Internationalization strategies of multi-product firms: The role of technology

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Abstract. High-performance firms typically have two features in common: (i) they produce in more than one country and (ii) they produce more than one product. In this paper, we analyze the internationalization strategies of multi-product firms. Guided by several new stylized facts, we develop a theoretical model to determine optimal modes of market access at the firm–product level. We find that the most productive firms sell core varieties via foreign direct investment and export products with intermediate productivity. Shocks to trade costs and technology affect the endogenous decision to export or produce abroad at the product-level and, in turn, the relative productivity between parents and affiliates.

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We would like to thank editor Peter M. Morrow, two anonymous referees as well as Carsten Eckel, Hartmut Egger, Udo Kreickemeier, Jens Wrona and participants at the Workshop IWB in Goettingen, the online conference “Workers and Firms in Production Networks: Policy Implications” and a seminar in Linz for helpful comments. Much of this paper was written while Daniel Baumgarten was affiliated with LMU Munich and the ifo Institute. He acknowledges financial support from Deutsche Forschungsgemeinschaft through CRC TRR 190.

Canadian Journal of Economics / Revue canadienne d’économique 2022 55(4)
November 2022. Printed in Canada / Novembre 2022. Imprimé au Canada

ISSN: 0008-4085 / 22 / pp. 1929–1965 / DOI: 10.1111/caje.12626
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des produits avec une productivité intermédiaire. Les chocs aux coûts de commerce et la technologie ont un effet sur la décision endogène d’exporter ou de produire à l’étranger au niveau du produit et, du coup, sur la productivité relative entre les sociétés mères et les sociétés affiliées.

JEL classification: F12, F23, L25, L11

1. Introduction

In international economics, one striking pattern emerges: internationalization is for the few.¹ Many empirical studies show that international activity is concentrated in a small share of very large firms. These companies successfully compete in international markets because they are the most productive firms, spend most on R&D activities and have the highest skilled workforce for whom they pay the highest wages. Among other characteristics, these high-performance firms typically have two features in common. First, they are multinationals, running affiliates in many countries around the world.² Second, these firms produce multiple products and contribute to a large extent to the product variety in the world economy.³ The similarities between the documented stylized facts on multinationals on the one hand, and multi-product firms on the other hand, are striking, yet only few studies have analyzed multinational, multi-product firms in a unified framework so far.⁴

In this paper, we analyze the internationalization strategies of multi-product firms at the firm–product level. We first present several stylized facts, making use of both representative Spanish firm-level data and very detailed firm–product–destination data of car producers that were recently used and made available by Head and Mayer (2019a,b). In particular, we show that the most productive firms choose both strategies, exporting and foreign direct investment (FDI), to serve foreign markets. As the evidence based on the car data confirms, this is true even for one and the same destination. In particular, car producers tend to use different market access modes for different products (i.e., car models). Guided by

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¹ See, for instance, the respective chapter on European firms in Mayer and Ottaviano (2008).

² See, e.g., the recent surveys on multinationals by Yeaple (2013a) and Antràs and Yeaple (2014).

³ For empirical evidence on the dominance of multi-product firms, see, e.g., Bernard et al. (2007), Bernard et al. (2009), Bernard et al. (2010); Bernard et al. (2011), Broda and Weinstein (2010) and Goldberg et al. (2010).

⁴ Important exemptions from this are Baldwin and Ottaviano (2001), Yeaple (2013b), Tintelnot (2017) and Head and Mayer (2019a), which are discussed in greater detail below.
these stylized facts, we develop a theoretical model to determine optimal modes of market access at the firm–product level. In doing so, we focus on the role of a firm’s production technology for the optimal mode of serving consumers. Firms are characterized by a flexible manufacturing technology and may decide on the optimal mode of internationalization for each of their products. Because firms produce multiple varieties with heterogeneous productivities, differential strategies will be optimal for the various products. In particular, we ask the following questions. Which goods are productive enough to be sold on foreign markets? Where are those goods produced: abroad via horizontal foreign direct investment or at home, to be exported to the foreign market? What is the role of globalization and technology shocks in these decisions? And, finally, how do such shocks affect the relative plant-level productivities of parents versus affiliates in multinational firms?

Following the standard literature, firms choose to produce a given product abroad, if their gain from avoiding trade costs offsets their greater fixed cost of production (proximity–concentration trade-off). The relative size of the gain depends importantly on the market share of the firm’s product. In analogy to Helpman et al. (2004), the most productive firms choose multinational production to serve foreign consumers, however, they do not do so for their entire product range. In contrast to most existing models on the proximity–concentration trade-off, we allow for a second source of heterogeneity that affects a product’s market share. Besides between-firm heterogeneity à la Melitz (2003), we introduce within-firm heterogeneity between products. Following Eckel and Neary (2010), firms operate with a flexible manufacturing technology such that the marginal cost of a product is increasing in its distance from the firm’s core competence. Firms may endogenously decide on the range of products being produced, and the rank of a product within the portfolio of a firm will determine the optimal way of serving consumers abroad. We find that core products are sold via FDI, while products of an intermediate productivity are exported. As a direct consequence of that, foreign affiliates show a higher level of productivity at the plant-level compared with their parent firms. This result differs importantly from a model with single-product firms, as in Helpman et al. (2004), where affiliate and parent firms have the same productivity. The reason behind this difference is that, in our case, the foreign plant produces only a subset of the products that are produced in the parent plant. Because FDI is profitable only for core varieties, plant-level productivity is higher in the foreign affiliate. In our model, also differently from Helpman et al. (2004), the most productive firms rely on

5 See, for example, Horstmann and Markusen (1992), Brainard (1993); Brainard (1997), Markusen and Venables (2000), Markusen and Maskus (2002) and Helpman et al. (2004).

both strategies, that is they both export and invest abroad, in line with the empirical evidence described above.

Having established the endogenous choice of the different modes of market entry at the product-level, we further investigate the role of technology in the internationalization decision. In particular, we analyze the impact of production flexibility on the relative sales in different modes at the firm level. For example, it could be that some firms operate a more flexible technology, where the introduction of new varieties is associated with a lower increase in marginal costs. The flexibility of technology might also vary across industries. We find that more flexible firms have greater domestic sales as well as greater sales in both exports and FDI. Moreover, an increase in production flexibility increases the share of export sales for multinationals, whereas the opposite is true for firms that export but do not engage in FDI.\(^7\) In these firms, greater flexibility decreases the share of export sales. The reason behind this result is that, as flexibility increases, firms skew their sales away from their best-performing products, that is products sold via FDI (exports) in the case of firms with high (medium) productivity.

As a direct implication of our analysis, we find that any shock (such as globalization or technology) that affects the endogenous FDI/export decision changes the productivities of both affiliate and parent firms. Moreover, these shocks also determine whether profits of the most profitable core varieties are recorded at home (in the case of exports) or abroad (in the case of FDI). This is crucial from a policy perspective because it defines the location where corporate taxes have to be paid. In addition, it determines the extent to which home workers or foreign workers are involved in production.

Our paper is related to two broad strands of the recent literature in international economics. First, it contributes to the literature on multi-product firms, which has been rapidly increasing in the past few years because of the availability of detailed product-level data.\(^8\) Based on novel stylized facts from empirical work, a growing number of theoretical contributions implement the analysis of multi-product firms in existing models of international trade (see, for example, Feenstra and Ma 2008; Bernard et al. 2010; Bernard et al. 2011; Eckel and Neary 2010; Dhingra 2013; Qiu and Zhou 2013; Yeaple 2013a; Yeaple 2013b).

\(^7\) These findings fit remarkably well with empirical evidence on US multinationals first pointed out by Yeaple (2013b).

\(^8\) A number of empirical contributions document the dominance of large multi-product firms in international markets (see, for example, Bernard et al. 2007; Bernard et al. 2009; Bernard et al. 2010; Bernard et al. 2011; Broda and Weinstein 2010 and Goldberg et al. 2010). Moreover, Bernard et al. (2010) and Broda and Weinstein (2010) show that most product creation and destruction happens within existing firms, which has important potential implications for aggregate product scope and welfare.
Mayer et al. 2014; Nocke and Yeaple 2014; Flach and Irlacher 2018; Arkolakis et al. 2021). They typically investigate the product scope within multi-product firms (intra-firm extensive margin) as an important margin of adjustment to changes in market conditions. In contrast to our paper, their focus is mainly on the effect of trade liberalization on export scope, whereas the role of FDI is not included in the analysis.

Second, our paper contributes to the literature that analyses firm’s optimal mode of foreign market access, distinguishing between multinational production and exporting as two different choices based on the so-called proximity–concentration trade-off (see, e.g., Horstmann and Markusen 1992; Brainard 1993; Brainard 1997; Markusen and Venables 2000; Markusen and Maskus 2002; Helpman et al. 2004). In particular, similar to Helpman et al. (2004), we focus on the role of firm heterogeneity for individual market access strategies and the resulting pattern of aggregate international production and trade. However, we extend Helpman et al. (2004), who focus on single-product firms, in allowing for firms to produce more than one product. In this framework, we can analyze optimal product scope together with optimal market access at the firm–product level. Importantly, we distinguish between two different sources of heterogeneity: between-firm heterogeneity in (core) productivity and within-firm heterogeneity across products.

