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Export-Platform FDI: Cannibalization or Complementarity?†

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The dominant branch of the economics literature on multinational enterprises (MNEs) treats their final-good production location choices as substitutes. In these models, global firms face a "proximity-concentration trade-off" in which their plant-location decisions depend on the cost of production in each country, the size of trade costs between production and consumption locations, and the benefits of concentrating production in fewer locations to reduce fixed overhead costs (Markusen 1984; Helpman, Melitz, and Yeaple 2004; Tintelnot 2017). In these settings, improvements in one country's productivity generate cannibalization effects that reduce the profitability of operating affiliates in other countries.

Recent empirical work, however, suggests that MNEs' plant locations may not always be substitutes. Garetto, Oldenski, and Ramondo (2019) find that US MNEs' affiliate sales in certain countries are *unaffected* by their affiliate activities in other countries. Using newly merged data on US firms' trade and multinational activity by country, Antràs et al. (forthcoming) show that US MNEs are not only more likely to export to countries in which they have affiliates but also to other countries that are proximate to those affiliates, a fact that is hard to square with canonical "export-platform" FDI models.

This paper provides conditions under which a model of export-platform FDI generates complementarities rather than cannibalization effects across MNEs' production locations. We first develop a baseline model similar to Tintelnot (2017) in which final goods are produced only with labor and there are no fixed costs to export. Perhaps surprisingly, this model does *not* necessarily generate cannibalization effects. We derive a simple condition that determines whether an MNE's plants are substitutes or complements. This condition is shaped by the relative size of (i) the *cross-firm* elasticity of demand the MNE faces for its goods and (ii) the *within-firm* elasticity of labor substitution across the MNE's plants.

Having developed this baseline model, we introduce destination-specific fixed costs of exporting that are incurred at the *firm level* and show that this extension expands the range of parameter values for which the model delivers complementarity across MNEs' production locations. Finally, we introduce tradable intermediate inputs and show that whenever global sourcing entails firm-by-country-specific fixed costs of sourcing shared across all of the MNE's plants, the range of parameter values for which assembly location decisions are complements is again expanded.

I. A Model of Export-Platform FDI

We begin by developing a simple multicountry model of export-platform FDI similar to Tintelnot (2017).

A. *Environment and Preferences*

We consider a world in which individuals in J countries consume differentiated manufactured goods produced by heterogeneous firms using labor. Although each firm produces a single good, we assume that this firm's good is differentiated based on its production country and that the same firm may produce in multiple countries.

We index firms by φ and varieties within firms by k. Given our Armington assumption, k also corresponds to an index for production locations. We assume a nested CES structure in which the degree of substitutability across varieties produced by different firms may differ from the degree of substitutability across varieties

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produced by different plants of the same firm. More formally, preferences are represented by

$$(1) \qquad U_{Mi} = \left[\int_{\varphi\in\Omega_i} \mathbf{q}_i(\varphi)^{\frac{\sigma-1}{\sigma}} d\varphi\right]^{\frac{\sigma}{\sigma-1}},$$

where Ω_i is the endogenous measure of firms selling differentiated goods in country i and the firm-specific composite $\mathbf{q}_i(\varphi)$ is

$$(2) \qquad \mathbf{q}_i(\varphi) = \left[\sum_{k\in\mathcal{K}(\varphi)} q_i(\varphi,k)^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}.$$

The set $\mathcal{K}(\varphi) \subseteq J$ includes the assembly locations from which firm φ sells varieties.

The parameter σ governs the *cross-firm* elasticity of demand for a firm's bundle of products. Our Armington assumption introduces an additional parameter ε controlling *within-firm* factor substitutability across a firm's various active plants. Because labor is the only factor of production, ε also governs the elasticity of labor substitution within an MNE. In Section II, we extend our results to a more general setting, which encompasses cases with *no* product differentiation by country of production.

