Contracts, Export and FDI with Heterogeneous Firms*

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Abstract

One prominent feature in the area of FDI is the co-existence of the facts that most FDI goes into developed countries from developed countries and that most FDI happens in non-production-work-intensive (management-intensive hereafter) industries. This could not be explained by the current horizontal FDI theories. To account for this phenomenon, I develop a model embedding contract incompleteness, which is determined by industry technology and host country development level, in the proximity-concentration model with heterogeneous firms. [Firms could choose export or FDI to serve a relatively less developed foreign country. Production uses a unique factor, labor, but employees work as workers or managers to perform two kinds of work, production-work and management, respectively. Relative to export, FDI involves low labor costs but a contract friction between the firm and the managers due to some unverifiable specific investments, which means a hold-up problem. In the bargaining, the lower the host country’s development level, the lower the outside managers’ quality level, thus the worse the firm’s outside option. Therefore, the hold-up problem is more serious in more management-intensive industries (industry heterogeneity) and in less developed countries (country heterogeneity). In management-intensive sectors, the hold-up effect will dominate the labor cost effect, otherwise, the latter dominates the former.] With this contract friction and the conventional proximity-concentration factors, this model predicts that, in management-intensive industries, the prevalence of FDI (the cutoff productivity level between export/FDI) is increasing (decreasing) in the host country’s development level, while in production-work-intensive industries, the relations are reversed. In both kinds of industry, the prevalence of FDI (the cutoff productivity) is increasing (decreasing) in the interaction of management-intensity and host country development level(?). Also, this paper characterizes the industries and countries where there will be no FDI inflow at all.

Keywords: Contract friction; Heterogeneous firms; Production-work-intensity; Host country development level; Export and FDI.

JEL: D23, F12, F14, F23, L22

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1 Introduction

The effect of host country development level on foreign direct investment (FDI) is an empirical challenge to the theory of international trade/FDI. One well-documented fact in the literature is that the bulk of FDI is horizontal\(^1\) and is from developed countries to those with similar per capita incomes (Markusen 1995, 2002). World Investment Report (2001) also documents that in 2000, developed countries were the source and the recipient of 91 and 79 percent, respectively, of world FDI flows, while 80 percent of the flows into developing countries went exclusively to China (including Hong Kong) and South Korea, with the 49 least developed countries attracting only 0.3 percent. Brainard (1997) finds that the ratio of foreign affiliate sales to export sales is decreasing in the difference in GDP per capita between two trading countries.

The second fact to be noted is the effect of industrial heterogeneity, especially production-work-intensity, on FDI decision. The significance of multinational enterprises (MNEs) varies by industries, with higher significance in sectors with higher non-production-work-intensities (Markusen 1995, 2002). Helpman, Melitz and Yeaple (2004) also find in their TABLE 2 that there will be more outward FDI (MNEs) in industries with higher productivity dispersion which is, at the same time, discovered to be highly correlated with the number of non-production-workers per establishment in those industries.

The above facts and their co-existence are robust. Then, how to explain the two facts, especially explain them jointly? Is the co-existence an incidence or is there any underlying relation between the effects of country and industry level heterogeneity? [Given that developed countries attract more FDI than less developed countries, why does this happen in management-intensive sectors? Given that significant FDI outflows happen in management-intensive sectors, why are developed countries more attractive than less developed countries? (?? to be refined)]

Thirdly, as the first fact says, except the developed countries, and China and South Korea, the rest of the world receives very little FDI. A reasonable inference is that there is no FDI

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\(^1\)Horizontal FDI means the foreign production (not only investment in distribution, wholesaling, and servicing) of products and services roughly similar to those the firm produces for its home market, whereas vertical FDI means fragmenting the production process geographically by stages of production (Markusen 1995). See the early studies on the former in Markusen (1984) and the latter in Helpman (1984).
inflows in many industries in many countries. (On the other hand, export is more extensive in the whole world. ...) Then, what are the characteristics of these no-FDI industries and countries? How to justify this no-FDI case in such industries and countries?

Leaving the above puzzles aside, on the tool side, contract friction and firm heterogeneity have been proved important in affecting firms’ ways of doing business. On one hand, Antras (2003), Antras and Helpman (2004), show that contract incompleteness is crucial in determining a firm’s global sourcing strategy. Nunn (2007) empirically shows that consideration of contract incompleteness explains more of the trade pattern than capital and skilled labor combined. Thus, one may naturally ask: is this factor also important for a firm’s business of choosing between export and FDI in serving a foreign market? This has not been examined yet.

One the other hand, the influential work of Helpman, Melitz and Yeaple (2004), through adding firm level heterogeneity of Melitz (2003) type into a standard proximity-concentration model (Brainard 1997), finds a neat sorting pattern of firms’ choices between export and FDI according to their productivity levels while confirming the proximity-concentration trade-off. Then how about the effects of industry and/or country level heterogeneity in explaining frms’ export/FDI decision? Anyway, to a great extent, the export vs. FDI choice is a production location choice. The host country’s characteristics, as well as industry properties, should play crucial roles as the first two facts say.

This paper is intended to explore from the perspective of contract friction firms’ choice between export and FDI in serving a relatively less developed foreign country and the resulting FDI pattern. In particular, I embed an incomplete contract model in Helpman, Melitz and Yeaple (2004) and incorporate all the firm, industry, and country level heterogeneity. Firms differ in their productivity levels as in Melitz (2003), industries differ in their production-work-intensities as well as within-sector productivity dispersion, and countries differ in their development levels.

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2 The proximity-concentration trade-off says, firms will choose FDI when the gains from avoiding trade costs outweigh the costs of producing in multiple markets.

3 Helpman, Melitz and Yeaple (2004) consider the variation of productivity dispersion across industries, which is also included in my model. Here, I refer to a kind of more relevant industry heterogeneity, technology (specifically, the input intensity in production).

4 There are other modes of serving a foreign country, such as licensing, joint venture, etc. I focus on the choice between export and FDI here. See the discussion about licensing in Markusen (1995).
The degree of contract friction is determined by the industry and country characteristics.

In this way, this model predicts principally that, in non-production-work-intensive (referred to as management-intensive hereafter) industries, the prevalence of FDI (the cutoff productivity level between export/FDI) is increasing (decreasing) in the host country’s development level, while in production-work-intensive industries, the relations are reversed, respectively. In both kinds of industry, the prevalence of FDI (the cutoff productivity) is increasing (decreasing) in the interaction of management-intensity and host country development level(?). Also, this paper characterizes the industries and countries where there will be no FDI inflow at all.

1.1 Main Idea and Implications

The rough idea is as follows. Firms compete monopolistically in the host market. Production uses a unique factor, labor, but employees work as workers or managers to perform two kinds of work, production-work and non-production-work (called management in the paper), respectively. Workers can work without any knowledge, but, to manage an establishment in a specific country, managers need two kinds of knowledge: formal management knowledge and country-specific knowledge. For a firm of a developed country to serve a relatively less developed country, if it produces at home and then export with fixed export costs and iceberg transport costs, it involves high worker costs but without contract friction. The contract between the firm and the managers is complete because managers there are well-prepared and no relationship-specific investment is needed.

If it chooses FDI, the worker costs is low but the fixed investment costs are high and the contract will be incomplete because of the unverifiable specific investment that need to be undertaken by the managers: if the firm employs managers from the home country, they need to learn host-country-specific knowledge; if employs local managers, they need to obtain advanced formal management knowledge (the local managers are not well-prepared because of, for example, the less developed education there). The firm could produce with not-well-prepared managers, but then the output will be discounted. Thus the problem of hold-up arises for FDI, and the firm and the managers need to bargain over the division of the surplus. In the bargaining, the lower the host country’s development level, the lower the outside managers’ quality level, thus
the worse the firm’s outside option. Also, as in standard incomplete contract models, the higher the management-intensity in production, the more the firm relies on the managers. This means a hold-up effect: the hold-up problem is more serious for the firm in more management-intensive industries (industry heterogeneity) and in less developed countries (country heterogeneity). On the other side, there is a labor cost effect: the worker costs are low when the host country’s development level is low. In short, for a firm in a given industry, when it evaluates a production location of FDI, it needs to consider the trade-off between the labor cost effect and the hold-up effect. This trade-off will affect the profits from FDI.

The firm compares the profits from export and FDI to decide the modes of serving a foreign market. The total trade-off is also proximity-concentration, but are encroached on by the trade-off between labor cost effect and hold-up effect in FDI.

The crucial difference of this paper from Helpman, Melitz and Yeaple (2004) is that, this paper looks at FDI from an incomplete contract view such that firms need to consider both the labor cost effect and the hold-up effect. Though it is possible to extend Helpman, Melitz and Yeaple (2004) to include the labor cost effect, this extension will generate a prediction contrast to the first fact rather than explain it (see details later). This demonstrates the essential role of contract friction.

While confirming all results in Helpman, Melitz and Yeaple (2004), this model shows that the host country’s development level as well as industrial management-intensity, and their interaction, have important and clear implications for the export/FDI sorting pattern and the prevalence of FDI. First, in a production-work-intensive industry: If export and FDI co-exist, the cutoff productivity level between them (the prevalence of MNEs) is increasing (decreasing) in the host country’s development level and the management-intensity, but decreasing (increasing) in the interaction of the two terms; If the transport cost is very low, in those relatively

\footnote{That is, besides the proximity-concentration effect, firms sort according to productivity into different modes of serving a foreign market: the most productive firms become MNEs (FDI), the firms with medium productivity levels export, and the remaining firms exit; there will be more FDI in industries with greater productivity dispersion.}

\footnote{Following Helpman, Melitz and Yeaple (2004), the prevalence is defined as the fraction of active firms that choose FDI to serve the foreign country.}
management-intensive industries, there may be no FDI at all, and the higher the host country’s development level, the more likely this be true.

This implies that, in such industries, in a cross-country sample, we should observe firms investing in a more developed country be more productive than those investing in a relatively less developed country, thus FDI be more popular in the latter. Also, in such industries, after controlling for the transport cost effect, the probability of no-FDI in an industry in a country should be increasing in the interaction of management-intensity and country development level. The intuition is that in these industries, the hold-up problem is not that serious, thus the labor cost effect will dominate the hold-up effect. The lower the host country’s development level, the lower the labor costs, the higher the profits from FDI, thus the more likely that FDI is advantageous to export, and vice versa.

Second, things are different in management-intensive sectors: If export and FDI co-exist, the cutoff productivity level between export and FDI is decreasing in the host country’s development level and increasing in the management-intensity, but still decreasing in the interaction of the two terms, and for the prevalence of MNEs, the relations are, respectively, reversed; If the transport cost is moderate, there is an area in the country-industry space where there is no FDI at all, the lower the development level and/or the higher the management-intensity, the more likely which being true; If the transport cost is very low, there could be no FDI in any management-intensive industry in any kind of country.

This means that, in management-intensive sectors, we should observe that, firms investing in a relatively less developed country be more productive than those investing in a more developed country, thus FDI be more popular in a more developed country. This is exactly the world FDI pattern the first two facts revealed. The intuition is that in these industries, the hold-up effect will dominate the labor cost effect. The higher the development level of the destination country, the less costly the hold-up problem, thus the more profitable the FDI there.

This result is impossible in all previous export/FDI models (Brainard 1997; Helpman, Melitz and Yeaple 2004) without contract friction. In those models, keeping other proximity-concentration factors unchanged, the higher the host country’s wage level, the less likely will it
be FDI destination because of its high labor cost, whichever industry the firm is in.

Third, this model implies that if we put all sectors together, in a cross-country sample, we should not observe a significant pattern between the cutoff productivity and the host country’s development level, or between the prevalence of MNEs and that development level. This emphasizes that we should go into more details, i.e., taking into account all firm, industry, and country level heterogeneity, as well as transport cost, when we investigate export and MNEs. The no-FDI results also shed lights on why there is no FDI in some industries in some countries, why many production-work-intensive MNEs move away from China along China’s developing but management-intensive MNEs stay, and why China could nowadays upgrade its doorsill in attracting FDI.

This paper contributes to the literature in several ways. First, it provides a different perspective, i.e., an incomplete contract view of firms’ FDI thus a different view of firms’ export vs. FDI decision. Second, it is the first to identify the effects (and the joint effect) of industry as well as host-country heterogeneity on the decision. Third, the combination of contract friction and industry-country heterogeneity enriches our understanding of MNEs, provides explanations for several long-standing puzzles in the literature, and generates several testable predictions that go beyond those of the current models on export/FDI choice.

