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The life-cycle dynamics of exporters and multinational firms

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ABSTRACT

This paper studies the life-cycle dynamics of exporters and multinational enterprises (MNEs). Using rich firm-level data, we document a comprehensive set of facts on entry, exit, and growth of new exporters and new MNEs. Guided by these facts, we build a model based on the standard proximity-concentration trade-off extended to incorporate time-varying firm productivity and sunk costs of MNE entry. The calibrated version of the model goes far in matching cross-sectional and dynamic moments of the data on exporters and MNEs. Our results point to much higher sunk costs for MNE than for export activities. Finally, we show how including the choice to become an MNE affects the predicted export dynamics after a trade liberalization episode.

1. Introduction

Exporters' life-cycle dynamics are important to understand the long- and short-term effects of economic shocks and trade policy changes. In consequence, they have been extensively studied. However, exporting is only one possible option for firms to serve a foreign market. Firms may also choose to become multinational enterprises (henceforth, MNEs). Despite the overwhelming importance of these firms in the data, we know comparatively little about the life-cycle dynamics of MNEs and their possible interaction with exporter dynamics.[1]

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[1] MNE affiliates' global sales are twice as large as global exports, and they account for disproportionally large shares of aggregate output and employment in many countries (Antrás and Yeaple, 2014).

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This paper studies the life-cycle dynamics of exporters and MNEs. We exploit data on domestic firms, exporters, and MNEs from France and Norway and complement them with data on MNEs from Germany. Using these rich firm-level data, we first provide a comprehensive set of facts on the life-cycle dynamics of new exporters and new MNEs. First, the exit rates of new exporters in a foreign market are two to three times higher than those of new affiliates of MNEs in the same market. Second, conditional on survival in the market, average sales growth is similar for new exporters and new MNEs. However, the export growth profiles of exporters that switch to serving the market as MNEs are steeper than those of exporters that do not switch to MNE status. Finally, the exit rates of exporters at age one exhibit gravity—they are strongly correlated negatively with foreign market size and positively with distance—whereas those of young MNE affiliates are uncorrelated with these foreign country characteristics. In contrast, entry rates do not present stark differences in their gravity patterns between the two groups. Our findings are strikingly very similar across the three economies under study, despite their different size and structure.

Guided by the facts, we develop a dynamic model of trade and foreign direct investment (FDI) based on the static model of the proximity-concentration trade-off in Helpman et al. (2004, henceforth, HMY). We introduce dynamics into the model by assuming that firm productivity evolves according to a Markov process and that MNE activities face a sunk entry cost. The model preserves the ranking of the export and MNE choice from the static model: the most productive firms become MNEs; firms with intermediate productivity levels become exporters; and the least productive firms serve only their home market. The sunk costs of MNE activities lead to a band of inaction, a range of productivity levels where existing MNEs do not exit a market, but non-MNEs with the same productivity do not enter. We show that the model is rich enough to *qualitatively* capture the facts we document.

In the calibrated version of the model, we incorporate sunk export costs and assume that fixed and sunk costs for both MNE and export activities are heterogeneous at the firm-destination level. We evaluate the *quantitative* fit of this model where HMY is coupled with dynamics features of Roberts and Tybout (1997). Although we do not target the exit and growth profiles of new exporters and new MNEs, nor the transition probabilities between domestic, exporter, and MNE status, the calibrated model captures the patterns observed in the data fairly well.

Our calibration shows that sunk MNE costs are much higher than sunk export costs: conditional on entry, the average sunk MNE cost across destinations represents 21.4% of the median French MNE's affiliate annual sales, while the average sunk export cost across destinations is less than 1% of the median exporter's annual sales to a destination. Similarly for Norway, conditional on entry, the average sunk MNE cost across destinations represents 26.8% of the median Norwegian MNE annual affiliate sales, with a very small estimated sunk export cost per destination. Across destinations, the average fixed cost for an affiliate represents about 10% of the median Norwegian MNE affiliate sales, whereas the annual fixed export cost represents around 15% of the median Norwegian annual export sales to a destination. The median affiliate sales, however, are two orders of magnitude larger than the median export sales.

We evaluate the predictions of our calibrated model after a hypothetical trade-liberalization episode. We compare the predictions of our model with both exporters and MNEs to a calibrated version of the model with only exporters. Enriching the canonical dynamic model of trade to include MNEs—a first-order feature of the data—has consequences for the behavior of exporters. The main source of the different responses of exporters between the two models hinges on the right truncation induced by the inclusion of the MNE choice. Without the MNE choice, the most productive firms are exporters, as in the static model in Melitz (2003); with the MNE choice, the most productive firms become MNEs, as in HMY. In a dynamic setup, including the MNE choice not only truncates the exporters' distribution of productivity levels but also induces a higher exit likelihood for the most productive exporters, along with a truncation to the right of the distribution of growth rates. The fastest-growing exporters exit exporting and become MNEs when that option is allowed, whereas the slowest-growing exporters remain exporters. Those exporters with the highest productivity growth do not contribute to the average growth rate of exporters in the model with MNEs—because they change status—but they do so in the model in which the MNE option is not included.[2] While we find significant quantitative differences in the aggregate response of exporters to a trade-liberalization shock, we find only moderate differences in the life-cycle growth profiles of exporters between the models with and without MNEs.

Our paper contributes to several strands of the literature. First, we contribute to the small but growing literature that studies the joint behavior of exporters and MNEs using dynamic models. Ramondo et al. (2013), Fillat and Garetto (2015), and Conconi et al. (2016), among others, document and study different implications of the proximity-concentration trade-off in dynamic setups. We present new evidence and study implications related to the joint life-cycle behavior of exporters and MNEs.[3]

Second, we complement the extensive literature that studies exporters' dynamics. Early work by Baldwin (1989), Baldwin and Krugman (1989), and Dixit (1989), followed by Roberts and Tybout (1997), Ghironi and Melitz (2005), Das et al. (2007), Alessandria and Choi (2007), and Impullitti et al. (2013), point to the importance of the hysteresis created by sunk investments

[2] This mechanism hinges on the assumption that exporters that become MNEs abandon exports to serve a foreign market. We find that exports relative to total sales in a foreign destination decrease sharply after MNE entry, consistent with the evidence documented by Belderbos and Sleuwaegen (1998), Bloningen (2001), and Head and Ries (2001), which use detailed firm- and product-level data.

[3] Ramondo et al. (2013) include aggregate uncertainty into a two-period model of trade and FDI to analyze how the properties of the international business cycle affect the choice of the entry mode into foreign markets. Fillat and Garetto (2015) include aggregate uncertainty and sunk entry cost to study the consequences for asset pricing. Conconi et al. (2016) include a learning mechanism to explain that most firms enter foreign markets as exporters before opening an affiliate there. Early work by Rob and Vettas (2003) features demand uncertainty together with capacity constraints to study the mechanism behind the choice of firms to simultaneously export to and maintain affiliates in the same market.

for understanding the effects of temporary and permanent shocks on aggregate trade flows and exchange rate movements. Our model combines elements of this rich dynamic literature on exporters with the canonical model of trade and FDI in HMY.

Our paper is closely related to Ruhl and Willis (2017), who document a set of life-cycle dynamics facts for Colombian exporters. We document a similar set of facts for new French and Norwegian exporters but also include facts for new MNEs. We find, as they do, that matching the observed patterns of survival and growth of new exporters requires very low sunk export costs, but this is not the case for MNEs. While they expand the canonical export model to include demand-side frictions, we include MNEs, a first-order feature of the data. We evaluate how far the model with MNEs goes in matching the data and whether the presence of MNEs changes the dynamic behavior of new exporters.[4]

The paper proceeds as follows. Section 2 describes the data, Section 3 documents the facts, Section 4 describes the model, Section 5 presents the calibration, Section 6 presents the counterfactual exercises, and Section 7 concludes.

2. Data

Our empirical analysis is based on rich firm-level panel datasets from France, Norway, and Germany. The French and Norwegian data contain information on domestic firms, exporters, and MNEs in varying levels of detail. In contrast, the German data contain extremely detailed information on the foreign affiliates of German MNEs but do not provide any information on exporters and domestic firms. Our analysis exploits the strengths of each of the three data sources, all of which cover a period of more than 10 years.

2.1. France

The data span the years 1999–2011 and combine information from several sources. Information on a firm's domestic sales is from FICUS (1999–2007) and FARE (2008–2011); the export data are from the French customs; information on ownership links between firms in France and between firms in France and abroad are from LiFi; and information on foreign affiliate sales is from OFATS (2007, 2009–2011). We restrict the sample to firms that are subject to the BRN taxation regime and, for some of the analysis, to the subperiod 1999–2007.[5]

The data contain information on each firm's domestic sales and export sales by destination, as well as the location of foreign affiliates of French MNEs. Information on foreign affiliate sales is available only for a subset of large MNEs and for some (non-consecutive) years.[6] While affiliate sales are recorded annually, exports are recorded monthly. Following Kleinert et al. (2015), we consolidate the information on domestic activities, exports, and foreign affiliates to the level of the French group (i.e., if firms A and B belong to firm C, we consolidate all three firms). We keep a consolidated firm in the sample if at least one of its domestic members is active in the manufacturing sector in at least 1 year.[7] For independent firms, we focus on those that operate in the manufacturing sector in at least 1 year. Our sample contains only firms headquartered in France and excludes French affiliates of foreign MNEs.

We consider MNE-country pairs and exporter-country pairs with multiple entry and exit over the sample period.[8] We restrict our attention to majority-owned affiliates of French MNEs, which account for around 80% of all affiliates of French MNEs. We aggregate both exports and FDI at the parent firm-foreign destination-year level. We end up with a sample of 963,375 firm-year observations. The upper panel of Appendix Table F.1 shows that 1.6% of firms in our sample are MNEs and 28.7% are non-MNE exporters. French MNEs account for almost 60% of employment in our sample, while non-MNE exporters account for more than 30%. The median (mean) French MNE operates in two (five) markets, with a handful of MNEs serving more than 81 markets, while the median (mean) exporter serves four (ten) markets, with some exporters serving more than 178 markets (top-coded to preserve confidentiality).

[4] The literature on the life cycle of domestic firms (summarized by Haltiwanger et al., 2013) and the literature on exporters find that models with a AR(1) firm-level productivity process, as in Hopenhayn (1992), deliver new firms that grow too large too quickly. Both literatures have resorted to demand frictions to slow down firm growth (see Foster et al. (2016) for domestic firms). In relation to exporters' growth driven by demand factors, papers such as Albornoz et al. (2012), Eaton et al. (2014), and Morales et al. (2019) focus on the dynamics of trade associated with learning. Arkolakis (2016) includes the cost of building a customer base in a dynamic model of trade. Fitzgerald et al. (2017) evaluate the importance of demand-learning firm growth versus customer-based firm growth to explain the life-cycle dynamics of firm export quantities and export prices. Araujo et al. (2016) document that in markets with better contracting institutions, new exporters start bigger but grow slower (conditional on survival). They propose a framework in which imperfect contract enforcement, together with imperfect information (and previous export experience in other foreign markets), interact to match the observed pattern of exporter growth and survival.

[5] The FICUS/FARE databases provide balance sheet data on virtually all French firms. The principal data source is firms' tax statements. The BRN regime applies to larger firms. We conducted our analysis also including all firms. As small firms rarely export or conduct FDI, results are very similar. The period restriction is made to avoid structural breaks in the time series, as both the industry classification and the definition of the domestic sales variable changed in 2008.

[6] OFATS is a survey of French MNEs with affiliates outside of the European Union. The sample is biased toward large MNEs, as a comparison of domestic sales for MNEs in OFATS and the other sources reveals.

[7] This consolidation implies that wholesale firms in France may be part of our sample, which is important because large French groups often channel exports through wholesale affiliates.

[8] Restricting the sample to MNE-country and exporter-country pairs with a single entry and exit over the sample period yields very similar results.

2.2. Norway

The data, which span the years 1996–2006, include information on each firm's domestic sales, as well as export and foreign affiliate sales by destination country. The data nest balance sheet information on firms in the Norwegian manufacturing sector from Statistics Norway's Capital Database; information on exporters from customs declarations; and data on firms' foreign operations from the Directorate of Taxes' Foreign Company Report. The coverage is comprehensive: all foreign affiliates of Norwegian firms in the manufacturing sector, as well as 90% of Norwegian manufacturing revenues, are included; firms in the oil sector are excluded.

We consider MNE-country pairs and exporter-country pairs with multiple entry and exit over the sample period. We include both majority- and minority-owned foreign affiliates of Norwegian parents and adjust the affiliate sales by the parent's ownership share.[9] Our sample consists of 89,018 firm-year observations. As the lower panel of Appendix Table F.1 shows, only 1.5% of Norwegian firms have affiliates abroad, and 36.4% are non-MNE exporters. Norwegian MNEs represent more than 13% of total manufacturing employment in Norway, while exporters represent 63%. The median (mean) Norwegian MNE operates in two (four) markets, with a maximum at 37 markets, while the median (mean) exporter serves three (seven) markets, with a maximum of 122 markets.

2.3. Germany

The data, which span the years 1999–2011, contain detailed balance sheet information about foreign affiliates of German MNEs. The main data source is the Micro-database Direct investment (MiDi; see Schild and Walter, 2015). Information about parent firms is limited; for instance, it is not possible to distinguish between domestic and export sales of the parent.

We consolidate the information on direct and indirect ownership shares and restrict our attention to majority-owned affiliates, which represent 95% of foreign affiliates of German MNEs and affiliates whose parent operates in the manufacturing sector or whose parent is a holding company belonging to a corporate group in the manufacturing sector in at least 1 year.[10] We consolidate affiliates at the parent firm-foreign destination-year level and end up with a sample of 37,843 parent-year observations. Only 0.21% of German firms have affiliates abroad, but they account for 27% of total sales in Germany (Buch et al., 2005). The median (mean) German MNE operates in one (three) country(ies), with some parents operating in more than 27 markets (top-coded to preserve confidentiality).

3. Facts on the life-cycle dynamics of exporters and MNEs

We document three novel facts about the life-cycle dynamics of MNEs and exporters. First, we show the life-cycle patterns of exit rates. Second, we present evidence on life-cycle growth. Third, we document the relation between exit and entry rates across destination markets and the characteristics of those markets. Taken together, these facts are informative about the features to be included in a dynamic model of exports and FDI, and we explain this connection in more detail below.

We study the behavior of new firms that start exporting to—or open an affiliate in—a foreign country. We focus on the firm's main mode of international operation and distinguish between non-MNE exporters and MNEs. That is, only firms that are not MNEs are considered exporters to a foreign destination, whereas firms with foreign operations in a market are considered MNEs whether or not they export contemporaneously to the same foreign destination. This distinction is motivated by the observation that FDI is the dominant mode of serving the foreign market after MNE entry. Appendix Fig. E.1 shows that the average ratio of exports to total foreign sales decreases from 100% to around 10% in 3 years after a firm opens its first affiliate in a market and that around 10% of MNEs with exports to that market before MNE entry completely discontinue exporting in 2 years after they switch to FDI.

Our facts are based on observations at the firm-destination-year level. For expositional purposes, in the body of the paper, we present figures that show averages across the destinations, weighted by each destination's share of export (MNE) firms. Appendix Table F.2 contains the results of ordinary least squares (OLS) regressions that include a battery of fixed effects and additional controls.

3.1. Exit rates

We first study the exit patterns of new exporters and new MNEs. We focus on exit from the current mode of international operation and a foreign country.

Fig. 1 plots the exit rates of exporters and MNEs at the firm-destination level by age. Exit rates are calculated as the number of MNEs (exporters) that exit a given destination relative to the number of active MNEs (exporters) in that destination at each age. Age refers to the number of years after entry in a given market-mode, with age in the entry year equal to zero. The figure presents averages across all firm-destination pairs.

[9] A 20% ownership threshold, not 10%, is used to distinguish direct from portfolio investment. The ownership shares considered for Norway are lower than the ones for France (20 versus 50%) in order to gain observations.

[10] Reporting foreign investments to the German central bank is compulsory, but the reporting requirements change over time. We adjust the sample to unify thresholds: we include only affiliates with either a participation of 10% and revenues of at least ten million DM (euro equivalent) or with participation of at least 50% and revenues of at least three million euro. We consolidate ownership shares and restrict the sample to majority-owned affiliates only after unifying the reporting threshold.

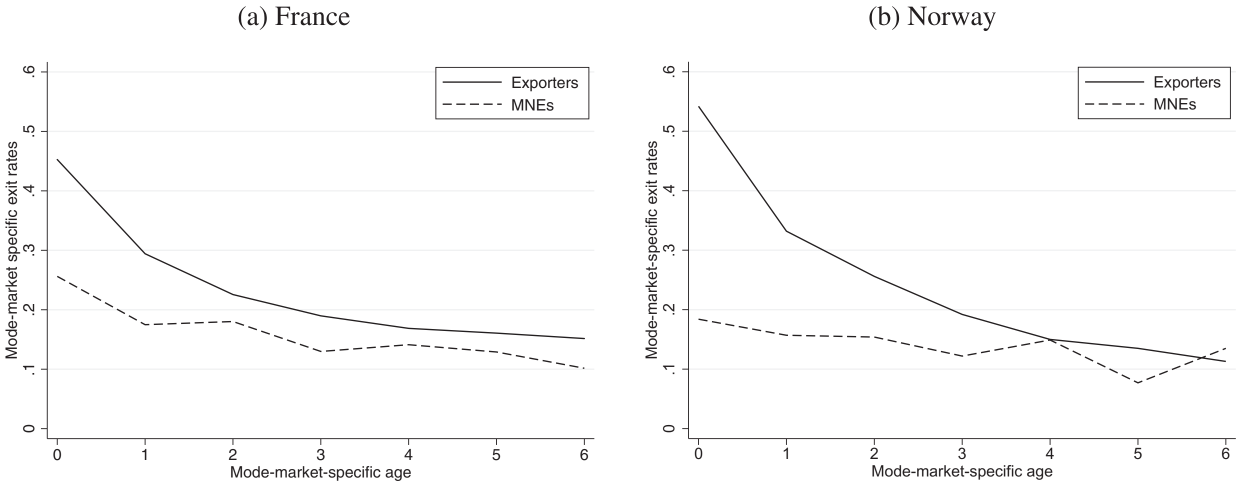


Fig. 1. Exit rates by age. Notes: Number of exits from a mode-market relative to the number of firms active in a mode-market, by mode-market-specific age, for exporters and MNEs. Observations are at the firm-destination-year level. We show averages across destinations weighted by each destination's share of export (MNE) firms. Exporters refers to non-MNE exporters.

On average, MNEs in a foreign market have between one-third and one-half of the exit rates of exporters in their first year of life. For both modes of internationalization, exit rates are declining with age, though more drastically for exporters. It is remarkable that results are qualitatively and quantitatively similar between France and Norway.[11]

A formal test confirms that French exporters are around 15 percentage points more likely to exit than foreign affiliates of French MNEs in the first 2 years after entry, but the difference disappears later in life. For Norway, the difference in exit rates between exporters and MNEs is 30 percentage points at entry, but, after 2 years, the difference is not statistically different from zero. This finding is summarized in Appendix Fig. E.2.

A reasonable conjecture is that having experienced a destination market as an exporter before entering with an MNE affiliate has an effect on the chances of survival in that market. We explore this evidence in Fig. 2. We define an "experienced MNE" as an MNE that exported to a given destination market in any year before opening a foreign affiliate there.[12] The exit rate of experienced MNEs is almost 10 percentage points lower, on average, in the first year after entry relative to the exit rate of new affiliates without export experience. However, this advantage disappears later in life (see also Appendix Fig. E.3).

We conclude that:

3.1.1. Fact 1

New MNEs in a foreign destination have lower exit rates than new exporters in that destination. MNEs with previous export experience in a market have lower exit rates at entry than MNEs without that experience.

The large difference between the exit rates of exporters and MNEs suggests the presence of sunk costs of MNEs that are much higher than the sunk costs of exporting. Additionally, the co-existence of experienced and non-experienced MNEs supports an HMY-type model with time-varying firm productivity.

