Vertical FDI and Global Sourcing Strategies of Multinational Firms

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Abstract

In this paper I study global organization of production by multinational firms along two dimensions - geography of their inputs suppliers and their ownership structure. I build a multi-country general equilibrium model of trade in intermediate goods, which features two vertically related industries with heterogeneous firms. Importantly, when making their sourcing decisions, final goods producers face fixed costs of importing and fixed costs of vertical integration with their suppliers. As a result, the model shows that ownership over inputs suppliers magnifies any exogenous differences in firms productivity and thus affects their endogenous outcomes, such as prices and sales. The proposed framework allows to study the determinants of intra-firm trade between countries and quantify the effects of trade liberalization or increased protectionism on both intra-firm and between-firm trade. Moreover, it provides rational for investment climate as separate margin of welfare gains from trade.

Key words: FDI; global sourcing; intra-firm trade; multinationals

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1 Introduction

The expansion of multinational corporations has led to the emergence of intra-firm trade - which refers to international trade flows between parent companies and their affiliates or between these affiliates. Based on the U.S. Census Bureau’s Related Party Trade data, intra-firm transactions accounted for about 50% of imports by US multinationals, on average, in 2000-2011. At the same time, active participation of multinational enterprises in global value chains implies that a substantial portion of these imports is made up of imports of intermediate goods used in production of export goods.

Figure 1 illustrates that intra-firm imports of intermediates by U.S. multinationals (solid line) comprised a significant share of overall imports of intermediate goods over the period 2000-2011. It implies that vertical foreign direct investment plays an important role in firms’ sourcing decisions and the observed patterns of trade flows. However, vertical FDI, in contrast to horizontal FDI, remains under-explored in the international trade literature.

In this paper, I study the interaction of firms’ sourcing strategies with their decisions to engage in vertical foreign direct investment. In order to do so, I develop a multi-country model of input sourcing with endogenous allocation of ownership along the value chain. Both upstream and downstream sectors of the economy are explicitly modeled as markets consisting of monopolistically competitive firms. In this model, final goods producers differing in productivity decide how to organize their production process along two dimensions - geography and ownership over their suppliers. There are four options available to them: domestic outsourcing, domestic in-house production, offshore-outsourcing and vertical foreign direct investment. When deciding on the geography of their sourcing strategies, firms trade off lower transportation costs of domestic sourcing with potentially lower variable costs of production abroad. When deciding on the ownership structure along the value chain, firms trade off the elimination of mark-ups charged by intermediate goods producers in the case of vertical integration with fixed costs of merging the businesses. I model this using the market-power based approach to vertical integration, which unlike the property-rights based approach of Antràs (2003), reflects transfer pricing practices of multinational firms. According to Bernard et al. (2006), prices of arms length transactions are higher than prices of transactions with related parties.
As a result, this paper seeks to contribute to several strands of the literature. First, it contributes to the literature studying "global firms" - large firms that participate in the international economy along multiple margins. This literature studies these firms' input sourcing decisions and their interdependencies with export participation (Antras et al. (2014), Bernard et al. (2016), Kasahara & Lapham (2013)). The focus of this paper is the organizational choices of globally engaged firms and the determinants of intra-firm trade flows. It complements Helpman et al. (2003), by studying firms choice between importing and vertical FDI, rather than exporting and horizontal FDI. Beyond that, the theoretical framework proposed in the paper allows to analyze firms importing and vertical FDI decisions in a set-up with multiple (possibly) non-symmetric countries.

Second, this paper adds to the literature on the link between international trade and aggregate productivity. In particular, recent studies show that better access to foreign inputs can increase firm productivity (Amiti & Konings (2007), Kasahara & Rodrigue (2008), Topalova & Khandelwal (2011), Halpern et al. (2009)). This paper proposes vertical integration with input suppliers as an additional mechanism through which imports of inputs can affect firms productivity. The model predicts selection of more productive final goods producers into importing and vertical FDI, which further increases their productivity by providing access to the world lowest-price mark-up free inputs.

Finally, this paper has implications for the literature on the welfare effects of trade and FDI liberalization. Incorporating fixed costs of both importing and FDI allows me to study...
the interdependencies between trade policies and investment environment of a country. In the future research, I plan to quantify the welfare gains from free trade and improvements in the investment climate.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the data and documents stylized facts. Section 4 introduces a novel theoretical model of vertical FDI and input sourcing. Section 5 concludes the paper.

2 Related Literature

In the previous studies it was shown that intra-firm trade flows are heterogeneous across products, industries and trading partners. Since the seminal work of Antràs (2003), this heterogeneity has been largely studied through the lens of property-rights theory. Antràs (2003) rationalizes intra-firm trade as a way to overcome contractual incompleteness. In order to alleviate the hold-up problem faced by their suppliers, firms contribute to the relationship-specific investment in capital and vertically integrate with the suppliers. Since capital-intensive industries are more likely to require large investments in capital, this framework explains why U.S. multinationals tend to import capital-intensive goods from their affiliates, while they import labor-intensive goods from unaffiliated parties. This approach was further extended to feature firm heterogeneity in Antras & Helpman (2004).

In contrast, in Garetto (2013), intra-firm trade arises as a result of firms trading off better technologies of an independent supplier with a lower input prices of their affiliates abroad. Intra-firm trade is associated with lower transaction prices, because by vertically integrating with their suppliers, firms can avoid mark-ups charged by monopolistically competitive suppliers. Using BEA data on U.S. multinationals, Garetto (2013) finds that, in support of her theoretical predictions, intra-firm share of imports is higher the lower the elasticity of substitution of inputs used in production and the higher the average productivity of final goods producers. The proposed theoretical framework also allows the author to quantify the welfare effect of FDI liberalization. Garetto (2013) estimates that opening a completely autarkic economy to trade with costless FDI implies a total gain of 23 % in consumption per capita for the United States.

Unlike Garetto (2013), who views FDI as activity associated with higher variable costs compared to imports, Helpman et al. (2003) suggest that FDI involves higher fixed costs and lower variable costs than trade. They build a symmetric multi-country, multi-sector general equilibrium model to explain the decisions of heterogenous firms to serve foreign markets either through exports or local subsidiaries. Thus, the focus of the paper is
horizontal, rather than vertical, FDI. Their theoretical model predicts that in equilibrium, only the more productive firms choose to export and the most productive among them choose to serve foreign markets via their affiliates.