1.2 Literature Review

The model is related to three strands of literature. One is on firms’ export/FDI decision. The second is firm heterogeneity. The third is incomplete contract view of MNEs, though this strand is mainly on firms’ sourcing strategies (for example, Antras and Helpman (2004)).

Brainard (1997) shows, theoretically and empirically, the proximity-concentration trade-off in export/FDI decision: firms export (concentration of production) when plant-level economies of scale are high, while choose FDI (proximity to consumers) when transport costs and/or firm-level economies of scale are high, foreign market size is large. However, in Brainard’s work firms are identical (not mentioning the heterogeneity of industry or country levels), thus in each country, firms pervasively export or pervasively invest, with the mixed equilibrium existent only in a knife-edge case. Therefore it can not account for the fact that the extent and the way of
different firms engaging in international economic activities vary (see Bernard, Eaton, Jenson and Kortum 2003, among many others).

Helpman, Melitz and Yeaple (2004) augment the proximity-concentration model by adding firm heterogeneity of the Melitz (2003) type. They confirm the proximity-concentration trade-off and find a neat sorting pattern of the modes of serving foreign markets according to firm productivity levels, that is, FDI (most productive firms), exporting (moderately productive firms) and exiting (least productive firms), and predict that the prevalence of FDI should be higher in industries with higher productivity dispersion. Their findings are extensively supported by empirical studies. In their model, however, there is no explicit role for industry or country level heterogeneity, though they think that these factors are important and are included in the empirical regressions. Thus this model does not consider one of a firm’s important investment decisions, i.e., production location choice, in a given industry. I introduce and focus on industry and country heterogeneity through their effects on contract friction which affects the export/FDI trade-off, and provide predictions consistent with the facts. Without the effect through contract friction, these facts could not be explained by the proximity-concentration model even incorporating the industry and country heterogeneity in this paper.

Antras (2003), Antras and Helpman (2004, 2007) develop an incomplete contract view of MNEs. Nunn (2007), Nunn and Trefler (2008) provide robust empirical supports for the theory. However, though they highlight the importance of contract friction in shaping firms decision in the international economy, they all consider the vertical global sourcing problem. I view from the incomplete contract perspective firms’ horizontal investment problem.

Recently there are several papers incorporating host country characteristics in considering FDI. Chen and Moore (2008) empirically test several comparative statics of the export/FDI cutoff productivity in Helpman, Melitz and Yeaple (2004) with regard to destination market size, fixed FDI costs and transport costs. They find robust evidence for the effects of these host-country attributes in affecting firms choice. Their work, however, incorporates neither the effect of industry heterogeneity nor the effect of host country’s development level, thus does not

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7 See, for example, Bernard, Jenson and Schott (2005), Girma, Kneller and Pisu (2005), Head and Ries (2003), Tomiura (2007), and Helpman, Melitz and Yeaple (2004) themselves.
explain the world FDI patterns I focus on.

Markusen and Venables (2000) extend an otherwise standard Helpman-Krugman model to include transport costs and endogenous MNEs. They show numerically that MNEs are more likely to exist the more similar are countries in both relative and absolute factor endowments. The intuition is that, if two countries differ greatly in their relative factor endowments, the relative factor price differences will be large, then the costs of production will be much higher in one country than the other, thus the firm should not set up plants in each country. Large difference in market size will also deter the emergence of MNEs. However, there is little evidence that FDI is related to differences in factor endowments or in the general return to capital across countries (Markusen 1995, 2002). In this paper, I focus on the more robust and notable relation between FDI and host country development level. Secondly, the crucial link in their argument is that large relative endowment differences generate large factor price differneces across countries, which is questionable (...). Thirdly, an implicit assumption in their paper is that MNEs purchase both factors (for example, capital and labor) from host markets. This is not necessarily true, since mostly there is investment (capital) in FDI. Finally, firms in their model are homogenous, thus in the Edgeworth box (endowment space) either all firms are national or all are multinational, and even in the mixed area there is no identity of the firm. I model firms as heterogeneous and could identify the exporters and MNEs.

The outline of the remainder is as follows. I describe the set-up of the model in section 2. Section 3 gives firms optimization behaviors under export and FDI, respectively. Firms’ equilibrium choices is discussed in section 4, and the prevalence of MNEs is characterized in section 5. I provide empirical test for the model in section 6 and conclude the paper in the last section.

8Yeaple (2003) is an exception. He finds that factor endowment differences increase vertical FDI.
2 Set-up

The world consists of two countries, developed country $D$ and relatively less developed country $L$. I consider the export/FDI problem of firms of country $D$. To serve the $L$ market, a firm of country $D$ could choose export, i.e., to produce the goods at home and then sell them to $L$, or to do FDI, i.e., to produce and sell the goods directly in $L$. There are $N + 1$ sectors in the world economy. One sector produces a homogeneous good $z$, which is taken as numeraire, while each of the other $N$ sectors, denoted by $n = 1, \ldots, N$, produces a continuum of differentiated products. We refer to these differentiated products as varieties and denote a variety by $v$.

2.1 The Demand Side

Country $L$ is inhabited by a unit measure of identical consumers. A representative consumer will derive the following utility from consuming $z$ units of the homogeneous good and $x_n(v)$ units of variety $v$ in sector $n:$

$$U = (1 - \sum_{n=1}^{N} \mu_n) \log z + \sum_{n=1}^{N} \mu_n \log(\int_{V_n} x_n(v)^{\alpha_n} dv)^{\frac{1}{\alpha_n}}, \quad 0 < \alpha_n < 1,$$

where $V_n$ denotes the measure of available products in sector $n$, $(1 - \sum_{n=1}^{N} \mu_n)$ and $\mu_n$, respectively, are the fractions of expenditure on the homogeneous good and on sector $n$ goods. The elasticity of substitution across varieties within a sector, say $n$, is $\varepsilon_n = \frac{1}{1-\alpha_n} > 1$, while the elasticity of substitution across varieties in different sectors is unity, which means the expenditure on each sector is a constant. Due to this specification, I could do the analysis sector-by-sector and thus drop sector notation $n$ when not causing confusion.

Assume that the homogeneous good is freely traded and produced by both countries$^{10}$ with constant-returns-to-scale technology under different productivity. In particular, one unit of labor in country $i$, $i = D, L$, produces $w_i$ units of $z$, with $w_D > w_L$. This also means that the normal

\[9\text{But they are not necessarily the usually categorized north and south in the trade literature, respectively. }L\text{ is less developed only relatively to }D.\text{ It could be a developing or a developed country in the model.}\]

\[10\text{This could be justified by assuming that }\sum_{n=1}^{N} \mu_n \text{ is small enough, and/or that the labor supply is large enough in each country.}\]
worker wage in country \(i\) is \(w_i\).\(^{11}\) For simplicity, normalize \(w_D = 1\), \(w_L \in (0, 1)\).

Suppose a consumer in country \(L\) maximizes her utility subject to the budget constraint

\[
z + \sum_{n=1}^{N} \int_{v \in V_n} p_n(v)x_n(v)dv \leq E,
\]

where \(E\) is the total expenditure of country \(L\), which is exogenous in my partial equilibrium analysis. It is well-known that \(\mu_n E\) will be expended on goods in sector \(n\), thus the consumer’s problem is

\[
\max_{x_n(v)} \left( \int_{v \in V_n} x_n(v)^{\alpha_n} dv \right) \frac{1}{\alpha_n} \text{ s.t. } \int_{v \in V_n} p_n(v)x_n(v)dv \leq \mu_n E.
\]

The F.O.C. is \(\left( \int_{v \in V_n} x_n(v)^{\alpha_n} dv \right)^{\frac{1-\alpha_n}{\alpha_n}} x_n(v)^{\alpha_n - 1} = \lambda p_n(v)\), thus

\[
x_n(v) = \lambda^{\frac{1}{\alpha_n - 1}} p_n(v)^{\frac{1}{\alpha_n - 1}} \left( \int_{v \in V_n} x_n(v)^{\alpha_n} dv \right)^{\frac{1}{\alpha_n}}, \quad p_n(v)x_n(v) = \lambda^{\frac{1}{\alpha_n - 1}} p_n(v)^{\frac{\alpha_n}{\alpha_n - 1}} \left( \int_{v \in V_n} x_n(v)^{\alpha_n} dv \right)^{\frac{1}{\alpha_n}}.
\]

With

\[
\mu_n E = \int_{v \in V_n} p_n(v)x_n(v)dv = \lambda^{\frac{1}{\alpha_n - 1}} \left( \int_{v \in V_n} x_n(v)^{\alpha_n} dv \right)^{\frac{1}{\alpha_n}} \int_{v \in V_n} p_n(v)^{\alpha_n - 1} dv
\]

\[
= p_n(v)^{\frac{1}{\alpha_n - 1}} x_n(v) \int_{v \in V_n} p_n(v)^{\frac{\alpha_n}{\alpha_n - 1}} dv
\]

\[
= p_n(v)^{\frac{\varepsilon_n}{\alpha_n}} x_n(v) \int_{v \in V_n} p_n(v)^{1-\varepsilon_n} dv,
\]

dropping the sector notation, the demand for each variety in a given sector is derived as follows:

\[
x(v) = \frac{\mu E}{\int_{v \in V} p(v)^{1-\varepsilon} dv} p(v)^{-\varepsilon} \equiv A p(v)^{-\varepsilon},
\]

where \(A\) is the sector’s aggregate consumption index to be endogenously determined in equilibrium, and is exogenous to an individual firm.

### 2.2 The Supply Side

Each of the differentiated varieties is produced by a single firm and there is free entry into all industries. To produce a variety \(v\) in a sector, the firm need to pay a fixed entry cost, \(f_E\) units

\(^{11}\)Here ”normal” is in the sense that the labor contract is complete. When the labor contract is incomplete, the income will be determined by bargaining. This will be clear later.
of numeraire, which may include expenditures on R&D, brand development, etc. As in Melitz (2003), upon paying this fixed cost, the firm draws a productivity level \( \theta \) from a cumulative distribution \( G(\theta) \), then decides whether to exit or to stay in the market. If exits, then the game is over for it. If chooses to stay in the market, it need to choose how to serve the market \( L \).

If produces at home and then exports, the firm pays an additional overhead cost of \( f_X \) units of numeraire (including costs of setting up a plant at home, forming a distribution and servicing network abroad), and bears an iceberg transport cost \( \tau \in (0,1) \) (only \( 1-\tau \) units of good reach the destination per unit shipped), while if it decides to do FDI, he pays an additional overhead cost \( f_I \) (including costs of setting up a plant and forming a distribution and servicing network abroad). Thus \( f_I - f_X \) represents the extra costs of forming a plant in the foreign country. Assume \( f_I - f_X > 0 \).

Firms use a unique factor, labor, to produce goods. To produce a variety, the employees need to perform two kinds of work, production work and non-production work (management work), with the former done by production workers (hereafter, \textit{workers}) and the latter done by a management party (hereafter, MP) consisting of managers. Suppose the MP is controlled by a CEO who employs and pays (and possibly, trains) the managers through complete contracts. The firm need to contract with the workers and the CEO. I denote the management services by \( m \) and production work by \( l \).

To perform good management in a country, MP needs two kinds of essential knowledge: formal management knowledge (e.g., management knowledge about human capital, production process, supply-chain, financing, etc, which could be learned from, for example, formal school education or specific short-term training) and country-specific knowledge (e.g., local culture, religion, institutions, language, network, market characteristics, etc, which could be learned from, for example, life experience or specific short-term training). Since more developed

\[\text{(12)}\]

To fix idea, I ignore the domestic market here. Introducing the domestic market will not change the analysis.

\[\text{(13)}\]

Introducing this CEO is to simplify the possible bargaining between the firm and the managers to a Nash bargaining between the firm and the CEO, otherwise, it should be a bargaining á la Shapley. "CEO" and "MP" will be used interchangeably in the paper.

\[\text{(14)}\]

For example, the importance of local knowledge for MNEs is highlighted by the Economist Intelligence Unit (2006) in a report commissioned by UK Trade & Investment.
countries have better school education, I assume that everyone in country \( D \) is endowed with full-scope formal management knowledge, whereas people in country \( L \) only have limited such knowledge and the higher the country \( L's \) development level, the more such knowledge its people are endowed with. Considering individual life experience, I assume that everyone has full country-specific knowledge about his mother country, but limited such knowledge about the foreign country. Since more developed countries are generally more open to the foreigners, it is reasonable to assume that the extent to which \( L's \) specific knowledge is known by foreigners is positively determined by country \( L's \) development level. For expositional simplicity, I call MP with both kinds of needed knowledge high quality MP, otherwise low quality MP.