Our paper is most closely related to papers that combine the two strands of the literature discussed above. In an early contribution, Baldwin and Ottaviano (2001) build a model in an oligopolistic setting where multi-product firms reduce inter-variety competition (i.e., cannibalization) by relocating some varieties abroad. The driving force in their model is similar to the reciprocal dumping model in Brander and Krugman (1983) and fundamentally different to the logic in our analysis. Yeaple (2013b) provides an interesting set of novel stylized facts on multinational multi-product firms consistent with our predictions. However, in contrast to our model, his focus is not on production flexibility but on managerial expertise as a scarce resource that has to be subdivided across products in different locations. Firms differ both in their endowments of managerial expertise and in their efficiency of transferring this expertise to foreign affiliates. The analysis investigates how these two sources of managerial heterogeneity affect the product range as well as the exports/FDI mix of multi-product firms. Tintelnot (2017) investigates the determinants of the location and production of multinational firms when foreign affiliates of multinationals may serve as export platforms. Head and Mayer (2019a) consider a model of multinational production in the car industry that accounts for the multi-product nature of car producers. Their framework allows for adjustments at the firm-product extensive margin in response to trade policy changes. Using French firm–product-level data, Bricongne et al. (2019) analyze whether FDI and exports are complements or substitutes. They find that firms that do FDI export more, confirming the predominant result in the literature.
However, consistent with our model, they also find that this is not true for core products, in particular for the most productive firms in countries with strong demand.

The structure of the remainder of this paper is as follows. In section 2, we provide an empirical motivation for our subsequent analysis. In section 3, we describe our theoretical model and derive our main results. Section 4 concludes.

2. Empirical motivation

To motivate our theoretical framework, we draw on a number of stylized facts. In the following, we first describe the relationship between firm productivity and the modes of serving foreign markets, making use of Spanish firm-level data. The drawback of these data is that they lack a product (and a highly disaggregated destination market) dimension. In a next step, we, therefore, make use of rich data for the car industry to describe more precisely the internationalization strategies of multi-product firms.

2.1. The link between firm productivity and the modes of serving foreign markets

We use the Spanish Encuesta sobre Estrategias Empresariales (ESEE), a representative sample of Spanish manufacturing firms with more than 10 employees. The data set contains information on both export and FDI activities of firms. We are interested in the relationship between firm productivity and the mode of serving foreign markets. In figure 1, (labour) productivity is measured as value added per hour worked by employees. On the basis of this measure, firms are grouped into deciles, normalized by industry and year. That is, we explore variation across firms within the same industry–year combination.

The graph shows that the composition of firms by mode of access changes along the productivity distribution. The share of firms engaged in only exporting increases steadily up to the 7th productivity decile and levels off thereafter. In contrast, hardly any firms are engaged in FDI in the bottom half of the productivity distribution, but the share rises steadily thereafter. Importantly, the entire increase is driven by firms doing both exports and FDI, while the share of firms with only FDI (and no exports) is extremely low along the entire distribution.

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9 It is a panel data set, which runs since 1990 and has a high response rate among repeatedly interviewed firms. Between 1,500 and 2,000 firms are interviewed each year. For the purpose of our data exploration, we make use of the waves of the years 2002, 2006, 2010 and 2014. These data have been used by, among others, Guadalupe et al. (2012), Garicano and Steinwender (2016) and Koch and Smolka (2019).
Stylized facts I (at the firm level)
Relating firm productivity to the differential modes of serving foreign markets, we find the following facts:

1. The share of firms engaged in only exporting increases steadily up to the 7th productivity decile and levels off thereafter.
2. The share of firms that rely on both exports, and FDI strictly increases in productivity.
3. The share of firms that rely on only FDI is close to zero across all deciles.

While the first fact above is consistent with the standard model of Helpman et al. (2004), the remaining two are not. A number of studies analyze the relationship between exports and FDI at the firm level. For US firms, Lipsey and Weiss (1984) and Desai et al. (2005) show that increased production

10 They could, however, be reconciled with a multi-country version of Helpman et al. (2004), where the proximity–concentration tradeoff arises for each destination. Firms might, therefore, export to some destinations and conduct FDI in others. To explore this possibility, we have redone figure 1 at the firm–destination level, which yields a very similar pattern (see appendix A7). Unfortunately, the Spanish ESEE data allow us to distinguish only four broad destination regions: the EU, Latin America, OECD (outside the EU) and rest of the world. We, therefore, cite additional firm–destination level evidence below.
in foreign affiliates is related to larger parent exports. Similarly, Lipsey et al. (2000) and Head and Ries (2001) find a positive correlation between exports and foreign production for Japanese firms. These studies indicate that firms may rely on both strategies in serving a particular region or country.\footnote{Lipsey et al. (2000) control for the region of destination. Gumpert et al. (2020), referred to below, document the coexistence of FDI and exports in Norwegian firms at the firm–country-of-destination–year level.} There are several possible reasons. First, foreign production may promote the exports of intermediate goods in firms that are vertically integrated.\footnote{Head and Ries (2001) find some evidence for this.} Second, firms may serve a given foreign market via FDI at one point in time and via exports at another (see, e.g., the dynamic models of Rob and Vettas 2003, Conconi et al. 2016 and Gumpert et al. 2020). Third, firms may produce some products abroad and export others (Yeaple 2013a). The latter fits well with evidence at the product level, where exports and FDI have been shown to constitute substitutes rather than complements (see, e.g., Blonigen 2001, Swenson 2004, Bricongne et al. 2019).

Clearly, figure 1 does not allow us to distinguish between these reasons. To motivate our multi-product perspective further, we make use of very rich data about export and FDI activities at the firm–product–country-of-destination level in a specific industry: the car industry.

### 2.2. Internationalization strategies of multi-product car producers

We use detailed data about the origin–destination flows of car producers, which were collected by the automotive industry consultancy IHS Markit and recently used in Head and Mayer (2019a). We make use of the anonymized replication data kindly provided by the authors (Head and Mayer 2019b) to reproduce and augment some of the stylized facts presented in their paper. The data set contains yearly information about the country of assembly and the country of sale at the level of brands and models, which Head and Mayer (2019a) link to the theoretical concepts of firms and varieties, respectively.\footnote{We associate brands with firms and models with products in our theoretical framework. In the following, however, we stick to the terms brands and models to avoid confusion.} The final replication sample contains information on 93 brands and 76 destination markets over the time period 2000–2016.\footnote{In the replication data, brands, models, countries and years have been anonymized. Also, it is not possible to link models of brands across different markets and years.}

We first reproduce a striking pattern already exposed in Head and Mayer (2019a): 98% of models sold in a given year in a given destination market are sourced from a single country of assembly (figure 2). Thus, for
each model, producers almost always choose a unique mode of accessing a particular destination market. However, the pattern looks different if we focus on the brand–destination–year level, i.e., if we aggregate across models sold by the same brand. Now, only 36% of destination markets are served from a single country of origin. Instead, the distribution is much more right-skewed, the median number being 2 and the mean 2.4. Thus, the combined evidence in figure 2 suggests that, for a given year and a given destination market, brands tend to choose different sourcing locations for different models.

For our purposes, it is useful to distinguish between three types of assembly locations that are connected to different market access modes: (i) in the home country of the headquarter, (ii) in the destination country and (iii) in a third country. From the perspective of the headquarter, (i) constitutes exporting, (ii) pure horizontal FDI and (iii) export-platform FDI. In the following, to reduce complexity further and in line with our simplified two-country theoretical framework, we combine export-platform FDI and pure horizontal FDI into one combined FDI category. In doing so, we assume that both strategies (typically) imply greater proximity to the destination market but less concentration of production at the headquarter. Table 1 shows how car producers combine different internationalization strategies to serve a given destination market in a given year. 31% of all brand–destination–year observations feature only exporting, 9% only FDI and 61% both exporting and FDI (excluding the home market of the headquarter). On average, 35% of the models sold by

15 In contrast to the evidence presented above based on the Spanish ESEE data, now the shares sum to 100% because we condition on serving the foreign market.
### TABLE 1

Modes of foreign market access at the brand–destination–year level

<table>
<thead>
<tr>
<th>Share of obs</th>
<th>Share of models served via FDI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Export only</td>
<td>0.31</td>
</tr>
<tr>
<td>FDI only</td>
<td>0.09</td>
</tr>
<tr>
<td>Export + FDI</td>
<td>0.61</td>
</tr>
<tr>
<td>Total</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**NOTES:** The table shows foreign market access modes from the perspective of the brand’s headquarter location, conditional on serving the foreign market. Pure horizontal FDI (assembly location in the destination market) and export-platform FDI (assembly location in a third country) are grouped into one combined FDI category. Exporting is implied by the assembly location being at the brand’s headquarter location.

a particular brand in a particular market and year are served via FDI and 65% are exported. However, there is substantial variation in the share of models served via FDI (standard deviation of 33%-points). To get a better sense of the sources of this variation, we decompose the variance into a between and within component along two different dimensions (table 2). Panel A shows that only 42% of the variance is between origin–destination–years and 58% is within origin–destination–years (i.e., between brands headquartered in the same country of origin that sell to the same destination in the same year). Thus, brand heterogeneity is important. On the other hand, it is also the case that a non-negligible share of 36% of the variance is within brand–years (i.e., across destinations served by the same brand; see panel B). In sum, we derive the following additional stylized facts.

**Stylized facts II (at the firm–product–destination level)**

1. For each model (i.e., product), car producers tend to choose a unique mode of accessing a particular destination market.
2. For a given destination market, car producers use different market access modes for different models.
3. There is considerable variation in the share of models served via FDI:
   - within country pairs, across producers
   - within producers, across different destination markets

In the following, we build on these stylized facts and develop a model to determine optimal modes of market access at the firm–product level. We

16 Coşar et al. (2018) is another paper that studies the automobile industry using a worldwide dataset containing the assembly plant locations of 598 car models. They find that 43% of the models are assembled in more than one country and account for 64% of total revenue. This indicates that, in line with our theoretical predictions, foreign assembly takes place in particular for core varieties within the firm.
find that the most productive firms sell their most productive products via FDI and the products with intermediate productivity via exports. Firms with medium productivity sell their most productive products via exports. They do not engage in FDI. Firms with low productivity sell only at home. Our findings are consistent with the stylized facts above and provide a novel explanation for the relative importance of exports and FDI as well as the relative performance of parent firms and affiliates.