Antras et al. (2014) study the role of fixed costs of importing in firms’ global sourcing decisions. Their theoretical framework suggests that global sourcing decisions naturally interact through firms’ cost function if those firms face countries pair-specific fixed costs of importing inputs. Adding more countries to a firm’s global sourcing strategy features complementarity across markets whenever demand is relatively elastic and whenever input efficiency levels are relatively heterogeneous across markets. Structural estimation of these parameters suggests that sourcing decisions of the U.S. firms are complements. The estimates imply that a firm sourcing from all foreign countries faces 7% lower variable costs and achieves 24% higher sales than when sourcing exclusively domestically. Moreover, Antras et al. (2014) show that fixed costs of offshoring are important in explaining the extensive margins of importing.

In the recent study of global firms, Bernard et al. (2016) develop a new theoretical framework that allows firms to have large market shares and make decisions on the location of production, destination and products of their exports, origin and variety of inputs that they source. Their model predicts strong interdependencies and complementaries between these margins of firms’ participation in international trade. Using U.S. firm- and transaction-level data, Bernard et al. (2016) find evidence in support of their theoretical predictions and argue that firms’ decisions along multiple margins magnify any initial differences in firms productivity and increase their share in trade flows.

The analysis of the existing literature shows that, unlike horizontal FDI and exporting, vertical FDI and importing activities of firms remain under-explored. But at the same time, there are studies showing that improved access to foreign increase can increase firm productivity. Amiti & Konings (2007) find this effect for Indonesian firms, Kasahara & Rodrigue (2008) - for Chilean firms and Topalova & Khandelwal (2011) - for Indian ones. In their structural analysis, Halpern et al. (2009) argue that imported goods affect firm productivity through two channels: higher price-adjusted quality and imperfect substitution with domestic imports. In addition, they find that foreign-owned companies gain more from spending on imports in term of productivity. The authors suggest that this could be due to the knowledge about foreign markets and thus, their ability to get cheaper inputs.

The effect of foreign inputs on productivity can then be transalated into social welfare through prices. Therefore, it is important to understand how globally engaged firms make their sourcing decisions and, in particular, how they decide whether to source inputs from a related or non-related party abroad.
3 Data and Stylized Facts

For the purposes of this paper, I use U.S. multinationals’ trade with their foreign affiliates as a measure of intra-firm trade. These data is publicly available from the U.S. Census Bureau’s Related Party Trade Database, which reports U.S. exports and imports at the disaggregated country-product level and distinguishes between related- and non-related parties transactions. In this paper, a product is defined as a 6-digit code in the HS industry classification.

Related-party import is defined as ”trade with an entity located outside the United States in which the importer holds at least a 6% equity interest”. Related-party exports are analogously defined as ”trade with an entity located outside the United States in which the exporter holds at least a 10% equity interest”. Therefore, these data covers cross-border transactions of two types: U.S. headquarter - U.S. affiliate abroad and foreign company’s affiliate in the U.S. - foreign company’s headquarter. Non-related trade, on the other hand, is defined as ”trade between parties, whether importers or exporters that have no affiliation with each other or who do not meet the relevant equity requirements”. In this paper, I use yearly data on related-parties and non-related parties imports and exports over the time period from 2002 to 2014 and document the following facts.

**Fact 1.** Intra-firm transactions are more of an import rather than an export phenomenon for U.S. multinationals.

Figure 2 shows general trends in U.S. imports (left panel) and U.S. exports (right panel) in total and by type of transactions (between related and non-related parties) over this period.

![Figure 2: U.S. imports and exports in 2002 - 2014, US$ billions](image)

The first vertical line indicates year 2008, the outburst of the recession, while the second
vertical line indicates year 2011, when there was a recovery. The figure demonstrates that intra-firm trade is more of an import rather than an export phenomenon - its contribution to total imports is almost the same as the arm’s length trade. Interestingly, after the recovery, at the times of trade slowdown (after 2011), U.S. intra-firm imports have exceeded arm’s length imports. In contrast, U.S. firms export mostly to the non-related parties abroad, and the share of intra-firm exports is less than the share of arm’s length exports.

In order to document the connection between intra-firm trade and firms’ productivity, I study intra-firm imports of intermediate goods and total exports at the industry level. Since international trade literature suggests that there is a selection of more productive firms into exporting, higher level of industrial exports would imply higher average productivity of firms in that industry.

Fact 2. Industries sourcing their inputs intra-firm more intensively export more.

I use BEA Benchmark 2002 Input-Output tables to distribute intra-firm and arm’s length trade flows among 113 manufacturing industries. I measure the intensity of intra-firm imports with the share of inputs imported to the U.S. industry from related-parties in total imports of intermediate goods to that industry. Table 1 shows the results of the regression with total industry’s export as a dependent and the share of intra-firm imports as an independent variable. Following the existing literature on the determinants of intra-firm trade flows, I also control for industry’s relative capital intensity as well as its R&I intensity. As a result, I find that intensity of intra-firm imports of intermediate goods is positively related to the industry’s export value. This results provides as a suggestive evidence of the positive link between intra-firm imports of intermediate goods and firms productivity.
<table>
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<th>(2)</th>
<th>(3)</th>
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<tbody>
<tr>
<td>ln((Imp_{rel}/Imp))</td>
<td>0.126**</td>
<td>0.228***</td>
<td>0.134**</td>
</tr>
<tr>
<td></td>
<td>(3.75)</td>
<td>(6.31)</td>
<td>(3.87)</td>
</tr>
<tr>
<td>ln(K/L)</td>
<td>0.408***</td>
<td>0.314***</td>
<td>0.329***</td>
</tr>
<tr>
<td></td>
<td>(19.84)</td>
<td>(14.91)</td>
<td>(16.25)</td>
</tr>
<tr>
<td>ln(R&amp;D/Sales)</td>
<td>0.0127</td>
<td>0.0649***</td>
<td>0.0783***</td>
</tr>
<tr>
<td></td>
<td>(1.50)</td>
<td>(7.39)</td>
<td>(9.32)</td>
</tr>
<tr>
<td>Constant</td>
<td>11.17***</td>
<td>10.55***</td>
<td>9.939***</td>
</tr>
<tr>
<td></td>
<td>(117.46)</td>
<td>(61.77)</td>
<td>(45.46)</td>
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<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Year FE</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
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<td>13</td>
<td>13</td>
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<tr>
<td>N</td>
<td>79478</td>
<td>79478</td>
<td>79478</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.020</td>
<td>0.507</td>
<td>0.516</td>
</tr>
</tbody>
</table>

\[ t \text{ statistics in parentheses} \]

* \( p < 0.05 \), ** \( p < 0.01 \), *** \( p < 0.001 \)