It is straightforward to show that the above preferences imply that consumers in country i spend an amount

$$(3) \quad S_{ki}(\varphi) = \left[\frac{p_i(\varphi,k)}{\mathbf{p}_i(\varphi)}\right]^{1-\varepsilon}\left[\frac{\mathbf{p}_i(\varphi)}{P_i}\right]^{1-\sigma} E_i$$

of their income on variety k produced by firm φ. In this expression, $p_i(\varphi,k)$ is the price charged for that variety k, $\mathbf{p}_i(\varphi)$ is the overall price index for varieties sold by firm φ, and P_i is the economy-wide ideal price index in country i (see the online Appendix for formal definitions). E_i is total spending on manufactured goods in country $i \in J$.

B. *Manufacturing Production*

Manufactured varieties are produced under increasing returns to scale and monopolistic competition. The variable φ used to index final-good firms also corresponds to their "core" productivity, which firms only learn after incurring a fixed cost of entry.

After paying this fixed cost, each firm acquires blueprints to produce varieties of a final good. Although the firm could produce its varieties anywhere in the world, we assume that opening an assembly plant in a given country $k \in J$ entails a fixed overhead cost equal to f_k^a units of labor in country k. In equilibrium, firms therefore open a limited number of assembly plants (possibly a single one). We denote the optimal set of countries $k \in J$ for which firm φ has paid the associated fixed cost of assembly by $\mathcal{K}(\varphi) \subseteq J$ and refer to it as the firm's *global assembly strategy*.

For the time being, we assume that production of final-good varieties requires only local labor. The cost at which a firm can manufacture in each location k is shaped by its core productivity φ, by firm-location-specific wages w_k (which the firm takes as given), and by a firm-location-specific productivity parameter Z_k^a. Shipping final goods from country k to country i also entails variable (iceberg) trade costs τ_{ki}^a. For now, we abstract from fixed costs of exporting.

C. *Interdependencies in the Intensive Margin*

The model delivers a simple, closed-form solution for sales of an assembly plant in k to each market i (see the online Appendix):

$$(4) \qquad S_{ki}(\varphi) = \kappa\varphi^{\sigma-1}\xi_k^a\left(\tau_{ki}^a\right)^{1-\varepsilon} \times \left[\Psi_i(\varphi)\right]^{\frac{\sigma-\varepsilon}{\varepsilon-1}} P_i^{\sigma-1} E_i,$$

where κ is a constant, $\xi_k^a \equiv \left(w_k/Z_k^a\right)^{1-\varepsilon}$ captures plant k's *assembly potential*, and Ψ_i is given by

$$(5) \qquad \Psi_i(\varphi) \equiv \sum_{k'\in J} \mathcal{I}_{k'}^a \cdot \xi_{k'}^a\left(\tau_{k'i}^a\right)^{1-\varepsilon},$$

with $\mathcal{I}_{k'}^a$ taking a value of one when $k' \in \mathcal{K}(\varphi)$ and a value of zero otherwise. Although both $\mathcal{I}_k^a$ and ξ_k^a are firm-specific variables, we omit their dependence on φ to make the notation less cumbersome.

Holding the firm's global assembly strategy fixed, equation (4) indicates that an idiosyncratic increase in plant k's assembly potential ξ_k^a naturally raises sales of this plant k to all countries $i \in J$.

Whether changes in ξ_k^a generate positive or negative effects on the sales to country i of plants based in *other* countries $k' \neq k$ is less clear cut and depends on the relative size of σ and ε. When the cross-firm elasticity of demand for goods is low relative to the degree of within-firm labor substitution across plants (i.e., $\sigma < \varepsilon$), cannibalization effects dominate and the sales of a particular plant k' of firm φ are decreased by efficiency improvements in its other plants. Conversely, when the cross-firm demand elasticity is high relative to the degree of within-firm labor substitution across plants ($\sigma > \varepsilon$), complementarity effects dominate and improvements in plant k's efficiency in serving market i also increase the sales of other plants k' in i.

