPPC_d) - \ln(GDPPC_o) \mid$	-0.332***	-0.986***	-0.563***	-0.875***	-0.871***	-0.834***
	(0.039)	(0.040)	(0.039)	(0.039)	(0.039)	(0.040)
rta_{od}	1.596***	1.568***	1.605***	1.670***	1.577***	1.564***
	(0.085)	(0.082)	(0.084)	(0.085)	(0.084)	(0.084)
$comcur_{od}$	-0.645***	-0.692***	-0.687***	-0.795***	-0.774***	-0.819***
	(0.104)	(0.102)	(0.103)	(0.102)	(0.102)	(0.101)
bit_{od}	1.039***	1.081***	0.969***	0.973***	0.909***	0.902***
	(0.084)	(0.083)	(0.084)	(0.084)	(0.084)	(0.085)
$contig_{od}$	0.435***	0.411***	0.403***	0.339***	0.376***	0.407***
	(0.105)	(0.106)	(0.105)	(0.105)	(0.106)	(0.106)
$comlang_{od}$	0.805***	0.901***	0.860***	0.879***	0.899***	0.904***
	(0.095)	(0.095)	(0.097)	(0.098)	(0.098)	(0.098)
$comcol_{od}$	1.710***	1.570***	1.641***	1.634***	1.525***	1.535***
	(0.121)	(0.117)	(0.121)	(0.121)	(0.121)	(0.121)
$colony_{od}$	2.681***	2.779***	2.704***	2.743***	2.742***	2.713***
	(0.076)	(0.076)	(0.077)	(0.078)	(0.078)	(0.078)
$smctry_{od}$	2.450***	2.510***	2.371***	2.198***	2.187***	2.275***
	(0.177)	(0.172)	(0.177)	(0.177)	(0.178)	(0.177)
$lnDist_{od}$	-1.546***	-1.624***	-1.591***	-1.611***	-1.628***	-1.625***
	(0.011)	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)
Home Country FE	Y	Y	Y	Y	Y	Y
Host Country FE	Y	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y	Y
Obs	1,575,937	1,575,937	1,575,937	1,575,937	1,575,937	1,575,937
R^2	0.418	0.419	0.418	0.418	0.418	0.418

Note: The sample used in the estimation is firms undertaking vertical FDI only and domestic firms. Vertical FDI is defined as headquarters owning the subsidiary and headquarter sector requires more than 1% output of subsidiary sector, and vice versa. Dependent variable is the (log) share of headquarter owning the subsidiary, if a firm does not have FDI in country d, it's recorded as 0. The methodology is Tobit. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 5: Baseline Results with Probit

	VA	PV	RQ	RL	CC
TFP_i	0.0451***	0.0498***	0.0543***	0.0523***	0.0516***
	(0.00901)	(0.00798)	(0.0104)	(0.00968)	(0.00907)
$TFP_i * G_d$	0.00255	-0.00566	-0.00789	-0.00612	-0.00544
	(0.00594)	(0.0064)	(0.00659)	(0.00586)	(0.00502)
$R\&D_i$	-0.665***	-0.161*	-0.451***	-0.642***	-0.418***
	(0.185)	(0.0918)	(0.173)	(0.185)	(0.145)
$R\&D_i * G_d$	0.428***	0.121*	0.253***	0.358***	0.200***
	(0.108)	(0.0685)	(0.0913)	(0.0974)	(0.0621)
$G_d * G_o$	0.0411	-0.241***	-0.190***	-0.129***	-0.0910***
	(0.0389)	(0.0403)	(0.0505)	(0.0441)	(0.0303)
$\mid \ln(GDPPC_d) - \ln(GDPPC_o) \mid$	-0.0855***	-0.219***	-0.228***	-0.197***	-0.191***
	(0.033)	(0.0336)	(0.0436)	(0.0433)	(0.0406)
rta_{od}	0.251***	0.239***	0.271***	0.245***	0.241***
	(0.0763)	(0.0766)	(0.077)	(0.0761)	(0.076)
$comcur_{od}$	-0.113	-0.123	-0.161*	-0.146	-0.156
	(0.0969)	(0.0981)	(0.0976)	(0.0973)	(0.0978)
bit_{od}	0.196***	0.217***	0.197***	0.178***	0.179***
	(0.0609)	(0.0604)	(0.0611)	(0.0605)	(0.0604)
$contig_{od}$	0.202**	0.198*	0.182*	0.195*	0.204*
	(0.103)	(0.103)	(0.102)	(0.103)	(0.104)
$comlang_{od}$	0.422***	0.435***	0.439***	0.439***	0.440***
	(0.0854)	(0.0859)	(0.0869)	(0.0865)	(0.0863)
$comcol_{od}$	0.138	0.105	0.108	0.094	0.0973
	(0.143)	(0.137)	(0.143)	(0.143)	(0.143)
$colony_{od}$	0.499***	0.523***	0.513***	0.512***	0.504***
	(0.0893)	(0.0893)	(0.0877)	(0.0881)	(0.0888)
$smctry_{od}$	0.617***	0.620***	0.524**	0.528**	0.548**
	(0.213)	(0.199)	(0.213)	(0.218)	(0.217)
$lnDist_{od}$	-0.433***	-0.457***	-0.451***	-0.454***	-0.452***
	(0.0501)	(0.0509)	(0.0497)	(0.0501)	(0.0501)
Home Country FE	Y	Y	Y	Y	Y
Host Country FE	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y
Obs	1078995	1078995	1078995	1078995	1078995
R^2	0.585	0.587	0.585	0.585	0.585