Both kinds of knowledge could be learned through costly short-term on-the-job training if a person is not endowed with them, where the training is organized and paid for by the CEO at \( t_L \) per manager. However, and importantly, such knowledge obtained ex post through short-term training is by nature different from those from ex ante formal education or life experience: the former could not be as general in scope as the latter. Knowledge from short-term on-the-job training is, more or less, just firm-specific (variety-specific) relative to the ex ante endowed knowledge.\(^{15}\) Due to the nature of knowledge, whether the MP really obtains the needed knowledge is not verifiable, though it is observable to the firm ex post. Therefore, the firm and the MP could not contract on the knowledge.

Now, it is clear that, if the firm produces the variety at home (country \( D \)) and then exports, it can employ local managers through complete contracts because there managers are of high quality and no problem of firm-specific investment.\(^{16}\) But if it sets up the plant in \( L \) (FDI), it can only sign an incomplete contract with the CEO wherever the MP is employed from: if from home, they need to invest in obtaining knowledge about country \( L \); if from the host country, they need to invest in obtaining formal management knowledge.

\(^{15}\)This could be justified in the following way. On the one hand, the management knowledge obtained from school education and the endowed country-specific knowledge cover all the needed knowledge for a special variety. On the other hand, however, if these kinds of knowledge are obtained through on-the-job training, the CEO will only pay for the acquisition of those special parts of the two kinds of knowledge needed for the special variety. This may be due to that full training is too time-consuming and too costly.

\(^{16}\)Here, I exclude the possibility of producing at home with workers from \( D \) but managers from \( L \), which not only counters reality but also incurs both high worker wage and CEO’s opportunism. Even allowing for this possibility does not change the analysis qualitatively. See this in footnote* later.
Following Antras and Helpman (2004), I assume that the firm and the CEO could not write enforceable contracts contingent on the amount of labor hired, and that at the beginning they cannot contract on the future output or revenue either.\textsuperscript{17} Therefore, in the case of no ready high quality MP, the contract between the firm and the CEO/MP on the input of both managers and workers could only be incomplete. Additionally, I assume that MP is mobile freely but workers are not across countries.

As for the production work, everyone, whichever country he is in, could do it without any knowledge. Once the firm has signed an employment contract with the workers, it could not dismiss them freely. For simplicity, I assume that the firm has to pay the wage specified in the contract if it wants to dismiss them.

To summarize, production needs two kinds of work, management services by MP and production work by workers. MP must have two kinds of knowledge, formal management knowledge and country-specific knowledge. If the knowledge is an ex ante endowment, it is quite general. In contrast, if it is obtained through ex post training, it is firm-specific. Production workers could work without knowledge, and they must be paid if employed. The timing of the events is as follows:

(1) A firm, upon paying an up-front cost, enters an industry and draws a productivity level. After observing the draw, it could choose to exit or to stay in the game.

(2) If stays, it needs to choose serving market \( L \) via export or FDI; if via export, it employs domestic workers and managers through complete contracts; if via FDI, it needs to sign an incomplete contract with a CEO to specify a lump-sum transfer \( T \) between them.

(3) In FDI, the CEO employs managers in the market and pays to train them to obtain the firm-specific, unverifiable knowledge, and the firm employs workers. [\textit{WHY the firm need to sign contracts with workers now but not after observing MP’s knowledge preparation?}]

(4) The firm and the CEO play a Nash bargaining game to divide the surplus and production\textsuperscript{17}These specifications could be justified by the arguments developed by Hart and Moore (1999) and Segal (1999), that is, the parties could not commit not to renegotiate an initial contract and that the precise nature of the required input is revealed only ex post and is not verifiable by a third party.
is done.

It is clear that it is an incomplete contract setting in FDI in the sense of Williamson (1985) and Grossman and Hart (1986). The Williamson’s fundamental transformation happens in step (3), where both the firm and the CEO are locked-in.

As for the production technology, suppose the output of each variety is a sector-specific Cobb-Douglas function of the two inputs as follows:

\[ x_n(v) = \theta \left[ \frac{m_n(v)}{\eta_n} \right]^{\eta_n} \left[ \frac{l_n(v)}{1 - \eta_n} \right]^{1 - \eta_n}, \quad 0 < \eta_n < 1, \]

where \( \theta \) is the firm-specific productivity level, \( \eta_n \) is sector-specific and denotes management-intensity in production. Suppose each person could provide one unit of management or production service.

### 3 Firm Behavior

Now consider a firm’s optimization behavior. If it exports, it need to pay iceberg transport cost and high production labor cost. The advantage is that the fixed export cost is lower than the fixed FDI cost, and it is free from contract friction. The reverse is true for FDI.

#### 3.1 Export

If it chooses to produce goods at home and then export, a firm need to allocate its inputs between management work and production work, and decide its product price monopolistically in market \( L \). After producing \( x(v) \) units of product \( v \) at home and transport them abroad, it gets revenue

\[
R(v) = A^{1-\alpha}[(1 - \tau)x(v)]^\alpha \\
= (1 - \tau)^\alpha A^{1-\alpha} \theta^\alpha \left[ \frac{m(v)}{\eta} \right]^\alpha \left[ \frac{l(v)}{1 - \eta} \right]^\alpha (1-\eta).
\]

Therefore, the firm’s problem is to maximize its operating profit

\[
\max_{m(v),l(v)} \pi_X(\tau, \theta) = (1 - \tau)^\alpha A^{1-\alpha} \theta^\alpha \left[ \frac{m(v)}{\eta} \right]^\alpha \left[ \frac{l(v)}{1 - \eta} \right]^\alpha (1-\eta) - m(v) - l(v) - f_X.
\]
With the F.O.C.s:

\[(1 - \tau)\alpha A^{1-\alpha} \theta^\alpha \alpha \left( \frac{m(v)}{\eta} \right)^{\alpha \eta} - \left( \frac{l(v)}{1 - \eta} \right)^{\alpha (1 - \eta)} - 1 = 0, \]

we have \( \frac{m(v)}{\eta} = \frac{l(v)}{1 - \eta} \). Substitute this into one of the F.O.C.s, we get

\[
\hat{m}(v) = A\eta((1 - \tau)^{\alpha} \theta^\alpha \alpha)^{\frac{1}{1 - \alpha}},
\]

\[
\hat{l}(v) = A(1 - \eta)((1 - \tau)^{\alpha} \theta^\alpha \alpha)^{\frac{1}{1 - \alpha}}.
\]

Thus the operating profit from export is

\[
\pi_X(\tau, \theta) = A(1 - \tau)^{\frac{\alpha}{1 - \alpha}} \alpha^{\frac{\alpha}{1 - \alpha}} (1 - \alpha) \theta^{\frac{\alpha}{1 - \alpha}} - f_X
\]

\[
\equiv A\psi_X(\tau)\theta^{\frac{\alpha}{1 - \alpha}} - f_X, \tag{1}
\]

with \( \psi_X(\tau) \equiv (1 - \tau)^{\frac{\alpha}{1 - \alpha}} \alpha^{\frac{\alpha}{1 - \alpha}} (1 - \alpha) > 0 \) as a component of the slope of \( \pi_X(\tau, \theta) \) with regard to the measure of productivity \( \Theta \equiv \theta^{\frac{\alpha}{1 - \alpha}} \).

Intuition here...

### 3.2 FDI

Though in any kind of \( L \) the contract between the firm and the CEO is incomplete and they need to bargain, the division of the surplus is sensitive to the characteristics of \( L \). In particular, *in the bargaining, the higher the development level of \( L \), the higher the firm’s outside option.* The logic is as follows. When the two parties fail to reach an agreement in the negotiation, the firm could fire the CEO/MP and employ new managers. Since the new MP is not endowed with full formal management knowledge (if from \( L \)), or not with full \( L \)-specific knowledge (if from \( D \)), the disagreement will cause a loss in output. The more management (or \( L \)-specific) knowledge the new MP is endowed, the less the loss will be, thus the higher the outside option the firm has. On the other hand, because for the the host country of higher development level people
have more formal education and the country is more widely known by the world,\(^\text{18}\) therefore in the bargaining, the higher the development level of \(L\), the less loss in output when negotiation fails, that is, the higher the firm’s outside option.

This argument is analogous to the popular assumption in the literature (for example, Antras and Helpman 2004) that such discount is smaller in a developed country than in a relatively less developed country. While the literature defends this assumption by less corruption and better legal protection in the more developed country, I provide additional, reasonable justification for this outside option argument and make it natural in the current context.

The idea is formalized specifically in the following way. If the negotiation fails, the firm employs a new untrained management party from home with market wage to fill the positions.\(^\text{19}\) For simplicity, assume that, to start the production, the replacement has to be done position-by-position. Due to the discount, this new management team could only produce a fraction of \(\delta_L\) of the variety, where \(\delta_L\) is increasing in the host country’s development level, \(w_L\). The fired managers will earn market wage and the CEO’s training costs are sunk. Due to the same reasoning, a less important assumption is that the per manager training cost, \(t_L\), is decreasing in \(w_L\).\(^\text{20}\) [Assume \(\delta_L = ..., t_L = ...\)]

If the negotiation between the firm and the CEO fails, the payoff to the firm is\(^\text{21}\)

\[
A^{1-\alpha} (\delta_L x(v))^\alpha - m(v) - w_L l(v) - f_I = \delta_L^\alpha A^{1-\alpha} \theta \left[ \frac{m(v)}{\eta} \right]^{\alpha \eta} \left[ \frac{l(v)}{1 - \eta} \right]^{\alpha (1-\eta)} - m(v) - w_L l(v) - f_I.
\]

\(^{18}\)The idea that the extent to which the host country is known by the world affects FDI inflows could be supported by Daude and Fratzscher (2008), where this idea is referred to as ”familiarity effect”. They find that FDI is substantially more sensitive to information frictions between investors and host countries than all other cross-border investment types (loans, portfolio equity and debt securities).

\(^{19}\)Because firms are more familiar with their home country’s labor market than that of the host country. Surely, the investor could employ a new MP from the host country. This option changes the model very little, but makes it not that neat. Since my interest is in firm’s choice between export and FDI, not in the global human resource allocation, and for the sake of the neatness of the model, I exclude this option. See more demonstrations in footnote* and **.

\(^{20}\)This is to save exogenous parameters in the model (see this later). \(t_L\) could be any reasonable constant. The point is the existence of such a cost to lock-in the CEO.

\(^{21}\)*If the firm employ new MP from \(L\), then the cost item \(m(v)\) should be \(w_L m(v)\), and the surplus should be less by \((1 - w_L)m(v)\). This will not qualitatively change the following analysis, but make the model complicated.
The CEO’s payoff is $-t_L m(v)$. If they reach an agreement, the firm’s and the CEO’s joint payoff is
\[ A^{1-\alpha} \theta^\alpha \left( \frac{m(v)}{\eta} \right)^{\alpha \eta} \left( \frac{l(v)}{1 - \eta} \right)^{\alpha (1-\eta)} - m(v) - t_L m(v) - w_L l(v) - f_I. \]

The managers’ revenue is always $m(v)$. So the surplus for the firm and the CEO from the relationship is
\[ (1 - \delta_L^\alpha) A^{1-\alpha} \theta^\alpha \left( \frac{m(v)}{\eta} \right)^{\alpha \eta} \left( \frac{l(v)}{1 - \eta} \right)^{\alpha (1-\eta)}, \]
which is divided equally by the firm and the CEO in the bargaining.