Intuitively, a lower price of variety k' reduces the share of sales of plant k, but it also reduces the firm-level price index $\mathbf{p}_i(\varphi)$, and this shifts spending away from other firms and toward the goods produced by firm φ in all of its locations. If consumers' price sensitivity to $\mathbf{p}_i(\varphi)$ is greater than the elasticity of labor substitution within the firm ($\sigma > \varepsilon$), the latter effect dominates the former.

D. *Interdependencies in the Extensive Margin*

We now analyze the optimal set of countries in which a firm locates final-good assembly plants (i.e., its global assembly strategy $\mathcal{K}(\varphi) \subseteq J$). Starting from equation (4), using the optimal constant markup rule (see the online Appendix) and aggregating across export platforms and their destination markets, firm profits (net of the initial entry cost) can be expressed as

$$(6) \quad \pi(\varphi) = \kappa_\pi \varphi^{\sigma-1} \sum_{i \in J} \left[\Psi_i(\varphi)\right]^{\frac{\sigma-1}{\varepsilon-1}} P_i^{\sigma-1} E_i - \sum_{k \in J} \mathcal{I}_k^a \cdot w_k f_k^a,$$

where κ_π is a constant and $\Psi_i(\varphi)$ is defined in (5). Solving for the set $\mathcal{K}(\varphi)$ that maximizes equation (6) is a combinatorial problem, but regardless of its specific solution, we can characterize whether the firm's global assembly location decisions are complements or substitutes.

To build intuition, note that whenever the (cross-firm) elasticity of demand for the MNE's goods is low relative to the elasticity of within-firm labor substitution across the MNE's plants, the profitability of setting up an export platform in country k is reduced by the existence of assembly plants in other locations $k' \neq k$ because these other assembly plants cannibalize on plant k's sales (as shown in equation (4)). Similarly, setting up a new plant in k is less desirable because this new plant would cannibalize sales from existing plants in other locations. These are canonical features of export-platform FDI models; however, equation (6) demonstrates that when within-firm labor substitution is low, the opposite may be true, and extensive margin assembly decisions are complements.

Formally, we consider an idiosyncratic increase from ξ_k^a to $\hat{\xi}_k^a > \xi_k^a$ in a given plant k's assembly potential. Denote the optimal assembly decisions under ξ_k^a and $\hat{\xi}_k^a$ by $\mathcal{I}^a = (\mathcal{I}_1^a, \ldots, \mathcal{I}_J^a)$ and $\hat{\mathcal{I}}^a = (\hat{\mathcal{I}}_1^a, \ldots, \hat{\mathcal{I}}_J^a)$, respectively. Denote by X_{-k} the vector X excluding element k. For vectors X and Y, we say that $X \geq Y$ if $X_i \geq Y_i$ for all i, and $X > Y$ if $X \geq Y$ and $X_j > Y_j$ for some j. Given this notation, we prove the following in the online Appendix:

PROPOSITION 1: *An increase in the assembly potential of a given plant k from ξ_k^a to $\hat{\xi}_k^a > \xi_k^a$ leads to $\hat{\mathcal{I}}^a \geq \mathcal{I}^a$ whenever $\varepsilon \leq \sigma$, but it would not lead to $\hat{\mathcal{I}}_{-k}^a > \mathcal{I}_{-k}^a$ whenever $\varepsilon > \sigma$ and $\mathcal{I}^a$ is a unique solution.*

In sum, whenever $\varepsilon > \sigma$, this baseline model cannot feature complementarities in the extensive margin of global assembly.

II. Beyond Armington

The assumption that goods are differentiated based on their country of production might be unpalatable. If instead MNEs produced a single homogeneous good, its various candidate locations would be perfect substitutes and cannibalization effects would always dominate. Nevertheless, the vast majority of MNEs are multiproduct firms, and a nontrivial part of their operational decisions relate to the optimal allocation of products to plants, taking into account each plant's productivity in the production of the firm's various goods and their relative distance to consumers.