Note: The sample used in the estimation is firms undertaking vertical FDI only and domestic firms. Vertical FDI is defined as headquarters owning the subsidiary and headquarter sector requires more than 1% output of subsidiary sector, and vice versa. Dependent variable equals 1 if a firm has at least one subsidiary in country d, 0 otherwise. The methodology is Probit. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. When $G_d = GE$, no convergence is achieved.

Table 6: Robust Checks with All Firms

	(1)	(2)	(3)	(4)	(5)	(6)
TFP_i	0.624***	0.630***	0.643***	0.642***	0.499***	0.498***
	(0.018)	(0.019)	(0.021)	(0.022)	(0.022)	(0.023)
$TFP_i * G_d$	-0.140***	-0.139***	-0.194***	-0.200***	-0.0579***	-0.0640***
	(0.014)	(0.014)	(0.016)	(0.017)	(0.017)	(0.017)
$R\&D_i$	-7.959***	-8.189***	-11.43***	-11.75***	-15.93***	-16.38***
	(0.176)	(0.178)	(0.208)	(0.217)	(0.171)	(0.175)
$R\&D_i * G_d$	4.234***	4.371***	6.077***	6.264***	8.406***	8.661***
	(0.081)	(0.082)	(0.117)	(0.122)	(0.099)	(0.101)
$G_o * G_d$	-1.133***	-1.192***	-0.762***	-2.649***	-0.0449	-1.697***
	(0.079)	(0.082)	(0.094)	(0.083)	(0.096)	(0.080)
$\mid \ln(GDPPC_d) - \ln(GDPPC_o) \mid$	-2.772***	-2.855***	-2.533***	-0.741***	-1.600***	0.0644
	(0.066)	(0.068)	(0.081)	(0.096)	(0.078)	(0.097)
rta_{od}	2.691***	2.862***	3.289***	3.390***	2.316***	2.378***
	(0.169)	(0.174)	(0.199)	(0.203)	(0.201)	(0.203)
$comcur_{od}$	0.15	0.169	-0.0839	-0.241	0.0365	-0.22
	(0.231)	(0.239)	(0.258)	(0.264)	(0.269)	(0.271)
bit_{od}	2.125***	2.142***	2.254***	2.233***	2.568***	2.644***
	(0.133)	(0.137)	(0.169)	(0.174)	(0.169)	(0.173)
$contig_{od}$	0.352	0.365	0.572**	0.728***	1.233***	1.394***
	(0.216)	(0.223)	(0.246)	(0.252)	(0.248)	(0.251)
$comlang_{od}$	4.715***	4.691***	4.705***	4.729***	5.034***	5.078***
	(0.199)	(0.205)	(0.239)	(0.245)	(0.226)	(0.228)
$comcol_{od}$	1.937***	2.003***	-1.720***	-1.661***	-2.991***	-3.048***
	(0.282)	(0.290)	(0.363)	(0.372)	(0.356)	(0.363)
$colony_{od}$	5.851***	6.062***	4.275***	4.345***	2.701***	2.711***
	(0.163)	(0.168)	(0.205)	(0.209)	(0.210)	(0.211)
$smctry_{od}$	8.263***	8.231***	5.940***	5.908***	3.806***	3.904***
	(0.319)	(0.318)	(0.341)	(0.351)	(0.363)	(0.368)
$lnDist_{od}$	-3.836***	-3.946***	-3.849***	-3.936***	-3.547***	-3.549***
	(0.020)	(0.021)	(0.024)	(0.025)	(0.024)	(0.025)
Home Country FE	Y	Y	Y	Y	Y	Y
Host Country FE	Y	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y	Y
Obs	1549267	1549267	1549267	1549267	1549267	1549267
R^2	0.292	0.293	0.288	0.289	0.27	0.271