3. The model

We extend the model of Helpman et al. (2004) to explain how heterogeneous multi-product firms choose to enter foreign markets and to explore the role of production technology in these decisions. As in the standard model, there is heterogeneity in the productivity between firms. In addition, there is heterogeneity in the productivity between products within firms due to flexible manufacturing à la Eckel and Neary (2010). As a result, the model features two sources of firm heterogeneity: first, in absolute core productivity (between-firm heterogeneity) and, second, within-firm heterogeneity between products due to flexible manufacturing. Firms decide whether to enter the market or not, how many goods to produce, where to supply these goods and whether to serve a foreign market via exports or FDI. Importantly, the last two decisions are made at the product level. We find that there is firm dispersion in total sales, in product scope (the number of products sold domestically and abroad via exports or FDI) and in the decision of whether to supply a given product to a foreign market via exports or FDI (or not

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17 We abstract from the possibility of exports by foreign affiliates (see also Helpman et al. 2004).
at all). In particular, in line with our empirical motivation, we find that the most productive firms choose to serve foreign markets through both FDI and exports.

3.1. Consumers

We consider a world of two symmetric countries $i$ and $j$. Both countries use labour to produce goods in $M + 1$ sectors. We take the homogeneous good as the numeraire and assume that both countries always produce it with one unit of labour per-unit output. As a result, the wage rate is equal to one in both countries. The remaining $M$ sectors are characterized by monopolistic competition and produce differentiated varieties with a constant elasticity of substitution $\sigma > 1$. Consumers in country $j$ spend a share $\beta_m$ of their income $E_j$ on goods from sector $m$ and the remaining fraction $1 - \sum_{m=1}^{M} \beta_m$ on the outside good. Each country’s representative consumer has preferences described by the following utility function:

$$U = \left(1 - \sum_{m=1}^{M} \beta_m\right) \log z + \sum_{m=1}^{M} \beta_m \log C_m,$$

(1)

$$C_m = \left(\int_{\omega \in \Omega_{ijgm}} (c_{ijgm}(\omega))^{\frac{\sigma - 1}{\sigma}} d\omega\right)^{\frac{1}{\sigma - 1}},$$

(2)

where $z$ is the consumed quantity of the homogeneous good, and $c_{ijgm}(\omega)$ is the quantity of variety $\omega$ of product $g$ from sector $m$ produced in country $i$ and consumed in country $j$.\(^{18}\) Here, $\omega$ indexes varieties of product $g$ supplied from country $i$ to country $j$ and $\Omega_{ijgm}$ is the endogenous set of these varieties.\(^{19}\) Consumers maximize utility subject to the budget constraint $z + \sum_{m=1}^{M} \int_{\omega = 0}^{\infty} \sum_{i=1}^{2} \int_{\omega \in \Omega_{ijgm}} p_{ijgm}(\omega) c_{ijgm}(\omega) d\omega d\gamma \leq E_j$. In the following, we focus on a sector-by-sector analysis and drop the subscript $m$ as well as the subscripts $g$, $i$ and $j$, unless required. Utility maximization implies that product demand in country $j$ in any particular sector is given by:

$$c_j(\omega) = B_j p_j(\omega)^{-\sigma},$$

(3)

where $B_j = \frac{\beta E_j}{\sum_{j=1}^{\infty} p_j^{1-\sigma}}$ is the demand level, which depends on the price index

$$p_j = \left(\sum_{m=1}^{M} \int_{\omega = 0}^{\infty} \sum_{i=1}^{2} \int_{\omega \in \Omega_{ijgm}} p_{ijgm}(\omega)^{1-\sigma} d\omega d\gamma\right)^{\frac{1}{1-\sigma}}.$$

\(^{18}\) Sectors are defined such that firms produce all their products within the same sector.

\(^{19}\) It is assumed here for simplicity that the elasticity of substitution across varieties within products is the same for all products and equal to the elasticity of substitution across products. Moreover, each firm produces at most one variety of product $g$ (see also, e.g., Bernard et al. 2011).
3.2. Firms

Starting a firm in a differentiated sector requires a fixed cost of entry \( f_e \). Firms are heterogeneous in productivity and draw a firm-specific efficiency parameter \( \phi \in [0, \infty] \) from a cumulative distribution function \( F(\phi) \) that is the same across countries. After a firm has paid the fixed entry cost, it observes its core productivity, \( \phi \), and decides whether to exit or remain in the market. In case it remains, it also decides how many products to sell in a given country and – if it decides to sell a given product also in a foreign country – whether to do so via exports or via FDI. Serving the domestic market requires a fixed cost \( f_d \) per variety. Serving a foreign market via exports requires a fixed cost \( f_x \) and, in addition, for each product that is exported, firms face common (across firms and products) iceberg trade costs, so that \( \tau_{ij} > 1 \) units must be shipped from country \( i \) to country \( j \) for one unit to arrive.\(^{20}\) Firms that serve a foreign market via FDI avoid variable trade costs but have to pay a higher fixed cost \( f_m \). Importantly, in contrast to the fixed market entry cost \( f_e \), the fixed costs \( f_d \), \( f_x \) and \( f_m \) are product-specific. We follow Helpman et al. (2004) and assume the following parameter restriction:

**Assumption 1.** \( f_d < \tau^\sigma f_x < f_m \).

Throughout our analysis, we assume that both fixed as well as variable trade costs are identical for all firms in a given sector but may vary across sectors. This allows us to compare results across sectors with a different cost structure.

3.2.1. Technology

Following Eckel and Neary (2010), we assume that firms operate with a flexible manufacturing technology, such that introducing additional varieties is associated with a lower productivity. Firms produce each product according to a linear production technology using labour with product-specific efficiency \( \phi_g \). Marginal costs are constant for a given product, but increase in distance from a firm’s core competence, such that

\[
\phi_g \equiv \phi / h(g) \quad \text{with} \quad h'(g) > 0, \quad h(1) = 1, \tag{4}
\]

where \( h(g) \) is strictly increasing in \( g \) and goods are ordered in increasing distance from the core competence product.

To derive closed form solutions, we follow Arkolakis et al. (2021) and parameterize the cost function as follows:

\[
h(g) = g^\alpha, \quad \alpha \in [0, +\infty). \tag{5}
\]

The parameter \( \alpha \) plays an important role because it governs the flexibility of the production process. Smaller values of \( \alpha \) imply a higher flexibility of

\(^{20}\) There are no transport costs for products that are sold domestically (\( \tau_{ii} = 1 \)).
production because marginal costs increase only moderately with distance from a firm’s core competence. In principle, this parameter could vary between firms such that firms differ in the flexibility of production. In the main part of this paper, we do not need to take a stand on whether $\alpha$ varies between firms within an industry or between industries. In the appendix, we solve for the general equilibrium and assume that, similarly to the fixed costs of production, the flexibility of production technology is sector-specific (i.e., identical for all firms within a given sector). There, comparative statics with respect to $\alpha$ should be interpreted as comparing results across sectors with different production flexibility.

In analogy to Arkolakis et al. (2021), we define an efficiency index at the plant-level. The average product efficiency of a plant producing a total of $G$ products (not taking into account fixed costs of production) is given by

$$H(G) = \left( \sum_{1}^{G} g^{-\alpha(\sigma-1)} \right)^{-\frac{1}{\sigma-1}}.$$  \hspace{1cm} (6)

This index decreases in the number of varieties $G$, and the drop in average efficiency for each additional variety is larger the greater the value of $\alpha$ (see figure 3). Note that this index converges to one for large values of the technology parameter $\alpha$ or the elasticity of substitution $\sigma$, which reflects the the scenario where almost all sales are concentrated in the core variety.

3.2.2. Optimal firm behaviour

Each firm chooses product prices to maximize profits under monopolistic competition given consumer demand (3) and productivity $\phi/h(g)$.  

21 In appendix A1, we provide a model extension that allows for heterogeneity not only in variable production costs but also in per-variety fixed costs.

22 Monopolistic competition implies that the price of each product variety can be chosen independently of the prices of other varieties. That is, there is no strategic interaction, unlike in, e.g., Eckel and Neary (2010).
This results in identical markups $\sigma/ (\sigma - 1)$ over marginal costs:\(^{23}\)

$$p_{ii} = \frac{\sigma}{\sigma - 1} g_i^\alpha \quad \text{and} \quad p_{ij} = \frac{\sigma}{\sigma - 1} \tau_{ij} g_j^\alpha.$$  \hspace{1cm} (7)

In the next step, we derive per-variety profits for domestic sales, exports as well as FDI sales. Before we do that, it is convenient to define the operating profit of the core product of a firm with productivity $\phi$:

$$\tilde{\pi}(\phi) = A\phi^{\sigma - 1},$$  \hspace{1cm} (8)

where $A \equiv \frac{1}{\sigma} (\frac{\sigma - 1}{\sigma}) \sigma^{-1} B$ denotes the markup-adjusted revenue shifter (identical across the two countries due to the symmetry assumption). Obviously, firms with a higher core productivity $\phi$ are more profitable in their core variety $g = 1$. Substituting optimal prices into the firm’s profit functions, we obtain the respective profits for the different modes of serving a market (domestically or abroad via exports or FDI):

$$\pi_d(g) = \tilde{\pi}(\phi)g^{-\alpha(\sigma - 1)} - f_d,$$  \hspace{1cm} (9)

$$\pi_e(g) = \tilde{\pi}(\phi)\tau^{1-\sigma}g^{-\alpha(\sigma - 1)} - f_x,$$  \hspace{1cm} (10)

$$\pi_m(g) = \tilde{\pi}(\phi)g^{-\alpha(\sigma - 1)} - f_m.$$  \hspace{1cm} (11)

Equations (9) to (11) indicate that in any mode of market entry, per-variety profits decrease in distance from the core competence. This drop in profitability is more pronounced the lower is the flexibility of production (higher values of $\alpha$).