In the online Appendix, we build on Tintelnot (2017) and develop a version of our model in which goods are *not* differentiated based on where they are produced. Instead, productivity heterogeneity across a continuum of goods generates a well-defined (and interior) allocation of products to plants. When such productivity dispersion follows a Fréchet distribution with shape parameter θ, we obtain an isomorphic set of equilibrium equations (4)–(6) with θ replacing $\varepsilon - 1$ throughout. In such a case, the Fréchet parameter θ governs the substitutability of labor across an MNE's plants.

Even without imposing a Fréchet distribution of productivity, we show in the online Appendix that whether assembly plants are substitutes or complements depends on the relative size of the elasticity of demand for the MNE's goods and the (Allen) *within-firm* elasticity of substitution of labor across the MNE's active plants.[1]

III. Export-Platform FDI Model with Firm-Level Export Costs

We now assume that firms incur fixed marketing costs of f_i^x units of labor in country i to sell their varieties in country i. We use the superscript x to denote these fixed costs and assume that they are incurred at the firm level rather than the plant level. Crucially, when a firm pays the fixed marketing cost to sell in country i, *all* of its assembly plants may access that market. This assumption aligns well with the fact that multinational firms often centralize their sales and marketing decisions in a specialized division. We denote the optimal set of countries $i \in J$ for which a firm with productivity φ has paid the associated fixed cost of marketing by $\Upsilon(\varphi) \subseteq J$ and refer to it as the firm's *global marketing strategy*.

It should be clear that these firm-level fixed costs to export have no bearing on equation (4) capturing sales of an assembly plant in k to each market i, except that the equation now only applies to destination markets i in the *firm*'s global marketing strategy (i.e., $i \in \Upsilon(\varphi)$). Holding the firm's extensive-margin strategies constant, whether an idiosyncratic increase in the assembly potential ξ_k^a of plant k increases or decreases sales of plants based in $k' \neq k$ continues to depend only on the relative size of σ and ε, with $\varepsilon > \sigma$ leading to cannibalization and $\varepsilon < \sigma$ leading to complementarity.

Profits net of entry costs are also given by an expression almost identical to that in equation (6), namely

$$(7)\ \pi(\varphi) = \kappa_\pi \varphi^{\sigma-1} \sum_{i \in J} \mathcal{I}_i^x \cdot \left[\Psi_i(\varphi)\right]^{\frac{\sigma-1}{\varepsilon-1}} P_i^{\sigma-1} E_i - \sum_{i \in J} \mathcal{I}_i^x \cdot w_i f_i^x - \sum_{k \in J} \mathcal{I}_k^a \cdot w_k f_k^a.$$

Despite these strong similarities with our starting model of export-platform FDI, the presence of firm-level fixed costs of exporting carries important implications for the nature of the interdependencies across the assembly plants of a firm. More specifically, denote by $\mathcal{I}^x$ and $\hat{\mathcal{I}}^x$ the optimal exporting decisions under ξ_k^a and $\hat{\xi}_k^a$, respectively. We prove the following in the online Appendix:

PROPOSITION 2: *With firm-level fixed costs of exporting, an increase in the assembly potential of a given plant k from ξ_k^a to $\hat{\xi}_k^a > \xi_k^a$ leads to $\hat{\mathcal{I}}^a \geq \mathcal{I}^a$ and $\hat{\mathcal{I}}^x \geq \mathcal{I}^x$ whenever $\varepsilon \leq \sigma$, and it may lead to $\hat{\mathcal{I}}_{-k}^a > \mathcal{I}_{-k}^a$ and $\hat{\mathcal{I}}^x \geq \mathcal{I}^x$ even when $\varepsilon > \sigma$.*

This result implies that the model generates complementarities across assembly locations for a wider range of parameter values than our baseline model.