Note: The sample used in the estimation is all firms. $G_d = RQ$. Different vertical FDI definitions apply to different columns. Column (1), (3) and (5) define vertical FDI as headquarters owning the subsidiary and headquarter sector requires more than 1%, 5% and 10% output of subsidiary sector, and vice versa, respectively. Column (2), (4) and (6) define vertical FDI as headquarters owning more than 10% shares of the subsidiary and headquarter sector requires more than 1%, 5% and 10% output of subsidiary sector, and vice versa, respectively. Dependent variable is the (log) share of headquarter owning the subsidiary, if a firm does not have FDI in country d, it's recorded as 0. The methodology is Tobit. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 7: Robust Checks with All Multinationals

	(1)	(2)	(3)	(4)	(5)	(6)
TFP_i	0.402***	0.405***	0.442***	0.444***	0.359***	0.358***
	(0.017)	(0.018)	(0.021)	(0.021)	(0.022)	(0.022)
$TFP_i * G_d$	-0.126***	-0.125***	-0.167***	-0.172***	-0.0359**	-0.0415**
	(0.013)	(0.013)	(0.016)	(0.016)	(0.017)	(0.017)
$R\&D_i$	-10.26***	-10.55***	-17.09***	-17.56***	-23.11***	-23.65***
	(0.552)	(0.566)	(0.856)	(0.876)	(0.860)	(0.871)
$R\&D_i * G_d$	6.249***	6.471***	9.999***	10.28***	13.43***	13.75***
	(0.295)	(0.302)	(0.505)	(0.517)	(0.513)	(0.520)
$G_o * G_d$	-0.983***	-1.037***	-0.721***	-0.710***	-0.00473	0.101
	(0.078)	(0.081)	(0.096)	(0.098)	(0.099)	(0.100)
$\mid \ln(GDPPC_d) - \ln(GDPPC_o) \mid$	-2.617***	-2.695***	-2.556***	-2.674***	-1.654***	-1.743***
	(0.065)	(0.066)	(0.082)	(0.084)	(0.079)	(0.081)
rta_{od}	2.764***	2.930***	3.367***	3.460***	2.343***	2.395***
	(0.166)	(0.171)	(0.199)	(0.203)	(0.201)	(0.204)
$comcur_{od}$	-0.0324	-0.0167	-0.138	-0.299	0.0403	-0.216
	(0.224)	(0.232)	(0.259)	(0.264)	(0.269)	(0.272)
bit_{od}	2.282***	2.298***	2.439***	2.416***	2.718***	2.789***
	(0.130)	(0.133)	(0.168)	(0.173)	(0.169)	(0.173)
$contig_{od}$	0.272	0.283	0.533**	0.685***	1.188***	1.343***
	(0.215)	(0.222)	(0.250)	(0.255)	(0.252)	(0.255)
$comlang_{od}$	4.421***	4.392***	4.440***	4.456***	4.738***	4.775***
	(0.200)	(0.206)	(0.245)	(0.251)	(0.238)	(0.240)
$comcol_{od}$	2.355***	2.432***	-1.599***	-1.514***	-2.757***	-2.798***
	(0.271)	(0.279)	(0.369)	(0.379)	(0.362)	(0.369)
$colony_{od}$	5.592***	5.789***	3.948***	4.003***	2.422***	2.426***
	(0.165)	(0.171)	(0.221)	(0.226)	(0.239)	(0.240)
$smctry_{od}$	8.166***	8.132***	5.842***	5.798***	3.760***	3.848***
	(0.312)	(0.312)	(0.344)	(0.354)	(0.365)	(0.370)
$lnDist_{od}$	-3.711***	-3.821***	-3.724***	-3.816***	-3.439***	-3.450***
	(0.020)	(0.020)	(0.024)	(0.025)	(0.025)	(0.025)
Home Country FE	Y	Y	Y	Y	Y	Y
Host Country FE	Y	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y	Y
Obs	713625	713625	713625	713625	713625	713625
R^2	0.253	0.253	0.249	0.25	0.232	0.233