Since there is positive surplus, they will always reach an agreement. Thus the firm’s profit is
\[ (\delta_L^\alpha + \frac{1}{2} (1 - \delta_L^\alpha)) A^{1-\alpha} \theta^\alpha \left( \frac{m(v)}{\eta} \right)^{\alpha \eta} \left( \frac{l(v)}{1 - \eta} \right)^{\alpha (1-\eta)} - m(v) - w_L l(v) - f_I \]
\[ = \frac{1}{2} (1 + \delta_L^\alpha) A^{1-\alpha} \theta^\alpha \left( \frac{m(v)}{\eta} \right)^{\alpha \eta} \left( \frac{l(v)}{1 - \eta} \right)^{\alpha (1-\eta)} - m(v) - w_L l(v) - f_I, \]
and its problem is
\[ \max_{l(v)} \frac{1}{2} (1 + \delta_L^\alpha) A^{1-\alpha} \theta^\alpha \left( \frac{m(v)}{\eta} \right)^{\alpha \eta} \left( \frac{l(v)}{1 - \eta} \right)^{\alpha (1-\eta)} - m(v) - w_L l(v) - f_I. \]

The F.O.C. is
\[ \frac{1}{2} (1 + \delta_L^\alpha) A^{1-\alpha} \theta^\alpha \left( \frac{m(v)}{\eta} \right)^{\alpha \eta} \left( \frac{l(v)}{1 - \eta} \right)^{\alpha (1-\eta)} - w_L = 0 \]

The CEO’s problem is
\[ \max_{m(v)} \frac{1}{2} (1 - \delta_L^\alpha) A^{1-\alpha} \theta^\alpha \left( \frac{m(v)}{\eta} \right)^{\alpha \eta} \left( \frac{l(v)}{1 - \eta} \right)^{\alpha (1-\eta)} - t_L m(v), \]

The F.O.C. is
\[ \frac{1}{2} (1 - \delta_L^\alpha) A^{1-\alpha} \theta^\alpha \left( \frac{m(v)}{\eta} \right)^{\alpha \eta - 1} \left( \frac{l(v)}{1 - \eta} \right)^{\alpha (1-\eta)} - t_L = 0 \]

With these two F.O.C.s, we can find
\[ \frac{l(v)}{1 - \eta} = \frac{t_L (1 + \delta_L^\alpha) m(v)}{w_L (1 - \delta_L^\alpha) \eta}, \]
and solve the system with

\[ m^*(v) = \eta A \theta^{1-\alpha} \alpha^{1-\alpha}(2w_L)^{1-\alpha} (1 + \delta^0_L) \frac{1}{1-\alpha} \left( \frac{t_L(1 + \delta^0_L)}{w_L(1 - \delta^0_L)} \right)^{\alpha/(1-\alpha)} \]

\[ l^*(v) = (1 - \eta) A \theta^{1-\alpha} \alpha^{1-\alpha}(2w_L)^{1-\alpha} (1 + \delta^0_L) \frac{1}{1-\alpha} \left( \frac{t_L(1 + \delta^0_L)}{w_L(1 - \delta^0_L)} \right)^{\alpha/(1-\alpha)} \]

Because ex ante the firm could require a lump-sum transfer \( T \) from the CEO, which would make the CEO break even and the firm grasp all the profits from the relationship, thus, the firm’s profit is

\[ \pi_I = A^{1-\alpha} \theta^\alpha \left[ \frac{m^*(v)}{\eta} \right]^{1-\alpha} \frac{\alpha}{1-\alpha} \frac{l^*(v)}{\eta}^{1-\alpha} - m^*(v) - t_L m^*(v) - w_L l^*(v) - f_I \]

\[ = A \theta^{1-\alpha} \alpha^{1-\alpha}(2w_L)^{1-\alpha} (1 + \delta^0_L) \frac{1}{1-\alpha} \left( \frac{t_L(1 + \delta^0_L)}{w_L(1 - \delta^0_L)} \right)^{\alpha/(1-\alpha)} - A \theta^{1-\alpha} \alpha^{1-\alpha}(2w_L)^{1-\alpha} \cdot \]

\[ (1 + \delta^0_L)^{1-\alpha} \left[ \eta(1 + t_L) \left( \frac{t_L(1 + \delta^0_L)}{w_L(1 - \delta^0_L)} \right)^{\alpha/(1-\alpha)} + (1 - \eta) w_L \left( \frac{t_L(1 + \delta^0_L)}{w_L(1 - \delta^0_L)} \right)^{\alpha/(1-\alpha)} \right] - f_I \]

\[ = A \theta^{1-\alpha} \alpha^{1-\alpha}(2w_L)^{1-\alpha} (1 + \delta^0_L) \frac{1}{1-\alpha} \left( \frac{t_L(1 + \delta^0_L)}{w_L(1 - \delta^0_L)} \right)^{\alpha/(1-\alpha)} \{ 1 - \alpha (2w_L)^{-1} \cdot \]

\[ (1 + \delta^0_L) \left[ \eta(1 + t_L) \left( \frac{t_L(1 + \delta^0_L)}{w_L(1 - \delta^0_L)} \right)^{-1} + (1 - \eta) w_L \right] \} - f_I \]

\[ = A \theta^{1-\alpha} \alpha^{1-\alpha}(2w_L)^{1-\alpha} (1 + \delta^0_L) \frac{1}{1-\alpha} \left( \frac{t_L(1 + \delta^0_L)}{w_L(1 - \delta^0_L)} \right)^{\alpha/(1-\alpha)} \left[ 1 - \frac{1}{2} \right] \cdot \]

\[ | \eta \frac{1 + t_L}{t_L}(1 - \delta^0_L) + (1 - \eta)(1 + \delta^0_L) \} - f_I \]

\[ \equiv A \psi_I(w_L, t_L, \delta_L, \eta) \theta^{1-\alpha} - f_I, \]

with \( \psi_I(w_L, t_L, \delta_L, \eta) \equiv \alpha \frac{1}{2} 2 \frac{(w_L)}{t_L}^{1-\alpha} (1 + \delta^0_L) \frac{1}{1-\alpha} (t_L) \frac{1-\alpha}{1-\alpha} \left( 1 - \delta^0_L \right) \frac{\alpha}{1-\alpha} \left( 1 - \frac{1}{2} \left[ | \eta \frac{1 + t_L}{t_L}(1 - \delta^0_L) + (1 - \eta)(1 + \delta^0_L) \} \right| \}} \) as a component of the slope of \( \pi_I \) with regard to the measure of productivity \( \Theta \equiv \theta^{1-\alpha} \).

Education/Improvement in management and (or) openness level could improve \( \pi_I \) thus attract more FDI: \( \frac{\partial \psi_I(w_L, \eta, \delta_L)}{\partial \delta^0_L} > 0 \)
In the model, \( w_L, t_L, \) and \( \delta_L \) are associated with each other: \( t_L \) and \( \delta_L \) are determined by \( w_L \). Without defining relations among them, it is difficult to analytically discuss the problem. To stick to the idea and at the same time simplify the expression, I assume \( L = (2w_L - 1) \frac{1}{2} \), that is, \( w_L = \frac{1 + \delta_L}{2} \), and \( t_L = 1 - \delta_L = 2(1 - w_L) \). To make sense, this need \( w_L \in (\frac{1}{2}, 1) \), thus \( \delta_L, t_L \in (0, 1) \). Here, \( \delta_L \) is convex in \( w_L \), which means, as country \( L \)'s development level improves, its education level and popularity among foreigners approach those of country \( D \) faster and faster. With this simplification, we get

\[
\psi_I(w_L, t_L, \delta_L, \eta) = \alpha \frac{\alpha}{1-\alpha} 2^{\frac{\alpha}{1-\alpha}} (w_L)^{\frac{\alpha}{1-\alpha}} (1 + \delta_L)^{\frac{\alpha}{1-\alpha}} (t_L)^{\frac{\alpha}{1-\alpha}} (1 - \delta_L)^{\frac{\alpha}{1-\alpha}} \left\{ 1 - \frac{\alpha}{2} \right\}.
\]

\[
\eta \frac{1 + t_L}{t_L} (1 - \delta_L) + (1 - \eta)(1 + \delta_L) \right\} \\
= \alpha \frac{\alpha}{1-\alpha} 2^{\frac{\alpha}{1-\alpha}} \left\{ 1 - \frac{\alpha}{2} \right\} \left[ 3 \eta + 2(1 - 2 \eta) w_L \right] \\
= \psi_I(w_L, \eta).
\]

4 Equilibrium Choice: Export vs. FDI

To derive a firm’s equilibrium choice between export and FDI, compare the two profits:

\[
\pi_X(\tau, \theta) = (1 - \tau)^{\alpha} A^{1-\alpha} \theta^{\alpha} \left[ \frac{m(v)}{\eta} \right]^{\alpha \eta} \left[ \frac{l(v)}{1-\eta} \right]^{\alpha(1-\eta)} - m(v) - l(v) - f_X \\
= A \psi_X(\tau) \theta \frac{\alpha}{1-\alpha} - f_X, \\
\pi_I(w_L, \eta, \theta) = A^{1-\alpha} \theta^{\alpha} \left[ \frac{m^*(v)}{\eta} \right]^{\alpha \eta} \left[ \frac{l^*(v)}{1-\eta} \right]^{\alpha(1-\eta)} - m^*(v) - t_L m^*(v) - w_L l^*(v) - f_I \\
= A \psi_I(w_L, \eta) \theta \frac{\alpha}{1-\alpha} - f_I,
\]

with

\[
\psi_X(\tau) \equiv (1 - \tau)^{\frac{\alpha}{1-\alpha}} A^{\frac{\alpha}{1-\alpha}} (1 - \alpha), \\
\psi_I(w_L, \eta) \equiv \alpha \frac{\alpha}{1-\alpha} 2^{\frac{\alpha}{1-\alpha}} \left\{ 1 - \frac{\alpha}{2} \right\} \left[ 3 \eta + 2(1 - 2 \eta) w_L \right] \).
\]

I try different specifications for \( t_L \). All results in the paper holds qualitatively with some support restrictions on \( \alpha \). With the current specification, I need no such restriction.

This is intuitive. Examples.
Some useful properties of the profit functions are summarized in the following lemmas.

Lemma 1 Both profit functions, \( \pi_X(\tau, \theta) \) and \( \pi_I(w_L, \eta, \theta) \), are linearly increasing in productivity measure, \( \Theta \equiv \theta^{1-\alpha} \), i.e., \( \psi_X(\tau) > 0, \psi_I(w_L, \eta) > 0 \).

Proof. For \( 0 < \alpha < 1, 0 < \tau < 1, \psi_X(\tau) > 0 \) is straightforward.

Consider \( 3\eta + 2(1 - 2\eta)w_L \equiv \Lambda(w_L, \eta) \). When \( \frac{\partial \Lambda}{\partial \eta} = 3 - 4w_L = 0, \frac{\partial \Lambda}{\partial w_L} = 2(1 - 2\eta) = 0 \), we have \( (w_L, \eta) = (\frac{3}{4}, \frac{1}{2}) \), and \( \Lambda(\frac{3}{4}, \frac{1}{2}) = \frac{3}{2} \). Because \( \eta \in (0, 1), w_L \in (\frac{1}{2}, 1), \Lambda(\frac{1}{2}, 0) = 1, \Lambda(1, 0) = 2, \Lambda(\frac{1}{2}, 1) = 2, \Lambda(1, 1) = 1 \), we have \( 3\eta + 2(1 - 2\eta)w_L \equiv \Lambda(w_L, \eta) < 2 \). For \( 0 < \alpha < 1, 1 - \frac{2}{\alpha}[3\eta + 2(1 - 2\eta)w_L] > 1 - \alpha > 0 \). Thus, \( \psi_I(w_L, \eta) > 0 \). ■

In words, firms drawing higher productivity levels will earn higher profits no matter they export or invest abroad to serve a foreign market. This implies, more productive firms are more likely to cover any kinds of fixed costs and become viable.

To determine a firm’s choice between export and FDI, we compare its profits from each choice. Checking the profit functions, with \( f_I > f_X \) and a common component \( A \), we see that what matters is the comparison between \( \psi_X(\tau) \) and \( \psi_I(w_L, \eta) \). Firstly we characterize the properties of \( \psi_I(w_L, \eta) \). Other things given, an increase in \( \psi_I(w_L, \eta) \) represents an increase in \( \pi_I(w_L, \eta, \theta) \).

The following proposition summarizes the effects of sectoral technology and host country development level through contract friction on FDI profits and provides the driving force of our main results.