3.1.2. Robustness

One may be concerned that the differences in exit rates documented in Fig. 1 are not due to differences between the two modes of internationalization, but that they are artifacts of definitions of age and exit. Firms may switch between modes so that exporters become MNEs, and MNEs become exporters, for example. To exclude the possibility that such patterns are driving our results, we present two robustness results using the French data. First, we recompute age as the number of years that the firm is active in a market, regardless of its international mode of operation; that is, we compute market-specific, rather than mode-market-specific, age. Second, we redefine exit as complete exit from the market rather than as exit from either exporting or MNE activities in a market. Baseline results still hold, as columns (3) and (4) in Appendix Table F.2 show. Additionally, one may be concerned that the entry mode of FDI plays a role: if MNEs enter a market through merger and acquisition (M&A), they take over pre-existing domestic firms, whereas Greenfield affiliates are, by definition, brand-new firms. Using the data from Germany, Appendix Fig. E.5a shows that there is no difference in exit rates between the two modes of entry of foreign affiliates of German MNEs.[13]

[11] Eaton et al. (2008) document similar exit rates for new Colombian exporters at the firm-destination level. In unreported evidence, we find that the exit patterns of new MNEs from Germany are also remarkably similar to the patterns found for French and Norwegian MNEs.

[12] Experienced MNEs represent almost 60% of new MNEs for France (47% for Norway).

[13] In unreported results for France, we find that our baseline results are robust to: splitting the sample into European Single Market (ESM) and non-ESM countries to address concerns about the different reporting thresholds for exports to EU and non-EU members; using the unconsolidated rather than the consolidated data; splitting the sample into the 1999–2005 and 2006–2011 periods; including cohort, rather than year, fixed effects; and correcting for partial-year effects. Additionally, results at the firm level are very similar to results at the firm-destination level.

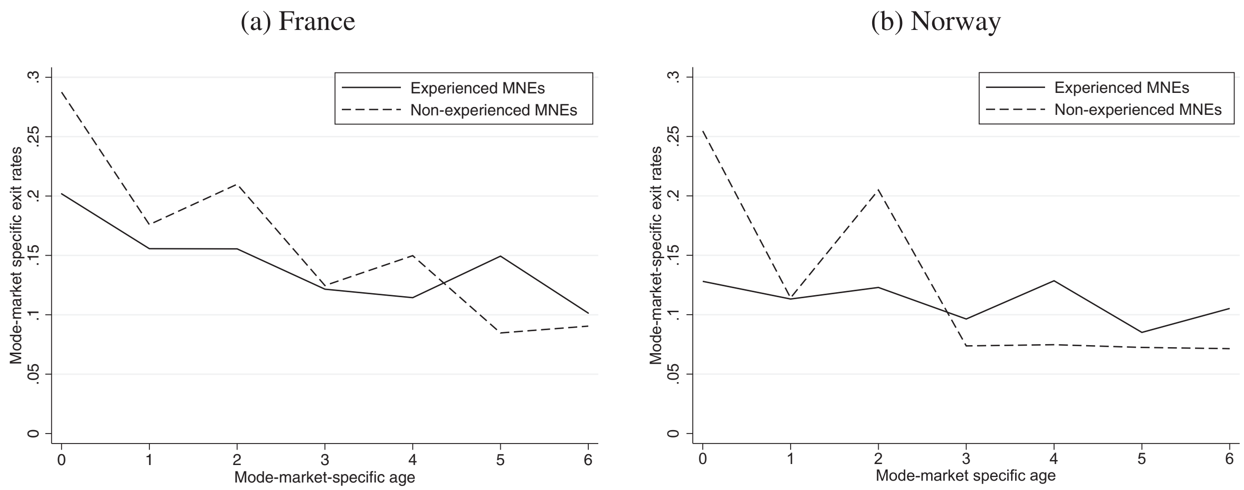


Fig. 2. Exit rates by age: experienced versus non-experienced MNEs. Notes: Number of exits from a mode-market relative to the number of firms active in a mode-market, by mode-market-specific age. Experienced MNEs are new affiliates of MNEs that exported to a foreign market for one or more years before opening an affiliate there. Observations are at the firm-destination-year level. We show averages across destinations weighted by each destination's share of MNE firms.

3.2. Sales growth

Fig. 3 shows the sales growth of exporters and MNE affiliates by age. We focus on firms that survive for at least 4 years in a mode-market and demean the firm-destination observations by industry, year, and destination fixed effects. We normalize sales with respect to 1 year after entry because the entry year may be contaminated, particularly for exporters, by the so-called partial-year effects—artificially high first-year growth rates attributed to firms that start operations in the middle of the calendar year (see Bernard et al., 2017). Columns (5) and (6) in Appendix Table F.2 show the OLS results.

Fig. 3 shows that foreign sales grow at similar rates for French exporters, Norwegian exporters, and Norwegian MNEs, conditional on surviving for at least 4 years in the market. Growth rates are markedly different only between age zero and age one, but as outlined, this difference is likely attributable to partial-year effects.[14]

Lumping together exporters that eventually become MNEs with the ones that never do may mask substantial heterogeneity. Fig. 4 shows that, in the French data, the group of exporters that switch to FDI to serve a given market ("ever-MNE" exporters) clearly grow faster, in terms of exports, in the years previous to MNE entry, than the exporters that never become MNE ("never-MNE" exporters). In the Norwegian data, the difference is less marked, but the number of observations also decreases substantially.

We conclude that:

3.2.1. Fact 2

Average life-cycle sales growth is similar for exporters and MNEs. However, ever-MNE exporters grow, on average, much faster before MNE entry than do never-MNE exporters.

The similarity between export and affiliate sales growth suggests that productivity evolves in a similar way for exporters, parents, and affiliates of MNEs. The higher export sales growth of ever-MNEs relative to never-MNEs supports a strong role for self-selection of firms into the different modes of internationalization, as in HMY.

3.2.2. Robustness

One may be concerned that normalizing sales growth by the year after entry is not sufficient to adequately account for partial-year effects. As the French data contain monthly export sales, we can correct for partial-year effects by calculating 12-month growth rates (as also done by Bernard et al., 2017). A comparison of columns (5) and (7) in Appendix Table F.2 confirms that the entry year does seem contaminated by these effects: growth at age one is much higher for the calendar-year data than for the adjusted data; for subsequent ages, growth rates are quite similar, which supports the age-one normalization in Fig. 3.

To document the selection induced by non-random survival, Appendix Fig. E.4 shows growth profiles by tenure in the market. As expected, firms that survive longer grow faster. The differences are less pronounced for MNEs, but for all tenure lengths, exports from age one onward grow at rates similar to MNE sales.

Finally, one may rightly be concerned that sales growth rates of new MNEs differ between new MNE affiliates that enter the market through M&A versus Greenfield FDI. One may expect that, as brand-new firms, affiliates created through Greenfield FDI

[14] Unreported evidence for Germany shows that sales profiles of German MNEs are quite similar to the ones of Norwegian MNEs.

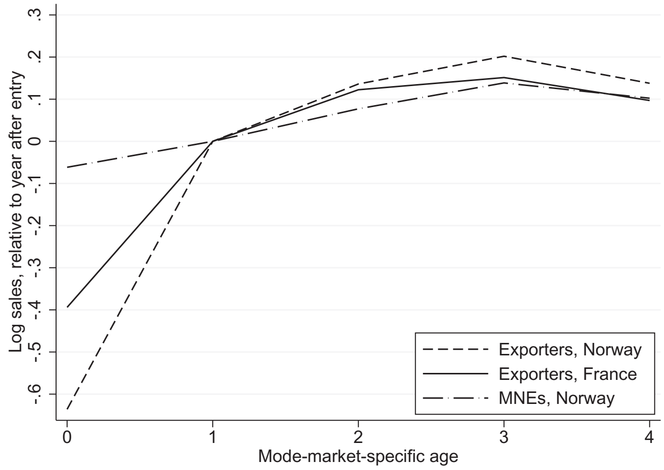


Fig. 3. Sales growth by age. Notes: Log of firm-destination export (affiliate) sales with respect to firm-destination export (affiliate) sales in the year after entry. Firms have five or more years in the market. Observations are at the firm-destination-year level. We show averages across destinations weighted by each destination's share of export (MNE) firms. Log of sales are first demeaned by industry, year, and destination fixed effects. Exporters refers to non-MNE exporters.

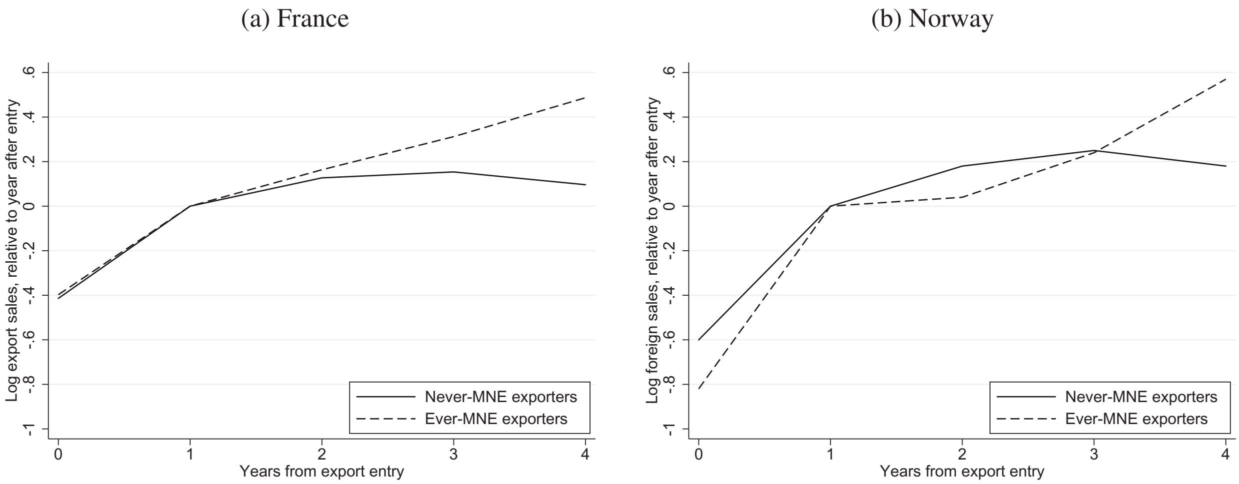


Fig. 4. Exporters' sales growth by age and type. Notes: Log of firm-destination export sales with respect to firm-destination export sales in the year after export entry, for firms with five or more years in the market as exporters. Observations are at the firm-destination-year level. We show averages across destinations weighted by each destination's share of export firms. Log of sales are first demeaned by industry, year, and destination fixed effects. Never-MNE exporters are exporters that, in our sample period, do not change to MNE status. Ever-MNE exporters are exporters that become MNEs after export entry. Exports for ever-MNE exporters are computed for the years before MNE entry, for exporters that enter MNE status after exporting for 4 years into a given market.

grow faster than affiliates created through M&As, which are older.[15] Using the German data, Appendix Fig. E.5b shows that, as expected, MNEs that enter through M&A grow less than MNEs that enter a market with a Greenfield project. Nonetheless, the differences are not large if one disregards the entry year, again supporting our normalization choice in Fig. 3.

3.3. Entry, exit, and gravity

The previous two facts pool firms across different destination countries. Country characteristics, however, may be an important determinant of a firm's development over its life cycle. To explore this issue, we study the correlation between first-year exit rates and entry rates of exporters and MNEs, and two country characteristics that are prominent in the international trade literature: the size of the destination country, as measured by GDP, and the distance of the destination country from the firm's home country. Our finding is that:

[15] Part of the higher growth rate may be due to partial-year effects for MNEs because some affiliates may start operating later in the year rather than January.

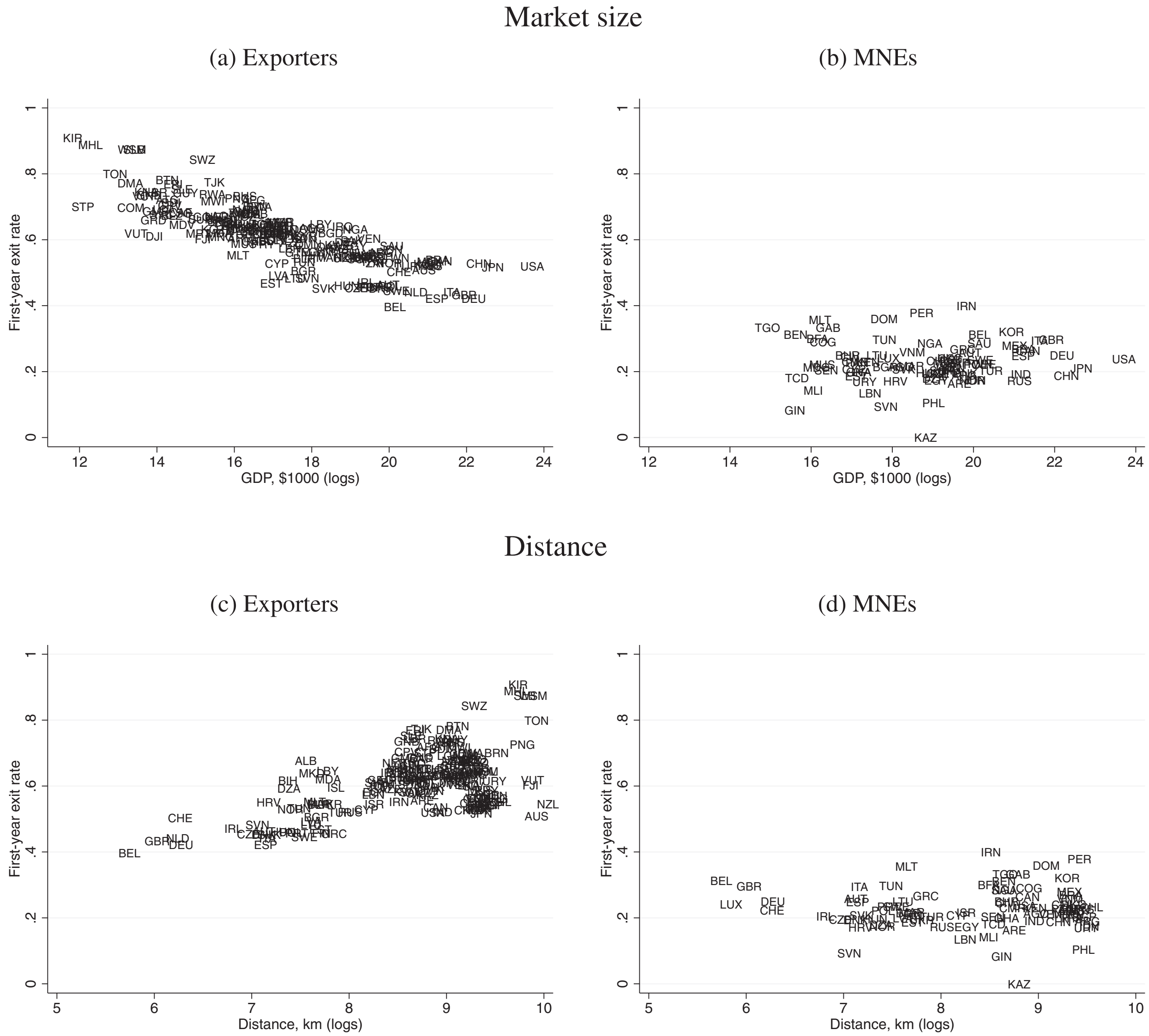


Fig. 5. First-year exit rates and market characteristics, France. Notes: Number of exits from a mode-market relative to the number of firms active in a mode-market, for exporters and MNEs, in the first year upon mode-market entry (i.e., age zero). Destinations with ten or more firm-year observations and with available GDP data. Exporters refers to non-MNE exporters. GDP data from *International Financial Statistics* (IMF). Distance data from *CEPII* (Mayer and Zignago, 2011).

3.3.1. Fact 3

First-year exit rates of exporters exhibit gravity, whereas those of MNEs do not. Entry rates for both exporters and MNEs exhibit gravity.

Fig. 5 shows scatter plots of first-year exit rates against market size (upper panels) and distance (lower panels) for France. We restrict the sample to countries with at least ten firm-destination observations. We relegate results for Norway, which are extremely similar, to Appendix Fig. E.6.

The cross-country patterns of first-year exit between the two modes of international operation are strikingly different: while exporters operating in smaller and more distant markets are more likely to stop operations right after entry, it is not clear that affiliates of MNEs do.[16] An OLS regression shows that the exit probability increases by almost seven percentage points when distance doubles, and it decreases by 3.4 percentage points when GDP doubles, with both coefficients significant at the 1% level. In contrast, the effects of GDP and distance on the exit rates of MNE affiliates are insignificant.

[16] Using data from Argentina, Albornoz et al. (2016) document a similar pattern for exporters: survival probabilities decrease with distance. They rationalize this finding with a model in which sunk export costs increase with distance proportionally less than fixed costs.

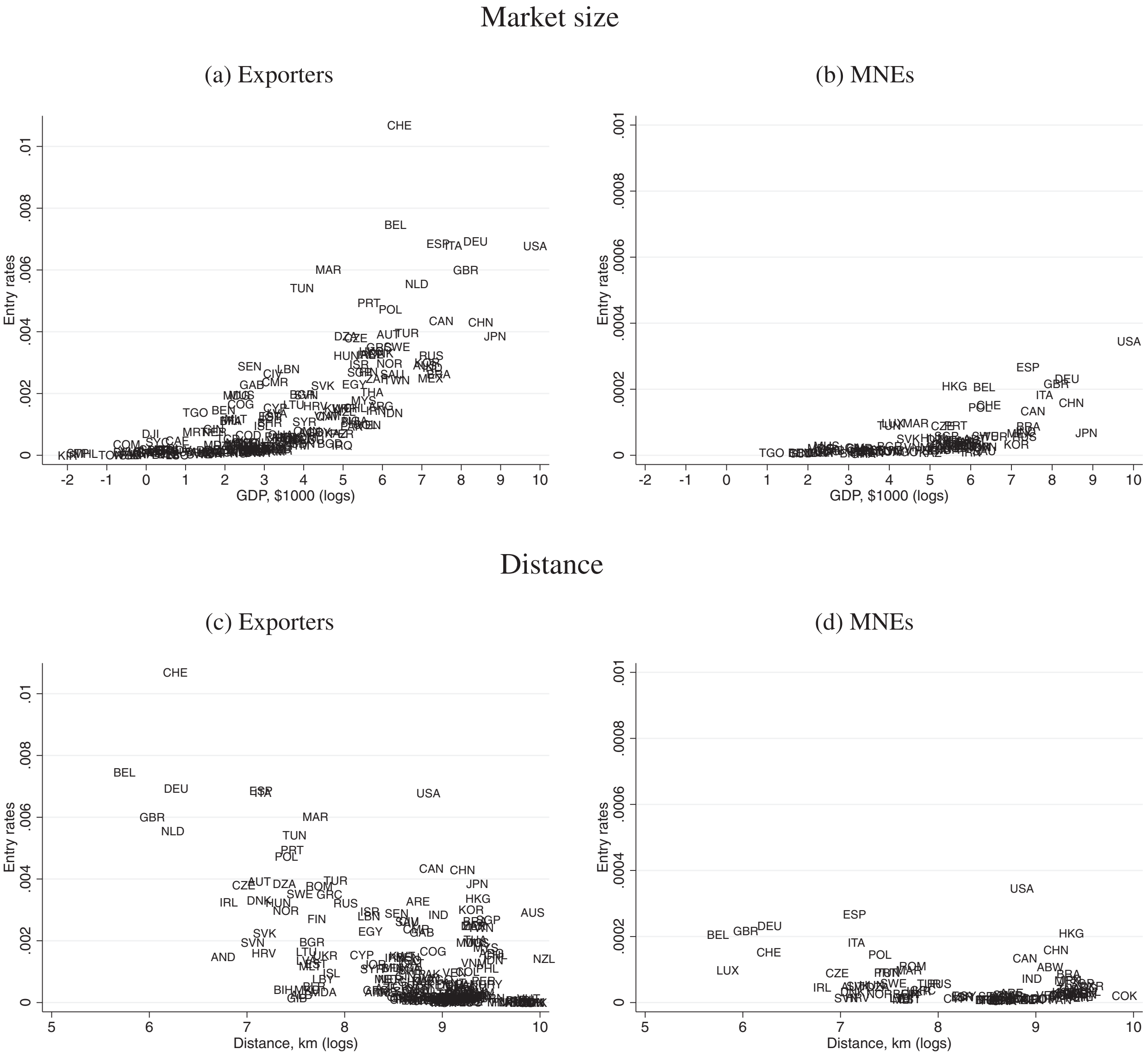


Fig. 6. Entry rates and market characteristics, France. Notes: Number of entries to a mode-market relative to the number of domestic firms active in the home market. Destinations with ten or more firm-year observations and with available GDP data. Exporters refers to non-MNE exporters. GDP data from *International Financial Statistics* (IMF). Distance data from *CEPII* (Mayer and Zignago, 2011).