Table 1: Intra-firm imports and exports of U.S. industries

**Fact 3.** *Vertical FDI is associated with fixed costs.*

I use the Doing Business indicators to measure the costs of setting up business abroad and study how the probability of sourcing inputs intra-firm is affected by those costs. The Doing Business survey for each country reports the costs of setting up the business in that country (in % of GDP per capita), the time necessary to open it up (in days) and the number of required procedures. I merge these country-level characteristics with the intra-firm trade data and study whether the probability of sourcing inputs from a related party is affected by the costs of setting up the business abroad. Table 2 summarizes the results, which show that higher costs of setting up a firm in one country indeed discourage intra-firm imports from that country. This, in turn, is a suggestive evidence of the fact that final goods producers are less likely to have affiliates in countries with higher fixed costs.
Table 2: Doing Business indicators and the probability of sourcing inputs intra-firm

<table>
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<th>(1) Pr(intra)</th>
<th>(2) Pr(intra)</th>
<th>(3) Pr(intra)</th>
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<tbody>
<tr>
<td>cost</td>
<td>-0.000878**</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(0.000343)</td>
<td></td>
<td></td>
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<tr>
<td>time</td>
<td>-0.00130**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.000549)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>procedure</td>
<td>-0.0167***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.00504)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.565***</td>
<td>0.590***</td>
<td>0.685***</td>
</tr>
<tr>
<td></td>
<td>(0.0241)</td>
<td>(0.0296)</td>
<td>(0.0455)</td>
</tr>
<tr>
<td>Observations</td>
<td>488,878</td>
<td>488,878</td>
<td>488,878</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.009</td>
<td>0.009</td>
<td>0.016</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In order to explain the patterns of intra-firm imports of intermediates and rationalize the described in this section observations, I propose a novel theoretical model of vertical FDI and global sourcing strategies of firms.

4 Theoretical Model

4.1 Closed economy

Consider a closed economy populated with identical consumers with CES preferences over a continuum of varieties. This varieties are produced in the downstream sector by monopolistically competitive firms, which use intermediate goods produced in the upstream sector in production of final goods. Upstream sector consists of monopolistically competitive firms, which may or may not be related to final goods producers through common ownership. In this model, the allocation of ownership is done by final goods producers, who decide whether to integrate with the producers of inputs or not. Vertically integrated firms produce at least some of their inputs in-house, while vertically non-integrated firms outsource all their inputs production to independent upstream suppliers.

Both upstream and downstream sectors consist of heterogenous firms, which differ in their productivity. Final goods producers learn their productivities after paying fixed entry costs. Those final goods producers, who stay on the market after learning their productiv-
ity, are able to observe the marginal costs of intermediate goods producers. Based on their own productivity and the productivity of the input producers, final goods producers make their input sourcing decisions and decide which inputs to produce in-house and which of them to outsource.

This section describes the environment of this model in a greater detail and defines equilibrium in the closed economy.

\textit{A. Consumer’s Problem}

Consumers have CES preferences and maximize their utility from consumption of a continuum of differentiated varieties:

\begin{equation}
U = \left[ \int_0^1 q(\omega) \frac{\sigma-1}{\sigma} d\omega \right]^{\frac{\sigma}{\sigma-1}},
\end{equation}

where $\sigma$ is elasticity of substitution between varieties. First order condition for utility maximization implies the following demand for each variety $\omega$:

\begin{equation}
q(\omega) = \frac{P_\sigma^{\sigma-1}}{P_f(\omega)^\sigma} Y,
\end{equation}

where $Y$ is consumers income, $p_f(\omega)$ is a price of final goods variety $\omega$ and $P_f^{1-\sigma} = \int_0^1 p(\omega)^{1-\sigma} d\omega$ is a CES consumer price index.

\textit{B. Final Goods Producers Problem}

Final goods producers pay entry costs $f_e$ in order to learn their productivity $\phi$, which is drawn from cumulative distribution function $G(\phi)$. Upon entry, they face fixed production costs $F$.

There is a continuum of inputs $v \in (0, 1)$ that final goods producers use in production with CES production function and elasticity of substitution $\rho$. They source these inputs from monopolistically competitive upstream producers charging a common constant mark-ups on top of their costs. Final goods producers can decide whether to integrate with their input suppliers or purchase inputs from independent suppliers. Vertical integration with suppliers is costly - it is associated with fixed costs $F_V$, but gives access to cheaper inputs due to the elimination of the mark-ups charged by upstream firms. Importantly, vertical integration does not alter the production efficiency of input producers - they have the same marginal costs as the ones they would have had as stand-alone producers.

Therefore, after learning their productivity $\phi$, the problem of the firm is to decide which inputs to produce in-house or outsource, to purchase the optimal amount of each input, and to set prices to maximize profits.
Consider a firm with productivity \( \phi \) making its input sourcing decisions. Without loss of generally, all inputs can be arranged in order of decreasing marginal costs. Then, as it will be proven later, there exists input \( \mu \in [0, 1] \) such that inputs \([0, \mu]\) are outsourced, while inputs \([\mu, 1]\) are produced in-house (Figure 3). The reason is that under CES production function, high-cost inputs are associated with lower quantities used in production. Hence, mark-ups are applied to lower quantities, which makes outsourcing a better option relative to costly vertical integration.

Figure 3: Outsourcing and in-house production of inputs

Firm’s problem is to choose quantities \( q_O(v), v \in [0, \mu] \) and \( q_V(v'), v' \in [\mu, 1] \) as well as the extent of its vertical integration with the suppliers \( 1 - \mu \) by minimizing its costs:

\[
\frac{1}{\phi} \left[ \int_0^\mu p_O(v)q_O(v)dv + \int_\mu^1 p_V(v)q_V(v)dv \right] + (1 - \mu)F_V \tag{2}
\]

subject to \( \left[ \int_0^\mu q_O(v)\frac{v}{x}dv + \int_\mu^1 q_V(v)\frac{v-1}{x}dv \right]^{\frac{1}{x-1}} \geq q \),

where \( \mu \) is a fraction of intermediate inputs sourced from independent producers and \( q \) is determined by the demand for a variety produced by this final goods producer.

The solution of this cost-minimization problem results in the following expressions for input quantities sourced from independent suppliers \( (q_O(v)) \) and for the ones produced in-house \( (q_V(v)) \):

\[
q_V(v) = q \left( \frac{P}{p_V(v)} \right)^{\rho} \tag{3}
\]

\[
q_O(v) = q \left( \frac{P}{p_O(v)} \right)^{\rho} \tag{4}
\]

Given these equilibrium quantities of inputs, the first order condition for the level of vertical
integration \( (\mu) \) can be rearranged as:

\[
p_V(\mu)^{1-\rho} - p_O(\mu)^{1-\rho} = \frac{F_V(\rho - 1)}{P^\rho q}
\]  

(5)

Final goods producers set prices of their final goods in order to maximize their profits. Faced with monopolistic competition, they end up charging a constant mark-up \( \frac{\sigma}{\sigma - 1} \) over their marginal costs. The optimal input sourcing decision of a final goods producer imply that her total costs of production are equal to:

\[
TC(q) = \frac{1}{\phi} qP + (1 - \mu) F_V
\]

(6)

Hence, the marginal costs are simply \( \frac{1}{\phi} P \) and the price of variety \( \omega \) is \( p(\omega) = \frac{\sigma}{\sigma - 1} \frac{P}{\phi} \).