The intuition for this result is as follows. An increase in ξ_k^a necessarily increases the profits associated with sales emanating from that plant k. This increase in profitability may lead firm φ to activate export destinations that were not profitable before the increase in ξ_k^a. Crucially, because plants in other potential assembly locations $k' \neq k$ would benefit from the activation of such an export destination, this induced change in the firm-level extensive margin of exports may well increase the profitability of activating these other potential assembly locations k', especially when cannibalization effects are small.

As we show in the online Appendix, the fact that fixed costs of exporting are incurred at the firm level is crucial for these results: if these fixed costs were incurred at the plant level, we would revert to the result stated in Proposition 1, and complementarities could not arise when $\varepsilon > \sigma$.

[1] It is important to stress that what is relevant is the *intensive-margin* elasticity of labor substitution across plants, taking the location of all plants (and their associated fixed costs) as given.

IV. Export-Platform FDI Model with Firm-Level Sourcing Costs

We finally relax the assumption that final goods are only produced with labor and introduce tradable intermediate inputs. Following our approach for preferences, we assume that inputs sourced from different countries are imperfect substitutes, with a constant elasticity of substitution $\rho > 1$. Intermediates are produced worldwide by a competitive fringe of suppliers that sells its products at marginal cost. All intermediates are produced with labor under a linear technology delivering Z_j^s units of output per unit of labor. Shipping intermediates from country j to country k entails iceberg trade costs τ_{jk}^s. As a result, the cost at which firms producing in k can procure inputs from country j is given by $\tau_{jk}^s w_j / Z_j^s$.

A firm must incur a country-specific fixed cost $w_j f_j^s$ to source inputs from a particular country j. Although this assumption is similar to Antràs, Fort, and Tintelnot (2017), a crucial distinction here is that the fixed cost grants *all* of the firm's assembly plants $k \in \mathcal{K}(\varphi)$ access to inputs from that country. We denote the set of countries for which firm φ has paid the fixed costs of sourcing by $\mathcal{J}(\varphi) \subseteq J$ and refer to it as the firm's *global sourcing strategy*.

The overall marginal cost for firm φ to produce units of the final-good variety in country k is given by

$$c(\varphi, k) = \frac{\left(\xi_k^a\right)^{\frac{1-\alpha}{1-\varepsilon}} \left[\sum_{j \in \mathcal{J}(\varphi)} \xi_j^s \left(\tau_{jk}^s\right)^{1-\rho}\right]^{\frac{\alpha}{1-\rho}}}{\varphi},$$

where $1 - \alpha$ is the labor share in final-good production, $\xi_k^a \equiv \left(w_k / Z_k^a\right)^{1-\varepsilon}$ is the firm's assembly potential in country k, and $\xi_j^s \equiv \left(w_j / Z_j^s\right)^{1-\rho}$ is country j's *sourcing potential*.

Invoking constant-markup pricing, one can show that the sales of an assembly plant in k to each market i (we ignore fixed costs of exporting in this section) are given by

$$(8) \quad S_{ki}(\varphi) = \kappa \varphi^{\sigma-1} \left(\xi_k^a\right)^{1-\alpha} \left(\tau_{ki}^a\right)^{1-\varepsilon} \times \left[\Theta_k(\varphi)\right]^{\frac{\alpha(\varepsilon-1)}{\rho-1}} \left[\Lambda_i(\varphi)\right]^{\frac{\sigma-\varepsilon}{\varepsilon-1}} \times E_i P_i^{\sigma-1},$$

where κ is a constant. The term $\Theta_k(\varphi)$ is plant k's *sourcing capability* (see Antràs, Fort, and Tintelnot 2017) and is given by

$$\Theta_k(\varphi) \equiv \sum_{j \in J} \mathcal{I}_j^s \cdot \xi_j^s \left(\tau_{jk}^s\right)^{1-\rho},$$

where $\mathcal{I}_j^s$ is an indicator function that takes a value of one if the firm activates country j as a source of inputs and zero otherwise. Finally, the term $\Lambda_i(\varphi)$ is

$$\Lambda_i(\varphi) \equiv \sum_{k' \in J} \mathcal{I}_{k'}^a \cdot \left(\xi_{k'}^a\right)^{1-\alpha} \times \left(\tau_{k'i}^a\right)^{1-\varepsilon} \left[\Theta_{k'}(\varphi)\right]^{\frac{\alpha(\varepsilon-1)}{\rho-1}}.$$

The empirical complementarities in global sourcing documented in Antràs, Fort, and Tintelnot (2017) lead us to impose the following:

ASSUMPTION 1: $\alpha(\varepsilon - 1) \geq \rho - 1$.