Proposition 1 (1) \( \psi_I(w_L, \eta) \), thus FDI profits \( \pi_I(w_L, \eta, \theta) \), is decreasing in the management intensity of production, \( \eta \).

(2) When \( \eta \) is low, specifically, \( \eta \in (0, \frac{1}{2}) \), \( \psi_I(w_L, \eta) \), thus FDI profits \( \pi_I(w_L, \eta, \theta) \), is decreasing in \( w_L \). When it is high, specifically, \( \eta \in (\frac{1}{2}, 1) \), \( \psi_I(w_L, \eta) \), thus FDI profits \( \pi_I(w_L, \eta, \theta) \), is increasing in \( w_L \).

(3) \( \psi_I(w_L, \eta) \), thus FDI profits \( \pi_I(w_L, \eta, \theta) \), is increasing in \( \eta w_L \), i.e., \( \frac{\partial \psi_I(w_L, \eta)}{\partial w_L \partial \eta} > 0 \).

Proof. (1) For management intensity of production, \( \eta \):

\[
\frac{\partial \psi_I(w_L, \eta)}{\partial \eta} = \alpha \tau \frac{\alpha - \eta}{2 - \alpha} \left[ \frac{\alpha(\alpha w_L - 1) \ln 2}{1 - \alpha} + \frac{\alpha(4w_L - 3) \ln 2}{2} - \frac{\alpha^2(4w_L - 3) \ln 2}{2(1 - \alpha) \eta} \right].
\]
When \( w_L = \frac{1}{2} \), for \( \eta \in (0, 1) \),
\[
\frac{\partial \psi_I(\frac{1}{2}, \eta)}{\partial \eta} = -\alpha^{1-\alpha} \frac{a_{-\alpha^{1-\alpha}}}{1-\alpha} \left[ (\ln 2 + 1)(1 - \alpha) + (1 - \alpha \eta) \ln 2 \right] < 0.
\]

When \( w_L = 1 \), for \( \eta \in (0, 1) \),
\[
\frac{\partial \psi_I(1, \eta)}{\partial \eta} = -\alpha^{1-\alpha} \frac{a_{-\alpha^{1-\alpha}}}{1-\alpha} (2 \ln 2 - 1 + \alpha - \alpha \ln 2 - \alpha \eta \ln 2).
\]

Let \( \Delta(\eta) \equiv 2 \ln 2 - 1 + \alpha - \alpha \ln 2 - \alpha \eta \ln 2 \), where \( \frac{\partial \Delta(\eta)}{\partial \eta} = -\alpha \ln 2 < 0 \), and
\[
\Delta(0) = 2 \ln 2 - 1 + \alpha(1 - \ln 2) = 0.3863 + 0.30685\alpha > 0,
\]
\[
\Delta(1) = (2 \ln 2 - 1)(1 - \alpha) = 0.3863(1 - \alpha) > 0,
\]

therefore, \( \Delta(\eta) > 0 \) for all \( \eta \in (0, 1) \). Then, \( \frac{\partial \psi_I(1, \eta)}{\partial \eta} < 0 \) for \( \eta \in (0, 1) \).

Because \( \frac{\partial \psi_I(w_L, \eta)}{\partial \eta} \) is linear in \( w_L, w_L \in (\frac{1}{2}, 1) \), and \( \frac{\partial \psi_I(1, \eta)}{\partial \eta}, \frac{\partial \psi_I(\frac{1}{2}, \eta)}{\partial \eta} < 0 \), we must have \( \frac{\partial \psi_I(w_L, \eta)}{\partial \eta} < 0 \).

(2) For L’s development level, \( w_L \):
\[
\frac{\partial \psi_I(w_L, \eta)}{\partial w_L} = \alpha^{1-\alpha} \frac{a_{-\alpha^{1-\alpha}}}{2^{1-\alpha}} (2\eta - 1),
\]

so, when \( \eta \in (0, \frac{1}{2}) \), \( \frac{\partial \psi_I(w_L, \eta)}{\partial w_L} < 0 \); when \( \eta \in (\frac{1}{2}, 1) \), \( \frac{\partial \psi_I(w_L, \eta)}{\partial w_L} > 0 \).

(3) For the interaction term:
\[
\frac{\partial \psi_I(w_L, \eta)}{\partial \eta \partial w_L} = \alpha^{1-\alpha} \frac{a_{-\alpha^{1-\alpha}}}{2^{1-\alpha}} \left[ 2\alpha + \frac{\alpha^2 \ln 2}{1-\alpha}(1 - 2\eta) \right],
\]

thus, \( \frac{\partial \psi_I(w_L, \eta)}{\partial \eta \partial w_L} > 0 \) when \( \eta \in (0, \frac{1}{2}) \).

***When \( \eta \in (\frac{1}{2}, 1) \):

- if \( \alpha < \frac{2}{2 + \ln 2} = 0.74263 \), \( 2\alpha + \frac{\alpha^2 \ln 2}{1-\alpha}(1 - 2\eta) > 2\alpha - \frac{\alpha^2 \ln 2}{1-\alpha} > 0 \), that is, \( \frac{\partial \psi_I(w_L, \eta)}{\partial \eta \partial w_L} > 0 \);
- if \( \alpha > \frac{2}{2 + \ln 2} \), then when \( \eta < \frac{2\alpha + \alpha \ln 2}{2\alpha \ln 2}, \frac{\partial \psi_I(w_L, \eta)}{\partial \eta \partial w_L} > 0 \), when \( \eta > \frac{2\alpha + \alpha \ln 2}{2\alpha \ln 2}, \frac{\partial \psi_I(w_L, \eta)}{\partial \eta \partial w_L} < 0 \).***

About part (1), an increase in management intensity, \( \eta \), means the production relies more on management, with contract friction, which has three effects: depressing the firm’s initial investment in production-work \( (l(v)) \); encouraging CEO’s investment in management \( (m(v)) \);
costing more on training managers \( t_L m(v) \). The first two are standard in incomplete contract theory (see Grossman and Hart 1986, Hart and Moore 1990), and the third is new in this paper. With the first two effects, standard incomplete contract theory predicts that the joint profit will be decreasing in \( \eta \) if the firm has the residual control rights. Here, it is the firm who owns the rights. Thus it is natural that \( \psi_I(w_L, \eta) \) decreases in \( \eta \), especially with the third effect to reinforce the relation.

The second part of the proposition is also quite intuitive. When \( w_L \) increases, the production labor cost will increase, which tends to decrease FDI profits (labor cost effect), while the hold-up problem and the unit training cost will be mitigated, which tends to increase FDI profits (hold-up effect). In low \( \eta \) sectors, the input of management is not intensive and the hold-up problem is not that serious, at the same time the quantity of worker is large in the production, thus the labor cost effect dominates the hold-up effect. On the contrary, in high \( \eta \) sectors, the hold-up problem is serious and the use of worker is not that intensive, thus the labor cost effect will be dominated. Therefore an increase in \( w_L \) will decrease FDI profits in production-work-intensive sectors but increase FDI profits in management-intensive sectors. This mechanism is central for our main results.

As for the interaction item, \( \eta w_L \), though its effect on the profit function slope is the same in both kinds of industry, the underlying channel of the effect is different. In production-work-intensive industries, the labor cost effect dominates and the marginal effect of wage on profits is negative. An increasing in the intensity of management will mitigate this negative effect because less workers are employed. Thus the cross-derivative is positive. For management-intensive industries, the hold-up effect dominates and the marginal effect of wage on profits is positive. An increasing in the intensity of management will reinforce this positive effect. Thus the cross-derivative is positive.

To identify different comparative possibilities between export and FDI, some extrem cases of \( \psi_I(w_L, \eta) \) are compared with \( \psi_X(\tau) \) in Lemma 2.

**Lemma 2**

1. \( \psi_I(\frac{1}{2}, 0) > \psi_X(\tau) \);

2. There is a cutoff \( \bar{\tau} \) such that when \( 1 > \tau > \bar{\tau} \), \( \psi_I(1, 1/2) > \psi_X(\tau) \), and when \( 0 < \tau < \bar{\tau} \),
\( \psi_I(1, \frac{1}{2}) < \psi_X(\tau); \)

(3) There is a cutoff \( \bar{\tau}' > \bar{\tau} \) such that when \( 1 > \tau > \bar{\tau}' \), \( \psi_I(\frac{1}{2}, 1) > \psi_X(\tau) \), and when \( 0 < \tau < \bar{\tau}' \), \( \psi_I(\frac{1}{2}, 1) < \psi_X(\tau) \).

**Proof.** (1) \( \psi_I(\frac{1}{2}, 0) = \alpha \frac{\alpha}{(1 - \frac{\alpha}{2})} > \alpha \frac{\alpha}{1 - \alpha} \psi_X(0) > \psi_X(\tau) \).

(2) With \( \psi_I(1, \frac{1}{2}) = \alpha \frac{\alpha}{1 - \alpha} 2^{-\frac{4}{3\alpha}} (4 - 3\alpha) > 0 = \psi_X(1) \), we have \( \psi_X(1) > \psi_I(1, \frac{1}{2}) \).

When \( \tau = 0 \), \( \psi_X(0) = \alpha \frac{\alpha}{1 - \alpha} (1 - \alpha) > 0 \). With \( \frac{\psi_I(1, \frac{1}{2})}{\psi_X(0)} = 2^{-\frac{4}{3\alpha}} \frac{4 - 3\alpha}{1 - \alpha} \), we define \( x \equiv \frac{4 - 3\alpha}{1 - \alpha} = \frac{1}{1 - \alpha} + 3 > 4 \), then \( \psi_I(1, \frac{1}{2}) = 2^{-\bar{\tau}} x \). Because \( \frac{d\ln(2^{-\bar{\tau}} x)}{dx} = \frac{1}{2} - \frac{1}{2} \ln 2 < \frac{1}{4} - \frac{0.69315}{2} < 0 \), so \( \ln(2^{-\bar{\tau}} x) < \ln(2^{-\bar{\tau}} x)_{x=4} = 0 \). Therefore, \( \frac{\psi_I(1, \frac{1}{2})}{\psi_X(0)} = 2^{-\bar{\tau}} x < 1 \), that is, \( \psi_X(0) > \psi_I(1, \frac{1}{2}) \).

Combining the above two steps, we have \( \psi_X(1) < \psi_I(1, \frac{1}{2}) < \psi_X(0) \). With \( \psi_X(\tau) \) being continuous, decreasing in \( \tau \), we must have a cutoff \( \bar{\tau} \) defined by \( \psi_X(\bar{\tau}) = \psi_I(1, \frac{1}{2}) \) such that when \( 0 < \tau < \bar{\tau} \), \( \psi_I(1, \frac{1}{2}) < \psi_X(\tau) \), and when \( \bar{\tau} < \tau < 1 \), \( \psi_I(1, \frac{1}{2}) > \psi_X(\tau) \);

(3) With \( \psi_I(\frac{1}{2}, 1) = \alpha \frac{\alpha}{1 - \alpha} 2^{-\bar{\tau}} (1 - \alpha) > 0, 2^{-\bar{\tau}} < 1 \), it is straightforward that \( \psi_X(1) = 0 < \psi_I(\frac{1}{2}, 1), \psi_X(0) = \alpha \frac{\alpha}{1 - \alpha} (1 - \alpha) > \psi_I(\frac{1}{2}, 1) \). Similarly, there must be a cutoff \( \bar{\tau}' \) defined by \( \psi_X(\bar{\tau}') = \psi_I(\frac{1}{2}, 1) \) such that when \( 0 < \tau < \bar{\tau}' \), \( \psi_I(\frac{1}{2}, 1) < \psi_X(\tau) \), and when \( \bar{\tau}' < \tau < 1 \), \( \psi_I(\frac{1}{2}, 1) > \psi_X(\tau) \). Because we always have \( \psi_I(1, \frac{1}{2}) = \psi_X(\bar{\tau}) > \psi_I(\frac{1}{2}, 1) = \psi_X(\bar{\tau}') \) and \( \psi_X(\tau) \) being decreasing in \( \tau \), \( \bar{\tau}' > \bar{\tau} \) must hold. ■