**C. Intermediate Goods Producers**

Upstream market consists of monopolistically competitive input producers, each producing one variety \( v \) from a continuum of intermediate goods using labor as the only factor of production with one-to-one technology. Intermediate goods producers are also heterogenous in their productivity \( a(v) \).

Therefore, an intermediate goods producer with productivity \( a(v) \) has marginal costs of production \( \frac{w}{a(v)} \), where \( w \) is a wage rate in the closed economy. Without loss of generality, the wage rate can be normalized to unity. Given the market structure, this intermediate goods producer, generally, would charges constant mark-up \( m = \frac{\rho}{\rho - 1} \) on top of her marginal costs \( \frac{1}{a(v)} \). However, vertical integration with the supplier allows the final goods producer to avoid paying the mark-up and thus obtain inputs at the marginal costs of their production \( \frac{1}{a(v)} \). Therefore, pricing decisions of an intermediate goods’ producer of an input \( v \) with productivity \( a \) take the following form:

\[
p_O(a(v)) = m \frac{1}{a(v)}
\]

(7)

\[
p_V(a(v)) = \frac{1}{a(v)}
\]

(8)

**D. Equilibrium in a Closed Economy**

A competitive equilibrium in a closed economy is characterized by a set of prices, organizational structure of final goods producers and allocation rules such that:

1). Consumers demand the quantities of final goods in order to maximize their utility;
2) Final goods producers choose their organizational structure and allocation of input purchases in order to minimize their total costs of production; and set prices in order to maximize their profits;
3) Intermediate goods producers set their prices in order to maximize their profits;
4) Goods and labor markets clear.

The focus of this paper is organizational choices, which final goods producers make with regards to whether to outsource inputs production or to produce them in-house. Using the pricing rules (7) and (8) in the first order condition for the extent of vertical integration (5), this can be determined as a solution of the following equation with respect to \( \mu \):

\[
\left( \frac{1}{a(\mu)} \right)^{\rho-1} = \frac{P^\rho q(1 - m^{1-\rho})}{F_V(\rho - 1)}
\]  \hspace{1cm} (9)

Since without loss of generally, all intermediate goods are arranged in order of decreasing marginal costs, the expression on the left-hand side of (9) is a decreasing function and expression on the right-hand side an increasing function of \( \mu \). The former comes from the fact that \( \left( \frac{1}{a(\mu)} \right) \) is simply an increasing transformation of marginal costs of producing the \( \mu \)-th input. The latter follows from the fact that the right-hand side expression is proportional to the aggregate price of intermediate goods \( P \) faced by final goods producers. When a firm produces more intermediate inputs in-house (\( \mu \) goes up), it cannot avoid double marginalization and thus faces higher aggregate price of intermediate goods (\( P \) goes up).

Therefore, optimal level of vertical integration is determined at the intersection of the decreasing function on the left-hand side and an increasing function on the right-hand side of Eq. (9). Graphically, the optimal level of vertical integration is depicted in Figure 4.
Intuitively, when deciding whether to outsource or produce intermediate goods in-house, firms consider how much they can save on avoiding double-marginalization. As a result, more expensive inputs are getting outsourced, because under the CES production function higher price of an input implies lower quantity and thus smaller economies on mark-ups. On the other hand, cheaper inputs are used a lot in production, which makes it crucial for a firm to produce them in-house.

Notice that the optimal organizational structure of the firm depends on the fixed costs of vertical integration - $F_V$. When these costs increase, the right-hand side of Eq. (9) decreases, which makes vertical integration a less appealing option and increases firm's outsourcing activity. Figure 5 illustrates this comparative statics exercise.
E. Firm Productivity and Vertical Integration

Since there are two production sectors in the economy (upstream input producers and downstream final goods producers), the productivity changes in both sectors will impact the observed level of vertical integration.

When the economy described in this section is undergoing non-biased technological progress in the upstream sector, all intermediate-goods producers experience a proportional cost reduction. Then, the model predicts that the final goods producers will rely more on outsourcing. As it is shown in Figure 6, this non-biased technological progress in the upstream sector will result in a downward shift of both left-hand side and right-hand side of Eq. (9). However, it can be proved that the decrease in intermediate-goods price index will dominate and lead to the expansion of outsourcing. The intuition behind this result in the following: the increased productivity of all input producers implies lower mark-up payments associated with outsourcing and thus makes outsourcing an attractive option.
The productivity of a final goods producer \( \phi \) also affects firm organizational structure through the demand on its variety affecting \( q \). Since in equilibrium, final goods market clears, \( q \) is determined from the demand for variety \( \omega \):

\[
q(\omega) = \frac{P^{\sigma-1}}{(\sigma-1)\omega(\frac{Y}{F})} \sigma Y
\]

Since more productive firms can capture higher market shares, they can enjoy larger benefits of in-house production and thus will produce more inputs in-house. Therefore, given the demand for final goods variety \( \omega \), Eq. (9) can be rewritten in the following way:

\[
\left( \frac{1}{a(\mu)} \right)^{\rho-1} = k_1 P^{p-\sigma}(\mu), \tag{10}
\]

where \( k_1 = \left( \frac{\sigma-1}{\sigma} \right) \frac{(1-m^1-\rho)P^{\sigma-1}\phi^\sigma Y}{F_Y(\rho-1)} \) summarizes the effect of mark-ups in the intermediate goods sector, elasticity of substitution, consumer price index, fixed costs, firms productivity and income on firms decisions to integrate input production.