Equation (8) is significantly more involved than its counterpart (4) in our baseline model, but holding the firm's extensive-margin strategies constant, whether an increase in the assembly potential ξ_k^a of plant k increases or decreases sales of plants based in $k' \neq k$ continues to be shaped solely by the relative size of σ and ε, with $\varepsilon > \sigma$ leading to cannibalization and $\varepsilon < \sigma$ leading to complementarity.

Profits are now given by

$$\pi(\varphi) = \kappa_\pi \varphi^{\sigma-1} \sum_{i \in J} E_i P_i^{\sigma-1} \times \left[\Lambda_i(\varphi)\right]^{\frac{\sigma-1}{\varepsilon-1}} - \sum_{k \in J} \mathcal{I}_k^a \cdot w_k f_k^a - \sum_{j \in J} \mathcal{I}_j^s \cdot w_j f_j^s$$

for some constant κ_π.

Whenever $\varepsilon \leq \sigma$, profits continue to feature increasing differences in $\left(\mathcal{I}_k^a, \mathcal{I}_{k'}^a\right)$ for $k, k' \in \{1, \ldots, J\}$ and $k \neq k'$. Denote by $\mathcal{I}^s$ and $\hat{\mathcal{I}}^s$ the optimal sourcing decisions under ξ_k^a and $\hat{\xi}_k^a$, respectively. In the online Appendix, we prove the following:

PROPOSITION 3: *With firm-level fixed costs of sourcing, under Assumption 1, an increase in the assembly potential of a given plant k from* ξ_k^a *to* $\hat{\xi}_k^a > \xi_k^a$ *leads to* $\hat{\mathcal{I}}^a \geq \mathcal{I}^a$ *and* $\hat{\mathcal{I}}^s \geq \mathcal{I}^s$ *whenever* $\varepsilon \leq \sigma$, *and it may lead to* $\hat{\mathcal{I}}_{-k}^a > \mathcal{I}_{-k}^a$ *and* $\hat{\mathcal{I}}^s \geq \mathcal{I}^s$ *even when* $\varepsilon > \sigma$.

As in the case of firm-level fixed export costs, the presence of firm-level fixed costs of sourcing again widens the range of parameter values for which assembly locations are complements. Intuitively, an increase in ξ_k^a increases the profitability of plant k, which in turn increases the marginal benefit of investing in a larger sourcing capability $\Theta_k(\varphi)$ for that plant. Since all of the firm's plants now benefit from a new input source country, their sourcing capabilities $\Theta_{k'}(\varphi)$ tend to be enhanced and necessarily so under Assumption 1. This larger sourcing capability may in turn increase the profitability of activating other potential assembly locations k', especially when cannibalization effects are small. If fixed costs of sourcing were incurred at the plant level rather than the firm level, this complementarity force would disappear and a result analogous to the one in Proposition 1 would apply (see the online Appendix).

V. Conclusion

We demonstrate that the various plants of an MNE do not cannibalize on each other whenever the elasticity of demand for the MNE's goods is low relative to the within-firm elasticity of labor substitution across the MNE's plants. We also show that this complementarity is enhanced by firm-country-specific fixed costs to sell those goods or source inputs for their production.

The existence of complementarities in the export-platform strategies of MNEs is important, among other reasons, because it constitutes a potential force contributing to the remarkable predominance of a small number of multinational firms in world trade flows, as documented for the case of the United States in Antràs et al. (forthcoming).

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