Fig. 6 shows the same scatter plots for the entry rates. Unlike the exit rates, the entry rates for both exporters and MNEs are correlated with country characteristics. In OLS regressions, we find that the elasticities with respect to market size are quite similar for exporters and MNEs, but the distance elasticities are three times as large for exporters.[17] Appendix Fig. E.7 shows that, for Norway, distance elasticities are also higher for exporter entry than for MNE entry, and market size elasticities are similar across the two entry modes.

The difference in first-year exit rates between exporters and MNEs suggests that the sunk costs of entry are higher for MNEs than for exporters. This fact is thus key in informing dynamic models of exporters and MNEs. The patterns observed for entry rates suggest that exporters face distance-dependent trade costs, whereas MNEs do not, consistent with the proximity-concentration trade-off in HMY. A static model thus suffices to capture this fact.

[17] The elasticities with respect to market size are 0.52 (s.e. 0.027) and 0.41 (s.e. 0.033) for exporters and MNEs, respectively; distance elasticities are −1.15 (s.e. 0.105) vs −0.36 (s.e. 0.094).

3.3.2. Robustness

Exporters and MNEs are active in different countries: firms penetrate many more countries as exporters than as MNEs. To exclude the possibility that the difference in country coverage is driving the results, we replicate our analysis for only those countries with both exporting and multinational activity for France. The patterns of both first-year exit and entry rates for exporters are less pronounced than in the full sample but are still clearly correlated with country characteristics.[18] For MNEs, the results are unchanged.

4. A dynamic model of exports and MNEs

Guided by the facts documented in the previous section, we build a dynamic model of export and MNE activities that is based on the model of the proximity-concentration trade-off with heterogeneous firms in HMY, extended to include an autoregressive process for firm productivity and sunk costs for MNE activities. We construct a model of "horizontal" FDI (i.e., affiliate sales are destined to the host market only). For simplicity, export platforms (i.e., locating production in market l and serving a third market n through exports from l) and intrafirm trade are excluded.[19] We focus on horizontal FDI instead of vertical FDI as the prior literature has found horizontal FDI to be the main form of FDI activity (see Ramondo et al., 2016). We use this simple model to establish a few propositions related to exit and sales growth of exporters and MNEs, with the goal of explaining the facts presented in Section 3. We later extend the simple model by further incorporating sunk export costs and assuming that all sunk and fixed costs are firm-destination specific. The full model is then calibrated to the data and aids in simulating counterfactuals.

4.1. Setup

We build a partial equilibrium model with two countries, Home and Foreign. Time is discrete. Labor is the only factor of production and is supplied in fixed quantity. The wage in each country is pinned down by a constant returns to scale freely tradable homogeneous good sector and is normalized to one, $w = 1$.

Goods that are exported to the foreign country are subject to an iceberg-type trade cost, $\tau \geq 1$, while production in foreign affiliates is subject to an efficiency loss given by $\gamma \geq 1$, with $\tau > \gamma$, consistent with the empirical evidence (Antrás and Yeaple, 2014). A firm that exports incurs a per-period fixed cost, f^x, and a firm that operates an affiliate in the foreign country incurs a per-period fixed cost, f^m, with $f^m/f^x > (\gamma/\tau)^{\sigma-1}$, as in HMY. Firms that decide to open an affiliate have to pay a sunk cost, $F^m > 0$, at the time of MNE entry. Fixed and sunk costs are paid in units of labor.

A firm is characterized by a core efficiency level, $\phi \equiv \exp(z)$, that evolves over time following a first-order autoregressive AR (1) process,

$$z' = \rho z + \sigma_\epsilon \epsilon',$$

where $0 \leq \rho < 1$ and $\epsilon' \sim N(0,1)$. If a firm from the home country opens an affiliate in the foreign country, that affiliate inherits its parent's productivity process.

There exists a continuum of firms that compete monopolistically. The mass of home firms, M, is fixed and normalized to one. We assume constant elasticity of substitution (CES) preferences, with the elasticity of substitution denoted by σ. Firms optimally charge a constant markup, $\kappa \equiv \sigma/(\sigma-1)$, over marginal costs, so that sales follow the standard CES formula. Let $E \equiv \kappa^{1-\sigma}X/P^{1-\sigma}$ be foreign demand. We assume that the firms from the home country account for only a small fraction of the overall sales in the foreign country, so that the price index in the foreign country is taken as fixed. We normalize $E_{home} = 1$ so that E is the size of Foreign relative to Home.

Static profit maximization implies that domestic sales are given by $X^d(\phi) = \phi^{\sigma-1}$, while exports from Home are $X^x(\phi) = E\phi^{\sigma-1}\tau^{1-\sigma}$, and affiliate sales in Foreign are $X^m(\phi) = E\phi^{\sigma-1}\gamma^{1-\sigma}$.

Firms have two possible states: producing in the home market for domestic consumers only and, potentially, for foreign consumers (D); or producing in the home market for domestic consumers and in the foreign market for foreign consumers (M). The value of being a multinational firm with core productivity ϕ is given by

$$V(\phi, M) = \frac{X^d(\phi)}{\sigma} + \max\left\{\frac{X^m(\phi)}{\sigma} - f^m + \beta EV(\phi', M|\phi),\ \max\left(0, \frac{X^x(\phi)}{\sigma} - f^x\right) + \beta EV(\phi', D|\phi)\right\}; \tag{1}$$

and the value of being a domestic firm with core productivity ϕ is given by

$$V(\phi, D) = \frac{X^d(\phi)}{\sigma} + \max\left\{\frac{X^m(\phi)}{\sigma} - f^m - F_e^m + \beta EV(\phi', M|\phi),\ \max\left(0, \frac{X^x(\phi)}{\sigma} - f^x\right) + \beta EV(\phi', D|\phi)\right\}. \tag{2}$$

[18] Export exit elasticities with respect to GDP and distance are −0.023 (s.e. 0.003) and 0.046 (s.e. 0.005), whereas entry elasticities with respect to the same variables are 0.23 (s.e. 0.026) and − 0.53 (s.e. 0.112).

[19] See Ramondo and Rodríguez-Clare (2013) and Tintelnot (2017) for recent models of export-platform FDI.

The optimal policy for an MNE is to discontinue the foreign investment if being domestic (state D) entails larger discounted expected profits than being an MNE (state M). This policy is characterized by a cutoff value of productivity, $\overline{\phi}^m$. If productivity falls below $\overline{\phi}^m$, a current MNE exits the foreign market and produces only in the domestic market. If productivity exceeds $\overline{\phi}^m$, the firm remains an MNE (state M). Similarly, the optimal policy for a domestic firm is characterized by a productivity cutoff level, $\overline{\phi}_e^m$. Once the productivity level of the domestic firm exceeds $\overline{\phi}_e^m$, it becomes an MNE. It is possible to rank the two productivity cutoffs: since the second terms in the outer maximization problem in (1) and (2), respectively, are identical, and X^m and V are increasing in ϕ, as the expectation operator preserves monotonicity, it follows that $\overline{\phi}^m < \overline{\phi}_e^m$. This implies that the model delivers an "inaction" zone that exists by virtue of the sunk cost of doing FDI (Baldwin, 1989). Domestic firms with productivity $\phi \in [\overline{\phi}^m, \overline{\phi}_e^m]$ remain domestic, whereas MNEs with productivity $\phi \in [\overline{\phi}^m, \overline{\phi}_e^m]$ remain MNEs. The inaction zone thus creates persistence in the MNE status.

Without sunk MNE costs, it suffices to have $f^m/f^x > (\gamma/\tau)^{1-\sigma}$ for MNEs to have a higher exit cutoff than exporters, $\overline{\phi}^m > \overline{\phi}^x$. With sunk MNE costs, that assumption is not enough. We proceed by assuming that the MNE exit cutoff is higher than the exporter exit cutoff.[20]

4.2. Model predictions

We now explain how the model captures the facts documented in Section 3.

The model can capture Fact 1 under some conditions. The "inaction" zone created by the presence of sunk and fixed costs makes MNEs less likely to exit than in a setup with no sunk costs. That exit rates for MNEs are lower than for exporters—and by how much—depends on the values of the model's parameters. Proposition 1 states the result.

Proposition 1. Let the entry cutoff for MNEs $\ln(\overline{\phi}_e^m) = \overline{z}_e^m$ and the entry and exit cutoff for exports $\ln(\overline{\phi}^x) = \overline{z}^x$ relate as $\overline{z}_e^m = \overline{z}^x + \varphi$, with $\varphi > 0$. There exists φ^* such that for $0 \leq \varphi < \varphi^*$, the exit probability upon entry is higher for an exporter than for an MNE with identical productivity before exit.

Proof. See Appendix B.1.

The effect of export experience on the exit probability of an MNE is driven by selection on productivity, as Proposition 2 shows.

Proposition 2. The probability that a new MNE exits upon entry is lower if the firm switched from export to MNE activity than from domestic to MNE activity.

Proof. See Appendix B.2.

All new MNEs have received a sufficiently good productivity shock that induces them to enter a market as MNEs. As exporters are more productive than domestic firms, firms with export experience enter MNE status with a productivity level that is higher than that of a firm with no export experience. Given that productivity follows a Markov process with log-normal distributed shocks, and the exit cutoffs are the same for MNEs with and without export experience, more productive firms at the time of entry are less likely to have a productivity draw that falls below the exit cutoff in the subsequent period. Proposition 2 is for the case of positive sunk costs of MNE entry, but the result also holds in the case of no sunk MNE costs.

Both exporters and MNEs follow the same productivity process in the model. However, this does not automatically lead to the similar sales growth rates of exporters and MNEs documented in Fact 2. The selection patterns that arise from the inclusion of fixed and sunk costs have subtle effects on the growth rates. Ultimately, how well the model can capture the similarity of exporter and MNE growth rates remains a quantitative question, which we address in Section 5. Self-selection of firms also drives the higher sales growth of ever-MNE exporters relative to never-MNE exporters.

Finally, the inclusion of sunk MNE costs allows the model to capture Fact 3: first-year exit rates of new exporters are correlated with country characteristics, whereas for MNEs, they are not. The following proposition shows the result.

Proposition 3. Let $\overline{z}$ be the productivity exit cutoff from a mode of international operation. The increase in the first-year exit probability when $\overline{z}$ increases is larger when sunk costs of entry into the mode are zero than when sunk costs are positive.

Proof. See Appendix B.3.

[20] The assumption that $\overline{\phi}^m > \overline{\phi}^x$ is implicit in the way we wrote the value functions: it rules out that, for the marginal MNE, the value of producing at home for the domestic market only is higher than the value of producing at home for the domestic and foreign market. In our calibrations and simulations below, this ranking of cutoffs is never violated.

[21] In an export-only model, Albornoz et al. (2016) show that the probability of export survival in a market increases with the ratio of sunk to fixed costs. While their result is about how export survival rates change with sunk costs, our Proposition 3 states a difference-in-difference result: how the survival—or, equivalently, exit—probability changes in response to a change in market characteristics, for different levels of sunk costs.

Because of MNE sunk costs, the productivity level required for MNE entry exceeds the productivity level for MNE exit, $\overline{\phi}_e^m > \overline{\phi}^m$. The higher the sunk costs, F^m, the higher the option value of being an MNE and, hence, the larger the zone of inaction and the less sensitive the exit behavior to differences in variable profits.[21]

An important implication of the model is that new exporters in an environment without the option to become an MNE have different life-cycle properties than in an environment where they can self-select into MNE activities. Intuitively, including the MNE choice not only truncates the exporters' distribution of productivity levels but also induces a truncation to the right of the distribution of productivity growth rates. Only firms with productivity above the export threshold but below the MNE threshold in two consecutive periods contribute to export productivity (and sales) growth. For each $z \in [\overline{\phi}^x, \overline{\phi}^m]$, there is a maximum possible increase in productivity such that an exporter remains an exporter. Exporters that receive a higher productivity shock turn into MNEs when the MNE choice is allowed. Those exporters with the highest productivity shocks, and thus the highest sales growth, do not contribute to the average growth rate of exporters in the model with MNEs (because they change status), but they do contribute in the model without MNEs. In turn, because the maximum possible growth in productivity decreases with productivity levels, smaller exporters are the ones contributing to average productivity in the model without MNEs, but not in the model with MNEs (because they switch status). As a consequence, exporters in the model for which the MNE option is present have higher average productivity early in life and, hence, lower exit rates.

Proposition 4 derives this result formally for the marginal exporter.[22]

Proposition 4. Assume that firm productivity follows a first-order autoregressive process, $z_t = \rho z_{t-1} + \sigma_\epsilon \epsilon_t$, with $\epsilon_t \sim N(0,1)$, and $0 \le \rho < 1$, and assume that sunk costs of MNE entry are zero, $F^m = 0$. Consider the firm with $z_{t-1} = \underline{z}$ and $z_t > \underline{z}$, where $\underline{z}$ denotes the productivity threshold above which firms become exporters. Expected productivity growth in a model with only left truncation in the productivity distribution is defined as $G^L \equiv \mathbb{E}(z_t - z_{t-1} | z_t > \underline{z}, z_{t-1} = \underline{z})$, whereas in a model with left and right truncation, expected productivity growth is defined as $G^{LR} \equiv \mathbb{E}(z_t - z_{t-1} | \underline{z} < z_t < \overline{z}, z_{t-1} = \underline{z})$, with $\overline{z}$ denoting the right truncation point above which the firm changes from export to MNE status. Then, there exists a value $\overline{z}^* \in (\underline{z}, \infty)$ such that for $\underline{z} < \overline{z} < \overline{z}^*$, $G^L > G^{LR}$, with equality for $\overline{z} = \overline{z}^*$.

Proof. See Appendix B.4.

We quantitatively explore the effect of including the option to become an MNE by comparing calibrated versions of the model with MNEs and with only exporters in Section 6.

5. Calibration

We calibrate the model and analyze how well the calibrated model quantitatively captures the patterns observed in the data. To such end, we use a quantitative version of the model in Section 4, which includes sunk export costs and firm-destination specific sunk and fixed costs. Assuming firm-destination specific sunk and fixed costs gives the model additional flexibility to match the data by making productivity cutoffs firm-level specific. In particular, this extension allows us to capture the fact that we observe some large firms that are neither exporters nor MNEs and, conversely, that we observe some small firms that are either exporters or MNEs. Additionally, it is through this extension that we incorporate *firm-destination* level heterogeneity into the quantitative model.[23] Appendix C presents the main equations of the full model.

Our goal is to parameterize the quantitative version of the model by targeting cross-sectional features of the data, as well as the dynamics of domestic sales, and then to assess how well our calibrated model accounts for new MNE and exporter dynamics as reflected in the facts in Section 3. We perform two model calibrations using moments from France and Norway. We present the calibration not only for France but also for Norway because the information on MNE sales in the French data is very limited. For both France and Norway, we use the top 15 destination markets for exports and MNEs, plus a sixteenth country constructed as a weighted average of the rest of the world (RoW). The top 15 destinations represent more than 75% of export and MNE sales.[24] We calibrate the model market by market. Consistent with the model presented in the previous section, we abstract away from export-platform sales, so that entry into each destination country can be solved independently. As in the model, we restrict the analysis to a partial equilibrium setting in which wages and price indices are exogenous.

5.1. Calibration procedure

We can divide the set of parameters in the model into three groups: a first group that is set externally; a second group that can be calibrated to moments in the data without having to solve for the firm's dynamic problem; and a third set that requires the computation of the firm's dynamic problem and is jointly calibrated using a moment-matching procedure. We describe each group next. Table 1 summarizes the procedure.

First, we set the discount factor for firms $\beta = 0.95$, which is consistent with an interest rate of 5%. The elasticity of substitution σ is set to 4, which implies a markup over unit cost of 33% and is a common value estimated for the trade elasticity.

[22] In Appendix A.1, we show that the growth rate for the average exporter can be lower in the model with MNEs for certain parameters' values.

[23] This extension is also the one with the most potential to deliver conservative results regarding the role of MNEs in new exporter dynamics.

[24] In the French data, it is not possible to distinguish exports to Belgium from exports to Luxembourg. Therefore, we aggregate Belgium-Luxembourg and the Netherlands into one country (Benelux). Because of its increasing importance, we add China to the list of foreign destination markets for France.

Table 1
Calibrated parameters and targeted moments.

	Parameter	Value	Targeted moments
I	Discount factor β	0.95	Annual interest rate of 5%
	Elasticity of substitution σ	4	Simonovska and Waugh (2014)
II	Size-adjusted trade costs $E_n\tau_n^{1-\sigma}$	Appendix Table F.3	Export-to-domestic sales ratio in n
	Size-adjusted MNE costs $E_n\gamma_n^{1-\sigma}$	Appendix Table F.3	MNE-to-domestic sales ratio in n
	AR(1) productivity process		OLS estimates, AR(1) for domestic sales
	autoregressive coefficient ρ	0.960 (FRA), 0.957 (NOR)	autoregressive coefficient $\hat{\rho}_{sales}^{ols}$
	standard error σ_ϵ	0.197 (FRA), 0.133 (NOR)	standard error $\hat{\sigma}_{sales}^{ols}$
III	Export fixed cost, mean μ_{fn}^x		Fraction of exporters into n
	MNE fixed cost, mean μ_{fn}^m		Fraction of MNEs into n
	Export fixed cost, s.d. σ_{fn}^x		Average exporter exit rate from n
	MNE fixed cost, s.d. σ_{fn}^m	Appendix Table F.5	Average MNE exit rate from n
	Export sunk cost, mean μ_{en}^x		First-year exporter exit rate from n
	MNE sunk cost, mean μ_{en}^m		First-year MNE exit rate from n
	Export sunk cost, s.d. σ_{en}^x		$\lvert\sigma_{en}^x/\mu_{en}^x\rvert = \lvert\sigma_{fn}^x/\mu_{fn}^x\rvert$
	MNE sunk cost, s.d. σ_{en}^m		$\lvert\sigma_{en}^m/\mu_{en}^m\rvert = \lvert\sigma_{fn}^m/\mu_{fn}^m\rvert$

Notes: Panel I: group of externally set parameters. Panel II: group of parameters calibrated without having to solve the firm's dynamic problem. Panel III: group of parameters jointly calibrated. Appendix Table F.4 shows data targets by destination for parameters in Panel III.

The second set of parameters, which are calibrated without having to solve for the firm's dynamic problem, includes a size-adjusted measure of trade and MNE iceberg costs and the parameters related to the firm-level productivity process. Given σ, we use the ratio of export to domestic sales, for firms serving market n, to directly pin down size-adjusted trade costs for market n, $r_n^x(\phi) \equiv X_n^x(\phi)/X^d(\phi) = E_n\tau_n^{1-\sigma}$. Analogously, we use the ratio of MNE to domestic sales, for MNE affiliates operating in market n, to get an estimate of size-adjusted MNE costs for market n, $r_n^m(\phi) \equiv X_n^m(\phi)/X^d(\phi) = E_n\gamma_n^{1-\sigma}$.[25] We aggregate these ratios across firms serving market n, in each mode, using weights given by the firm's domestic sales. For exports, we restrict attention to firms that served market n at least 3 years in a row. For MNEs, we do not limit the number of years in a market, given the lower number of observations. Appendix Table F.3 shows the values for these ratios for each destination market.