The solution of Eq. (10) is not always internal. Depending on their productivities, firms can optimally choose not to engage in any in-house production (\( \mu = 1 \)) or to produce all input exclusively in-house (\( \mu = 0 \)). Firms opt out from vertical integration with their
suppliers if their productivity is lower than some threshold ($\tilde{\phi}_1$) and they become fully integrated with their suppliers if their productivity is higher than some other threshold ($\tilde{\phi}_0$).\footnote{$\tilde{\phi}_1 = k\frac{a(1)^{1-\rho}}{P(1)^{1-\rho}}$, $\tilde{\phi}_0 = k\frac{a(0)^{1-\rho}}{P(0)^{1-\rho}}$, where $a(1)$ and $a(0)$ are the productivity of the least and the most expensive inputs suppliers, respectively, $P(1)$ and $P(0)$ are the intermediate goods price index for outsourcing and fully integrated firms, respectively, and $k$ is a constant.}

\[ \phi^\sigma \leq \tilde{\phi}_1 \iff \mu = 1 \quad (11) \]
\[ \phi^\sigma \geq \tilde{\phi}_0 \iff \mu = 0 \quad (12) \]
\[ \tilde{\phi}_1 \leq \phi^\sigma \leq \tilde{\phi}_0 \iff \mu \in (0, 1) \quad (13) \]

Given these conditions and the fact that for $\tilde{\phi}_1 < \phi < \tilde{\phi}_0$ vertical integration with the suppliers increases in firm’s productivity, the relation between firm productivity and vertical integration can be illustrated in the following way (Figure 7):

\[ \end{align*} \]

Since more productive firms optimally choose to produce more inputs in-house, they face higher total fixed costs (fixed costs of production plus fixed costs of integration) as it is shown in Figure 8. These fixed costs are essential for firms selection into the market, which is considered next.
F. Productivity Cut-off and Vertical Integration

Following Melitz (2003) per period profits of a firm with productivity draw $\phi$ is:

$$\pi(\phi) = \frac{r(\phi)}{\sigma} - F - F_v(1 - \mu(\phi)),$$

(14)

where $r(\phi)$ is revenue of the firm with productivity draw $\phi$.

Given this profit function, the zero profit condition becomes:

$$\pi(\phi^*) = 0 \iff r(\phi^*) = \sigma(F + F_v(1 - \mu(\phi^*))),$$

(15)

Both the left-hand side and the right-hand side of the expression in (15) are increasing functions of firm productivity $\phi$. However, since $r(0) = 0$, which is less than $F$, there exist a unique solution of (15). Figure 9 illustrates how the zero cut-off productivity $\phi^*$ is determined. This cut-off productivity level means that even after choosing the profit-maximizing organizational structure, firms with productivity draws $\phi < \phi^*$ can not cover the fixed production costs and thus have to leave the market. In contrast, firms with better productivity draws $\phi \geq \phi^*$ stay on the market with the optimally chosen organizational structure. The left panel of Figure 9 depicts the situation when parameter values are such that there are only vertically integrated firms staying on the market. In this case, firms with productivity draws $\phi^* \leq \phi \leq \phi_1$ produce some of their inputs in-house while outsourcing others, whereas firms with productivities $\phi > \phi_0$ are able to produce all their inputs in-house. The right panel of Figure 9 demonstrates the situation resulting in three types of final goods producers in equilibrium. Firms with low productivity draws ($\phi^* \leq \phi \leq \phi_1$) rely exclusively on outsourcing and stay on the market, firms with productivity medium
productivity draws ($\phi^1 \leq \phi \leq \bar{\phi}_0$) rely on a mixture of outsourcing and in-house production, while the most productive firms ($\phi \geq \bar{\phi}_0$) produce all their inputs in-house. There is also another possible scenario in this model - when only vertically integrated firms can stay on the market after learning their productivity levels. However, in order to have all both outsourcing and vertical integration in equilibrium, I will further assume that the parameters are such that $\phi^* \leq \bar{\phi}_1$.

In order to see how the possibility of choosing organizational structure changes the standard cut-off condition, first, consider the zero profit condition in the absence of in-house production of intermediate goods:

$$\pi(\phi^*_O) = 0 \iff r(\phi^*_O) = \sigma F,$$

where $\phi^*_O$ is the cut-off productivity of outsourcing firms. The average productivity of these firms can be expressed as:

$$\bar{\phi}_O = \left[ \int_0^{+\infty} \left( \frac{\phi}{F(1)} \right)^{\sigma-1} g_C d\phi \right]^\frac{1}{\sigma-1},$$

where $g_C$ is a conditional probability density function of firm-productivity levels, and $P(1)$ denotes the aggregate price index of intermediate goods produced by independent suppliers.

The average profits of firms is the same as the profit of the firm with average productivity:

$$\bar{\pi} = \pi(\bar{\phi}_O) = \frac{r(\bar{\phi}_O)}{\sigma} - F$$

Using the zero profit condition (16), this expression can be rearranged in the following way:

$$\bar{\pi} = F \left( \frac{r(\bar{\phi}_O)}{r(\phi^*_O)} - 1 \right)$$
As in Melitz (2003), the ratio of revenues is a function of the ratio of productivities:

\[
\frac{r(\bar{\varphi}_O)}{r(\bar{\varphi}^*_O)} = \left( \frac{\bar{\varphi}_O}{\bar{\varphi}^*_O} \right)^{\sigma-1}
\]

(19)

Combining this relationship with the expression for the average profits, one can obtain the following zero-cutoff profit condition:

\[
\bar{\pi} = F \left( \left( \frac{\bar{\varphi}_O}{\bar{\varphi}^*_O} \right)^{\sigma-1} - 1 \right)
\]

(20)

On the other hand, free entry requires that the total expected value of profits is equal to the fixed costs of entry \( f_e \):

\[
G(\bar{\varphi}_O)0 + (1 - G(\bar{\varphi}_O))^{\bar{\pi}} = f_e
\]

Therefore, free entry condition implies the following relation between average profits and the cut-off productivity:

\[
\bar{\pi} = \frac{\delta f_e}{1 - G(\bar{\varphi}_O)}
\]

(21)

As in Melitz (2003), the free entry condition describes a positive relationship between \( \bar{\pi} \) and \( \bar{\varphi}^*_O \) - the higher the cutoff productivity level, the higher the average profits of surviving firms. However, the zero cutoff profit (ZCP) condition (16) is not necessarily downward sloping - its slope depends on the distribution of productivity draws. In particular, it depends on whether \( \bar{\varphi}_O \) or \( \bar{\varphi}^*_O \) increases relatively faster. Under the same assumptions as in Melitz (2003), there is a negative relationship between \( \bar{\pi} \) and \( \bar{\varphi}^*_O \) associated with ZCP. Then the equilibrium can be represented graphically as in Figure 10, where ZCP and FE curves determine the cut-off productivity \( \bar{\varphi}^*_O \) of surviving firms.