From Proposition 1, we know, in sectors with \( \eta \in (0, \frac{1}{2}) \),

\[
\sup \psi_I(w_L, \eta) = \psi_I(\frac{1}{2}, 0), \quad \text{and} \quad \inf \psi_I(w_L, \eta) = \psi_I(1, \frac{1}{2});
\]
in sectors with \( \eta \in (\frac{1}{2}, 1) \),

\[
\sup \psi_I(w_L, \eta) = \psi_I(1, \frac{1}{2}), \quad \text{and} \quad \inf \psi_I(w_L, \eta) = \psi_I(\frac{1}{2}, 1).
\]

Lemma 2 says, if \( \tau > \bar{\tau}' \), \( \psi_I(w_L, \eta) > \psi_X(\tau) \) for \( \forall (w_L, \eta) \), i.e., when transport costs are high enough, for a given firm, \( \pi_I(w_L, \eta, \theta) \) is always steeper than \( \pi_X(\tau, \theta) \); if \( \bar{\tau} < \tau < \bar{\tau}' \), this is only true for production-work-intensive industries with \( \eta \in (0, \frac{1}{2}) \); if \( \tau < \bar{\tau} \), this may be true for only the cases with very small \( w_L \) and small \( \eta \). *(INTERPRETATION HERE ...)*

The productivity levels at which the operating profits of export and FDI are zero, respec-
tively, are

\[ \Theta_X(\tau) \equiv (\theta_X)^{1-\alpha} = \frac{f_X}{A\psi_X(\tau)} = \frac{f_X}{A(1-\tau)^{1-\alpha} \alpha^{1-\alpha}(1-\alpha)}, \]

\[ \Theta_I(w_L, \eta) \equiv (\theta_I)^{1-\alpha} = \frac{f_I}{A\psi_I(w_L, \eta)} = \frac{f_I}{A\alpha^{1-\alpha} 2^{-\frac{\alpha}{2}} \{1 - \frac{\alpha}{2} [3\eta + 2(1-2\eta)w_L]\}}, \]

with

\[ \inf \Theta_I(w_L, \eta) = \Theta_I(\frac{1}{2}, 0) = \frac{f_I}{A\psi_I(\frac{1}{2}, 0)} = \frac{f_I}{A\alpha^{1-\alpha} (1 - \frac{\alpha}{2})}, \forall (w_L, \eta). \]

The intersection productivity level of \( \pi_X \) and \( \pi_I \), if exists, is

\[ \overline{\Theta}(w_L, \eta) = \frac{f_I - f_X}{A[\psi_I(w_L, \eta) - \psi_X(\tau)]}. \]

Suppose \( f_X \) is small enough relative to \( f_I \) such that, for any reasonable \( \tau \), \( \Theta_X(\tau) < \Theta_I(\frac{1}{2}, 0) \) always holds.\(^{24}\) This kind of assumption is popular in the literature. It is to ensure that there are always some low productivity firms choosing export rather than FDI and still earning positive profits. Otherwise it is possible that all active firms choose FDI in the model, which is not interesting. On the other hand, with this assumption, it is straightforward that \( \Theta_X(\tau) < \overline{\Theta}(w_L, \eta) \) (if exists).

I now characterize the sorting patterns across firms in production-work-intensive sectors and in management-intensive sectors, respectively. There will be two kinds of sorting pattern between export and FDI, Sorting Pattern IEE and EE, as shown in figure 1. Sorting Pattern IEE says that, the most productive firms choose FDI, the firms with medium productivity levels export, while the least productive firms exit. Sorting Pattern EE says that, with the most productive firms exporting and the less productive firms exiting, no firm chooses FDI whatever its productivity is. These two patterns will apply in different cases.

[figure 1]

**Proposition 2** For firms of country \( D \) in a production-work-intensive sector, specifically, management-intensity \( \eta \in (0, \frac{1}{2}) \), to serve country \( L \):

(1) If transport cost \( \tau \) is high \( (\tau > \tau_0) \), Sorting Pattern IEE applies.

---

\(^{24}\)Because \( 0 < \tau < 1 \), there must exist such small \( f_X \) that \( \Theta_X(\tau) < \Theta_I(\frac{1}{2}, 0) \).
(2) If $\tau$ is low ($\tau < \tilde{\tau}$), there is a unique threshold $\tilde{\eta} \in (0, \frac{1}{2})$ such that in sectors very intensive in production-work ($\eta < \tilde{\eta}$), Sorting Pattern IEE applies, whereas in sectors not that intensive in production-work ($\tilde{\eta} < \eta < \frac{1}{2}$), Sorting Pattern EE applies; The threshold $\tilde{\eta}$ is decreasing in the host country development level $w_L$.

(3) When Sorting Pattern IEE applies, the cutoff productivity between export and FDI is of the property $\frac{\partial \widehat{\Theta}(w_L, \eta)}{\partial w_L} > 0$, $\frac{\partial \overline{\Theta}(w_L, \eta)}{\partial \eta} > 0$, and $\frac{\partial \overline{\Theta}(w_L, \eta)}{\partial w_L} < 0$.

**Proof.** (1) If $\tau > \tilde{\tau}$, then for sectors with $\eta \in (0, \frac{1}{2})$, we have $\psi_I(w_L, \eta) > \psi_I(1, \frac{1}{2}) > \psi_X(\tau)$. With $f_I > f_X$, we must have an intersection productivity

$$\Theta(w_L, \eta) = \frac{f_I - f_X}{A[\psi_I(w_L, \eta) - \psi_X(\tau)]} > 0,$$

such that if $\Theta > \Theta(w_L, \eta)$, $\pi_I(w_L, \eta, \theta) > \pi_X(\tau, \theta) > 0$, firms choose FDI; if $\Theta_X(\tau) < \Theta < \Theta(w_L, \eta)$, $\pi_X(\tau, \theta) > \pi_I(w_L, \eta, \theta)$ and $\pi_X(\tau, \theta) > 0$, firms choose export; when $\Theta < \Theta_X(\tau)$, $0 > \pi_X(\tau, \theta) > \pi_I(w_L, \eta, \theta)$, firms will exit.

(2) If $\tau < \tilde{\tau}$, then for sectors with $\eta \in (0, \frac{1}{2})$, we have $\psi_I(\frac{1}{2}, 0) > \psi_I(w_L, 0) = \alpha \frac{\pi}{\eta} (1 - \alpha w_L) > \psi_X(\tau) > \psi_I(w_L, \frac{1}{2}) = \psi_I(1, \frac{1}{2})$, that is, $\psi_I(w_L, 0) > \psi_X(\tau) > \psi_I(w_L, \frac{1}{2})$ for any $w_L$. Because $\psi_I(w_L, \eta)$ is decreasing and continuous in $\eta$, and from Proposition 1, $\forall w_L$, $\sup \psi_I(w_L, \eta) = \psi_I(w_L, 0)$, $\inf \psi_I(w_L, \eta) = \psi_I(w_L, \frac{1}{2})$, there must be a unique threshold $\tilde{\eta}$ for any given $w_L$ such that $\psi_I(w_L, \tilde{\eta}) = \psi_X(\tau)$.

Because $\frac{\partial \psi_I(w_L, \eta)}{\partial \eta} < 0$, for those sectors with $\eta > \tilde{\eta}$, $\psi_I(w_L, \eta) \leq \psi_X(\tau)$, thus, combined with $f_I > f_X$, we have $\pi_I(w_L, \eta, \theta) < \pi_X(\tau, \theta)$ for any $\Theta$. Thus, firms with $\Theta > \Theta_X(\tau)$ export, and other firms exit.

For those relatively production-work-intensive sectors with $\eta < \tilde{\eta}$, $\psi_I(w_L, \eta) > \psi_X(\tau)$, thus, as in (1) above, we must have an intersection productivity $\overline{\Theta}(w_L, \eta)$ such that if $\Theta > \overline{\Theta}(w_L, \eta)$, $\pi_I(w_L, \eta, \theta) > \pi_X(\tau, \theta) > 0$, firms choose FDI; if $\Theta_X(\tau) < \Theta < \overline{\Theta}(w_L, \eta)$, $\pi_X(\tau, \theta) > \pi_I(w_L, \eta, \theta)$ and $\pi_X(\tau, \theta) > 0$, firms choose export; when $\Theta < \Theta_X(\tau)$, $0 > \pi_X(\tau, \theta) > \pi_I(w_L, \eta, \theta)$, firms will exit.

Because $\frac{\partial \psi_I(w_L, \eta)}{\partial w_L} < 0$, $\frac{\partial \psi_I(w_L, \eta)}{\partial \eta} < 0$ and $\psi_I(w_L, \tilde{\eta}) = \psi_X(\tau)$, $\frac{\partial \psi_I(w_L, \eta)}{\partial w_L} = \frac{\partial \psi_I(w_L, \eta)}{\partial w_L} + \frac{\partial \psi_I(w_L, \eta)}{\partial \eta} \frac{\partial \tilde{\eta}}{\partial w_L} = 0$, we must have $\frac{\partial \tilde{\eta}}{\partial w_L} < 0$.

(3) It is straightforward from Proposition 1. \(\blacksquare\)
To understand the proof, it is easy to see figure 2 and 3. The productivity variable is measured along the horizontal axis and the operating profits are measured along the vertical axis. As in figure 2 for Part (1), when $\tau$ is high (here, $\tau > \bar{\tau}$), we have $\psi_I(w_L, \eta) > \psi_X(\tau)$ for $\forall (w_L, \eta) \in (\frac{1}{2}, 1) \times (0, \frac{1}{2})$, thus $\pi_I(w_L, \eta, \theta)$ is steeper than $\pi_X(\tau, \theta)$ and they will always intersect. Firms with $\Theta > \Theta(w_L, \eta)$ attain the highest profits through FDI, those with $\Theta \text{ s.t. } \Theta_X(\tau) < \Theta < \Theta(w_L, \eta)$ attain the highest profits through exporting, whereas the least productive firms with $\Theta < \Theta_X(\tau)$ exit the market. This is exactly the Sorting Pattern IEE.

This pattern applies for firms in any production-work-intensive industry in any host country when the transport costs are high enough. The intuition of this pattern is the same as in Helpman, Melitz and Yeaple (2004): given the transport costs, the more productive the firm is, the more likely for it to cover a higher fixed cost.

[figure 2] [figure 3]

In figure 3, when $\tau$ is low (here, $\tau < \bar{\tau}$), the two profit functions will intersect in some cases. Only for those sectors very intensive in production-work ($\eta < \tilde{\eta}$), $\pi_I(w_L, \eta, \theta)$ being steeper than $\pi_X(\tau, \theta)$ holds and the Sorting Pattern IEE applies; for those sectors not that intensive in production-work ($\tilde{\eta} < \eta < \frac{1}{2}$), $\pi_I(w_L, \eta, \theta)$ is flatter than $\pi_X(\tau, \theta)$, which means that any active firm will earn more profit through exporting than through FDI, thus firms with $\Theta > \Theta_X(\tau)$ will export and the rest firms exit. This is the Sorting Pattern EE.

The division by $\tilde{\eta}$ is due to the hold-up problem. The higher the $\eta$, the more serious the hold-up problem for FDI, thus the lower the $\pi_I(w_L, \eta, \theta)$ relative to $\pi_X(\tau, \theta)$. When the hold-up problem is serious enough, no active firm will earn more from FDI than from export. In production-work-intensive industries, as labor cost effect dominates hold-up effect, an increase in $w_L$ will even depress $\pi_I(w_L, \eta, \theta)$ thus allow for an even lower $\eta$ to make $\pi_I(w_L, \eta, \theta)$ parallel with $\pi_X(\tau, \theta)$, thus $\tilde{\eta}$ should be decreasing in $w_L$.

This Part (2) means, when transport costs are low, FDI exists only in the most production-work-intensive industries (in which the hold-up problem is least serious), and this is true especially in those host countries of high development level (because there the labor costs are high). An example for the sorting patterns in case $\tau < \bar{\tau}$ is given in figure 4. In the example,
\[ \alpha = 0.5, \text{ thus we have threshold } \bar{\tau} = 0.11612. \text{ When } \tau = 0, \bar{\eta} \text{ is defined by } w_L = \frac{-21 + \bar{\eta} - 3\bar{\eta} + 4}{2(1 - 2\bar{\eta})}. \]

If take \( \tau = 0.06, \bar{\eta} \text{ is defined by } w_L = \frac{-1.88 \times 2\bar{\eta} - 3\bar{\eta} + 4}{2(1 - 2\bar{\eta})}. \) This \( \bar{\eta} \) divides the \((w_L, \eta)\) space and is decreasing in \( w_L \). In the south-west area, Sorting Pattern IEE applies; in the north-east area, Sorting Pattern EE applies and there is no FDI; as transport costs increase, the division line moves towards north-east and the no-FDI space shrinks.