Note: The sample used in the estimation is all multinationals. $G_d = RQ$. Different vertical FDI definitions apply to different columns. Column (1), (3) and (5) define vertical FDI as headquarters owning the subsidiary and headquarter sector requires more than 1%, 5% and 10% output of subsidiary sector, and vice versa, respectively. Column (2), (4) and (6) define vertical FDI as headquarters owning more than 10% shares of the subsidiary and headquarter sector requires more than 1%, 5% and 10% output of subsidiary sector, and vice versa, respectively. Dependent variable is the (log) share of headquarter owning the subsidiary, if a firm does not have FDI in country d, it's recorded as 0. The methodology is Tobit. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 8: Robust Checks with Vertical FDI and Domestic Firms

	(1)	(2)	(3)	(4)	(5)
TFP_i	0.754***	0.745***	0.860***	0.634***	0.744***
	(0.021)	(0.020)	(0.024)	(0.021)	(0.025)
$TFP_i * G_d$	-0.107***	-0.153***	-0.142***	-0.0163	0.0016
	(0.016)	(0.015)	(0.018)	(0.016)	(0.018)
$R\&D_i$	-9.965***	-5.515***	-6.649***	-7.668***	-9.338***
	(0.194)	(0.262)	(0.246)	(0.172)	(0.183)
$R\&D_i * G_d$	5.271***	2.933***	3.589***	4.112***	5.026***
	(0.090)	(0.147)	(0.141)	(0.098)	(0.106)
$G_o * G_d$	-2.029***	-1.394***	-1.732***	-0.653***	-0.991***
	(0.089)	(0.086)	(0.102)	(0.086)	(0.101)
$\mid \ln(GDPPC_d) - \ln(GDPPC_o) \mid$	-3.692***	-3.286***	-3.403***	-2.319***	-2.365***
	(0.071)	(0.077)	(0.092)	(0.075)	(0.088)
rta_{od}	2.735***	2.498***	4.079***	1.663***	2.653***
	(0.195)	(0.189)	(0.226)	(0.188)	(0.221)
$comcur_{od}$	-0.212	-0.481*	0.0285	-0.520**	-0.554*
	(0.281)	(0.247)	(0.293)	(0.253)	(0.285)
bit_{od}	2.404***	2.316***	2.955***	2.398***	3.215***
	(0.146)	(0.167)	(0.198)	(0.166)	(0.192)
$contig_{od}$	1.682***	0.896***	2.017***	1.581***	2.201***
	(0.256)	(0.232)	(0.277)	(0.226)	(0.258)
$comlang_{od}$	5.565***	5.548***	6.058***	5.479***	5.790***
	(0.222)	(0.218)	(0.259)	(0.206)	(0.243)
$comcol_{od}$	1.287***	-2.216***	-2.299***	-2.470***	-2.904***
	(0.329)	(0.357)	(0.429)	(0.357)	(0.418)
$colony_{od}$	6.699***	4.905***	5.782***	3.427***	4.273***
	(0.170)	(0.183)	(0.215)	(0.174)	(0.212)
$smctry_{od}$	9.468***	6.352***	10.25***	4.808***	7.679***
	(0.371)	(0.338)	(0.410)	(0.369)	(0.431)
$lnDist_{od}$	-5.093***	-4.636***	-5.247***	-4.204***	-5.010***
	(0.022)	(0.022)	(0.026)	(0.022)	(0.027)
Home Country FE	Y	Y	Y	Y	Y
Host Country FE	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y
Obs	1240527	988248	984134	954796	951756
R^2	0.309	0.357	0.334	0.352	0.315