The parameters characterizing the firm-level productivity process, ρ and σ_ϵ, are pinned down from estimating by OLS a first-order autoregressive process on domestic sales, using all French and Norwegian firms. The regression includes year and industry fixed effects, with standard errors clustered at the industry level. With these estimates, using the equations of the model and $\sigma = 4$, we directly set ρ equal to the estimated sales autocorrelation coefficient, $\hat{\rho}_{sales}$, and σ_ϵ equal to $\hat{\sigma}_{sales}/(\sigma-1)$. For France, $\rho = 0.960$ and $\sigma_\epsilon = 0.197$, whereas for Norway, our estimates imply that $\rho = 0.957$ and $\sigma_\epsilon = 0.133$.[26]

The remaining parameters of the model, related to the sunk and fixed costs of export and MNE activities in each market, are jointly calibrated using a moment-matching procedure. We assume that sunk (fixed) costs are drawn from a log-normal distribution (see Eaton et al., 2011; Tintelnot, 2017; Antrás et al., 2017; Head and Mayer, 2019), are constant for each firm over time, and are independent from firm productivity. The relevant market-specific sunk and fixed cost parameters are: the mean and standard deviation of sunk export costs, μ_{en}^x and σ_{en}^x; the mean and variance of sunk MNE costs, μ_{en}^m and σ_{en}^m; the mean and variance of per-period export costs, μ_{fn}^x and σ_{fn}^x; and the mean and variance of per-period MNE costs, μ_{fn}^m and σ_{fn}^m. This would leave us with 8×16 parameters to jointly calibrate, for each of our data sources, France and Norway. To reduce the dimensionality of the computational problem, we assume that the coefficient of variation for sunk and fixed costs (in logs) is the same for each mode, $\lvert\sigma_{en}^s/\mu_{en}^s\rvert = \lvert\sigma_{fn}^s/\mu_{fn}^s\rvert$ $(s \in x, m)$. We are then left with 6×16 parameters to calibrate for which we target six moments, for each market: the number of non-MNE French (Norwegian) exporters serving market n relative to all French (Norwegian) firms; the number of French (Norwegian) MNEs serving market n relative to all French (Norwegian) firms; the number of French (Norwegian) MNEs that exit at age zero (i.e., entry year) market n relative to all MNEs at age zero in market n; the number of French (Norwegian) exporters that exit at age zero (i.e., entry year) market n relative to all exporter at age zero in market n; the average share of French (Norwegian) MNEs that exit market n; and the average share of French (Norwegian) exporters that exit market n.

Table 2 reports the targeted moments in the model and the data, an average across destinations.[27] Among the targeted moments, given the parsimony of parameters and the non-negativity constraint for sunk and fixed costs, the model under-predicts the first-year and average exit of new exporters. The model is able to accurately reproduce the remaining moments with the parameters at hand. Appendix Table F.4 shows the data and model moments for each destination.

[25] To gain observations, for some destinations of French MNEs, we impute missing MNE sales using as covariates (log) domestic sales, (log) domestic employment, an interaction of the two previous variables, and year and sector fixed effects, for firms surviving at least five years in a foreign destination.
[26] Results are very similar if we estimate a Tobit model rather than a linear model.
[27] See Appendix D for the numerical implementation of the algorithm to compute the model-based moments.

Table 2
Targeted moments, model and data, average.

	Data, avg		Model, avg	
	France	Norway	France	Norway
Share of MNEs	0.003	0.003	0.003	0.003
Share of exporters	0.090	0.087	0.083	0.081
First-year exit rate, MNEs	0.256	0.184	0.252	0.170
First-year exit rate, exporters	0.453	0.542	0.378	0.377
Average exit rate, MNEs	0.182	0.149	0.179	0.147
Average exit rate, exporters	0.316	0.313	0.212	0.210

Notes: Observations are at the firm-destination-year level. For each variable, we show averages across destinations included in the calibration, weighted by each destination's share of export (MNE) firms. Weights are data-based (model-based) for data (model) variables. The number of exporters (MNEs) that serve market n are calculated relative to all firms. The number of exporters (MNEs) that exit a market are calculated relative to all exporters (MNEs) in that market. Exporters in the data refers to non-MNE exporters.

Table 3
The size of calibrated costs.

	Norway				France			
	f_n^x	f_n^m	F_n^x	F_n^m	f_n^x	f_n^m	F_n^x	F_n^m
Values as % of sales								
25th sales pc	20.4	13.4	5e-04	37.7	15.0	7.8	8e-04	33.6
50th sales pc	15.3	9.5	4e-04	26.8	9.7	5.0	5e-04	21.4
75th sales pc	9.9	6.2	3e-04	17.4	5.0	2.6	3e-04	11.4
90th sales pc	6.0	4.0	2e-04	11.3	2.3	1.4	1e-04	5.9
Values in U.S. dollars								
25th sales pc	1100	278,000	0.03	783,000	1900	360,000*	0.10	1,555,000*
50th sales pc	5200	692,000	0.13	1,944,000	6900	756,000*	0.35	3,262,000*
75th sales pc	23,000	1,628,000	0.58	4,575,000	19,000	1,181,000*	0.99	5,096,000*
90th sales pc	69,000	3,608,000	1.77	10,138,000	42,000	1,954,000*	2.14	8,432,000*

Notes: f_n^x are per-period fixed export costs; f_n^m are per-period fixed MNE costs; F_n^x are sunk export costs; and F_n^m are sunk MNE costs. Values are averages across firms' draws, conditional on a positive measure of exporters (MNEs), in each destination. Averages across destinations included in the calibration, weighted by each destination's share of export (MNE) firms. Weights are data-based (model-based), for data (model) variables. Sales percentiles are with respect to the export (MNE) sales distribution in a destination. The values in U.S. dollars for different percentiles are calculated using the values of sales in the data, transformed to U.S. dollars using an average of the annual exchange rate observed over our sample period, from Penn World Tables 9.0 (Feenstra et al., 2015). (*) estimated values assuming that the xth pc of the MNE sales distribution is proportional to the xth pc of the export sales distribution, with the proportionality factor calculated using the ratio of export to MNE sales for each percentile, for Norway.

5.2. Calibration results

We evaluate the size of the calibrated per-period fixed costs and sunk entry costs, for exports and MNE activities, in terms of 1 year of firm sales and in monetary values. Table 3 presents the results, averaged across destinations. Appendix Table F.6 presents results by destination market.

MNE sunk costs are much higher than sunk export costs. Sunk MNE costs represent about 6% of annual sales for large MNEs, 21% for median MNEs, and 34% for small MNEs, according to our calibration for France. The sunk costs for Norwegian MNEs are comparable to those faced by French MNEs. In Norway, sunk MNE costs account for about 11% of annual sales for large MNEs, 27% for median MNEs, and 38% for small MNEs. In monetary terms, for Norwegian MNEs, sunk costs range from 783,000 to 10 million U.S. dollars. Our estimates for France yield monetary values of these costs in a similar range. In contrast, the calibrated sunk export costs are extremely small, ranging from 0.01% of annual export sales for large French exporters to 0.08% for small exporters. For Norwegian exporters, these costs range from 0.02% for large Norwegian exporters to 0.05% for small exporters.

While fixed per-period costs are relatively much larger than sunk costs for exporters, in terms of sales, for MNEs, both costs are in a similar range. Fixed costs represent 6% of export sales for large Norwegian exporters and reach 20% for small exporters; per-period fixed MNEs costs range from more than 4% of sales for large affiliates to 13% for small affiliates. French firms face smaller per-period costs in terms of sales relative to the costs faced by Norwegian firms. In monetary terms, given the difference in size between MNEs and exporters, per-period fixed costs for exporters are 278,000 U.S. dollars for the 90th percentile of Norwegian exporters, but reach 3.6 million U.S. dollars for the largest Norwegian MNEs.

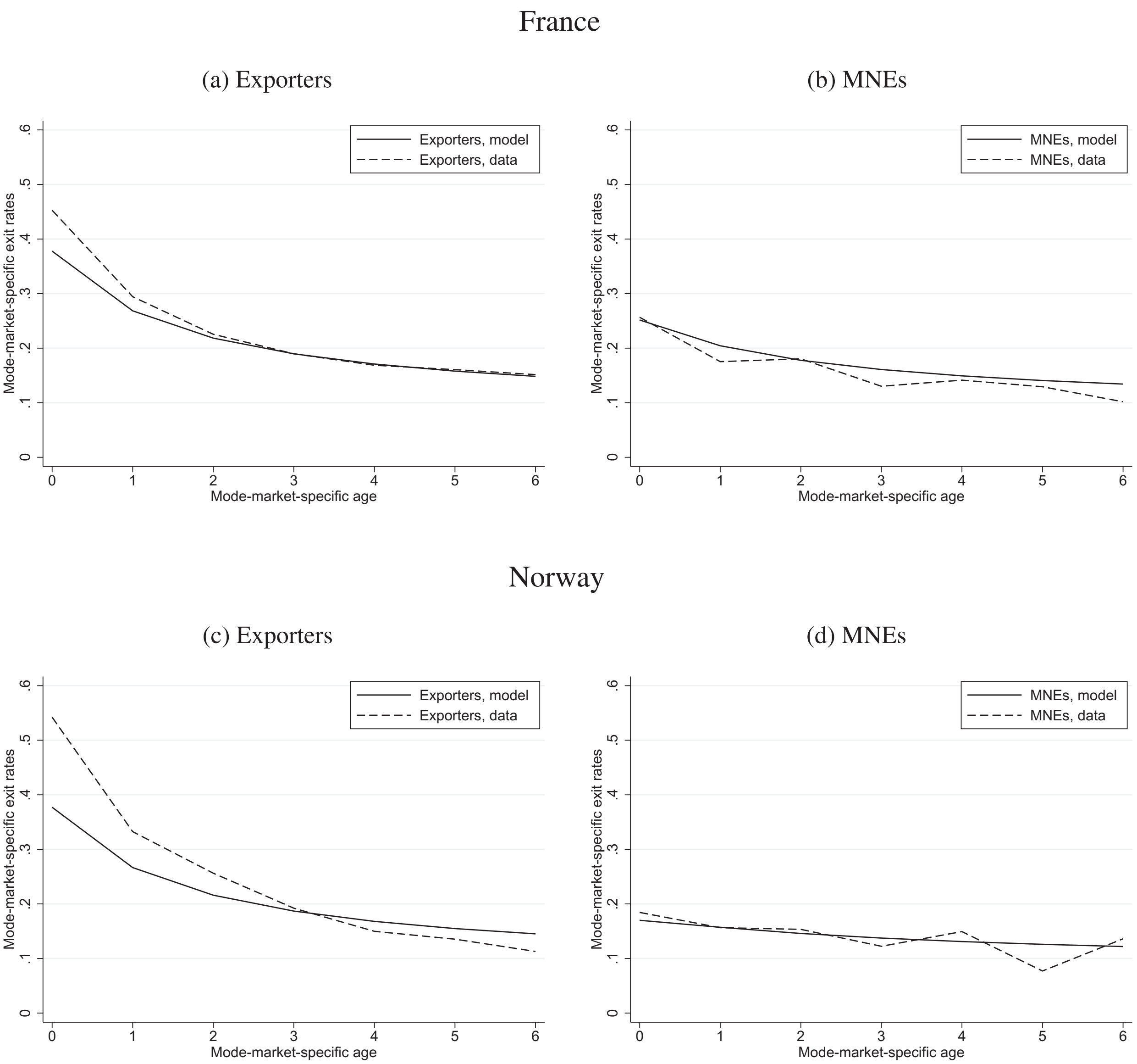


Fig. 7. Exit rates by age, model and data. Notes: Number of exits from a mode-market relative to the number of firms active in a mode-market, by mode-market-specific age, for exporters and MNEs. Observations are at the firm-destination-year level. We show averages across destinations included in the calibration, weighted by each destination's share of export (MNE) firms. Weights are data-based and model-based, for data and model variables, respectively. Exporters in the data refers to non-MNE exporters.

5.3. Fit of calibrated model

We now evaluate how well our calibrated model captures the facts in Section 3. We start by comparing the exit rates of new exporters and MNEs in the data and the model. Our calibration procedure targets exit rates of MNEs and exporters at entry and on average, but not at each age. Fig. 7 shows that the calibrated model does fairly well in capturing the pattern of exit for new MNEs and new exporters. Even though the first-year exit rate for exporters is a targeted moment, the model underestimates how much export exit is observed upon entry into a market—sunk and fixed costs are constrained to be non-negative. The quantitative model, however, captures fairly well the decline in exit rates with age, slightly over-predicting exit at older ages only for Norway. It is important to note that targeting the first-year exit rate is crucial to obtain a sharp decline in exit rates with age for exporters; if this moment were not included in the calibration, exit rates would increase, rather than decrease, at early ages, because of the dramatic difference, for exporters, between first-year and average exit rates, shown in Table 2. If only the (lower) average exit rate were targeted, sunk costs would be large(r), creating a large band of inaction for exporters; as a

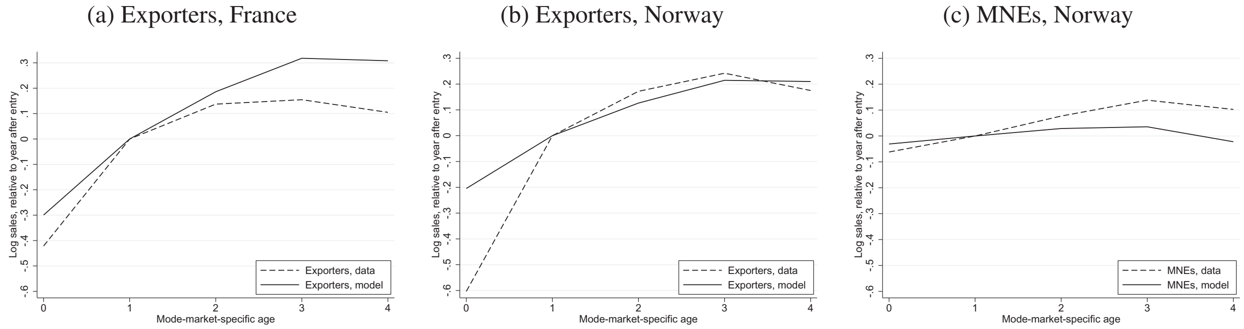


Fig. 8. Sales growth by age, model and data. Notes: Log of firm-destination export (affiliate) sales with respect to firm-destination export (affiliate) sales in the year after entry, for firms with five or more years in the market, in each mode. Observations are at the firm-destination-year level. We show averages across destinations included in the calibration, weighted by each destination's share of export (MNE) firms. Weights are data-based and model-based, for data and model variables, respectively. In the data, log of sales are first demeaned by industry, year, and destination fixed effects. Exporters in the data refers to non-MNE exporters.

consequence, exit rates would start low, increase, and then decrease with age.[28] Such dramatic difference between first-year and average exit rates is not observed for MNEs, so that the calibrated sunk costs are much higher than for exporters, creating a broader band of inaction for this internationalization mode.[29]

Fig. 8 shows the ability of the model to capture the growth profiles of MNE and export sales. We compute the geometric average across destination markets and normalize sales with respect to age one (i.e., 1 year after entry). The model matches the flat sales profile for MNEs remarkably well: with high(er) sunk costs, firms enter already large into the MNE status so that they grow little. The calibrated model captures fairly well the growth profile for Norwegian export sales, but the model calibrated to France delivers exporters that, after age one, grow faster than in the data. This is a feature observed in calibrated models in which firm-level productivity follows an AR(1) process and sunk costs are very low (see Syverson, 2011; Foster et al., 2016): Firms enter small and grow too large too fast.[30] It is worth noting, however, that the differences with the data are exclusively a result of exporters that never become MNEs; for exporters that eventually become MNE, the model matches the data extremely well, as Appendix Fig. E.8 shows.

To evaluate the model's ability to quantitatively capture Fact 3 in Section 3, we estimate by OLS the elasticity of exit rates at age zero and entry rates, for exporters and MNEs, on geography-adjusted country size, $r_n^x \equiv E_n \tau_n^{1-\sigma}$ ($r_n^m \equiv E_n \gamma_n^{1-\sigma}$), across the destinations included in our calibration for Norway and France. We use the observed and simulated data. Results are presented in the first two panels of Table 4. One has to keep in mind that these regressions have only 16 observations. Still, the model delivers sharper results for exporters' exit rates relative to those for MNEs, as the theory predicts and our third fact shows: new exporters' exit rates decrease with size-adjusted iceberg costs, whereas new MNEs' exit rates do not have a clear pattern. The elasticities of the model's implied entry rates are larger for MNEs than for exporters, as observed in the data, but the model difference between the two is smaller.

Table 4 includes comparisons for other non-targeted moments. The third panel shows that the calibrated model correctly captures not only that new experienced MNEs have lower exit rates than non-experienced MNEs, as expected from Proposition 2, but also the magnitudes of such exit rates. Yet, the calibrated model delivers between 23 and 33% more new MNEs that were previously exporters than observed in the data, mainly because of the productivity process being a rather persistent AR(1) process.

Additionally, starter rates in the model are close to the ones observed in the data, for both exporters and MNEs, especially for the calibration using the French data.

Despite not being targeted, the model captures rather accurately the transitions from exporter to domestic, from domestic to exporter, and from MNE to domestic. The model, however, over-predicts the transition from exporter to MNE and from MNE to exporter and under-predicts the transition from domestic to MNE. Again, this is a feature that may arise from the AR(1) process for productivity: too many exporters become MNEs, and too many MNEs transition into export status.[31]

[28] This is also the case in Ruhl and Willis (2017) (see their Fig. 2b and 3b) for Colombian exporters: when they target first-year exit rates for exporters, they obtain exit rates that decline with age; when they only target the average exit rate, exit rates increase with age. As in our data, first-year and average exit rates for Colombian exporters are dramatically different (0.37 vs 0.11).

[29] The model predicted that MNE exit rates for Norway slightly increase in year one, confirming the role of large sunk costs in generating rising exit rates in the first few years upon entry.

[30] Indeed, other mechanisms, such as the demand-side frictions considered, for example, by Arkolakis (2016) and Ruhl and Willis (2017), would be needed to better match the data on export sales growth.

[31] The domestic size of MNEs relative to exporters, in terms of revenues, is slightly smaller in the model than in the data: in the French (Norwegian) data, the ratio is 2.5 (2.2), and the model implies a size premium of 1.5 (1.4).

Table 4
Additional non-targeted moments, data and model.

	Data		Model	
	France	Norway	France	Norway
Elasticity of first-year exit rates to size-adjusted iceberg costs, OLS				
Exporters	−0.057**	−0.016	−0.023***	−0.073***
MNEs	0.035	0.062	0.073	0.085
Elasticity of entry rates to size-adjusted iceberg costs, OLS				
Exporters	0.143***	0.226	0.237***	0.771***
MNEs	0.554***	0.238**	0.518***	0.139
Share of experienced MNEs	0.60	0.47	0.83	0.80
Exit rates at age zero, experienced MNEs	0.21	0.16	0.23	0.16
Exit rates at age zero, non-experienced MNEs	0.29	0.21	0.29	0.20
Starter rate				
Exporters	0.020	0.035	0.019	0.019
MNEs	5.4e-04	5.0e-04	5.9e-04	4.1e-04
Probability of:				
Exporter to MNE	0.003	0.002	0.006	0.004
Exporter to domestic	0.188	0.275	0.206	0.206
Domestic to MNE	1.8e-04	9.4e-05	9.9e-05	7.9e-05
Domestic to exporter	0.019	0.038	0.018	0.018
MNE to exporter	0.059	0.069	0.138	0.097
MNE to domestic	0.043	0.057	0.042	0.050

Notes: The elasticity of first-year exit rates (entry rates) to size-adjusted iceberg costs (r_n^x and r_n^m, for exporters and MNEs, respectively) is the OLS coefficient of a bivariate regression (with a constant), using the 16 countries included in the calibration, for France and Norway. The fraction of experienced MNEs is calculated as the number of new MNEs of age zero with previous export experience in a market, relative to all new MNEs of age zero entering that market. Starter rates for exporters are calculated as the number of firms that export to j in t, but not in $t-1$, relative to the number of home firms at $t-1$. Starter rates for MNEs are calculated as the number of MNEs that have an affiliate j in t, but not in $t-1$, relative to the number of home firms at $t-1$. The transition probabilities are calculated as a weighted average across destinations: exporter to MNE (domestic) is relative to the number of non-MNE exporters; domestic to MNE (exporter) is relative to the number of domestic firms; and MNE to exporter (domestic) is relative to the number of MNEs. Observations are at the firm-destination-year level. Averages across destinations included in the calibration are weighted by each destination's share of export (MNE) firms, except for starter rates, and transitions from domestic status, which are weighted by (the inverse of) the number of destinations. Weights are data-based (model-based) for data (model) variables. Exporters in the data refers to non-MNE exporters. Levels of significance are denoted by $^{***}p<.01$, $^{**}p<.05$, and $^{*}p<.1$. Standard errors are in parentheses.

6. Counterfactual exercise: the effects of trade liberalization

Armed with the calibrated model, we analyze the effects of a hypothetical trade-liberalization shock on the aggregate dynamics and life-cycle dynamics of MNEs and exporters. We simulate a 20% change in the iceberg trade cost, τ_n, for all destinations n and analyze the dynamic aggregate and life-cycle response of exporters and MNEs.