As for the Part (3) of the proposition, it is due to Proposition 1. Higher management-intensity leads to more serious hold-up problem for FDI thus decreases its profits relative to export. In the production-work-intensive industries labor cost effect dominates hold-up effect, thus high wage level also decreases FDI profits relative to export. These changes will increase the cutoff productivity level between export and FDI. As for the interaction term, the negative sign means that an increase in management-intensity will cause a smaller increase of the cutoff productivity in a more developed country than in a relatively less developed country, and an increase in development level will cause a smaller increase of the cutoff productivity in a more management-intensive industry than in a more production-work-intensive industry. Management-intensity and development level could alleviate the effect each other on the cutoff productivity level.

These predictions are new in theory and consistent with the rough evidence available ......

**Proposition 3** For firms of country \( D \) in a management-intensive sector, specifically, \( \eta \in \left( \frac{1}{2}, 1 \right) \), to serve country \( L \):

1. If \( \tau \) is high \((\tau > \bar{\tau}')\), Sorting Pattern IEE applies. If \( \tau \) is low \((\tau < \bar{\tau})\), Sorting Pattern EE applies.

2. If \( \tau \) is moderate \((\bar{\tau} < \tau < \bar{\tau}')\), there is a unique threshold \((\bar{w}_L, \bar{\eta})\) in the space \((w_L, \eta) \in (\frac{1}{2}, 1) \times (\frac{1}{2}, 1)\), such that for those country-industry pairs with \((w_L, \eta) \in (\bar{w}_L, 1) \times (\frac{1}{2}, \bar{\eta})\), Sorting Pattern IEE applies, whereas for those country-industry pairs with \((w_L, \eta) \in (\frac{1}{2}, \bar{w}_L) \times (\bar{\eta}, 1)\), Sorting Pattern EE applies; \( \bar{w}_L \) and \( \bar{\eta} \) are positively correlated.

3. When Sorting Pattern IEE applies, the cutoff productivity between exporting and FDI is of the property \( \frac{\partial \psi(w_L, \eta)}{\partial w_L} < 0, \frac{\partial \psi(w_L, \eta)}{\partial \eta} > 0, \) and \( \frac{\partial^2 \psi(w_L, \eta)}{\partial w_L \partial \eta} < 0 \).

**Proof.** (1) If \( \tau > \bar{\tau}' \), then for sectors with \( \eta \in (\frac{1}{2}, 1) \), we have \( \psi_I(w_L, \eta) > \psi_I(\frac{1}{2}, 1) > \)
\( \psi_X(\tau) \). With \( f_I > f_X \), for all \( \eta \in (0, 1) \), we must have an intersection productivity

\[
\Theta(w_L, \eta) = \frac{f_I - f_X}{A[\psi_I(w_L, \eta) - \psi_X(\tau)]} > 0,
\]

such that if \( \Theta > \Theta(w_L, \eta) \), \( \pi_I(w_L, \eta, \theta) > \pi_X(\tau, \theta) > 0 \), firms choose FDI; if \( \Theta_X(\tau) < \Theta < \Theta(w_L, \eta) \), \( \pi_X(\tau, \theta) > \pi_I(w_L, \eta, \theta) \) and \( \pi_X(\tau, \theta) > 0 \), firms choose export; when \( \Theta < \Theta_X(\tau) \), \( 0 < \pi_X(\tau, \theta) > \pi_I(w_L, \eta, \theta) \), firms will exit.

If \( \tau < \bar{\tau} \), for \( \eta \in \left( \frac{1}{2}, 1 \right) \), \( \psi_X(\tau) > \psi_I(1, \frac{1}{2}) > \psi_I(w_L, \eta) \), combined with \( f_I > f_X \), we have \( \pi_I(w_L, \eta, \theta) < \pi_X(\tau, \theta) \) for any \( \Theta \). Thus, firms with \( \Theta > \Theta_X(\tau) \) export, and other firms exit.

(2) For \( \eta \in \left( \frac{1}{2}, 1 \right) \), if \( \bar{\tau} < \tau < \bar{\tau}' \), \( \psi_I(1, \frac{1}{2}) < \psi_X(\tau) < \psi_I(1, 1) \). From Proposition 1 we know that with \( \eta \in \left( \frac{1}{2}, 1 \right) \), \( \sup \psi_I(w_L, \eta) = \psi_I(1, \frac{1}{2}) \), \( \inf \psi_I(w_L, \eta) = \psi_I(1, 1) \). Thus there is a threshold \((\bar{w}_L, \bar{\eta})\) in the \((w_L, \eta)\) space such that \( \psi_I(\bar{w}_L, \bar{\eta}) = \psi_X(\tau) \), and \((\bar{w}_L, \bar{\eta})\) is uniquely determined by this condition.

Because \( \frac{\partial \psi_I(w_L, \eta)}{\partial w_L} > 0 \), \( \frac{\partial \psi_I(w_L, \eta)}{\partial \eta} < 0 \), for those country-industry pairs \((w_L, \eta) \in \left( \frac{1}{2}, \bar{w}_L \right) \times (\bar{\eta}, 1) \), \( \psi_I(w_L, \eta) \leq \psi_X(\tau) \), thus, combined with \( f_I > f_X \), we have \( \pi_I(w_L, \eta, \theta) < \pi_X(\tau, \theta) \) for any \( \Theta \). Thus, firms with \( \Theta > \Theta_X(\tau) \) export, and other firms exit. For those country-industry pairs \((w_L, \eta) \in (\bar{w}_L, 1) \times \left( \frac{1}{2}, \bar{\eta} \right) \), we have \( \psi_I(w_L, \eta) > \psi_X(\tau) \), thus the intersection of exists, and the proof is similar to that of (1).

Because \( \frac{\partial \psi_I(w_L, \eta)}{\partial w_L} > 0 \), \( \frac{\partial \psi_I(w_L, \eta)}{\partial \eta} < 0 \) and \( \psi_I(\bar{w}_L, \bar{\eta}) = \psi_X(\tau) \), \( \frac{\partial \psi_I(\bar{w}_L, \bar{\eta})}{\partial \eta} = \frac{\partial \psi_I(\bar{w}_L, \bar{\eta})}{\partial w_L} \frac{\partial \bar{w}_L}{\partial \eta} + \frac{\partial \psi_I(\bar{w}_L, \bar{\eta})}{\partial w_L} = \frac{\partial \psi_I(\bar{w}_L, \bar{\eta})}{\partial w_L} + \frac{\alpha(4w_L - 3)}{2} \frac{\partial \psi_I(\bar{w}_L, \bar{\eta})}{\partial w_L} \frac{\partial \bar{w}_L}{\partial \eta} - \frac{\alpha^2(4w_L - 3) \ln 2}{2(1 - \alpha)} \frac{\partial \psi_I(\bar{w}_L, \bar{\eta})}{\partial w_L} = \frac{\alpha(4w_L - 3)}{2(\alpha^2)} \frac{\partial \psi_I(\bar{w}_L, \bar{\eta})}{\partial \eta} / (2\eta - 1) |(\bar{w}_L, \bar{\eta}) |\).

(3) It is straightforward from Proposition 1. \( \blacksquare \)

The proof could be similarly understood through figure 2, 3 and 5. Part (1) is easy to understand. The second half means that when \( \tau \) is very low \( (\tau < \bar{\tau}) \), \( \pi_I(w_L, \eta, \theta) \) never intersect with \( \pi_X(\tau, \theta) \), and there could be no FDI at all (see figure 5).

[figure 5]

Part (2) is analogous to that of Proposition 2, with one different point worth noting: here \( \bar{w}_L \) and \( \bar{\eta} \) are positively correlated.\(^{25}\) This is because in management-intensive sectors, hold-up

\(^{25}\)Another technical difference is that the existence of the threshold is more restrictive here than in
effect dominates labor cost effect. An increase in $w_L$ will make $\pi_L(w_L, \eta, \theta)$ steeper relative to $\pi_X(\tau, \theta)$, thus allow for a higher $\eta$ to make $\pi_L(w_L, \eta, \theta)$ parallel with $\pi_X(\tau, \theta)$, therefore, $\tilde{\eta}$ should be positively correlated with $\tilde{w}_L$. This means, when transport costs are moderate, there will be no FDI in those most management-intensive industries in those low development level countries.

The sorting patterns in case $\tilde{\tau} < \tau < \tilde{\tau}'$ are depicted in figure 6 for the example when $\alpha = 0.5$ and thus $\tilde{\tau}' = 0.5$, $\tilde{\tau} = 0.11612$. Take $\tau = 0.2$, we have $\tilde{w}_L = \frac{-1.6 \times 2^{\bar{\eta}} - 3\bar{\eta} + 4}{2(1-2\bar{\eta})}$. If take $\tau = 0.25$, then $\tilde{w}_L = \frac{-1.5 \times 2^{\bar{\eta}} - 3\bar{\eta} + 4}{2(1-2\bar{\eta})}$. If take $\tau = 0.3$, then $\tilde{w}_L = \frac{-1.4 \times 2^{\bar{\eta}} - 3\bar{\eta} + 4}{2(1-2\bar{\eta})}$. This threshold divides the $(w_L, \eta)$ space in the way that, in the north-west area, Sorting Pattern IEE applies; in the south-east area, Sorting Pattern EE applies and there is no FDI; as transport costs increase, the division line moves towards south-east and the no-FDI space shrinks.

Part (3) is due to the fact of hold-up effect dominating labor cost effect in management-intensive-industries, as Proposition 1 says. In these industries, the cutoff productivity level between export and FDI is decreasing in the host country’s development level, decreasing in the interaction of host country development level and the intensity of management in production. Therefore, the higher the management-intensity of the industry, in which there will be more FDI in a more developed country than in a relatively less developed country.

This is exactly the pattern of world FDI flows the first two facts in the introduction raised.

This paper identifies the underlying driving force of this pattern as the contract friction determined by industrial technology and host country development level, in particular, the trade-off between the labor-cost effect and the hold-up effect. This is new in the literature.

Combinning Proposition 2 and 3, we could summarize several testable predictions:

(Prediction I): In a cross-country sample, ceteris paribus, (i) in a production-work-intensive industry, firms investing in a more developed country should be overall more productive than those investing in a relatively less developed country; (ii) in a management-intensive industry, the above relation is reversed. This difference is due to the comparison between hold-up effect and labor-cost effect in different countries in the two kinds of industry.

Proposition 2, in the sense that we could not guarantee a $\tilde{\eta}$ for any $w_L \in (\frac{1}{2}, 1)$, but we can always have a threshold $(\tilde{\eta}_L, \tilde{\eta})$ that divides the $(w_L, \eta)$ space in the way described in part (2).
(Prediction II): In a cross-industry sample, firms doing FDI in a more management-intensive industry should be overall more productive than those doing FDI in a relatively more production-work-intensive industry in a given country.

(Prediction III): In a country-industry panel sample, the cutoff productivity level between export and FDI should be decreasing in the interaction of development level and management-intensity.

(Prediction IV): In production-work-intensive industries, if the transport cost is low, there will be no FDI at all in some industries in some countries. Particularly, ceteris paribus, the probability of no-FDI is increasing in $w_L$, increasing in $\eta$, and increasing in the interaction term $\eta w_L$. This could be most easily seen from figure 4.

(Prediction V): In management-intensive industries, if the transport cost is not high, there could be no FDI in some industries in some countries. Particularly, when the transport cost is moderate, ceteris paribus, the probability of no-FDI is higher in a low-development-level country and high-management-intensity industry pair than in a respectively reverse pair.

Some evidence/discussion...

IS THIS PART NECESSARY?