**Productivity cut-offs**

The profit equations above determine the survival cut-off ($\phi^*_d$) as well as the minimum productivities for selling the core product abroad via exports ($\phi^*_x$) or FDI ($\phi^*_m$). The first two cut-offs are the solutions to $\pi_d(1) = 0$ and $\pi_e(1) = 0$, respectively. The cut-off for FDI is the solution to $\pi_e(1) = \pi_m(1)$. The solutions for the three cut-offs are given by

$$\phi^*_d = \left(\frac{f_d}{A}\right)^{\frac{1}{\sigma - 1}},$$  \hspace{1cm} (12)

$$\phi^*_x = \left(\frac{f_x}{A\tau^{1-\sigma}}\right)^{\frac{1}{\sigma - 1}},$$  \hspace{1cm} (13)

$$\phi^*_m = \left(\frac{f_m - f_x}{A(1 - \tau^{1-\sigma})}\right)^{\frac{1}{\sigma - 1}}.$$  \hspace{1cm} (14)

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23 Optimal prices are derived from the expressions for total firm operating profits by mode of production given in appendix A2.
Our parameter restrictions according to Assumption 1 ensure that \( \phi_d^* < \phi_x^* < \phi_m^* \). Hence, low-productivity firms sell their core product only in the domestic market, medium-productivity firms sell it abroad via exports, and high-productivity firms sell it abroad via FDI.

In general equilibrium, the cut-offs \( \phi_d^* \), \( \phi_x^* \) and \( \phi_m^* \), together with the demand level \( A \), are solutions to equations (12) to (14) in combination with the free entry condition (see appendix A3). In the following, we focus on firm-level adjustments in an industry equilibrium with a given number of firms. We postpone the general equilibrium analysis to the appendix of this paper.\(^{25}\)

**Optimal scope in each mode**

We define the scope of products sold domestically and abroad via exports or FDI as \( G_d \), \( G_x \) and \( G_m \). Given our parameter restrictions on fixed costs, the minimum operating profit required to cover fixed costs is smallest for products that are sold domestically and smaller for products that are exported compared with products that are sold via FDI. As a product’s price increases and, therefore, its revenue\(^{26}\) and operating profit\(^{27}\) decrease in distance from the core competence, products that are closest to a firm’s core will be sold via FDI (given that the firm undertakes any FDI at all, i.e., conditional on \( \phi \geq \phi_m^* \)). Products that are further away will be exported, and the products with the greatest distance from the core will be sold only domestically.\(^{28}\)

Next, we define the marginal products \( g_d \) and \( g_x \in \{0, 1, \ldots\} \), that is, the largest \( g \in \{0, 1, \ldots\} \) such that \( \pi_d(g) \) and \( \pi_x(g) \) are equal to (or greater than)

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\(^{24}\) In fact, the productivity cut-offs are identical to the proximity–concentration framework with single-product firms in Helpman et al. (2004). Moreover, they are very similar to models of firm heterogeneity relying on CES preferences that focus on tradeoffs between high fixed costs and low marginal costs (see for instance Bustos 2011 for a model focusing on innovation activities or a framework by Ahn et al. 2011 who investigate how firms serve export markets—either directly or indirectly through an intermediary). The reason behind this similarity comes from the fact that each cut-off is derived for the core variety of the firm that would represent the sole variety in a framework with single-product producers.

\(^{25}\) Note that, given the symmetry assumptions we made, the two countries share the same cut-offs and demand levels in general equilibrium. As long as wages are equalized, this result also holds for different country sizes. As discussed in Helpman et al. (2004), the larger country attracts a larger measure of entrants.

\(^{26}\) This is because demand is elastic (\( \sigma > 1 \)).

\(^{27}\) Operating profit is proportional to revenue due to CES preferences.

\(^{28}\) Products are sold abroad via FDI or exports in addition to being sold domestically.
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**FIGURE 4** Exports versus FDI at the product-level

**NOTE:** To draw this figure, we refer to equation (15) for the domestic and export loci and to equation (16) for the FDI locus. [Colour figure can be viewed at wileyonlinelibrary.com.]

The comparatively larger slope for the incremental export scope cost follows from Assumption 1. In our example, firm 1 with intermediate productivity ($\phi_1 > \phi_2 > \phi_m^*$) exports its core varieties (1 and 2) and additionally produces three more varieties for domestic sales. Now consider firm 2 with productivity $\phi_2 > \phi_m^*$. The marginal product $g_m$ is determined by the following equation:

$$\pi_m(g) = \pi_x(g) \Rightarrow \tilde{\pi}(\phi_2) = \frac{(f_m - f_x) g^{\alpha(\sigma-1)}}{(1 - \tau^1 \sigma^1)}.$$

Compared with the loci for domestic and export scope costs, the FDI locus, 

$$\frac{(f_m - f_x) g^{\alpha(\sigma-1)}}{(1 - \tau^1 \sigma^1)},$$

has the largest slope, by Assumption 1. Operative profits of the core variety of the firm with productivity $\phi_2 > \phi_m^*$ are above the FDI locus such that this firm prefers multinational production for its most productive varieties (1 and 2) and exports its products with intermediate productivity. Here, the firm exports three varieties and has an overall product range of

...
eight varieties. We summarize this analysis in our first proposition, which is in line with our empirical motivation.

**Proposition 1.** Firms with productivity $\phi > \phi^*_m$ engage in both multinational production and exporting. They sell core products via FDI and export products with an intermediate productivity.

Solving for the marginal products in each mode, we derive

$$g_d = \text{int}\left\{ \left( \frac{A\phi^\sigma - 1}{f_d} \right)^{\frac{1}{\alpha(\sigma - 1)}} \right\}, \quad (17)$$

$$g_x = \text{int}\left\{ \left( \frac{A\phi^\sigma - 1}{f_x} \right)^{\frac{1}{\alpha(\sigma - 1)}} \right\}, \quad (18)$$

$$g_m = \text{int}\left\{ \left( \frac{A\phi^\sigma - 1}{f_m - f_x} \right)^{\frac{1}{\alpha(\sigma - 1)}} \right\}. \quad (19)$$

The total range of products is given by $G_d = g_d$, $G_x = g_x - g_m$, and $G_m = g_m$, respectively (see figure 4). Using (12) to (14), we express marginal products in terms of the cut-off productivity level for the core product:

$$g_d = \text{int}\{(\phi/\phi^*_d)^\frac{1}{\alpha}\}, \quad g_x = \text{int}\{(\phi/\phi^*_x)^\frac{1}{\alpha}\}, \quad g_m = \text{int}\{(\phi/\phi^*_m)^\frac{1}{\alpha}\}. \quad (20)$$

Note that, for any strictly positive product scopes, we have $g_m < g_x < g_d$ because $\phi^*_d < \phi^*_x < \phi^*_m$ by Assumption 1. It follows that $G_d > G_x + G_m$, such that varieties sold abroad are a subset of all varieties within the portfolio of a firm. Marginal varieties are sold only domestically because they are not profitable enough to be sold abroad.

In a next step, we investigate the effect of production flexibility on the optimal product range in each mode. In partial equilibrium (i.e., conditional on given cut-offs), a more flexible production (lower levels of $\alpha$) increases optimal scope in each mode because the marginal product is getting more efficient in production. In figure 4, this corresponds to an outward rotation of the respective loci for all three modes. We summarize these results in the next proposition.

**Proposition 2.** In any given mode of entry, more productive firms produce a greater range of products. For given cut-off productivities, product scope in all modes increase in production flexibility (smaller values of $\alpha$). 29

To conclude this section, we briefly investigate the effects of trade liberalization on the product scopes of multi-product firms. In appendix A3, 29
we show that, in general equilibrium, lower variable trade costs \((\tau)\) or lower fixed costs of exporting \((fx)\) increase domestic competition and, therefore, the survival cut-off \(\phi^*_d\). According to equation (20), any shock that increases the survival productivity cut-off \(\phi^*_d\) induces firms to focus more on their core varieties and reduce total product scope.\(^{30}\)

### 3.3. Exports versus FDI at the firm-product level

In this section, we derive results with respect to the share of FDI and export products and sales at the firm level. This disaggregate analysis of optimal market entry strategies allows us to compare our results for different types of firms (i.e., multinationals versus exporters only). In addition, it allows us to compare plant-level productivities of multinational affiliates to their respective parent firms.

**Share of FDI products**

In the following, we determine the share of a firm’s FDI products in the total number of its varieties sold domestically and abroad. Using the expressions for marginal products (20) and substituting for the cut-off productivities (12) to (14), we derive

\[
\frac{G_m}{G_d} = \frac{g_m}{g_d} = \left( \frac{\phi^*_d}{\phi^*_m} \right)^{\frac{1}{\alpha}} = \left( \frac{(1 - \tau^{1-\sigma})f_d}{f_m - f_d} \right)^{\frac{1}{\alpha(\sigma - 1)}},
\]

(21)

\[
\frac{G_m}{G_x + G_m} = \frac{g_m}{g_x} = \left( \frac{\phi^*_m}{\phi^*_x} \right)^{\frac{1}{\alpha}} = \left( \frac{f_x}{f_m - f_x} \frac{(1 - \tau^{1-\sigma})}{\tau^{1-\sigma}} \right)^{\frac{1}{\alpha(\sigma - 1)}}.
\]

(22)

Equations (21) to (22) show that the share of FDI products does not depend on firm productivity \((\phi)\): conditional on being a multinational firm, the share of FDI products is constant across firms with different productivities. The FDI share does, however, depend on the flexibility of the production technology. Comparing two industries (or firms) that differ only in the flexibility of production (the parameter \(\alpha\)), equations (21) and (22) suggest that the share of FDI products is higher in the industry (firm) with a lower flexibility of production (higher values of \(\alpha\)).\(^{31}\) Intuitively, a lower flexibility of production implies that marginal costs increase faster in distance from the core

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30 This confirms a well-known result in the literature on multi-product firms saying that, as trade costs fall, competition in the domestic market rises such that firms drop products with the highest marginal costs (see, for instance, Eckel and Neary 2010, Bernard et al. 2010 or Mayer et al. 2014).