For exporters, we further compare the predictions of the calibrated model with MNEs to the predictions of a calibrated model with only exporters. The calibration of the exporter-only model targets the same moments related to exporters as our calibration of the model with MNEs.[32] Appendix Fig. E.9a and b compare exit rates and sales profiles for exporters, averaged across destination markets, in the data and in the calibrated model with and without MNEs for France. While both models deliver very similar sales profiles, the model without MNEs under-predicts the exit rates of old exporters, as it ignores the possibility that high-productivity exporters become MNEs.[33] Notice that even though the calibrated model with and without MNEs fits the data on exporters very similarly, the two models could deliver different *quantitative* predictions regarding counterfactual exercises; we have already showed in Section 4 that this is indeed the case theoretically.

6.1. Aggregate dynamics

Fig. 9 shows the evolution of average sales and participation rates for MNEs and exporters, from the old to the new steady state. The average MNE sales increase by around 20% when trade costs decrease, whereas participation rates for MNEs decrease by about 10%. These effects are not surprising in the context of the proximity-concentration trade-off: as in the static HMY model, lower trade costs create substitution away from MNE activities toward exports; the opposite is true for increases in trade costs

[32] The calibrated model with only exporters matches the export-related targeted and non-targeted moments equally well as the model with MNEs (not shown). Appendix Table F.5 shows the calibrated values of per-period and sunk export costs for the model without MNEs.

[33] In contrast with the results in Ruhl and Willis (2017), both our calibrated models yield a monotonic decrease in exit rates with age, which, as explained above, is driven by targeting first-year, rather than average, exit rates. Additionally, Appendix Fig. E.8 shows that while both models match equally well the sales profiles of exporters that eventually become MNEs, the model with MNEs matches a bit better the sales profiles of exporters that never become MNEs.

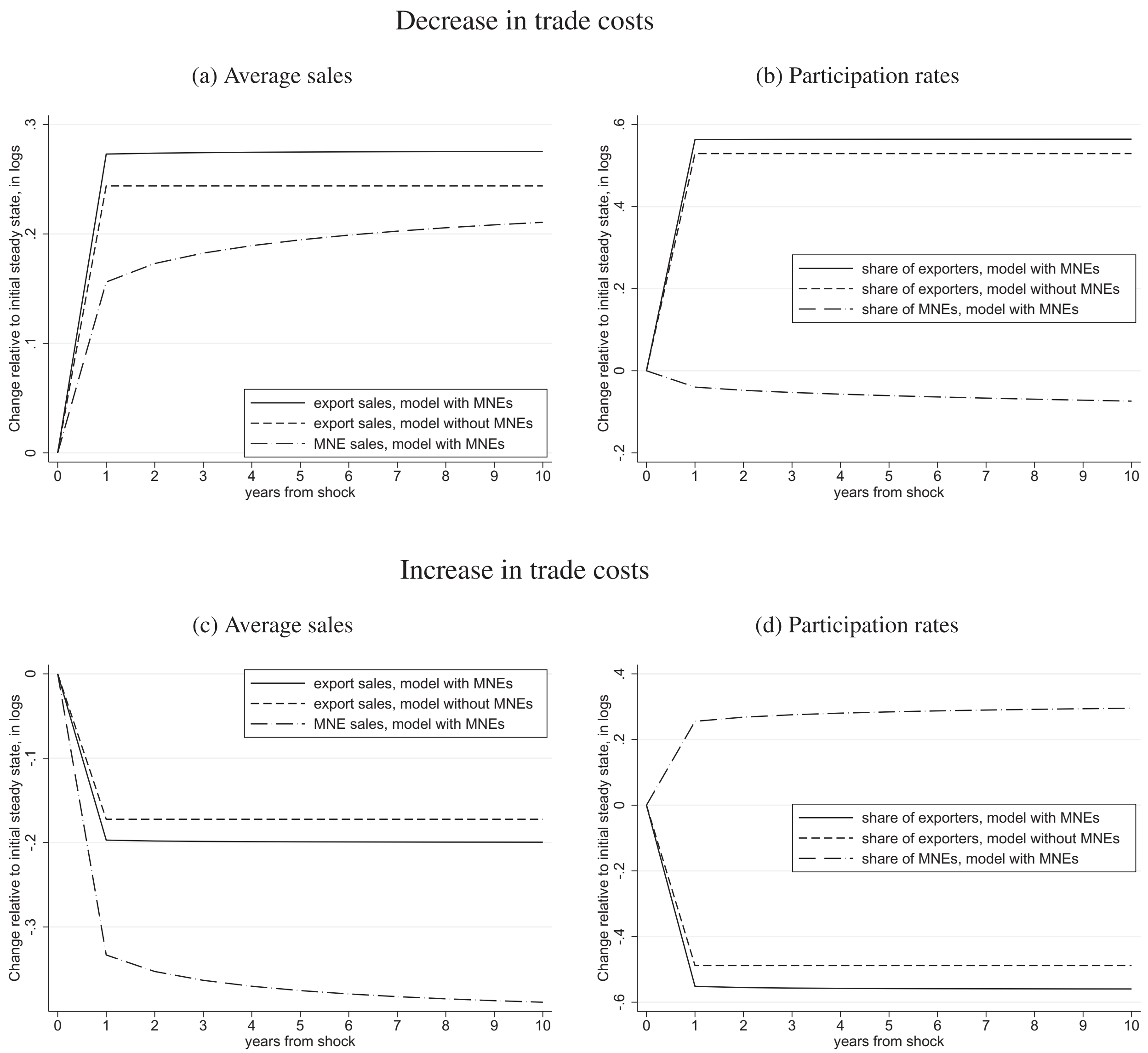
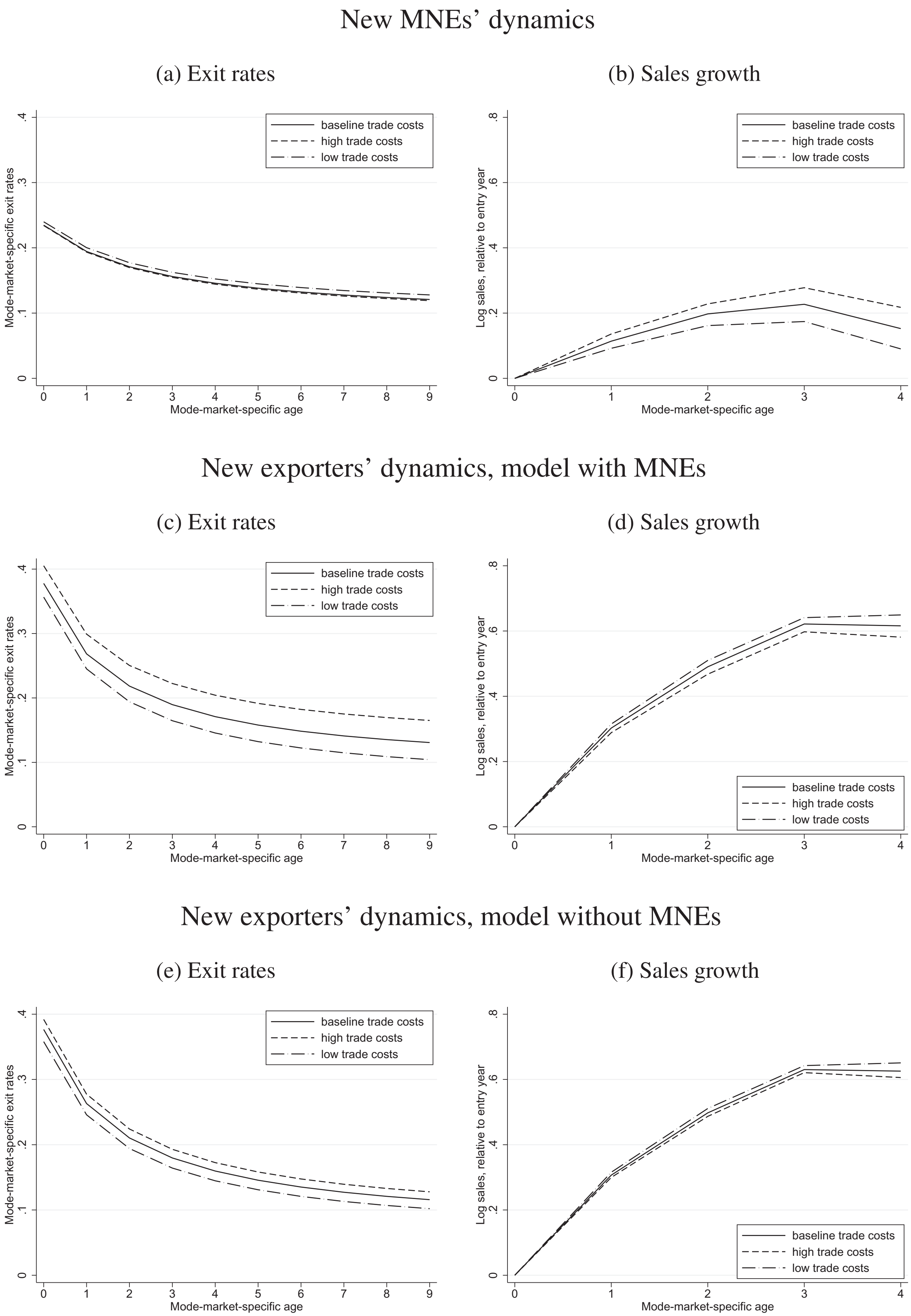


Fig. 9. Aggregate effects of a 20% change in trade costs. Notes: Models calibrated to French data. The y-axis is log change with respect to the initial steady state. Observations are at the firm-destination-year level. We show averages across destinations included in the calibration, weighted by each destination's share of export (MNE) firms.

(the so-called tariff-jumping effect).[34] Moreover, small MNEs switch to serving the market as an exporter so that the average sales of firm that stay in the market as MNEs increase.

The transition from the old to the new steady state for MNEs is rather fast, with most of the adjustment taking place within three periods. Given that sunk export costs are very low, most of the transition to the new steady state for exporters occurs in one period: for the case of decreasing trade costs, average export sales are about 30% higher and participation rates are about 60% higher than in the initial steady state. The model without MNEs predicts smaller quantitative effects for exporters than the model with MNEs: average sales and participation rates increase by about ten (five) percent less than in the full model when trade costs decrease by 20%. At the heart of these differences is the self-selection of exporters into MNE activities when that option is included in the model. In the model with MNEs, a decrease in trade costs creates entry into the exporter status of domestic firms (left truncation), which are small relative to the incumbent exporter, *and* of MNE firms (right truncation), which are large relative to the incumbent exporter. In the model with only exporters, the second margin does not exist.

[34] See Footnote 2 in the introduction for references on empirical support for the proximity-concentration trade-off, including our own Appendix Fig. E.1.


New MNEs' dynamics
(a) Exit rates
(b) Sales growth
baseline trade costs
high trade costs
low trade costs
Mode-market-specific exit rates
Log sales, relative to entry year
Mode-market-specific age
New exporters' dynamics, model with MNEs
(c) Exit rates
(d) Sales growth
baseline trade costs
high trade costs
low trade costs
Mode-market-specific exit rates
Log sales, relative to entry year
Mode-market-specific age
New exporters' dynamics, model without MNEs
(e) Exit rates
(f) Sales growth
baseline trade costs
high trade costs
low trade costs
Mode-market-specific exit rates
Log sales, relative to entry year
Mode-market-specific age

It is worth noting that increases and decreases in trade costs from the calibrated values do not produce symmetric changes in the aggregate variables under consideration. For instance, average sales for exporters drop by about 20% when trade costs increase but increase by as much as about 30% when trade costs decrease by the same percentage. This asymmetric effects are related to the density in the distribution of firm productivity; hence, they are directly linked to the calibration of the productivity process.

6.2. Life-cycle dynamics

In Fig. 10 we show the steady-state exit rates and sales profiles, by age, for MNEs and for exporters for the baseline economy, an economy with 20% higher trade costs, and an economy with 20% lower trade costs.[35]

While life-cycle exit patterns of MNEs do not change much with trade costs changes, life-cycle growth becomes slower in an environment with lower trade costs: by age four, new MNE sales (relative to entry) are five-percentage points lower than in our calibrated baseline.

For exporters, including MNEs matters for the effects of moving from an environment with high trade costs to one with low trade costs. The model with MNEs predicts that new exporters decrease their life-cycle exit rates by six percentage points by age nine and experience higher sales growth (seven percentage points by age four). The model without MNEs, however, predicts that new exporters have very similar exit and growth patterns before and after the change. These differences between the two models translate into differences in the dynamic behavior of aggregate exports after a shock shown in Fig. 9.

A lower τ decreases the likelihood of becoming an MNE but increases the one of becoming (or staying) an exporter; in the limit, for $\tau = 1$, MNEs disappear and the model collapses to one without MNEs. This result implies that exporters' life-cycle profiles are, on average, less similar between the model with and without MNEs as τ increases. At the same time, a change in trade costs produces a larger change in the life-cycle patterns of exit and growth rates of the average exporter in the model with MNEs relative to the model without MNEs. This is because the model with MNEs has two (left and right) margins changing at the same time, which results in a larger change in the number of fast-growing exporters.

Finally, Fig. 10 naturally relates to the effects of liberalizing MNE activities on new exporters' dynamics. Since the differences in new exporters' dynamics between the model with and without MNEs are larger in an environment with high iceberg trade costs, moving from a scenario without MNEs to one with MNEs leads to small changes in new exporters' dynamics if trade costs are already low but large changes if trade costs are high.

7. Conclusions

This paper studies the life-cycle dynamics of exporters and MNEs. We provide a comprehensive set of facts on the life-cycle dynamics of new exporters and new MNEs, which are informative about the features to be included in dynamic models of exporters' and MNEs' behavior. We show that a dynamic model of the proximity-concentration trade-off in HMY is qualitatively consistent with the documented facts. Our calibrated version of the model also includes heterogeneous sunk and fixed costs at the firm-destination level, similar to Roberts and Tybout (1997). We show that, quantitatively, the standard model of exporters' dynamics augmented to include MNEs goes far in matching cross-sectional and dynamic moments of the data on both exporters and MNEs. Our results point to much higher sunk costs for MNE activities relative to export activities.

Comparing the predictions of our calibrated model with both exporters and MNEs and a dynamic model with only exporters, we find that enriching the canonical dynamic model of trade to include MNEs—a first-order feature of the data—may have consequences for the life-cycle and aggregate dynamic behavior of exporters after a trade-liberalization episode. The different response of the exporters between the two models hinges on the right truncation of fast-growing exporters induced by the inclusion of the MNE choice. While we find significant quantitative differences in the aggregate response of exporters to a trade-liberalization shock, we find only moderate differences in the life-cycle growth profiles of exporters between the models with and without MNEs.

Fig. 10. Life-cycle effects of a 20% change in trade costs. Notes: Models calibrated to French data. High, low, and baseline trade costs refer, respectively, to iceberg trade costs, τ_n, which are 20% higher, lower, and equal to the baseline values, for each destination n. Number of exits from a mode-market relative to the number of firms active in a mode-market, by mode-market-specific age. Log of firm-destination export (affiliate) sales with respect to firm-destination export (affiliate) sales in the year after entry, for firms with five or more years in the market. Observations are at the firm-destination-year level. We show averages across destinations included in the calibration, weighted by each destination's share of export (MNE) firms.

[35] Because we only use data from the calibrated model, in Fig. 10, we normalize sales relative to sales at age 0 rather than age 1.

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Appendix A. Computations

A.1. Expected productivity growth for the average exporter

Assume that firm productivity follows a first-order autoregressive process, $z_t = \rho z_{t-1} + \sigma_\epsilon \epsilon_t$, with $\epsilon_t \sim N(0,1)$ and $0 \le \rho < 1$. The expected value of z_t is zero with variance given by $\sigma_z^2 \equiv \sigma_\epsilon^2/(1-\rho^2)$.

Conditional on a starting productivity value of k, the expected growth for an exporter in t in the model with only left truncation is given by

$$G^L(k) \equiv \mathbb{E}(z_t - z_{t-1} | z_t > \underline{z}, z_{t-1} = k),$$

whereas in a model with left and right truncation, we have that

$$G^{LR}(k) \equiv \mathbb{E}(z_t - z_{t-1} | \underline{z} < z_t < \overline{z}, \underline{z} = k),$$

with $\underline{z}$ and $\overline{z}$ denoting the left and right truncation points, respectively.

After some algebra, we get that

$$G^L(k) = \sigma_\varepsilon \frac{\phi(\underline{c}(k))}{1-\Phi(\underline{c}(k))} - k(1-\rho)$$

and

$$G^{LR}(k) = \sigma_\varepsilon \frac{\phi(\underline{c}(k)) - \phi(\overline{c}(k))}{\Phi(\overline{c}(k)) - \Phi(\underline{c}(k))} - k(1-\rho),$$

with $\overline{c}(k) \equiv (\overline{z} - \rho k)/\sigma_\varepsilon$, $\underline{c}(k) \equiv (\underline{z} - \rho k)/\sigma_\varepsilon$ and $\phi(\cdot)$ and $\Phi(\cdot)$ denoting the probability and cumulative distribution functions, respectively, of a standard normal distribution.

Taking expectations over all exporters yields

$$G^L = \frac{1}{1-F(\underline{z})} \int_{\underline{z}}^{\infty} \left(\sigma_\varepsilon \frac{\phi(\underline{c}(k))}{1-\Phi(\underline{c}(k))} - k(1-\rho) \right) dF(k)$$

and

$$G^{LR} = \frac{1}{F(\overline{z}) - F(\underline{z})} \int_{\underline{z}}^{\overline{z}} \left(\sigma_\varepsilon \frac{\phi(\underline{c}(k)) - \phi(\overline{c}(k))}{\Phi(\overline{c}(k)) - \Phi(\underline{c}(k))} - k(1-\rho) \right) dF(k).$$

The average exporter grows faster in the model with only left truncation if and only if $G^L > G^{LR}$, which is equivalent to

$$\sigma_\varepsilon \left(\int_{\underline{z}}^{\infty} \frac{\phi(\underline{c}(k))}{1-\Phi(\underline{c}(k))} \frac{dF(k)}{1-F(\underline{z})} - \int_{\underline{z}}^{\overline{z}} \frac{\phi(\underline{c}(k)) - \phi(\overline{c}(k))}{\Phi(\overline{c}(k)) - \Phi(\underline{c}(k))} \frac{dF(k)}{F(\overline{z}) - F(\underline{z})} \right) > (1-\rho) \left(\int_{\underline{z}}^{\infty} k \frac{dF(k)}{1-F(\underline{z})} - \int_{\underline{z}}^{\overline{z}} k \frac{dF(k)}{F(\overline{z}) - F(\underline{z})} \right).$$

The right-hand side is simply

$$(1-\rho)\sigma_z\left(\frac{\phi(\underline{z}/\sigma_z)}{1-\Phi(\underline{z}/\sigma_z)}-\frac{\phi(\underline{z}/\sigma_z)-\phi(\overline{z}/\sigma_z)}{\Phi(\overline{z}/\sigma_z)-\Phi(\underline{z}/\sigma_z)}\right).$$

Hence,

$$\int_{\underline{z}}^{\infty}\frac{\phi(\underline{c}(k))}{1-\Phi(\underline{c}(k))}\frac{dF(k)}{1-F(\underline{z})}-\int_{\underline{z}}^{\overline{z}}\frac{\phi(\underline{c}(k))-\phi(\overline{c}(k))}{\Phi(\overline{c}(k))-\Phi(\underline{c}(k))}\frac{dF(k)}{F(\overline{z})-F(\underline{z})}>$$

$$\sqrt{\frac{1-\rho}{1+\rho}}\left(\frac{\phi(\underline{z}/\sigma_z)}{1-\Phi(\underline{z}/\sigma_z)}-\frac{\phi(\underline{z}/\sigma_z)-\phi(\overline{z}/\sigma_z)}{\Phi(\overline{z}/\sigma_z)-\Phi(\underline{z}/\sigma_z)}\right).$$

Appendix B. Proofs

B.1. Proof of Proposition 1

Firm productivity z follows a first-order autoregressive process, $z' = \rho z + \sigma_\epsilon \epsilon'$ with $\epsilon' \sim N(0,1)$ and $0 \le \rho \le 1$. Let $\log\overline{\phi}_e^m \equiv \overline{z}_e^m$, $\log\overline{\phi}^m \equiv \overline{z}^m$, and $\log\overline{\phi}^x \equiv \overline{z}^x$, with $\overline{z}_e^m > \overline{z}^m > \overline{z}^x$. Let $f^m(a)$ denote the probability of exit from MNE status in $t+1$ for a firm that was not an MNE in $t-1$ and had productivity a in $t-1$,

$$f^m(a) = \frac{\int_{\overline{z}_e^m}^{\infty} \Pr\left(\rho x + \sigma_\varepsilon \varepsilon \le \overline{z}^m | x\right) g(x-\rho a)dx}{1-G(\overline{z}_e^m-\rho a)}, \tag{B.1}$$

where $g(\cdot)$ and $G(\cdot)$ denote, respectively, the probability and cumulative density functions of a normal distribution with mean zero and dispersion parameter σ_ϵ. Let $f^x(a)$ denote the probability of exit from export status in $t+1$ for a firm that was only domestic in $t-1$ and had a in $t-1$,

$$f^x(a) = \frac{\int_{\overline{z}^x}^{\overline{z}_e^m} \Pr\left(\rho x + \sigma_\epsilon \epsilon \le \overline{z}^x | x\right) g(x-\rho a)dx}{G(\overline{z}_e^m-\rho a)-G(\overline{z}^x-\rho a)}. \tag{B.2}$$

Under which conditions is $f^m(a) < f^x(a)$? First, notice that if $\overline{z}^x = \overline{z}^m = \overline{z}$, then

$$\int_{\overline{z}_e^m}^{\infty} \Pr(\rho x + \sigma_\epsilon \epsilon \le \overline{z}|x) g(x-\rho a)dx \le \int_{\overline{z}}^{\overline{z}_e^m} \Pr(\rho x + \sigma_\epsilon \epsilon \le \overline{z}|x) g(x-\rho a)dx. \tag{B.3}$$

Let $\overline{z}^m = \overline{z}^x + \xi$, with $\xi > 0$. Then,

$$\lim_{\xi\to 0}\int_{\overline{z}_e^m}^{\infty} \Pr(\rho x + \sigma_\epsilon \epsilon \le \overline{z}^x + \xi | x) g(x-\rho a)dx = \int_{\overline{z}_e^m}^{\infty} \Pr(\rho x + \sigma_\epsilon \epsilon \le \overline{z}^x | x) g(x-\rho a)dx,$$

which implies the inequality in (B.3). This means that the numerator in (B.1) is lower than in (B.2). If

$$1-G(\overline{z}_e^m-\rho a) > G(\overline{z}_e^m-\rho a)-G(\overline{z}^x-\rho a), \tag{B.4}$$

then $f^m(a) < f^x(a)$. Clearly, the inequality is true if $\overline{z}_e^m = \overline{z}^x$. Let $\overline{z}_e^m = \overline{z}^x + \varphi$, with $\varphi > 0$. When $\varphi \to 0$, then $1-2G(\overline{z}^x+\varphi-\rho a) > -G(\overline{z}^x-\rho a)$. More generally, there exists φ^* such that for $0 \le \varphi < \varphi^*$, the inequality in (B.4) holds and $f^m(a) < f^x(a)$.