Turning to the economy where vertical integration of final goods producers is allowed, the average productivity is defined as:

\[
\tilde{\varphi} = \left[ \int_0^\infty \left( \frac{\phi}{P(\phi)} \right)^{\sigma-1} g_C d\phi \right]^{\frac{1}{\sigma-1}}
\]

The average firms productivity in this case is different from the one in Melitz (2003), because it features intermediate goods sector and allows for the possibility of vertical integration between final goods producers and their input suppliers. Since intermediate goods are used as an input in the production of final goods, the observed productivity of final goods producers depend on two factors: their "raw" productivity \( \phi \) and aggregate price of intermediate goods \( P \) that they buy. The higher this aggregate price, the lower
the observed productivity of a final goods producer. The aggregate price of intermediate goods faced by a firm depends on the extent to which this firm is vertically integrated with its suppliers: if it produces all its inputs in-house, it does not pay mark-ups on any inputs and thus faces a lower aggregate price of intermediate goods. Since organizational choice in this model is endogenous, and, as it was shown above, depends on firm’s raw productivity $\phi$, then the aggregate price of intermediate goods also depends on $\phi$. In particular, firms with higher productivity draw $\phi$ produce more intermediate inputs in-house and thus face lower aggregate price of intermediate goods, which makes its observed productivity even larger.

![Figure 10: Closed economy equilibrium with outsourcing](image)

The average profits $\bar{\pi}$ are thus equal to:

$$\bar{\pi} = \pi(\tilde{\phi}) = \frac{r(\tilde{\phi})}{\sigma} - F - (1 - \mu(\tilde{\phi}))F_V$$

(22)

Note that under the assumption that $\phi^* \leq \bar{\phi}_1$, the zero profit condition is simply

$$\pi(\phi^*) = 0 \iff r(\phi^*) = \sigma F$$

(23)

Using this condition, average profits can be rearranged to obtain:

$$\bar{\pi} = F\left(\frac{r(\bar{\phi})}{r(\phi^*)} - 1\right) - (1 - \mu(\tilde{\phi}))F_V$$
Plugging in the expression for the ratio of revenues, one can obtain the following zero cut-off profit condition:

\[
\bar{\pi} = F\left(\left(\frac{\tilde{\phi}(\phi^*)/P(\tilde{\phi}(\phi^*))}{\tilde{\phi}^*/P(1)}\right)^{-1} - 1\right) - (1 - \mu(\tilde{\phi}(\phi^*)))F_V
\]

Comparing Eq. (20) and Eq. (24), one can see that, on the one hand, fixed costs of vertical integration \(F_V\) push the average profits downwards relative to the case when in-house production is not possible. But on the other hand, when in-house production is possible, the aggregate price index of intermediate goods is lower \((\frac{P(1)}{P(\tilde{\phi}(\phi^*))} \geq 1)\) and hence operating profits are higher.

The free entry condition is the same as in the case with no possibility of in-house production:

\[
\bar{\pi} = \frac{\delta f_e}{1 - G(\phi^*)}
\]

In equilibrium, the possibility of in-house production can both increase and decrease the cut-off productivity compared to the one when outsourcing is the only option. On the one hand, in-house production makes some firms more productive by increasing their operational profits, but on the other hand, these firms have to pay fixed costs of in-house production, which puts downward pressure on their profits. If the former force dominates the latter, then the possibility of in-house production forces more firms to exit and reallocates resource to the more productive firms. This equilibrium is depicted in Figure 11 (left panel). In contrast, if the fixed costs force dominates, more firms can stay on the market and the cut-off productivity goes down. This equilibrium is shown in the right panel of Figure 11.
4.2 Open Economy

Now consider final goods producers making their input sourcing decisions in a world with \( N \) countries denoted by \( i = 1, 2, \ldots, N \). Each country has environment identical to the one described above: there is a continuum of final goods producers, who use a continuum of intermediate goods in production and can decide which of them to produce in-house and which of them to outsource to independent suppliers. However, now trade flows of intermediate goods across borders are subject to iceberg trade costs. This implies that input variety \( v \) produced in country \( i \) and used in final goods production in country \( j \) is associated with marginal costs \( \tau_{ij} w_i a_i(v) \), where \( \tau_{ij} \) are iceberg trade costs and \( w_i \) is the wage rate in country \( i \). Labor is not mobile across countries, which means that wages may differ across countries and thus become a source of their comparative advantage.

Intermediate goods producers have country-specific productivity \( a_j(v) \) of producing each variety \( v \). Final goods producers in each country draw their productivity levels \( \phi \) from a country-specific distribution \( G(\phi) \).

For input sourcing decisions that final goods producers make, it is only the minimum-cost suppliers of each input that are relevant. If for country \( i \)’s final goods producer, the minimum-cost supplier of input \( v \) is located in some other country, its price will be denoted by \( p^*_i(v) = \min_{j \neq i} \{p_{ji}(v)\} \). On the other hand, if it is cheapest to source input \( i \) domestically, I will denote the price of that input by \( p_i(v) \). Therefore, the cost of using input \( v \) in production for a final goods producer located in country \( i \) is

\[
\begin{align*}
    c_i(v) & \equiv \min \{p_i(v), p^*_i(v)\}
\end{align*}
\]

Given these input prices and their own productivity draws, final goods producers make their global input sourcing decisions along two dimensions - geography and ownership over their suppliers. Figure 12 summarizes the four options available to them: domestic outsourcing, domestic in-house production, offshore-outsourcing and vertical foreign direct investment.

Intuitively, when deciding on the geography of their sourcing strategies, firms trade off lower transportation costs of domestic sourcing with potentially lower variable costs of production abroad. When deciding on the ownership structure along the value chain, firms trade off the elimination of mark-ups charged by intermediate goods producers in case of vertical integration with fixed costs of merging the businesses.

Before drawing their productivities, final goods producers pay fixed entry costs \( f_e \), but after learning their productivity they face two types of fixed costs. First, firms employing domestic sourcing strategies (domestic in-house production or domestic outsourcing) have fixed production costs \( F \), while firms considering global sourcing strategies (vertical FDI
and offshore-outsourcing) face fixed costs $F^* > F$. Fixed costs $F^*$ of global sourcing are higher than domestic fixed production costs $F$, because they include the costs of acquiring information about foreign markets on top of the fixed production costs. This interpretation of fixed costs $F^*$ is in line with international trade literature documenting the existence and importance of fixed costs of importing (Antras et al (2015), Halpern et al (2013)).

Second, final goods producers engaged in in-house production, are subject to the fixed costs of vertical integration $F_V$, regardless of the country where they wish to acquire their suppliers. Figure 12 offers a summary of the relationship between fixed costs and firms input sourcing strategies.

![Figure 12: Matrix of Sourcing Strategies of Multinational Firms](image)

In the next subsection, I set up the final goods producers cost minimization problem, when they can source their inputs globally and invest in vertical FDI throughout the world.