31 Note that the FDI share (as well as other relative measures of firm performance that follow) does not depend on the economy-wide productivity cut-off \(\phi^*_d\). Therefore, we do not need to consider general equilibrium effects here and can directly compare firms with different values of \(\alpha\). In the presence of general equilibrium effects, however, we could allow \(\alpha\) to vary only at the industry level.
competence, such that marginal varieties exhibit a greater cost disadvantage compared with core varieties. Because FDI products are closest to the core competence, they represent a higher share in total products.

Share of exported products

Next, we analyze a firm’s share of exported products in its total number of products. We distinguish between two different types of firms: firm (1) is a multinational enterprise and firm (2) is an exporter only. The respective shares of exported products are given by

\[
\frac{G^{(1)}_{x}}{G^{(1)}_{d}} = \frac{g_{x} - g_{m}}{g_{d}} = \left( \frac{\phi^{*}_{d}}{\phi^{*}_{x}} \right)^{\frac{1}{\alpha}} - \left( \frac{\phi^{*}_{d}}{\phi^{*}_{m}} \right)^{\frac{1}{\alpha}},
\]

(23)

\[
\frac{G^{(2)}_{x}}{G^{(2)}_{d}} = \frac{g_{x}}{g_{d}} = \left( \frac{\phi^{*}_{d}}{\phi^{*}_{x}} \right)^{\frac{1}{\alpha}}.
\]

(24)

From (23) to (24), it follows that the qualitative effect of production flexibility on export share differs by firm type. Our model predicts that a lower flexibility of production within an industry is associated with a lower share of exported products in multinationals but a higher share of exported products within firms that export only (and do not engage in FDI at the same time). This is because a lower flexibility of production results in a drop of the marginal varieties of a firm, increasing the share of the most productive varieties within the firm’s portfolio. Hence, regarding exporting firms, the share of exported varieties is greater when the flexibility of production is lower. For multinationals, this is different because exported varieties are less efficient than the (core) varieties for which the firm chooses multinational production. Thus, while for exporting-only firms the share of exported products is greater when the flexibility of production is lower, the opposite is true for multinational firms.

Relative sales

Next, we determine the composition of firm sales by domestic, export, and FDI sales. This allows us to compare relative sales by mode of market entry, similar to Helpman et al. (2004). The key difference is that we can compare relative sales not only between but also within firms.32 Similarly to our analysis above,

32 Note that, assuming that firms draw their core productivity from a Pareto distribution with shape parameter \( \kappa \), the ratio of aggregate export sales \( s_{x} \) to aggregate sales via FDI \( s_{m} \) in an industry is given by

\[
\frac{s_{x}}{s_{m}} = \tau^{1-\sigma} \left[ \left( \frac{f_{m} - f_{x}}{f_{x}} \right) \frac{1}{\frac{\kappa - (\sigma - 1)}{\sigma - 1} - 1} \right].
\]
we will again consider the effect of the degree of (in)flexibility of production $(\alpha)$ on the composition of firm sales.

Using the definitions above, domestic and FDI sales of any given product $g$ are given by

$$y_d(\phi) = y_m(\phi) = \sigma f_d \left( \frac{\phi}{\phi_d^*} \right)^{\sigma-1} g^{-\alpha(\sigma-1)},$$

and export sales are given by

$$y_x(\phi) = \sigma \tau^{1-\sigma} f_d \left( \frac{\phi}{\phi_d^*} \right)^{\sigma-1} g^{-\alpha(\sigma-1)}.$$  \hspace{1cm} (25)

Aggregating (at the level of the firm) over the varieties sold in each mode and using the efficiency index defined in equation (6), we can express total sales in the domestic market and abroad via exports and FDI for a firm with productivity $\phi$ as follows:

$$t_d(\phi) = \sigma f_d \left( \frac{\phi}{\phi_d^*} \right)^{\sigma-1} \frac{g_d}{g_d} \left( \frac{g_d}{g_{d+1}} \right)^{-\frac{1}{\sigma-1}},$$

$$t_x(\phi) = \sigma \tau^{1-\sigma} f_d \left( \frac{\phi}{\phi_d^*} \right)^{\sigma-1} \frac{g_x}{g_{x+1}} \left( \frac{g_x}{g_{x+1}} \right)^{-\frac{1}{\sigma-1}},$$

$$t_m(\phi) = \sigma f_d \left( \frac{\phi}{\phi_d^*} \right)^{\sigma-1} \frac{g_m}{g_{m+1}} \left( \frac{g_m}{g_{m+1}} \right)^{-\frac{1}{\sigma-1}}.$$  \hspace{1cm} (27)

Note that the terms $H_k(\phi)^{-(\sigma-1)}$ increase in product scope $g_k$ ($k \in d, x, m$), and, in turn, product scope weakly increases in $\phi$ according to (17) to (19). Hence, total sales in each mode increase in firm productivity $(\phi)$. Using (27) to (29), we can express relative firm-level sales via FDI as follows:

$$\frac{t_m}{t_d} = \frac{H_m}{H_d}, \quad \frac{t_m}{t_x} = \tau^{\sigma-1} \frac{H_m}{H_x}.$$  \hspace{1cm} (30)

This is identical to the corresponding expression in the case of single-product firms (see equation (7) in Helpman et al. 2004). In consequence, all the comparative statics results with respect to cross-sectoral variation in relative export sales derived for single-product firms continue to hold in a framework with multi-product firms. That is, relative export sales decrease in the costs of exporting, $f_x$ and $\tau$, and increase in the fixed cost of FDI, $f_m$. Furthermore, relative export sales are lower in sectors with higher dispersion in firm domestic sales, i.e., those with lower $\kappa$ or greater $\sigma$.

33 To see this, use $y(\phi) = cp = p^{1-\sigma} \beta EP^{\sigma-1}$ and substitute for $p$ using (7) and $(\frac{P}{\tau})^{-1} \beta E = \sigma A$. Using (12), we can express sales in terms of the productivity cut-off $\phi_d^*$. 

According to equation (30), relative sales via FDI, \( \frac{t_m}{t_d} \) and \( \frac{t_m}{t_x} \), increase in relative scopes \( g_m/g_d \) and \( g_m/g_x \) as defined in equations (21) and (22), respectively. Again, production technology governed by the parameter \( \alpha \) plays an important role. As shown above, the relative share of FDI products decreases in the flexibility of production (smaller values of \( \alpha \)). The higher the flexibility of production, the lower the cost differential among varieties within the firm and, hence, the smaller the share of products sold via FDI. In turn, relative FDI sales, according to equation (30), also decrease in production flexibility.

Next, we use (27) to (28) to derive the expression for export sales relative to domestic sales:

\[
\frac{t_x}{t_d} = \tau^{-\sigma} \frac{H_x^{-(\sigma-1)}}{H_d^{-(\sigma-1)}}. 
\]  

(31)

Similar to our discussion regarding relative product scope, the effect of technology depends on whether the firm is a multinational. For firms that conduct FDI, the share of export relative to domestic sales increases in the flexibility of production (smaller \( \alpha \)). The opposite is true for firms that only export. As mentioned above, a greater flexibility increases product scope and hence decreases the sales share of the most productive varieties. Because the most productive varieties are sold via FDI (exports) in multinational (exporting-only) firms, we derive differential effects for the two types of firms.

We summarize the above results in the following two propositions.

**Proposition 3.** For FDI firms (with productivity \( \phi \geq \phi_m^* \)), both the share of products sold via FDI and the share of FDI sales:

(i) decrease in the flexibility of production (smaller \( \alpha \)): \( \partial(g_m/g_d)/\partial \alpha > 0 \), \( \partial(g_m/g_x)/\partial \alpha > 0 \), \( \partial(t_m/t_d)/\partial \alpha > 0 \), \( \partial(t_m/t_x)/\partial \alpha > 0 \),

(ii) are constant in firm productivity \( \phi \),

(iii) increase in \( f_x \), \( \tau \), and

(iv) decrease in \( f_m \).

**Proof.** See appendix A4. This result also holds in general equilibrium. ■

**Proposition 4.** The flexibility of production affects both the share of exported products in total firm products and the share of export sales in domestic sales differently in multinational and exporting-only firms:

(i) For multinational firms (with productivity \( \phi \geq \phi_m^* \)), the share of exported products and the share of export sales increase in flexibility (smaller \( \alpha \)): \( \partial(G_x/G_d)/\partial \alpha < 0 \), \( \partial(t_x/t_d)/\partial \alpha < 0 \).

(ii) For exporting-only firms (with productivity \( \phi_x^* \leq \phi < \phi_m^* \)), the share of exported products and the share of export sales decrease in flexibility (smaller \( \alpha \)): \( \partial(G_x/G_d)/\partial \alpha > 0 \), \( \partial(t_x/t_d)/\partial \alpha > 0 \).

**Proof.** See appendix A5. Again, this result also holds in general equilibrium. ■
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We can test our results in proposition 3(ii) and (iii) using the car data and indeed find empirical support for them. First, we show that, for a given origin–destination–year, the probability of conducting FDI increases in the brand’s domestic market share (which we use as a proxy for productivity), but conditional on serving the foreign market via FDI, the share of FDI products does not. Second, we show that, for a given brand, the share of products sold via FDI increases in the distance to the destination market, which we use as a proxy for trade costs. See appendices A8.2 and A8.3 for details. Unfortunately, we are not able to test our predictions linking the flexibility of production to the relative prevalence of exporting and FDI at the firm level because we lack a proper proxy for the flexibility parameter $\alpha$. Specifically, for the latter, we would have to know the firm’s variable costs as a function of product scope.