B.2. Proof of Proposition 2

Firm productivity z follows a first-order autoregressive process, $z' = \rho z + \sigma_\epsilon \epsilon'$ with $\epsilon' \sim N(0,1)$ and $0 \le \rho \le 1$. Let $\overline{z}_e^m$ and $\overline{z}^m$ be the productivity entry and exit thresholds, respectively. Let $f(a)$ denote the probability of exit from multinational status in $t+1$ for a firm that was not a multinational in $t-1$, and with productivity a in $t-1$, defined by

$$f(a) = \frac{\int_{\overline{z}_e^m}^{\infty} \Pr\left(\rho x + \sigma_\epsilon \epsilon \le \overline{z}^m | x\right) g(x-\rho a)dx}{1-G(\overline{z}_e^m-\rho a)},$$

where $g(\cdot)$ and $G(\cdot)$ denote, respectively, the probability and cumulative density functions of a normal distribution with mean zero and dispersion parameter σ_ϵ.

Let $\xi \to 0$, with $\xi > 0$. We will show that $f(.)$ is a decreasing function—that is, $f(a) - f(a-\xi) < 0$. Replacing, we get that

$$f(a)-f(a-\xi) = \frac{\int_{\bar{z}_e^m}^{\infty} \Pr(\rho x+\sigma_\epsilon \epsilon \le \bar{z}^m|x) g(x-\rho a)dx}{1-G(\bar{z}_e^m-\rho a)} - \frac{\int_{\bar{z}_e^m}^{\infty} \Pr(\rho x+\sigma_\epsilon \epsilon \le \bar{z}^m|x) g(x-\rho a+\rho\xi)dx}{1-G(\bar{z}_e^m-\rho a+\rho\xi)},$$

which, after some algebra, becomes

$$f(a)-f(a-\xi) = \frac{\int_{\bar{z}_e^m}^{\infty} \Pr(\rho x+\sigma_\epsilon \epsilon \le \bar{z}^m|x) \left[g(x-\rho a)(1-G(\bar{z}_e^m-\rho a+\rho\xi)-g(x-\rho a+\rho\xi)\left(1-G(\bar{z}_e^m-\rho a)\right)\right]dx}{[1-G(\bar{z}_e^m-\rho a)][1-G(\bar{z}_e^m-\rho a+\rho\xi)]}.$$

Since the denominator is always positive, we need to show that the numerator is negative. Note that $\Pr(\rho x+\sigma_\epsilon \epsilon \le \bar{z}^m|x)$ is decreasing in x and that

$$\frac{\int_{\bar{z}_e^m}^{\infty} g(x-\rho a)dx}{1-G(\bar{z}_e^m-\rho a)} - \frac{\int_{\bar{z}_e^m}^{\infty} g(x-\rho a+\rho\xi)dx}{1-G(\bar{z}_e^m-\rho a+\rho\xi)} = 0.$$

We then need to show that there exists only one point $m \in [c, \infty]$ such that for $x < m$,

$$g(x-\rho a)\left[1-G(\bar{z}_e^m-\rho a+\rho\xi)\right]-g(x-\rho a+\rho\xi)\left[1-G(\bar{z}_e^m-\rho a)\right]<0,$$

and for $x > m$,

$$g(x-\rho a)\left[1-G(\bar{z}_e^m-\rho a+\rho\xi)\right]-g(x-\rho a+\rho\xi)\left[1-G(\bar{z}_e^m-\rho a)\right]>0.$$

Since for $\xi > 0$ and $\xi \to 0$, $G(x-\xi) = G(x) - \xi g(x)$ and $g(x-\xi) = g(x) - \xi g'(x)$, replacing, we get that

$$\begin{aligned}
&g(x-\rho a)\left[1-G(\bar{z}_e^m-\rho a+\rho\xi)\right]-g(x-\rho a+\rho\xi)\left[1-G(\bar{z}_e^m-\rho a)\right] \\
&= g(x-\rho a)\left[1-G(\bar{z}_e^m-\rho a)-\rho\xi g(\bar{z}_e^m-\rho a)\right]-\left[g(x-\rho a)+\rho\xi g'(x-\rho a)\right]\left[1-G(\bar{z}_e^m-\rho a)\right] \\
&= -\rho\xi g(x-\rho a)g(\bar{z}_e^m-\rho a)-\rho\xi g'(x-\rho a)\left[1-G(\bar{z}_e^m-\rho a)\right] \\
&= \rho\xi g(x-\rho a)\left\{-g(\bar{z}_e^m-\rho a)+\frac{x-\rho a}{\sigma_\varepsilon^2}\left[1-G(\bar{z}_e^m-\rho a)\right]\right\},
\end{aligned} \tag{B.5}$$

where, in the last equality, we use that $g'(x-\rho a) = -g(x-\rho a)(x-\rho a)/\sigma_\varepsilon^2$.

Denote the function inside the curly brackets in (B.5) as

$$k(x) \equiv -g(\bar{z}_e^m-\rho a)+\frac{x-\rho a}{\sigma_\epsilon^2}\left[1-G(\bar{z}_e^m-\rho a)\right].$$

For $x = m$, $k(m) = 0$, with $m = c\sigma_\varepsilon^2 + \rho a$ where $c \equiv g(\bar{z}_e^m-\rho a)/[1-G(\bar{z}_e^m-\rho a)]>0$ (since $[1-G(\bar{z}_e^m-\rho a)]$ and $g(\bar{z}_e^m-\rho a)$ are positive constants). It remains to show that for $x < m$, $k(x)$ is negative, and for $x > m$, $k(x)$ is positive. Taking the derivative of $k(\cdot)$ with respect to x yields

$$k'(x) = \frac{1-G(\bar{z}_e^m-\rho a)}{\sigma_\epsilon^2},$$

which is positive for all x. Thus, $k(x) < k(m)$, for $x < m$, and $k(x) > k(m)$, for $x > m$, which implies that the expression in (B.5) is decreasing, proving that $f(a)$ is a decreasing function.■

B.3. Proof of Proposition 3

Firm productivity z follows a first-order autoregressive process, $z' = \rho z + \sigma_\epsilon \epsilon'$ with $\epsilon' \sim N(0,1)$ and $0 \le \rho \le 1$. Let $\bar{z}$ denote the exit cutoff and $\bar{z}_e$ the entry cutoff into an international activity. Let c be a constant in the interval $[\bar{z}_e, \infty)$. Let

$$f(a) = \frac{\int_{\bar{z}_e}^{c} \Pr(\rho x+\sigma_\epsilon \epsilon \le \bar{z}|x) g(x-\rho a)dx}{G(c)-G(\bar{z}_e-\rho a)}$$

denote the probability of exit from status i in $t + 1$ for a firm that is not yet in status i in $t - 1$ and that has a productivity level of

a in t-1. The functions $g(\cdot)$ and $G(\cdot)$ denote, respectively, the probability and cumulative density functions of a normal distribution with mean zero and dispersion parameter σ_ϵ.

Let ξ and φ be two positive constants, with $\xi \le \varphi$. Without loss of generality, the entry cutoff is $\overline{z}_e = \overline{z} + \varphi$. We want to show that when we increase the exit cutoff from $\overline{z}$ to $\overline{z} + \xi$, the exit probability increases more when sunk costs are zero—that is, $\varphi = 0$,

$$f(a;\xi>0;\varphi=0)-f(a;\xi=0;\varphi=0)>f(a;\xi>0;\varphi>0)-f(a;\xi=0;\varphi>0).$$

The first term is given by

$$f(a;\xi>0;\varphi=0)-f(a;\xi=0;\varphi=0)=\frac{\int_{\overline{z}}^{c}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}+\xi|x)g(x-\rho a)dx}{G(c)-G(\overline{z}-\rho a)}-\frac{\int_{\overline{z}}^{c}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}|x)g(x-\rho a)dx}{G(c)-G(\overline{z}-\rho a)}, \tag{B.6}$$

and the second one is

$$f(a;\xi>0;\varphi>0)-f(a;\xi=0;\varphi>0)=\frac{\int_{\overline{z}+\varphi}^{c}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}+\xi|x)g(x-\rho a)dx}{G(c)-G(\overline{z}+\varphi-\rho a)}-\frac{\int_{\overline{z}+\varphi}^{c}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}|x)g(x-\rho a)dx}{G(c)-G(\overline{z}+\varphi-\rho a)}. \tag{B.7}$$

Rearranging, we get that

$$f(a;\xi>0;\varphi=0)-f(a;\xi>0;\varphi>0)>f(a;\xi=0;\varphi=0)-f(a;\xi=0;\varphi>0),$$

which, after some algebra, yields

$$\frac{\int_{\overline{z}}^{c}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}+\xi|x)g(x-\rho a)dx-\int_{\overline{z}+\varphi}^{c}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}+\xi|x)g(x-\rho a)dx}{(G(c)-G(\overline{z}-\rho a))(G(c)-G(\overline{z}+\varphi-\rho a))}$$
$$>\frac{\int_{\overline{z}}^{c}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}|x)g(x-\rho a)dx-\int_{\overline{z}+\varphi}^{c}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}|x)g(x-\rho a)dx}{(G(c)-G(\overline{z}-\rho a))(G(c)-G(\overline{z}+\varphi-\rho a))}.$$

Denominators are always positive and simplify. The numerators can be written as

$$\int_{\overline{z}}^{\overline{z}+\varphi}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}+\xi|x)g(x-\rho a)dx+\int_{\overline{z}+\varphi}^{c}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}+\xi|x)g(x-\rho a)dx$$
$$-\int_{\overline{z}+\varphi}^{c}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}+\xi|x)g(x-\rho a)dx=\int_{\overline{z}}^{\overline{z}+\varphi}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}+\xi|x)g(x-\rho a)dx,$$

and analogously for the numerator in the right-hand side of the inequality. Hence,

$$\int_{\overline{z}}^{\overline{z}+\varphi}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}+\xi|x)g(x-\rho a)dx>\int_{\overline{z}}^{\overline{z}+\varphi}\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}|x)g(x-\rho a)dx.$$

Because $\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}+\xi|x)>\Pr(\rho x+\sigma_\epsilon\epsilon\le\overline{z}|x)$, we show that when we increase the exit cutoff, the probability of exit upon entry increases by less with the presence of sunk costs. ■

B.4. Proof of Proposition 4

Let $\phi(\cdot)$ and $\Phi(\cdot)$ denote the probability and cumulative density functions, respectively, of a standard normal distribution. Then,

$$G^L\equiv\mathbb{E}(z_t-z_{t-1}|z_t>\underline{z},z_{t-1}=\underline{z})=\mathbb{E}(z_t|z_t>\underline{z},z_{t-1}=\underline{z})-\underline{z}=\mathbb{E}(\rho z_{t-1}+\sigma_\epsilon\epsilon_t|z_t>\underline{z},z_{t-1}=\underline{z})-\underline{z}$$
$$=\rho\underline{z}+\mathbb{E}(\sigma_\epsilon\epsilon_t|z_t>\underline{z},z_{t-1}=\underline{z})-\underline{z}=\rho\underline{z}+\sigma_\epsilon\mathbb{E}(\epsilon_t|\epsilon_t>\underline{z}(1-\rho)/\sigma_\epsilon)-\underline{z}=\sigma_\epsilon\mathbb{E}(\epsilon_t|\epsilon_t>\underline{c})-\sigma_\epsilon\underline{c}=\sigma_\epsilon\left(\frac{\phi(\underline{c})}{1-\Phi(\underline{c})}-\underline{c}\right),$$

where $\underline{c} \equiv (1-\rho)\underline{z}/\sigma_\epsilon$. Similar calculations yield

$$G^{LR} \equiv \mathbb{E}(z_t - z_{t-1} | \underline{z} < z_t < \overline{z}, z_{t-1} = \underline{z}) = \sigma_\epsilon \left(\frac{\phi(\underline{c}) - \phi(\overline{c})}{\Phi(\overline{c}) - \Phi(\underline{c})} - \underline{c} \right),$$

where $\overline{c} \equiv (1-\rho)\overline{z}/\sigma_\epsilon$.

Growth is higher with left (L) than with left and right (LR) truncation when

$$\frac{\phi(\underline{c})}{1-\Phi(\underline{c})} > \frac{\phi(\underline{c}) - \phi(\overline{c})}{\Phi(\overline{c}) - \Phi(\underline{c})},$$

or equivalently,

$$\frac{\Phi(\overline{c}) - \Phi(\underline{c})}{1-\Phi(\underline{c})} > \frac{\phi(\underline{c}) - \phi(\overline{c})}{\phi(\underline{c})}.$$

The expression on the left-hand side (l.h.s.) of the inequality has the following properties:

$$\lim_{\overline{c} \to \underline{c}} \frac{\Phi(\overline{c}) - \Phi(\underline{c})}{1-\Phi(\underline{c})} = 0; \quad \lim_{\overline{c} \to \infty} \frac{\Phi(\overline{c}) - \Phi(\underline{c})}{1-\Phi(\underline{c})} = 1; \quad \frac{dl.h.s.}{d\overline{c}} = \frac{\phi(\overline{c})}{1-\Phi(\underline{c})} \cdot > 0.$$

With $\overline{z} > \underline{z}$, and $\overline{c} > 0$, the expression on the right-hand side (r.h.s.) of the inequality has the following properties:

$$\lim_{\overline{c} \to \underline{c}} \frac{\phi(\underline{c}) - \phi(\overline{c})}{\phi(\underline{c})} = 0; \quad \lim_{\overline{c} \to \infty} \frac{\phi(\underline{c}) - \phi(\overline{c})}{\phi(\underline{c})} = 1; \quad \frac{dr.h.s.}{d\overline{c}} = \overline{c}\frac{\phi(\overline{c})}{\phi(\underline{c})} > 0.$$

Both functions have the same limits, and both are increasing with $\overline{c}$. The left-hand side, however, grows faster than the right-hand side when

$$\overline{c} < \frac{\phi(\underline{c})}{1-\Phi(\underline{c})}.$$

Therefore, there exists $\overline{c}^*$—and consequently, $\overline{z}^*$—such that for all $\underline{c} < \overline{c} < \overline{c}^*$, $G^L > G^{LR}$, with $G^L = G^{LR}$ for $\overline{c} = \overline{c}^*$.

Appendix C. Quantitative model

We extend the model in Section 4 to include sunk export costs, $F^x > 0$, paid in units of labor and $F^m > F^x$. Additionally, we assume that all fixed and sunk costs are heterogeneous across firms but fixed over time for each firm. Fixed and sunk costs distributions are independent of the firm productivity distribution and follow a log-normal distribution,

$$\log(F_e^s) \sim N\left(\mu_e^s, (\sigma_e^s)^2\right) \quad \text{and} \quad \log(f^s) \sim N\left(\mu_f^s, \left(\sigma_f^s\right)^2\right),$$

where $s = m, x$. In practice, we calibrate the model country by country, and we allow the parameters μ_e^s, σ_e^s, μ_f^s, σ_f^s to vary across origin-destination pairs, as noted in Section C. Here we abstract from the country subscript, fixing one pair as an example.

Firms have three possible states: producing in the domestic market for home consumers only(D); producing in the domestic market for home and foreign consumers (X); or producing in the domestic market for home consumers and in the foreign market for foreign consumers (M).

The value of being an MNE with productivity ϕ is given by

$$V(\phi, F_e^m, F_e^x, f^m, f^x, M) = \frac{X^d(\phi)}{\sigma} + \max\left\{ \frac{X^m(\phi)}{\sigma} - f^m + \beta E_{\phi'} V(\phi', F_e^m, F_e^x, f^m, f^x, M|\phi), \right.$$
$$\left. \beta E_{\phi'} V(\phi', F_e^m, F_e^x, f^m, f^x, D|\phi), \frac{X^x(\phi)}{\sigma} - f^x - F_e^x + \beta E_{\phi'} V(\phi', F_e^m, F_e^x, f^m, f^x, X|\phi) \right\}.$$

An MNE chooses among continuing its operations abroad and incurring the per-period fixed cost f^m; shutting down the affiliate and becoming an exporter into the foreign market, incurring a per-period fixed cost f^x and sunk cost F^x; or abandoning the foreign market altogether.

The value of being an exporter with productivity ϕ is given by

$$V(\phi, F_e^m, F_e^x, f^m, f^x, X) = \frac{X^d(\phi)}{\sigma} + \max\Big\{\frac{X^x(\phi)}{\sigma} - f^x + \beta E_{\phi'} V(\phi', F_e^m, F_e^x, f^m, f^x, X|\phi),$$
$$\beta E_{\phi'} V(\phi', F_e^m, F_e^x, f^m, f^x, D|\phi), \frac{X^m(\phi)}{\sigma} - f^m - F_e^m + \beta E_{\phi'} V(\phi', F_e^m, F_e^x, f^m, f^x, M|\phi)\Big\}.$$

An exporter can choose to become an MNE in the foreign market and pay the per-period fixed cost f^m and the entry sunk cost F^m; continue exporting to the foreign market and pay the per-period fixed cost f^x; or operate in and serve only its home market.

The value of being a domestic firm with productivity ϕ is given by

$$V(\phi, F_e^m, F_e^x, f^m, f^x, D) = \frac{X^d(\phi)}{\sigma} + \max\Big\{\frac{X^m(\phi)}{\sigma} - f^m - F_e^m + \beta E_{\phi'} V(\phi', F_e^m, F_e^x, f^m, f^x, M|\phi),$$
$$\beta E_{\phi'} V(\phi', F_e^m, F_e^x, f^m, f^x, D|\phi), \frac{X^x(\phi)}{\sigma} - f^x - F_e^x + \beta E_{\phi'} V(\phi', F_e^m, F_e^x, f^m, f^x, X|\phi)\Big\}.$$

A domestic firm can choose to become an MNE in the foreign market and pay the per-period fixed cost f^m and the entry sunk cost F^m; export to the foreign market and pay the per-period fixed cost f^x and sunk cost F^x; or operate in and serve only its home market.