**A. Final Goods Producers’ Problem**

In open economy, without loss of generality, all intermediate goods $v \in [0, 1]$ can be arranged in order of decreasing marginal costs $c_i(v)$. It will be shown later, that there is input $\mu_i(\phi) \in [0, 1]$ such that country $i$’s final goods producer with productivity $\phi$ outsources the production of inputs $[0, \mu_i(\phi)]$ and produces the rest inputs $[\mu_i(\phi), 1]$ in-house. The proof is provided below.
Final goods producers take the costs of in-house production and outsourcing of intermediate inputs as given. These costs as faced by final goods producers in country $i$ can be expressed as:

$$c_{O_i}(v) \equiv \min \{p_{O_i}(v), p^*_O(v)\} \quad (26)$$

$$c_{V_i}(v) \equiv \min \{p_{V_i}(v), p^*_V(v)\}, \quad (27)$$

with subscript $O$ denoting outsourcing and subscript $V$ denoting vertical integration and further in-house production of inputs.

Therefore, a final goods producer in country $i$ with productivity draw $\phi$ solve the following cost minimization problem:

$$\min \frac{1}{\phi} \left[ \int_0^\mu c_{O_i}(v)q_{O_i}(v)dv + \int_\mu^1 c_{V_i}(v)q_{V_i}(v)dv \right] + (1 - \mu_i)F_V \quad (28)$$

subject to

$$\left[ \int_0^\mu q_{O_i}(v)\frac{\rho-1}{\rho} dv + \int_\mu^1 q_{V_i}(v)\frac{\rho-1}{\rho} dv \right]^{\frac{\mu}{\rho}} \geq q$$

The solution to this problem is similar to the one obtained for the closed economy. The optimal quantities of outsourced inputs $q_{O_i}(v)$ and inputs produced in-house $q_{V_i}(v)$, as well as the ownership structure $1 - \mu_i$ are determined by the following equations:

$$q_{O_i}(v) = q_i(\omega) \left( \frac{P_i}{c_{O_i}(v)} \right)^\rho \quad (29)$$

$$q_{V_i}(v) = q_i(\omega) \left( \frac{P_i}{c_{V_i}(v)} \right)^\rho \quad (30)$$

$$c_{V_i}(\mu)^{1-\rho} - c_{O_i}(\mu)^{1-\rho} = \frac{F_V(\rho - 1)q_i(\omega)}{P_i^\rho}, \quad (31)$$

where $P_i = \left( \int_0^\mu c_{O_i}(v)^{1-\rho}dv + \int_\mu^1 c_{V_i}(v)^{1-\rho}dv \right)^{\frac{1}{1-\rho}}$ is a CES price index of intermediate goods, and $q_i(\omega)$ is a demand for final goods variety $\omega$ in country $i$. The latter can be derived from the CES preferences of consumers given that final goods are not tradeable in this economy:

$$q_i(\omega) = \left( \frac{\sigma-1}{\sigma} \right)^\sigma \frac{P_i^{\sigma-1}Y_i^{\rho\sigma}}{P_i^\rho}$$

Using this in (31), firm’s decision on organization of its inputs production can be rewritten as:

$$c_{V_i}(\mu)^{1-\rho} - c_{O_i}(\mu)^{1-\rho} = k_i \frac{1}{P_i^{\rho-\sigma}Y_i^{\sigma}}, \quad (32)$$

where $k_i \equiv \frac{F_V(\rho - 1)}{P_i^{\frac{\sigma - 1}{\sigma}}Y_i^{\sigma}}$ is a country $i$-specific constant.
B. Intermediate Goods Producers’ Problem

Intermediate goods producer of input $v$ from country $j$ with productivity $a_j(v)$ has marginal costs of production $\frac{w_j}{a_j(v)}$. The price she charged to a non-related manufacturer with productivity $\phi$ in country $i$ includes mark-up $m$ as well as iceberg trade costs $\tau_{ji} > 1 \quad \forall i \neq j$. However, if this intermediate goods producer is vertically integrated with a manufacturer with productivity $\phi$ in country $i$, she charges the manufacturer only marginal costs, including iceberg trade costs. Therefore, the pricing rule of a supplier from country $j$ shipping her goods to a manufacturer in country $j$ is:

$$p_{O_{ji}} = m \frac{w_j \tau_{ji}}{a_j(v)} \quad \forall v \in (0, \mu_i(\phi))$$ (33)

$$p_{V_{ji}} = \frac{w_j \tau_{ji}}{a_j(v')} \quad \forall v' \in (\mu_i(\phi), 1)$$ (34)

The price of the minimum-cost independent supplier of input $v$ for a manufacturer in country $i$ is equal to:

$$c_{O_i} = \min \left\{ m \frac{w^* \tau_{si}}{a_s(v)} , \frac{w_i}{a_i(v)} \right\} = m \min \left\{ \frac{w^* \tau_{si}}{a_s(v)} , \frac{w_i}{a_i(v)} \right\} ,$$ (35)

where $(*)$ denotes the minimum-cost foreign independent supplier: $m \frac{w^* \tau_{si}}{a_s(v)} = \min_{j \neq i} \left\{ m \frac{w_j \tau_{ji}}{a_j(v)} \right\}$.

The price of the minimum-cost in-house supplier of input $v$ for a manufacturer in country $i$ can be analogously expressed as:

$$c_{O_i} = \min \left\{ \frac{w^* \tau_{si}}{a_s(v)} \cdot \frac{w_i}{a_i(v)} \right\}$$ (36)

Final goods producers observe these prices and then make their input sourcing decisions in order to minimize their costs as described in (28).

C. Equilibrium in an Open Economy

Open economy equilibrium is formally described in the same way as the closed economy equilibrium. Given the intermediate goods prices, a final goods producer with productivity $\phi$ from country $i$ decides to produce $1 - \mu_i(\phi)$ inputs in-house, with $\mu_i(\phi)$ being a solution of the following equation:

$$c_{V_i}(\mu_i)^{\rho-1} = k_1, P_i(\mu_i)^{\rho-\sigma} \phi^{\sigma}$$ (37)

where $k_{1i}$ is an inverse of $k_i$ defined above and analogous to $k_1$ is case of closed economy.
Arraying intermediate goods in the order from the most to the least expensive ones, the left-hand side of Eq. (37) becomes a decreasing function of $\mu_i$. On the other hand, intermediate goods price index $P_i(\mu_i)$ is an increasing function of $\mu_i$, because outsourcing is associated with higher input prices due to the mark-ups. Assuming that the intermediate goods are more substitutable than final goods ($\rho - \sigma > 0$), the right-hand side of Eq. (37) becomes an increasing function of $\mu_i$. Therefore, the solution to Eq. (37) exists and is unique. Notice that much like in the closed economy scenario, the optimal level of vertical integration $(1 - \mu_i)$ increases as country $i$ final goods producer becomes more productive.