Note: The sample used in the estimation is vertical firms and domestic firms. $G_d = RQ$. Different vertical FDI definitions apply to different columns. Column (3) and (5) define vertical FDI as headquarters owning the subsidiary and headquarter sector requires more than 5% and 10% output of subsidiary sector, and vice versa, respectively. Column (2), (4) and (6) define vertical FDI as headquarters owning more than 10% shares of the subsidiary and headquarter sector requires more than 1%, 5% and 10% output of subsidiary sector, and vice versa, respectively. Dependent variable is the (log) share of headquarter owning the subsidiary, if a firm does not have FDI in country d, it's recorded as 0. The methodology is Tobit. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Table 9: Robust Checks with Vertical FDI Firms Only

	(1)	(2)	(3)	(4)	(5)	(6)
TFP_i	0.303***	0.352***	0.217***	0.233***	0.181***	0.207***
	(0.054)	(0.060)	(0.067)	(0.079)	(0.067)	(0.080)
$TFP * G_d$	-0.104**	-0.104**	-0.123**	-0.123**	-0.00557	0.0052
	(0.041)	(0.045)	(0.052)	(0.060)	(0.048)	(0.060)
$R\&D_i$	-10.96***	-13.91***	-7.723	-8.655	-12.12*	-14.33*
	(2.774)	(3.430)	(5.376)	(6.346)	(6.461)	(8.106)
$R\&D_i * G_d$	6.459***	8.503***	5.056*	5.760*	7.588**	8.969**
	(1.902)	(2.228)	(2.926)	(3.442)	(3.312)	(4.139)
$G_o * G_d$	-1.316**	-3.335***	-1.14	-1.554*	-2.186***	-0.891
	(0.570)	(0.579)	(0.742)	(0.888)	(0.654)	(0.865)
$\mid \ln(GDPPC_d) - \ln(GDPPC_o) \mid$	-2.991***	-1.737***	-3.130***	-3.506***	-0.51	-2.466***
	(0.507)	(0.650)	(0.671)	(0.796)	(0.721)	(0.789)
rta_{od}	2.207***	2.858***	2.808***	4.438***	1.918**	2.975**
	(0.839)	(1.005)	(0.980)	(1.228)	(0.954)	(1.232)
$comcur_{od}$	-0.282	-0.371	-0.432	-0.179	-0.342	-0.498
	(0.928)	(1.102)	(1.167)	(1.403)	(1.180)	(1.420)
bit_{od}	2.266***	2.494***	2.473***	3.068***	2.539***	3.318***
	(0.645)	(0.740)	(0.790)	(0.958)	(0.810)	(0.999)
$contig_{od}$	1.207	1.882	1.147	2.286	1.741	2.431
	(1.153)	(1.365)	(1.286)	(1.532)	(1.254)	(1.529)
$comlang_{od}$	5.018***	5.386***	5.270***	5.882***	5.396***	5.840***
	(0.837)	(1.018)	(1.037)	(1.225)	(1.020)	(1.158)
$comcol_{od}$	2.382	2.045	-2.127	-1.84	-2.532	-2.797
	(1.832)	(2.232)	(2.611)	(3.379)	(2.717)	(3.437)
$colony_{od}$	5.768***	6.571***	4.866***	5.862***	3.341***	4.268***
	(0.887)	(1.028)	(1.176)	(1.312)	(1.153)	(1.262)
$smctry_{od}$	7.897***	9.355***	5.747**	9.536***	4.235*	6.836**
	(2.564)	(2.996)	(2.594)	(3.095)	(2.434)	(2.891)
$lnDist_{od}$	-3.999***	-4.897***	-4.382***	-5.062***	-4.003***	-4.914***
	(0.622)	(0.710)	(0.696)	(0.771)	(0.698)	(0.813)
Home Country FE	Y	Y	Y	Y	Y	Y
Host Country FE	Y	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y	Y
Obs	414319	404889	152610	148496	119158	116118
R^2	0.289	0.264	0.276	0.25	0.276	0.237

Note: The sample used in the estimation is vertical FDI firms of different criteria. $G_d = RQ$. Different vertical FDI definitions apply to different columns. Column (1), (3) and (5) define vertical FDI as headquarters owning the subsidiary and headquarter sector requires more than 1%, 5% and 10% output of subsidiary sector, and vice versa, respectively. Column (2), (4) and (6) define vertical FDI as headquarters owning more than 10% shares of the subsidiary and headquarter sector requires more than 1%, 5% and 10% output of subsidiary sector, and vice versa, respectively. Dependent variable is the (log) share of headquarter owning the subsidiary, if a firm does not have FDI in country d, it's recorded as 0. The methodology is Tobit. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.