Appendix D. Numerical implementation

We describe here the numerical algorithm used in the paper, proceeding in three steps. Appendix D.1 discusses the numerical methods to solve the model. Appendix D.2 describes how we calculate the moments from the model. Appendix D.3 provides details on the implementation of the simulated method of moments (SMM) to search for a set of parameters that minimize the differences between the model and data moments for each of our 32 origin-destination pairs.[36]

D.1. Solving the model

For each firm, the sunk and fixed costs of multinational production and exporting, F_e^s and f^s ($s = m,x$), do not vary over time. These costs are independent from each other and across firms, each following a log normal distribution with parameters (μ_e^s, σ_e^s) or (μ_f^s, σ_f^s), where $s = m, x$. With the goal of simplifying notations, we use a 4×1 vector $\vec{F}$ to collect these costs. We simulate I draws of the costs, denoted with $\{\vec{F_i}\}_{i=1}^I$. In order for the draws to get a good coverage in the space of the costs, we take the following approach. Conditional on a set of model parameters, μ_e^s, σ_e^s, μ_f^s and σ_f^s ($s = m, x$), we make $I = 150$ scrambled Halton quasi-random draws (Halton, 1960) for each of the four CDFs of MNE and exporter sunk and fixed costs.[37] To get the actual draws of $\{\vec{F_i}\}_{i=1}^I$, we use the inverse CDF transformation.

Given a vector of fixed and sunk cost draws, for each firm we have a problem with one exogenous state variable (productivity ϕ), and one endogenous state variable (firm status $S = D, X or M$). To solve a firm's problem, we first construct the discretized productivity grid and the Markovian productivity transition probability matrix with the Tauchen method (Tauchen, 1986). Then for each draw $\vec{F_i}$, we solve the Bellman equations in Appendix Section C with value function iteration. We can parallelize solving the problems across the I draws $\{\vec{F_i}\}_{i=1}^I$.

The solution to each firm's problem is characterized by a policy function $\mathbf{1}(S'|S, \phi_j, \vec{F_i})$ (the firm's decision that chooses the status for next period, conditional on the status today, productivity and the sunk and fixed cost draw), as well as the stationary distribution, $\Pr(S, \phi_j|\vec{F_i})$ (the joint probability of status and productivity in the stationary equilibrium, conditional on the sunk and fixed cost draw). Here S denotes the firm's status today ($S = D$, X or M) and S' the firm's status in the next period.

D.2. Calculation of moments

We describe the approach to compute the model moments (see Section 5.1) for the extended model described in Appendix Section C. We present the calculation of the *average exporter exit rate* as an example. The other five moments are computed in an analogous manner.

The average exporter exit rate (in the stationary distribution) equals the joint mass of firms being an exporter and exiting in the next period, divided by the mass of firms being an exporter, denoted as

$$\frac{\Pr(S' \neq X, S = X)}{\Pr(S = X)}. \quad \text{(D.1)}$$

[36] 16 destinations for French firms and 16 destinations for Norwegian firms. See Section 5.

[37] Scrambled Halton quasi-random draws have nice properties for simulating high-dimensional integrals. See Train (2009).

Expanding the numerator of (D.1) yields

$$\Pr(S'\neq X, S=X) = \int \Pr\left(S'\neq X|S=X,\phi,\vec{F}\right) \Pr\left(S=X|\phi,\vec{F}\right) f\left(\phi,\vec{F}\right) d\phi d\vec{F}.$$

The expression $f(\phi,\vec{F})$ denotes the joint density of the firm's productivity ϕ, and the vector of fixed and sunk costs of exporters and MNEs, $\vec{F}$. The joint mass of exiting exporters integrates over all levels of productivity and sunk and fixed costs, using their respective probability densities $f(\phi,\vec{F})$, multiplied by the mass of exporters conditional on productivity and sunk and fixed costs, $\Pr(S=X|\phi,\vec{F})$ (in the steady state), as well as exporters' probability to exit exporting in the next period conditional on their productivity and sunk and fixed costs, $\Pr(S'\neq X|S=X,\phi,\vec{F})$ (again, in the steady state).

Because ϕ and $\vec{F}$ are independent, we can write $f(\phi,\vec{F}) = f_1(\phi)f_2(\vec{F})$, where f_1 and f_2 are densities of productivity and sunk and fixed costs, respectively.

Let $g(S=X,\phi|\vec{F})$ denote the stationary joint distribution of exporters and productivity levels conditional on costs $\vec{F}$.[38]

Note that $\Pr(S=X|\phi,\vec{F})f_1(\phi) = \Pr(S=X|\phi,\vec{F})f_1(\phi|\vec{F}) = g(S=X,\phi|\vec{F})$.

Conditional on other state variables, the exporter's exiting policy function follows a productivity cutoff rule. As a result, the probability $\Pr(S'\neq X|S=X,\phi,\vec{F})$ is actually the policy function $\mathbf{1}(S'\neq X|S=X,\phi,\vec{F})$. Consequently,

$$\Pr(S'\neq X, S=X) = \int\left(\int 1\left(S'\neq X|S=X,\phi,\vec{F}\right) g(S=X,\phi|\vec{F}) d\phi\right) f_2\left(\vec{F}\right) d\vec{F}. \tag{D.2}$$

Similarly, the denominator of (D.1) equals

$$\Pr(S=X) = \int\left(\int g\left(S=X,\phi|\vec{F}\right) d\phi\right) f_2\left(\vec{F}\right) d\vec{F}. \tag{D.3}$$

Armed with the model solution in Appendix D.1, the interior integrals over ϕ in (D.2) and (D.3) are numerically evaluated as follows:

$$\int \mathbf{1}\left(S'\neq X|S=X,\phi,\vec{F}\right) g\left(S=X,\phi|\vec{F}\right) d\phi \approx \sum_j \mathbf{1}\left(S'\neq X|S=X,\phi_j,\vec{F}\right) \Pr\left(S=X,\phi_j|\vec{F}\right),$$

$$\int g\left(S=X,\phi|\vec{F}\right) d\phi \approx \sum_j \Pr\left(S=X,\phi_j|\vec{F}\right).$$

Further, note that the exterior integrals over $\vec{F}$ for both (D.2) and (D.3) are the simple average across all Halton draws for fixed and sunk costs. These lead up to the model moments in (D.1),

$$\frac{\Pr(S'\neq X, S=X)}{\Pr(S=X)} \approx \frac{\frac{1}{I}\sum_i \sum_j \mathbf{1}\left(S'\neq X|S=X,\phi_j,\vec{F_i}\right) \Pr\left(S=X,\phi_j|\vec{F_i}\right)}{\frac{1}{I}\sum_i \sum_j \Pr\left(S=X,\phi_j|\vec{F_i}\right)}.$$

D.3. Estimation

Conditional on a set of model parameters (means and standard deviations of exporters and μ_e^s, σ_e^s, μ_f^s, σ_f^s, where $s = m, x$), we compute the model moments as indicated in the previous sections. We next describe the SMM method to search for the parameters that minimize the distances between model and data moments.

We denote the six data moments (see Section 5.1) with column vector $\vec{m}$ and the model counterparts with $\vec{\hat{m}}$. In order to account for the size differences across model moments, we normalize the distances between the data and model moments with the levels of the corresponding data moments. As described in the main text, we also reduce the number of estimated parameters from eight to six by imposing the assumption that the coefficient of variation for sunk and fixed costs (in logs) is the same for each mode, $|\sigma_e^s/\mu_e^s| = |\sigma_f^s/\mu_f^s|$ $(s \in x, m)$. The estimation problem is the following:

$$\min_{\mu_e^m,\sigma_e^m,\mu_f^m,\mu_e^x,\sigma_e^x,\mu_f^x} \left(\left(\vec{m}-\vec{\hat{m}}\right)./\vec{m}\right)' \mathbf{W}\left(\left(\vec{m}-\vec{\hat{m}}\right)./\vec{m}\right) \tag{D.4}$$

[38] $g(S=X,\phi|\vec{F})$ is the continuous object of the discretized stationary distribution $\Pr(S=X,\phi_j|\vec{F_i})$ defined in the previous section.

where ./ represents element-wise matrix division and **W** is the weighting matrix for the moments, which we set to identity matrix. To minimize this objective, we use the MATLAB derivative-free nonlinear solver *fminsearch*, augmented with bound constraints on parameters. We solve the problem for each of our 32 origin-destination pairs. To reduce the possibility that the solver gets stuck in a local optimum, for every origin-destination pair, we kick off the solver from multiple starting values.

Appendix E. Additional figures

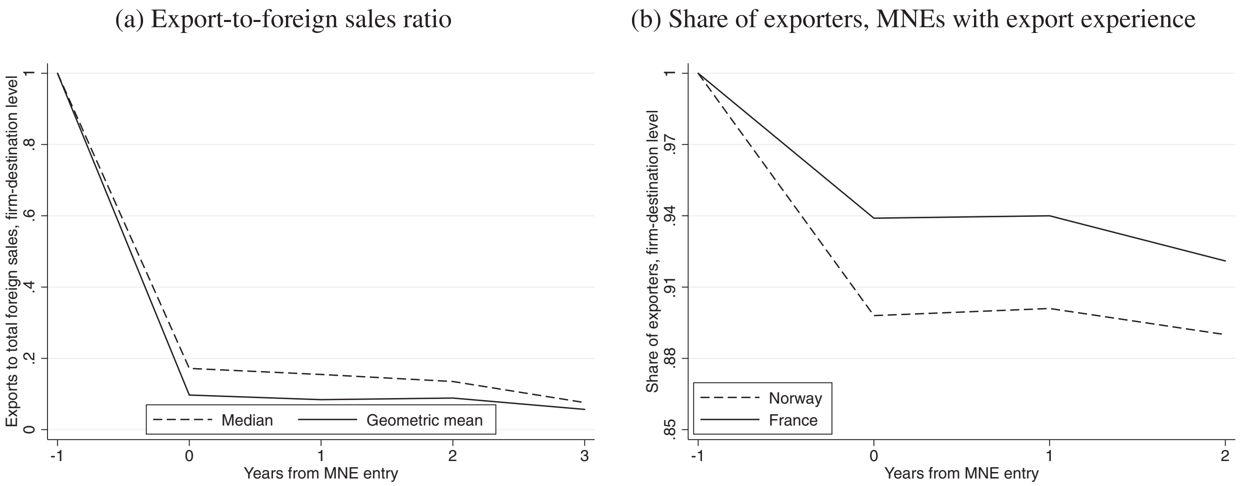

Fig. E.1. Life-cycle dynamics of exports for new MNEs.

Notes: Data on MNE sales are available only for Norway. (E.1a): ratio of exports to foreign sales, by years from MNE entry, at the firm-destination-year level, average over MNE-destination pairs with at least 4 years in the market and with positive exports before MNE entry. (E.1b): share of exporters among MNEs that export (to the market of the affiliate) in the year before MNE entry, by years from MNE entry, for firm-destination pairs that survive at least 4 years as MNEs in a market.

$$D(Exit_{inmta}) = \beta_0 MNE_{inta} + \sum_a \beta_1^a D(age_{inmt} = a) + \sum_a \beta_2^a MNE_{inta} \times D(age_{inmt} = a) + \epsilon_{inmta},$$

where $D(Exit_{inmta})$ is a dummy equal to one in the year t in which firm i of age a exits mode m in market n, and zero otherwise; MNE_{inta} is one if firm i at age a is active in market n and year t as an MNE, and zero otherwise; and $D(age_{inmt} = a)$ equals one if firm i in market n and mode m at time t is of age a, and zero otherwise. We include year, industry, country fixed effects, and the log of home sales as a control. Standard errors are clustered by industry. Exporters are the base group. Observations are at the firm-destination-year level. Exporters refers to non-MNE exporters.

$$\begin{aligned} D(Exit_{inmta}) = {} & \beta_0 MNE_{inta} + \sum_a \beta_1^a D(age_{inmt} = a) + \sum_a \beta_2^a MNE_{inta} \times D(age_{inmt} = a) \\ & + \beta_3 \; exp.mne_{inmta} + \sum_a \beta_4^a \; exp.mne_{inmta} \times D(age_{inmt} = a) + \beta_5 \; exp.mne_{inmta} \times MNE_{inta} \\ & + \sum_a \beta_6^a D(age_{inmt} = a) \times MNE_{inta} \times \; exp.mne_{inmta} + \epsilon_{inmta}, \end{aligned}$$

where $D(Exit_{inmta})$ is a dummy equal to one in the year t in which firm i of age a exits mode m in market n, and zero otherwise; MNE_{inta} is one if firm i at age a is active in market n and year t as an MNE, and zero otherwise; and $D(age_{inmt} = a)$ equals one if firm i in market n and mode m at time t is of age a, and zero otherwise. $exp.\ mne_{inmta}$ indicates the years of export experience before MNE entry in market n, for firm i at age a and year t. We include year, industry, country fixed effects, and the log of home sales as a control. Standard errors are clustered by industry. Non-experienced MNEs are the base group. Observations at the firm-destination-year level.

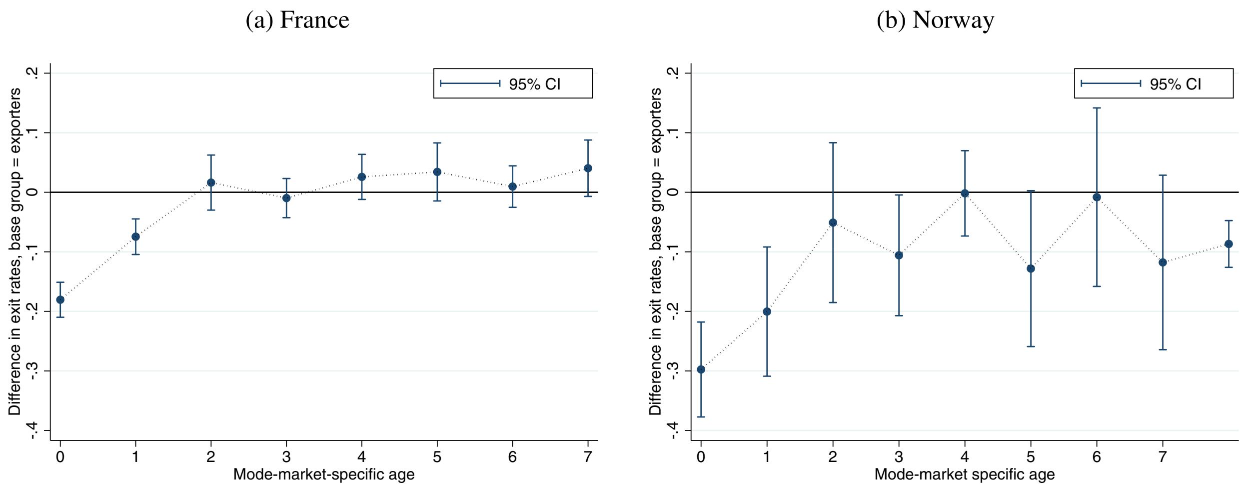

Fig. E.2. Exit rates by age: MNEs versus exporters, OLS.

Notes: Difference in coefficients and 95% confidence bands from estimating, by OLS,

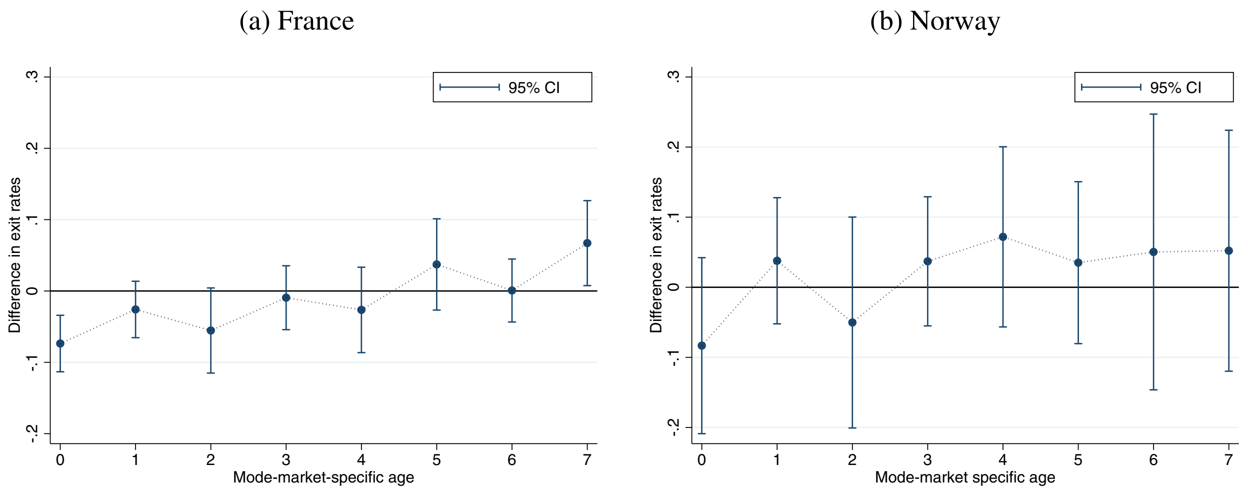

Fig. E.3. Exit rates by age: experienced versus non-experienced MNEs, OLS.

Notes: Number of exits from a mode-market relative to the number of firms active in a mode-market, by mode-market-specific age. Experienced MNEs are new affiliates of MNEs that exported to a foreign market for one or more years before opening an affiliate there. Difference in coefficients and 95% confidence bands from estimating, by OLS,

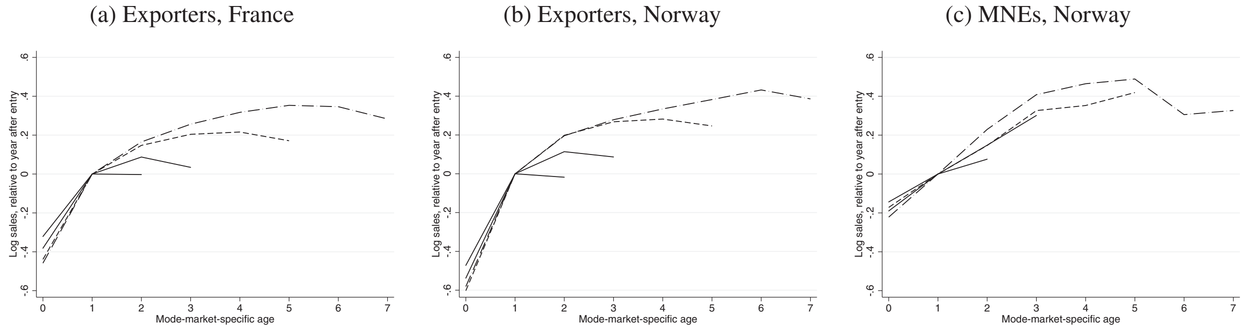

Fig. E.4. Sales growth by age and cohort.

Notes: Log of firm-destination export (affiliate) sales with respect to firm-destination export (MNE) sales in the year after entry, firms with at least *t* years in the market, selected cohorts in each mode. Observations are at the firm-destination-year level. We show averages across destinations weighted by each destination's share of export (MNE) firms. Log of sales are first demeaned by industry, year, and destination fixed effects. Exporters refers to non-MNE exporters.