Per period profits of a final goods producer with productivity $\phi$, located in country $i$ and sourcing inputs globally is:

$$\pi_i(\phi) = \frac{r_i(\phi)}{\sigma} - F^* - F_V (1 - \mu_i(\phi)),$$

(38)

where $r_i(\phi)$ is the firm’s revenue. Therefore, the zero profit condition can be expressed as:

$$\pi_i(\phi^*_i) = 0 \iff r_i(\phi^*_i) = \sigma (F^* + F_V (1 - \mu_i(\phi^*_i))),$$

where $\phi^*_i$ is a minimal productivity for final goods producers in country $i$ to start sourcing inputs from abroad. Figure 13 shows how this productivity level is determined.

Firms with productivity levels $\phi \geq \phi^*_i$ stay on the market and either import their inputs from foreign suppliers or engage in vertical FDI. In order to have both importers and vertical FDI in equilibrium, I assume that the parameters are such that firms with cut-off productivity rely exclusively on imported inputs. Under this assumption on the parameters, the zero profit condition becomes:
\[ \pi_i(\phi^*_i) = 0 \iff r_i(\phi^*_i) = \sigma F^* \]

Comparing this zero profit condition to the one in Eq. (23) for firms sourcing inputs only domestically, the following relationship can be derived:

\[ \frac{r_i(\phi^*_i)}{r(\phi^*)} = \frac{F^*}{F} \]  \hspace{1cm} (39)

Given that the ratio of revenue is a function of firms’ productivity, the above relationship can be rearrange to obtain:

\[ \left( \frac{\phi^*_i / P(\phi^*_i)}{\phi^*/ P(\phi^*)} \right)^{\sigma-1} = \frac{F^*}{F}, \]  \hspace{1cm} (40)

where \(P(\phi^*_i)\) and \(P(\phi^*)\) are the intermediate goods prices indexes faced by the firm with the cut-off productivity level, participating and not participating in global sourcing, respectively.

Note that in order to have firms outsourcing inputs to the domestic suppliers and in-house domestic production, the parameters were assumed to be such that at the cut-off level of productivity \(\phi^*\) firms can only outsource their inputs. Therefore, \(P(\phi^*_i) = P_i(1), \quad P(\phi^*) = P(1)\) with \(P_i(1) \leq P(1)\). Then Eq. (40) becomes:

\[ \left( \frac{\phi^*_i}{\phi^*} \right)^{\sigma-1} = \left( \frac{P_i(1)}{P(1)} \right)^{\sigma-1} \frac{F^*}{F} \]  \hspace{1cm} (41)

If fixed costs \(F^*\) are large enough\(^2\), it is true that \(\phi^*_i > \phi^*\). Therefore, firms that engage in global sourcing have to be more productive than the ones sourcing inputs locally.

Figure 14 shows how the availability of different sourcing strategies depicted in Figure 12 is related to firm’s productivity. The ordering of in-house production and offshore-outsourcing depends on the relative sizes of in-house production costs \(F + F_V\) and the fixed costs of importing \(F^*\). The figure shows the case when \(F^* < F + F_V\). In case, when the reverse is true and \(F + F_V < F^*\), then offshore-outsourcing will be available to firms with higher productivity than those, which can afford in-house production.

\(^2\)The precise condition for this is \(F^* > F \left( \frac{P_i(1)}{P(1)} \right)^{\sigma-1} \) where \(P(1)\) and \(P_i(1)\) are, respectively, closed economy and open economy price indices of outsourcing.
Therefore, since only more productive firms can afford paying higher fixed costs due to import and fixed costs of vertical integration, the model predicts firms selection into importing and vertical FDI. Next subsection summarizes how this, in turn, impacts the zero cut-off profit condition.

**D. The Impact of Trade and Vertical FDI on Cut-off Productivity**

The free entry condition in the open economy remains unchanged relative to the one in the closed economy case:

\[
\bar{\pi}_i = \frac{\delta f_e}{1 - G(\phi^*)}
\]  

(42)

The only difference is that average profits now reflect the fact that firms can source inputs globally:

\[
\bar{\pi}_i = \pi(\tilde{\phi}) + p_i \pi_i(\tilde{\phi}_i),
\]

where \( p_i = \frac{1 - G(\phi^*)}{1 - G(\phi^*)} \) is the probability of importing inputs conditional on successful entry, \( \pi(\phi) \) is profits of a domestically sourcing firm and \( \pi_i(\phi) \) is profits of a globally sourcing firm.

From Eq. (40), \( \phi^*_i = \phi^* \left( \frac{F^*}{F} \right) \left( \frac{\pi}{\phi} \right) \). Using this in the definition of the open economy average profits, \( \bar{\pi} \) can be rearranged as a function of \( \phi^* \) to obtain the zero cut-off profit condition:

\[
\bar{\pi} = F \left( \frac{\phi(\phi^*)/P(\tilde{\phi}(\phi^*))}{\phi^*/P(1)} \right)^{\sigma-1} - 1 \right) - (1 - \mu(\tilde{\phi}(\phi^*)))F_V +
\]

\[
p_i F^* \left( \frac{\phi_i(\phi^*)}{\phi_i^*} \right)^{\sigma-1} - 1 \right) - p_i (1 - \mu(\tilde{\phi}_i(\phi^*_i)) F_V)
\]

Figure 14: Firms productivity and sourcing strategies
Figure 15 demonstrates graphically that trade and FDI liberalization increases the cut-off productivity level of the surviving firms.

Intuitively, it happens because globally engaged firms obtain access to cheaper inputs abroad and thus become even more productive, while firms relying on domestic inputs can not resist competition and are thus are forced to leave the market. Therefore, trade and vertical FDI induce the reallocation of resources from less to more productive firms.

5 Conclusions

In this paper I proposed a trade model of vertical FDI and global sourcing by multinational firms. Using the U.S. Census Bureau’s data on the activities of U.S. multinationals, I first document the importance of intra-firm trade of intermediate goods, especially so for imports of inputs in the U.S. Then I offer suggestive evidence on the effect that intra-firm imports of intermediate goods can have on exports at the industry level. I argue that this effect can be explained by the selection of firms into vertical FDI, which further increases firms productivity. I support this argument with a novel theoretical model, which views FDI and importing as two substitutable sourcing strategies of firms.

This multi-country model of trade in intermediate goods features two vertically related industries populated by heterogeneous firms. Final goods producers face fixed costs of
importing and fixed costs of vertical integration with their suppliers. As a result, the model shows that ownership over input suppliers magnifies any exogenous differences in firms productivity and thus affects their endogenous outcomes, such as prices and sales. I show that trade and FDI liberalization leads to intra-industry reallocation of resources - from less productive domestically sourcing firms to more productive ones sourcing their inputs globally.

The proposed framework allows to study the determinants of intra-firm trade between countries and quantify the effects of trade liberalization or increased protectionism on both intra-firm and arm’s length trade.
References