3.4. Productivities at the plant level

In this subsection, we compare productivities of parent and affiliate plants of multinational multi-product firms. To do so, we make use again of the efficiency indices defined in equation (6) and used in equations (27) to (29). The respective productivities of the parent ($H_d(\phi)$) and the affiliate plant ($H_m(\phi)$) of a firm with core productivity $\phi$ are given by

$$H_d(\phi) \equiv \left( \sum_{g=1}^{g_d} g^{-\alpha(\sigma-1)} \right)^{-\frac{1}{\sigma-1}} \quad \text{and} \quad H_m(\phi) \equiv \left( \sum_{g=1}^{g_m} g^{-\alpha(\sigma-1)} \right)^{-\frac{1}{\sigma-1}} .$$

Note again that firms face diseconomies of scope such that plant efficiency decreases in the number of produced varieties. Because we determine product scope at the plant level endogenously, our framework provides a rationale for differences in plant-level productivities, which are not present in standard models with single-product firms. Considering the ratio between the efficiency indices of foreign and domestic production ($H_m/H_d$) allows us to analyze relative productivity between the affiliate and the parent company. This ratio is equal to one in a framework with single-product firms (Helpman et al. 2004), whereas it is endogenous and larger than one in our case, i.e., $H_m/H_d \text{MPF} > H_m/H_d \text{SPF} = 1$. In consequence, any shock that affects relative product scope (e.g., globalization or a change in technology) will affect the relative productivity between affiliate and parent plants in our framework. This is an important novel implication of our model. According to our analysis above, core varieties are sold via FDI. Hence, our model implies that affiliates are

34 In our framework, it would be equal to one only in the hypothetical case where $g_m = g_d$, i.e., where all varieties that are sold in the domestic market are also sold abroad via FDI. This case, however, is ruled out by the existence of fixed costs.
more productive than parent plants, which produce a comparatively larger range of domestic products.\footnote{Note that this result is derived in a setting where firms seek foreign market access and is, therefore, valid only for horizontal but not for vertical FDI.}\footnote{Eckel and Irlacher (2017) analyze vertical FDI in a setting of multi-product firms where marginal varieties with low productivities are relocated to save on factor costs. In such a setting, the productivity ranking between domestic and foreign plants is different to the one in our framework.}

We can use our framework to analyze the change in the relative efficiency between affiliates and parents, $H_m / H_d$, in response to changes in underlying parameter values. According to the equations in (32), relative efficiency decreases in the share of FDI products $(g_m / g_d)$ defined in equation (21). Hence, we can directly use previous insights regarding relative product scope in proposition 3 to determine how given changes in cost parameters or technology affect the relative productivity of plants. We summarize our findings in the following proposition.

**Proposition 5.** In a setting with horizontal FDI and multi-product firms, affiliates are more efficient in production than parent firms, i.e., $H_m / H_d > 1$. Any shock that decreases the relative scope of FDI products, $g_m / g_d$, increases the relative productivity advantage of the foreign affiliate.

**Discussion**

The result above is derived on the basis of the efficiency index defined in equation (6), which relies on variable costs only and endogenously adjusts to product scope. Empirical studies, however, often rely on plant sales and revenue-based measures of productivity.\footnote{See, for example, Syverson (2011).}

Comparing foreign sales to domestic sales given by $t_m / t_d = \frac{H_m}{H_d}^{(\sigma-1)}$ shows that foreign sales are lower than domestic sales because varieties sold via FDI are only a subset of all varieties within the firm. Hence, our framework is in line with papers such as Keller and Yeaple (2013) and Tintelnot (2017) that focus on relative sales between headquarters and affiliates. Moreover, in appendix A6, we show that the revenue-based productivity of varieties sold via FDI is lower than the productivity of the respective domestic counterpart.

Throughout our analysis, we have assumed that a firm uses the same technology at home and abroad. Extending the model by a parameter $\mu_{ij} > \mu_{ii} = 1$ that captures iceberg-type communication costs of production in destination $j$ would have two opposing effects on the efficiency index, with an overall effect that is unclear a priori.\footnote{Starting with the seminal contribution by Hymer (1976), the literature on multinationals often assumes a cost disadvantage of foreign production due to...
variety $g$ produced abroad would be lower and given by $\phi_g = \frac{\phi}{\mu_{ij} g^\alpha}$. On the other hand, the efficiency index for the affiliate could even increase because the introduction of communication costs would induce firms to produce fewer (more productive) varieties via FDI and instead export more. To allow a better comparison to the benchmark framework with single-product firms in Helpman et al. (2004), we have abstracted from modelling communication costs in multinational production.

4. Conclusion

In this paper, we analyze the international expansion strategies of multi-product firms. While the most productive firms choose to become multinationals, FDI is not the optimal mode of serving foreign consumers for each variety within a firm. Firms that operate with a flexible manufacturing technology open new affiliates for the production of their core varieties (i.e., the varieties with the highest productivity) and, hence, the largest sales. Exporting is chosen as the optimal mode for varieties with an intermediate productivity. This way, our model is able to rationalize the empirical fact that the most productive firms typically rely simultaneously on both FDI and exporting. After having determined the conditions for the endogenous export versus FDI decision at the product level, we derive a range of comparative statics results with respect to both changes in technology as well as globalization. This is important because understanding the export versus FDI decision at the product level is crucial for productivity at the plant level. Our model suggests that any shock that affects production decisions at the product level also affects the relative productivity between the parent firm and its affiliate. These shocks also determine where the profits of the most profitable core varieties are recorded: at home in the case of exporting or abroad in the case of FDI.

It would be interesting to further test empirically, with the help of suitable data at the firm–product–destination level, our predictions regarding the productivity effects of product reallocations within the boundaries of the firm as well as the role of production technology for the export/FDI mix in multinational firms.

Appendix A: Theoretical and empirical appendix

A1. Non-constant product-specific fixed costs

In this section, we extend our framework by modifying the modelling of product-specific fixed cost for the three different modes ($d$, $x$ and $m$). While communication costs. Note that this parameter would have to be smaller than $\tau$ for FDI to remain an attractive choice for a firm.
in our main analysis fixed costs are independent of scope, we now assume that
fixed costs in each mode may increase or decrease with scope. In particular,
we parameterize the fixed costs for product $g$ in the three different modes as follows:

$$ F_d = f_d g^\delta, \quad F_x(g) = f_x g^\delta, \quad F_m(g) = f_m g^\delta \quad \text{for} \quad \delta \in (-\infty, +\infty). \quad \text{(A1)} $$

The parameter $\delta$ (equal to zero in our main analysis) captures the scope
elasticity of fixed costs. In contrast to $\alpha$, we also allow $\delta$ to take negative
values as long as the following assumption is fulfilled:

**Assumption 2.** $\delta + \alpha (\sigma - 1) > 0$. ■

Assumption 2 ensures that the combined incremental scope costs are
strictly increasing in scope. Introducing the new parameter $\delta$ allows discussing
additional aspects of production technology. On the one hand, negative
values of $\delta$ could imply that different products rely on similar technologies
such that each additional variety may partly use previous investments of
core varieties and, hence, face lower product-specific fixed costs. Analyzing
exporting firms, Steingress (2019) relies on a related modelling of fixed
costs, which decrease with the number of exported products. This intra-firm
spillover effect allows multi-product firms to benefit from economies of scope.
On the other hand, core technologies could be better developed and, hence,
easier to be moved abroad (through exporting or FDI) when $\delta$ is positive. In
this case, fixed costs increase in product scope.

All our propositions continue to hold under this modified technology. To
see this, note that the productivity cut-offs in equations (12) to (14) remain
unaffected, and the new optimal range of products in each mode is given by

$$ g_d = \left(\frac{\phi}{\phi^*_d}\right)^{\frac{1}{\alpha+\sigma/(\sigma-1)}}, \quad g_x = \left(\frac{\phi}{\phi^*_x}\right)^{\frac{1}{\alpha+\sigma/(\sigma-1)}}, \quad \text{and} \quad g_m = \left(\frac{\phi}{\phi^*_m}\right)^{\frac{1}{\alpha+\sigma/(\sigma-1)}}. \quad \text{(A2)} $$

Comparing the optimal scope in each mode in equation (A2) with our results
in equation (20) in the main text shows that the scope elasticity of fixed
costs $\delta$ may both reinforce and counteract the effect of production flexibility $\alpha$. More precisely, optimal scope in each mode will be larger in the case of
intra-firm spillovers ($\delta < 0$) and smaller when firms face diseconomies of scope ($\delta > 0$). Moreover, inspection of equation (A2) shows that the relative impact of production flexibility $\alpha$ and scope elasticity of fixed costs $\delta$ is determined by the elasticity of substitution $\sigma$. Higher values of $\sigma$ (higher substitutability) increase the relative importance of production flexibility $\alpha$ because this parameter directly affects prices (see equation (7)) and, hence, quantities.