Now consider the industry equilibrium. It is obvious that firms with productivity level below $\Theta_X(\tau)$ will exit the market. Firms with productivity level between $\Theta_X(\tau)$ and $\Theta(w_L, \eta)$ (if exists) will keep active and export to market $L$, and those with productivity level above $\Theta(w_L, \eta)$ (if exists) will choose FDI. If $\Theta(w_L, \eta)$ does not exist, then all firms with $\Theta > \Theta_X(\tau)$ will choose export. Industry equilibrium could be derived from the free entry condition. Free entry means equality between the expected operating profit of a potential entrant and the fixed entry cost $f_E$, which will determine the aggregate consumption index $A$ of an individual sector in country $L$. This free entry condition is given by

$$\int_{\Theta_X(\tau)}^{\Theta(w_L, \eta)} \pi_X(\tau, \theta) dG(\theta) + \int_{\Theta(w_L, \eta)}^{+\infty} \pi_X(\tau, \theta) dG(\theta) = f_E$$

for the case $\Theta(w_L, \eta)$ exists, or otherwise,

$$\int_{\Theta_X(\tau)}^{+\infty} \pi_X(\tau, \theta) dG(\theta) = f_E.$$
With the implicit solution to index $A$ as a function of $(w_L, \eta)$, it is easy to calculate all other relevant variables, such as the threshold productivity level of surviving entrants and the intersection productivity level (if exists) of profits from export and FDI, and the measure of different kinds of entrants.

5 Prevalence of MNEs

This model has implications for variations of channels of serving a foreign country across firms, industries, as well as countries. The previous section mainly examines characteristics of each single firm choosing export or FDI. Now I turn to industries and countries, i.e., the variations of the prevalence of MNEs (i.e., firms performing FDI) across industries and countries.

Following Antras and Helpman (2004), Helpman, Melitz and Yeaple (2004), assume firm’s productivity is drawn from a Pareto distribution with shape parameter $k$, that is,

$$ G(\theta) = 1 - \left( \frac{d}{\theta} \right)^k, \text{ for } \theta \geq d > 0, $$

where $\frac{1}{k}$ is positively correlated with the productivity dispersion (or degree of heterogeneity) within an industry and is assumed small to ensure a finite variance of the distribution of firm size in that industry. With this productivity distribution, the sales distribution is also Pareto, which is consistent with the evidence (Axtell 2001; Helpman, Melitz and Yeaple 2004). Following Helpman, Melitz and Yeaple (2004), I employ the fraction of MNEs as the measure of prevalence of MNEs. Using the market share of MNEs as the measure should result in similar conclusions.

Denote by $s_I$ the fraction of active firms that choose FDI to serve country $L$. For the benchmark case of Sorting Pattern IEE, we have

$$ s_I = \frac{1 - G \left( \frac{\Theta(w_L, \eta)}{\Theta(w_L, \eta)} \right)^{1-\alpha}}{1 - G \left( \frac{\Theta_X(\tau)}{\Theta_X(\tau)} \right)^{1-\alpha}} = \left[ \frac{\Theta_X(\tau)}{\Theta(w_L, \eta)} \right]^{k(1-\alpha)/\alpha} $$

$$ = \left( \frac{\psi_I(w_L, \eta) - \psi_X(\tau)}{\psi_X(\tau)} \right) \frac{f_X}{f_I - f_X} \right]^{k(1-\alpha)/\alpha}, $$

with the fraction of active firms that choose export $s_X = 1 - s_I$. Because $0 < \frac{\Theta_X(\tau)}{\Theta(w_L, \eta)} < 1$, $0 < s_I < 1$. For the case that $\Theta(w_L, \eta)$ does not exist, we have $s_I = 0$ and $s_X = 1$. 

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Proposition 4  For the prevalence of MNEs, in a production-work-intensive sector, specifically, $\eta \in (0, \frac{1}{2})$:

1. If $\tau$ is high ($\tau > \bar{\tau}$), or if $\tau$ is low ($\tau < \bar{\tau}$) and $\eta < \bar{\eta}$, then $s_I > 0$. Otherwise, $s_I = 0$.

2. Overall, $s_I$ is nonincreasing in $f_I$, nondecreasing in $f_X$. If $s_I > 0$, the relations are strict.

3. Overall, $s_I$ is nondecreasing in productivity dispersion ($\frac{1}{k}$). If $s_I > 0$, the relation is strict.

4. Overall, $s_I$ is nonincreasing in $f_I$.

5. Overall, $s_I$ is nondecreasing in $w_L$.

6. Overall, $s_I$ is nondecreasing in the interaction $\eta w_L$. If $s_I > 0$, the relation is strict.

Proof. (1) If $\tau > \bar{\tau}$, for sectors with $\eta \in (0, \frac{1}{2})$, the two profit functions must intersect, thus

$$s_I = \left[\left(\frac{\psi_I(w_L, \eta)}{w_X(\tau)} - 1\right) \frac{f_X}{f_I - f_X} \right]^{(1-\alpha)/\alpha} > 0.$$  

If $\tau < \bar{\tau}$, $\eta \in (0, \frac{1}{2})$ and $\eta \geq \bar{\eta}$, then from Proposition 2 there will be no FDI, i.e., $s_I = 0$. For $\eta \in (0, \frac{1}{2})$ and $\eta < \bar{\eta}$, there will be an intersection productivity and the rest proof follows.

(2)(4)(5)(6) When the two profit functions have intersection, it is straightforward that $s_I$ is decreasing in $f_I$, increasing in $f_X$. Due to Proposition 1, for $\eta \in (0, \frac{1}{2})$, $\frac{\partial \psi_I(w_L, \eta)}{\partial \eta} < 0$, $\frac{\partial \psi_I(w_L, \eta)}{\partial w_L} > 0$, $s_I$ is decreasing in $w_L$ and $\eta$, and increasing in $\eta w_L$. When there is no intersection, $s_I$ is constant, zero, for any $f_I, f_X, w_L$ and $\eta$.

(3) Because the ratio of productivity levels in the $s_I$ expression is smaller than one, a decrease in $k$ will raise $s_I$ if it is greater than zero. When there is no intersection, $s_I$ is constant, zero.

Part (1) and (2) are the familiar proximity-concentration results. High transport cost will encourage FDI, while high extra fixed cost of FDI will discourage it. Serious hold-up problem in FDI will also discourage FDI. Part (3) is due to the same mechanism in Melitz (2003) and Helpman, Melitz and Yeaple (2004): a larger dispersion means a fatter right tail of the distribution, i.e., a larger fraction of highly productive firms, thus more firms become MNEs.

Other things equal, an increase in $\eta$ will aggravate the hold-up problem for FDI, thus, as part (4) says, decrease the prevalence of MNEs, if any. Part (5) predicts that (Prediction VI): In production-work-intensive sectors, the prevalence of MNEs (if any) will decrease in $w_L$. This means, other things equal, in such industries, there will be more MNEs in a less developed
country than in a relatively more developed country. FDI in these industries will mainly go to less developed countries rather than developed countries. This is quite intuitive: in such industries, the labor cost effect dominates the hold-up effect, thus firms are more likely to invest in countries with lower labor costs. Part (6) is discussed later together with the following proposition.

Evidence...

**Proposition 5** For the prevalence of MNEs, in a management-intensive sector, specifically, 
\( \eta \in (1/2, 1) \):

1. If \( \tau \) is high \( (\tau > \bar{\tau}) \), or if \( \tau \) is moderate \( (\bar{\tau} < \tau < \bar{\tau}') \) and \((w_L, \eta) \in (\bar{w}_L, 1) \times (1/2, \bar{\eta})\), then \( s_I > 0 \). Otherwise, \( s_I = 0 \).
2. Overall, \( s_I \) is nonincreasing in \( f_i \), nondecreasing in \( f_X \). If \( s_I > 0 \), the relations are strict.
3. Overall, \( s_I \) is nondecreasing in productivity dispersion \((1/\tilde{r})\). If \( s_I > 0 \), the relation is strict.
4. Overall, \( s_I \) is nonincreasing in \( \eta \). If \( s_I > 0 \), the relation is strict.
5. Overall, \( s_I \) is nondecreasing in \( w_L \). If \( s_I > 0 \), the relation is strict.
6. Overall, \( s_I \) is nondecreasing in the interaction \( \eta w_L \). If \( s_I > 0 \), the relation is strict.

**Proof.** (1) From Proposition 1 and 2, if \( \tau \) is high \( (\tau > \bar{\tau}) \), or if \( \tau \) is moderate \( (\bar{\tau} < \tau < \bar{\tau}') \) and \((w_L, \eta) \in (\bar{w}_L, 1) \times (1/2, \bar{\eta})\), the two profit functions must intersect, thus \( s_I > 0 \). Otherwise, \( s_I = 0 \).

(2)(3)(4)(6) are the same as Proposition 4.

(5) For \( \eta \in (1/2, 1) \), \( \frac{\partial \phi_i(w_L, \eta)}{\partial w_L} > 0 \), thus the proof follows. ■

Part (1)-(4) are similar to their counterparts in Proposition 4. However, part (5) makes an opposite prediction (Prediction VII): In management-intensive sectors, the prevalence of MNEs (if any) will increase in \( w_L \). More developed countries rather than less developed countries will attract more MNEs in these industries, which is consistent with the pattern of the world FDI flows. As I pointed out in the introduction, this result is impossible in all previous horizontal FDI models without contract friction, but it is quite intuitive in the current model. The intuition is that, in management-intensive sectors, in doing FDI, the hold-up effect
dominates the labor cost effect. Though investing in a more developed country incurs higher labor costs, it will even more significantly reduce the hold-up problem, thus raises the profits of FDI and makes MNEs more prevalent in such country than its relatively less developed counterparts. On the contrary, in the previous proximity-concentration models, the higher the host country’s wage level, the less likely will it be FDI destination because of its high labor costs.

There could be a similar result in the two-factor, two-sector, two-country model by Markusen and Venables (2000) if we reinterprete their capital/labor ratio as my development level, and their capital-intensive industry as my management-intensive industry. However, besides the differences or weakness of the model mentioned in the introduction, this reinterpretation seems unrobust either: a more developed country is anyway defined by a higher per capita income, but not a higher capital/labor ratio, and a country’s development level is not necessarily proportional to its capital/labor ratio. Thus that model is not likely to explain the important facts at the beginning of the paper.

Part (6) of both propositions says (Prediction VIII): The prevalence of MNEs (if any) will increase in $\eta w_L$ in all industries. The underlying reason is familiar: as mentioned in Proposition 1, the management-intensity and the development level could mitigate the effect of each other in the production-work-intensive industries, but reinforce the effect of each other in the management-intensive industries.

6 Econometric Evidence

To be added.

7 Conclusions

This paper extends the proximity-concentration model with heterogeneous firms through embedding contract friction in FDI to account for firms’ export and FDI location decisions. The degree of contract friction, which is determined by industry technology and host country development level, will affect profits from FDI: an increase in host country development level will
mitigate the friction, i.e., the hold-up problem (hold-up effect) but increase labor costs (labor cost effect), and the former effect dominates the latter in non-production-work-intensive industries while the latter dominates the former in production-work-intensive industries. In this way, this paper provides an explanation for the world FDI patterns and several testable predictions about MNEs and the no-FDI inflow cases. These results call for more detailed investigations when analysing export and FDI empirically, that is, taking into account all firm, industry, and country level heterogeneity, as well as the proximity-concentration factors.

As for future work, it is easy to consider in this model the export/FDI problem of MNEs from relatively less developed countries to serve developed countries. To my knowledge this is never discussed by previous literature on MNEs but is becoming a more and more important economic phenomenon. The incomplete contract view of horizontal FDI in this model could also be employed to explore other related questions, such as the composition of FDI (for example, joint ventures vs. wholly-owned enterprises, merger vs. greenfield investment).
References


Figure 1. The two export/FDI sorting patterns
Figure 2: Equilibrium when intersection always exists.
Figure 3: Equilibrium when intersection exists in some cases.

\[
\begin{align*}
\text{for } \eta \in (0, \frac{1}{2}) : & \quad w_L \uparrow, \eta \uparrow \\
\text{for } \eta \in (\frac{1}{2}, 1) : & \quad w_L \downarrow, \eta \uparrow
\end{align*}
\]
Figure 4. The threshold $\tilde{\eta}$ when $\alpha = 0.5$. 
Figure 5: Equilibrium when intersection never exists.

\[ \text{for } \eta \in \left(\frac{1}{2}, 1\right) : w_L \downarrow, \eta \uparrow \]
Figure 6. The threshold $(\bar{w}_L, \bar{\eta})$ when $\alpha = 0.5$. 