When substitutability and, therefore, competition among products is high, a
less flexible production technology (higher values of $\alpha$) will lead to a more
pronounced drop in per-variety sales when moving away from a firm’s core
competence.
A2. Total operating profits

Total operating profits from selling an optimal number of products $G_{id}$, $G_{ix}$ and $G_{im}$ at optimal prices $p_{ijg}$ domestically and via exports and FDI, respectively, are

$$\pi_{id}(\phi) = \max_{G_{id}} \sum_{g_{id}=1}^{G_{id}} \left[ \max_{\{p_{ijg}\}_{g_{id}=1}^{G_{id}}} \left( p_{ijg} - \frac{w_i}{\phi/h(g)} \right) \left( \frac{p_{ijg}}{P_i} \right) \right] \beta \frac{E_i}{P_i},$$

$$\pi_{ix}(\phi) = \max_{G_{ix}} \sum_{g_{ix}=1}^{G_{ix}} \left[ \max_{\{p_{ijg}\}_{g_{ix}=1}^{G_{ix}}} \left( p_{ijg} - \tau_{ij} \frac{w_i}{\phi/h(g)} \right) \left( \frac{p_{ijg}}{P_j} \right) \right] \beta \frac{E_j}{P_j},$$

$$\pi_{im}(\phi) = \max_{G_{im}} \sum_{g_{im}=1}^{G_{im}} \left[ \max_{\{p_{ijg}\}_{g_{im}=1}^{G_{im}}} \left( p_{ijg} - \frac{w_j}{\phi/h(g)} \right) \left( \frac{p_{ijg}}{P_j} \right) \right] \beta \frac{E_j}{P_j}.$$

A3. General equilibrium

Due to free entry, expected profits are zero in equilibrium. That is, expected operating profits of a potential entrant are equal to market entry costs, given by $f_e$:

$$f_e = \int_{\phi_d^*}^{\infty} \Pi_d(\phi, g) dF(\phi) + \int_{\phi_x^*}^{\phi_d^*} \Pi_x(\phi, g) dF(\phi) + \int_{\phi_m^*}^{\infty} \Pi_m(\phi, g) dF(\phi),$$

(A3)

where

$$\Pi_d(\phi, g) \equiv \sum_{g=1}^{g_d} \pi_d(\phi, g), \quad \Pi_x(\phi, g) \equiv \sum_{g=1}^{g_x} \pi_x(\phi, g), \text{ and}$$

$$\Pi_m(\phi, g) \equiv \sum_{g=1}^{g_m} \pi_m(\phi, g) + \sum_{g=g_m+1}^{g_x} \pi_x(\phi, g).$$

Using (9) to (11) to substitute for $\pi_d(\phi, g)$, $\pi_x(\phi, g)$ and $\pi_m(\phi, g)$ and using (17) to (19) to substitute for $g_d$, $g_x$ and $g_m$, the free-entry condition (A3) and the zero-cut-off profit conditions (12) to (14) provide implicit solutions for the cut-off productivities $\phi_d^*$, $\phi_x^*$ and $\phi_m^*$ and for the demand level $A \equiv \frac{1}{\sigma} \left( \frac{\sigma-1}{\sigma} \right)^{\sigma-1} B$, which depends on the range of available varieties via the price index $P$ (see equation (3)).

Averaging first over the $g$th variety produced by all firms and then summing over all $g$ (compare Mayer et al. 2014), we can write$^{38}$

$^{38}$ The bounds of the three integrals correspond to the values of $\phi$ such that $E(\pi_d(g)) \geq 0$ (first integral, lower bound), $E(\pi_x(g)) \geq 0$ and $E(\pi_x(g)) \geq E(\pi_m(g))$ (second integral, lower and upper bound) and $E(\pi_m(g)) \geq E(\pi_x(g))$ (third integral, lower bound).
\[ f_e = \sum_{g=1}^{\infty} \int_{g^a \phi_d^a}^{\infty} (A\phi^{\sigma-1}g^{-\alpha(\sigma-1)} - f_d) dF(\phi) \]
\[ + \sum_{g=1}^{\infty} \int_{g^a \phi_m^a}^{\infty} (A\tau^{1-\sigma}\phi^{\sigma-1}g^{-\alpha(\sigma-1)} - f_x) dF(\phi) \]
\[ + \sum_{g=1}^{\infty} \int_{g^a \phi_m^a}^{\infty} (A\phi^{\sigma-1}g^{-\alpha(\sigma-1)} - f_m) dF(\phi). \quad (A4) \]

To pin down \( \phi_d^* \) (and, hence, \( \phi_x^* \) and \( \phi_m^* \)), consider the free entry condition (A4) and use the zero-cut-off profit conditions (12) to (14) to substitute for \( A = \frac{f_d}{(\phi_d^*)^{\sigma-1}} \), \( A\tau^{1-\sigma} = \frac{f_x}{(\phi_x^*)^{\sigma-1}} \) and \( A(1 - \tau^{1-\sigma}) = \frac{f_m - f_x}{(\phi_m^*)^{\sigma-1}} \). We further assume that firm productivities are drawn from a Pareto distribution following Helpman et al. (2004) with a scale parameter \( \kappa > 1/\alpha \), such that \( F(\phi) = 1 - \phi^{-\kappa} \) with \( dF(\phi) = \kappa\phi^{-\kappa-1} \). Solving for the integrals and simplifying, we get
\[ \phi_d^* = (B\Omega)^{\frac{1}{\kappa}}, \quad (A5) \]

where
\[ B \equiv \frac{\kappa}{f_e} \left( \frac{1}{\kappa - \sigma + 1} - \frac{1}{\kappa} \right) f_d^{\kappa-1} \]
\[ \times \left( f_d^{1-\frac{\kappa}{\sigma-1}} + f_x^{1-\frac{\kappa}{\sigma-1}} \tau^{-\kappa} + (f_m - f_x)^{1-\frac{\kappa}{\sigma-1}} (1 - \tau^{1-\sigma})^{\frac{\kappa}{\sigma-1}} \right) \quad (A6) \]

and
\[ \Omega \equiv \sum_{g=1}^{\infty} g^{-\alpha\kappa}. \]

Note that \( \sum_{g=1}^{\infty} g^{-\alpha\kappa} \) converges because of the assumption that \( \alpha\kappa > 1 \).

**Result.** The cut-off productivity \( \phi_d^* \) increases in response to: (i) greater production flexibility (smaller values of \( \alpha \)) and (ii) a reduction in trade costs, \( f_x \) and \( \tau \). In turn, domestic product scope, \( g_d \), decreases.

**Proof.** Regarding (i), \( \frac{\partial \phi_d^*}{\partial \alpha} < 0 \) directly follows from (A5). Regarding (ii), note that
\[ \frac{\partial \phi_d^*}{\partial f_x} = \frac{1}{\kappa}(B\Omega)^{\frac{1}{\kappa}-1}\Omega \frac{\partial B}{\partial f_x} \quad \text{and} \quad \frac{\partial \phi_d^*}{\partial \tau} = \frac{1}{\kappa}(B\Omega)^{\frac{1}{\kappa}-1}\Omega \frac{\partial B}{\partial \tau}, \]
where
\[ \frac{\partial B}{\partial f_x} = \frac{f_d^{\kappa-1}}{f_e} \left[ -f_x^{\frac{\kappa}{\sigma-1}} \tau^{-\kappa} + (f_m - f_x)^{\frac{\kappa}{\sigma-1}} (1 - \tau^{1-\sigma})^{\frac{\kappa}{\sigma-1}} \right] < 0 \]

39 We assume \( \kappa > \sigma + 1 \). This ensures that the distribution of productivity draws has a finite variance (a Pareto random variable has a finite variance if and only if \( \kappa > 2 \)).
Internationalization strategies of multi-product firms

and

$$\frac{\partial B}{\partial \tau} = \frac{f_{\phi^d}}{f_{\phi^e}} \frac{\sigma - 1}{\kappa - \sigma + 1} \left[-\frac{\sigma - 1}{\tau - \kappa - 1} + (f_m - f_x) \frac{\sigma - 1}{\tau - \sigma + 1} \right] < 0$$

because $f_m > \tau^{\sigma - 1} f_x$. Furthermore, $\frac{\partial g_d}{\partial \phi_d^*} < 0$ according to (20).

A4. Proof of proposition 3

Proof. The share of a firm’s FDI sales, $t_m/t_d$ and $t_m/t_x$, increases in the relative scope for FDI, $g_m/g_d$ and $g_m/g_x$, according to equation (30). Differentiating equation (21) with respect to $\alpha$, we derive

$$\frac{\partial g_m^1}{\partial \alpha} = \frac{1}{\alpha^2} \left( \ln \left( \frac{\phi_d^*}{\phi_d^m} \right) \left( \frac{\phi_d^*}{\phi_d^m} \right)^{\frac{1}{\alpha}} - \ln \left( \frac{\phi_d^*}{\phi_d^m} \right) \left( \frac{\phi_d^*}{\phi_d^m} \right)^{\frac{1}{\alpha}} \right) < 0.$$

Analogously, we can differentiate equation (22) to derive $\frac{\partial g_m^2}{\partial \alpha > 0}$. Note that this result also holds in general equilibrium. The indirect effect of $\alpha$ on the cut-offs in general equilibrium affects both cut-offs in the same way and, hence, cancels out when considering relative cut-offs. A firm’s FDI share also varies with the costs of exporting and FDI. Equations (21) to (22) show that it increases in $f_x$ and $\tau$ and decreases in $f_m$.

A5. Proof of proposition 4

Proof. Relative exports sales $t_x/t_d$ increase in relative export scope $G_x/G_d$ according to equation (31). Differentiating equations (23) and (24) with respect to $\alpha$, we derive

$$\frac{\partial G_x^{(1)}}{\partial \alpha} = -\frac{1}{\alpha^2} \left( \ln \left( \frac{\phi_d^*}{\phi_x^*} \right) \left( \frac{\phi_d^*}{\phi_x^*} \right)^{\frac{1}{\alpha}} - \ln \left( \frac{\phi_d^*}{\phi_m^*} \right) \left( \frac{\phi_d^*}{\phi_m^*} \right)^{\frac{1}{\alpha}} \right) < 0,$$

$$\frac{\partial G_x^{(2)}}{\partial \alpha} = -\frac{1}{\alpha^2} \ln \left( \frac{\phi_d^*}{\phi_x^*} \right) \left( \frac{\phi_d^*}{\phi_x^*} \right)^{\frac{1}{\alpha}} > 0,$$

To see this, note that Assumption 1 implies that $1 > (\phi_d^*/\phi_x^*)(\phi_d^*/\phi_m^*)^{1/\alpha} > (\phi_d^*/\phi_m^*)^{1/\alpha}$. Again, this result also holds in general equilibrium (compare the proof to proposition 3).

A6. Productivities at the plant level

Empirical work often relies on revenue-based measures of productivity. The constant markup (CES preferences) implies that product prices are inversely proportional to product-specific productivity. Hence, revenue per variable input is constant across products. Revenue-based productivity per variety, however, varies because of the fixed production cost. To
see this, we construct an empirically relevant measure of revenue-based productivity of product $g$ for a firm with productivity draw $\phi$. The respective revenue and labour input are given by $r(g) = B\left(\frac{\sigma - 1}{\sigma}\frac{\phi}{\varphi}\right)^{\sigma - 1}$ and $l(g) = f + q(g)\frac{\varphi}{\phi} = f + B\left(\frac{\sigma}{\sigma - 1}\right)^{-\sigma}\left(\frac{\varphi}{\phi}\right)^{1-\sigma}$, where $f = f_d$ in the case of domestic sales and $f = f_m$ when the product is sold via FDI. Revenue-based productivity of product $g$ is then given by

$$\frac{r(g)}{l(g)} = \frac{\sigma}{\sigma - 1}\left[1 - \frac{f}{l(g)}\right]$$

(A7)

The later expression decreases in $f$, as

$$\frac{\partial}{\partial f}\left(\frac{r(g)}{l(g)}\right) = -\frac{\sigma}{\sigma - 1}\frac{q(g)\varphi}{\left(f + q(g)\frac{\varphi}{\phi}\right)^2} < 0.$$  

(A8)

Because $f_m > f_d$, revenue-based productivity of variety $g$ in the foreign affiliate is lower than in the domestic plant.

### A7. The link between firm productivity and the modes of serving foreign markets at the firm–destination level

The Spanish ESEE data distinguish exports and FDI at the level of four broad destination regions: EU, Latin America, OECD (outside EU) and rest of the world. In figure A1, we reorganize the data at the firm–destination–year level and redo the graph from figure 1, which was based on the firm–year level. Again, firms are grouped into US labour productivity deciles, normalized by industry and year.

 Compared with the graph in the main text, the fraction of observations featuring exports and/or FDI is generally lower, reflecting the fact that only a subset of firms is active in all of the four regions. Qualitatively, the pattern is similar, though. In particular, most firms engaged in FDI in a particular region also export to the same region.

### A8. Internationalization strategies of multi-product car producers

#### A8.1. Data source and data preparation

We make use of the anonymized replication data kindly provided by Head and Mayer (2019b), which in turn combine data on the origin–destination flows of car producers collected by the automotive industry consultancy IHS Markit and gravity data assembled from various sources (CEPII, WITS and WTO).  

Specifically, we make use of three different data files provided by Head and Mayer (2019b). First, we use the `Estimating_sample_sourcing_annual_anon.dta`
FIGURE A1 Share of firm–destination observations engaged in exports and/or FDI across productivity deciles [Colour figure can be viewed at wileyonlinelibrary.com.]

data file to reproduce the results pertaining to the number of sourcing locations at the brand–model–destination–year level presented in section 2.1 of Head and Mayer (2019a). In doing so, we also use the n_sources Stata do file provided by the authors. Second, we use the Estimating_sample_sourcing_poisson_anon.dta data file to calculate the corresponding statistics at the brand–destination–year level. This is the data set that Head and Mayer (2019a) use for the sourcing estimates in their section 5.1. Third, we use the estimating_sample_brand_tot_anon.dta data file to obtain information about brand-level market shares across destinations and years.

In all data sets, the following variables have been anonymized: brand, (model), country of assembly, country of sale, country of the headquarter and year. In addition, several variables have been dropped from the original data. Importantly, Estimating_sample_sourcing_annual_anon.dta has been anonymized separately from the other data sets so that it is not possible to link them to each other. The sample restrictions differ slightly. For example, the period of analysis is 2000–2016 for the brand–model–destination–year–level data and 2002–2016 for the brand–destination–year–level data. As a consequence, the number of brand–destination–year observations is smaller in the latter case. This also implies that the frequency distributions of the number of sourcing locations in figure 2 is calculated from largely overlapping, but not identical, samples.

Estimating_sample_sourcing_poisson_anon.dta is organized as a firm-level gravity data set, where the countries of origin are the assembly locations of the brand and the destinations the countries of sale. The data set includes information about the number of car models sourced from origin o that are
sold in destination $n$ as well as standard gravity controls. In addition, the data set also includes gravity-type variables that capture the distance and other bilateral trade frictions between the assembly location and the location of the headquarter. We reorganize the data at the brand–destination–year level such that all trade frictions are between the headquarter location and the destination. In this form, we can merge the data with estimating_sample_brand_tot_anon.dta.

A8.2. The link between productivity and the relative prevalence of exporting and FDI at the firm level

According to proposition 3(ii), for FDI firms, the share of products sold via FDI is constant in firm productivity (whereas the probability of conducting FDI increases in productivity, see proposition 1). We take this prediction to the data by comparing the share of FDI products across brands within the same origin–destination–year. That is, we compare brands from the same headquarter location that serve the same foreign destination market in the same year. We use the log of the domestic market share (in the headquarter location) as a proxy for productivity. We estimate variants of the following regression equation:

$$FDI share_{bnt} = \gamma \ln \text{market share}_b^{\text{home}} + \nu_{ont} + u_{bnt},$$

(A9)

where $b$ denotes the brand, $n$ the destination and $t$ the year. $\gamma$ is the coefficient of interest, while $\nu_{ont}$ is origin–destination–year fixed effects, which account for all monadic and dyadic terms. Standard errors are clustered at the brand level.

Table A1 presents the regression results. Column (1) shows that there is a positive and statistically significant relationship between the domestic market share and the share of products served via FDI in the foreign destination. However, this is due entirely to the extensive margin of conducting FDI (column (2)), while, conditional on serving the market via FDI, the relationship between the share of products sold via FDI and the domestic market share is flat (column (3)), in line with our theoretical prediction.

A8.3. The link between distance and the relative prevalence of exporting and FDI at the firm level

According to proposition 3(iii), the share of products sold via FDI increases in fixed as well as variable trade costs. We take this prediction to the data by analyzing the share of FDI products within the same brand–year across destinations. We focus on the distance between the headquarter location and the destination as a generic proxy for trade costs. In particular, we estimate the following regression equation:

$$FDI share_{bnt} = \delta \ln \text{dist}_{o(b)n} + \mu_{bt} + \eta_{nt} + e_{bnt},$$

(A10)

where $b$ denotes the brand, $n$ the destination, $t$ the year and $o(b)$ the headquarter location of the brand. $\delta$ is the coefficient of interest, while $\mu_{bt}$ and
TABLE A1
Productivity and the share of products served via FDI

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>(1) FDI share</th>
<th>(2) FDI (0/1)</th>
<th>(3) FDI share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log domestic market share</td>
<td>0.084***</td>
<td>0.159***</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>[0.024]</td>
<td>[0.028]</td>
<td>[0.041]</td>
</tr>
<tr>
<td>Origin–destination–year FEs</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample</td>
<td>All</td>
<td>All</td>
<td>FDI &gt; 0</td>
</tr>
<tr>
<td>Observations</td>
<td>32,868</td>
<td>32,868</td>
<td>22,463</td>
</tr>
</tbody>
</table>

NOTES: *p < 0.1, **p < 0.05, ***p < 0.01. Standard errors (clustered at the brand level) in brackets. The dependent variable is the share of products served via FDI in columns (1) and (3) and an FDI dummy variable in column (2). In all cases, FDI comprises both pure horizontal FDI (assembly location in the destination market) and export-platform FDI (assembly location in a third country). All columns exclude observations in the home market of the headquarter. Column (3) restricts attention to observations with positive FDI sales.

TABLE A2
The share of products served via FDI against distance: Gravity estimates

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log distance</td>
<td>0.017***</td>
<td>0.028***</td>
</tr>
<tr>
<td></td>
<td>[0.005]</td>
<td>[0.007]</td>
</tr>
<tr>
<td>Brand–year FEs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Destination–year FEs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample</td>
<td>All</td>
<td>FDI &gt; 0</td>
</tr>
<tr>
<td>Observations</td>
<td>37,699</td>
<td>26,082</td>
</tr>
</tbody>
</table>

NOTES: *p < 0.1, **p < 0.05, ***p < 0.01. Standard errors (clustered at the origin–destination level) in brackets. The dependent variable is the share of products served via FDI at the brand–destination–year level, where FDI comprises both pure horizontal FDI (assembly location in the destination market) and export-platform FDI (assembly location in a third country). Both columns exclude observations in the home market of the headquarter. Column (2) restricts attention to observations with positive FDI sales.

η_{nt} are brand–year and destination–year fixed effects, respectively. Standard errors are clustered at the origin–destination level.

Table A2 presents the regression results, and figure A2 shows the corresponding binscatter plot.\(^{41}\) There is a positive and statistically

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\(^{41}\) The number of observations differs between tables A1 and A2. This is for two reasons. First, regressions in table A1 include only brands that serve the domestic market (and hence have a positive market share). Second, singleton observations, which are dropped from the estimation, differ between the two specifications because the latter include different types of fixed effects.
significant relationship between distance and the share of products served via FDI, in line with our theoretical prediction.

**Supporting information**

The data and code that support the findings of this study are available in the Canadian Journal of Economics Dataverse at [https://doi.org/10.5683/SP3/I0GRQR](https://doi.org/10.5683/SP3/I0GRQR).

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