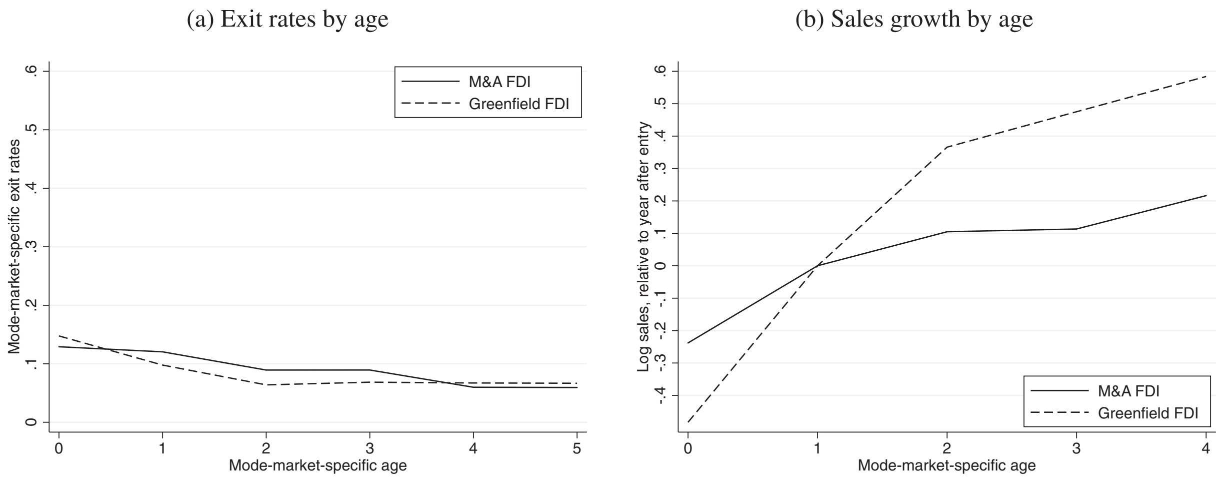

Fig. E.5. Greenfield versus M&A FDI, Germany.

Notes: (E.5a): number of exits from a mode-market relative to the number of firms active in a mode-market, by mode-market-specific age. (E.5b): log of firm-destination MNE sales with respect to firm-destination MNE sales in the year after entry, firms with five or more years in the market. Observations are at the firm-destination-year level. We show averages across destinations weighted by each destination's share of MNE firms. Log of sales are first demeaned by industry, year, and destination fixed effects. The sample period is 2005–2011 (no information on FDI entry mode available before 2005). Source: Deutsche Bundesbank Research Data and Service Centre, Microdatabase Direct investment, own calculations.

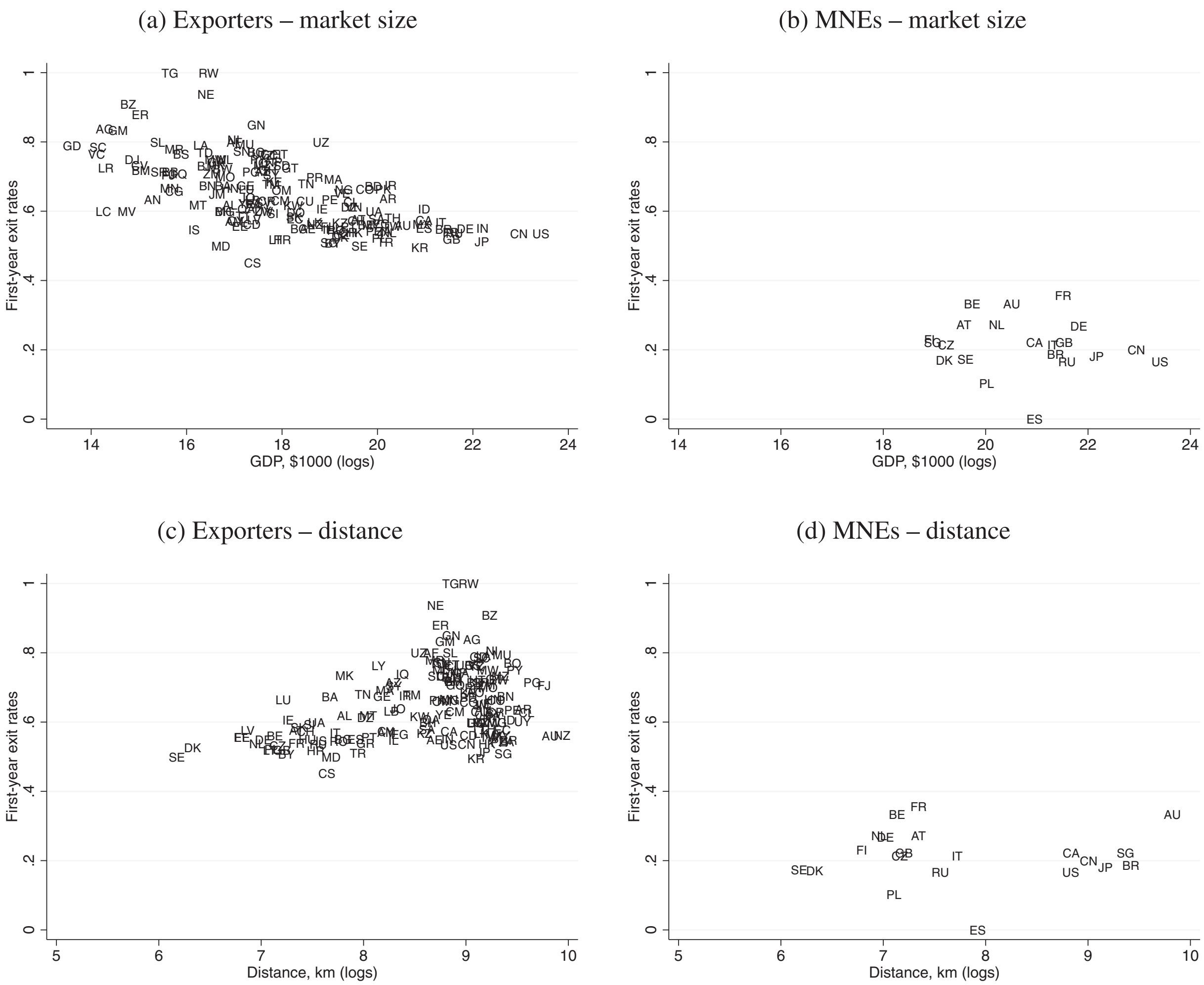

Fig. E.6. First-year exit rates and market characteristics, Norway.

Notes: Number of exits from a mode-market relative to the number of firms active in a mode-market, for exporters and MNEs, in the first year upon market-mode entry. Destinations with ten or more firm-year observations and with available GDP data. Exporters refers to non-MNE exporters. GDP data from *International Financial Statistics* (IMF). Distance data from *CEPII* (Mayer and Zignago, 2011).

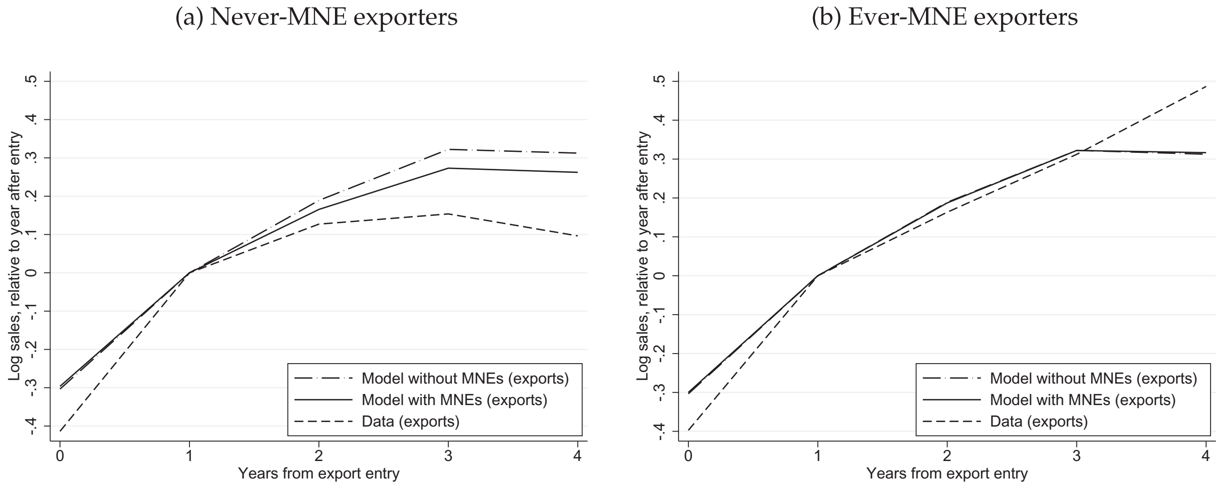

Fig. E.7. Entry rates and market characteristics, Norway.

Notes: Number of entries to a mode-market relative to the number of domestic firms (MNEs) active in the home market. Destinations with ten or more firm-year observations and with available GDP data. Exporters refers to non-MNE exporters. GDP data from *International Financial Statistics* (IMF). Distance data from *CEPII* (Mayer and Zignago, 2011).

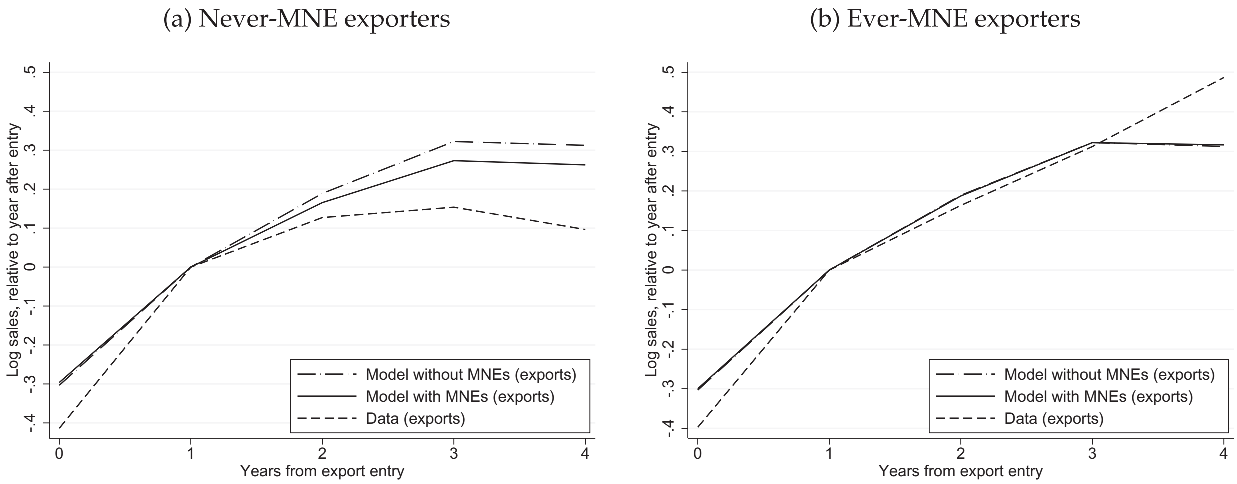

Fig. E.8. Sales growth, by age and exporter type.

Notes: Models calibrated to French data. Log of firm-destination export sales with respect to firm-destination export sales in the year after export entry, an average over firms with five or more years in the market as exporters. Observations are at the firm-destination-year level. We show averages across destinations included in the calibration, weighted by each destination's share of export firms. Never-MNE exporters are exporters that, in our sample period, do not change to MNE status. Ever-MNE exporters are exporters that become MNEs after export entry. Exports for ever-MNE exporters are computed for the years before MNE entry. Exporters in the data refers to non-MNE exporters.

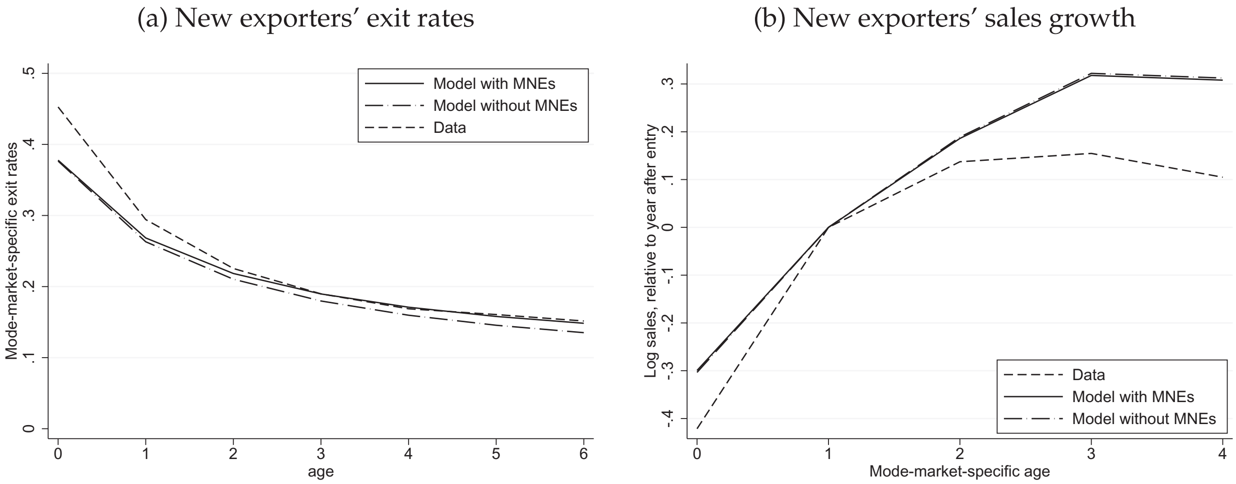

Fig. E.9. Exporters exit rates and sales growth, by age.

Notes: Models calibrated to French data. (E.9a): number of exits from a mode-market relative to the number of firms active in a mode-market, by mode-market-specific age. (E.9b): log of firm-destination export sales with respect to firm-destination export sales in the year after entry, an average over firms with five or more years in the market. In the data, log of sales are first demeaned by industry, year, and destination fixed effects. Observations are at the firm-destination-year level. We show averages across destinations included in the calibration, weighted by each destination's share of export firms. Weights are data-based (model-based) for data (model) variables. Exporters in the data refers to non-MNE exporters.

Appendix F. Additional tables

Table F.1
Summary statistics.

	France			
	Share of revenues	Share of employment	Share of firm-year obs	Firm-year obs
Domestic firms	0.076	0.116	0.697	671,283
Non-MNE exporters	0.289	0.317	0.287	276,499
Non-exporter MNEs	0.005	0.010	0.001	1007
Exporter MNEs	0.630	0.557	0.015	14,589
	Norway			
	Share of revenues	Share of employment	Share of firm-year obs	Firm-year obs
Domestic firms	0.153	0.235	0.622	55,359
Non-MNE exporters	0.625	0.630	0.364	32,376
Non-exporter MNEs	0.002	0.002	0.002	136
Exporter MNEs	0.220	0.133	0.013	1147

Notes: Non-MNE exporters are exporters that do not have MNE activities. Non-exporter MNEs are MNEs that are not exporters. Exporter MNEs are MNEs that also export.

Table F.2
Exit rates and growth rates, OLS.

Dep variable	D(exit)				Sales, relative to age one						
	Market-mode		Market	Market age	Calendar yr		12-mo yr	"never MNEs"		"ever MNEs"	
	FRA	NOR	FRA	FRA	FRA (exp)	NOR	FRA (exp)	FRA	NOR	FRA	NOR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
MNE	−0.181***	−0.211***	−0.273***	−0.177***		−0.079**					
	(0.015)	(0.038)	(0.014)	(0.016)		(0.045)					
$D(age = 0)$	−0.172***	−0.218***	−0.171***	−0.172***	−0.436***	−0.686***	−0.109***	−0.436***	−0.683***	−0.448***	−2.540**
	(0.003)	(0.008)	(0.003)	(0.003)	(0.011)	(0.045)	(0.010)	(0.011)	(0.045)	(0.089)	(1.059)
×*MNE*	0.106***	0.116***	0.126***	0.106***		0.469***					
	(0.015)	(0.039)	(0.015)	(0.017)		(0.109)					
$D(age = 1)$	−0.246***	−0.270	−0.246***	−0.246***							
	(0.004)	(0.011))	(0.004)	(0.004)							
×*MNE*	0.197***	0.257***	0.229***	0.198***							
	(0.029)	(0.045)	(0.029)	(0.025)							
$D(age = 2)$	−0.283***	−0.316***	−0.283***	−0.283***	0.154***	0.178***	0.126***	0.154***	0.179***	0.204**	0.929
	(0.004)	(0.016)	(0.004)	(0.004)	(0.008)	(0.024)	(0.009)	(0.008)	(0.0249)	(0.080)	(0.972)
×*MNE*	0.171***	0.236***	0.207***	0.179***		0.021					
	(0.019)	(0.044)	(0.018)	(0.020)		(0.102)					
$D(age = 3)$	−0.308***	−0.334***	−0.308***	−0.308***	0.209***	0.277***	0.164***	0.209***	0.280***	0.361***	1.376
	(0.006)	(0.013)	(0.006)	(0.006)	(0.012)	(0.042)	(0.014)	(0.012)	(0.043)	(0.086)	(1.509)
×*MNE*	0.207***	0.250***	0.246***	0.214***		0.071					
	(0.021)	(0.044)	(0.020)	(0.026)		(0.140)					
$D(age = 4)$	−0.316***	−0.343***	−0.316***	−0.317***	0.157***	0.241***	0.088***	0.157***	0.245***	0.460***	2.671
	(0.008)	(0.015)	(0.008)	(0.008)	(0.020)	(0.054)	(0.020)	(0.020)	(0.055)	(0.125)	(2.166)
×*MNE*	0.214***	0.283***	0.248***	0.216***		0.132					
	(0.025)	(0.050)	(0.024)	(0.026)		(0.143)					
Observations	1,044,855	74,119	1,044,855	1,044,855	405,009	25,887	297,896	405,009	24,902	2632	104

Notes: Dummy equals one if firm *i* exits. Cols 1–2: mode-market by mode-market age; col. 3: market by mode-market age. Col 4: mode-market by market age. Cols 5–11: Log of firm-destination export sales with respect to firm-destination export sales in the year after export entry, firms with five or more years in the market-mode. Col 7: adjusted by partial-year effects. Cols 8–9: Never-MNEs are exporters that, in our sample period, do not change to MNE status. Cols 10–11: Ever-MNEs are exporters that become MNEs after export entry. Exports for ever-MNE exporters computed for the years before MNE entry. All regressions with year, industry, and country fixed effects. Regressions for exit rates include log of home sales and age dummies (and interactions) to age 6. Standard errors, clustered by industry, are in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Observations are at the firm-destination-year level. Exporters refers to non-MNE exporters.

Table F.3
Foreign-to-domestic sales ratio, by country.

	France			Norway	
	r_n^x	r_n^m		r_n^x	r_n^m
Austria	0.003	0.024*	Austria	0.009	0.432
Benelux	0.068	0.135*	Belgium	0.029	0.086
Switzerland	0.011	0.064	Canada	0.010	0.130
China	0.014	0.213*	Germany	0.087	0.456
Germany	0.123	0.181	Denmark	0.030	0.501
Denmark	0.003	0.017*	Spain	0.031	0.051
Spain	0.044	0.119	Finland	0.025	0.546
Great Britain	0.040	0.181	France	0.045	0.231
Italy	0.054	0.100	Great Britain	0.069	0.193
Morocco	0.004	0.037	Italy	0.034	0.094
Portugal	0.006	0.019*	Netherlands	0.031	0.178
Poland	0.013	0.038	Poland	0.016	0.088
Sweden	0.012	0.037*	Sweden	0.065	0.918
Tunisia	0.004	0.008*	Singapore	0.018	0.382
United States	0.038	0.427*	United States	0.056	0.749
RoW	0.067	0.074	RoW	0.009	0.110

Notes: r_n^x refers to the export-to-domestic sales ratio, and r_n^m refers to the MNE affiliate-to-domestic sales ratio, for market n. Ratios are aggregated across firms serving market n in each mode using weights given by the firm's domestic sales. (*) imputed values. RoW refers to the rest of the world, a weighted average among the remaining countries in the sample. Observations are at the firm-destination-year level.

Table F.4
Targeted moments, model and data, by country.

	Data						Model					
	Shares		1st-yr exit rates		Avg exit rates		Shares		1st-yr exit rates		Avg exit rates	
	exp	MNEs	exp	MNEs	exp	MNEs	exp	MNEs	exp	MNEs	exp	MNEs
France												
Benelux	0.155	0.004	0.339	0.299	0.269	0.209	0.119	0.004	0.339	0.270	0.200	0.200
Switzerland	0.133	0.003	0.501	0.223	0.354	0.166	0.118	0.003	0.501	0.210	0.197	0.185
Germany	0.128	0.005	0.418	0.250	0.284	0.174	0.116	0.005	0.418	0.243	0.204	0.186
Spain	0.118	0.005	0.416	0.249	0.285	0.187	0.108	0.005	0.416	0.250	0.209	0.188
Italy	0.111	0.004	0.438	0.295	0.297	0.192	0.094	0.004	0.438	0.281	0.207	0.207
G. Britain	0.105	0.004	0.429	0.297	0.291	0.194	0.096	0.004	0.429	0.288	0.211	0.203
USA	0.078	0.006	0.511	0.238	0.362	0.175	0.071	0.006	0.511	0.239	0.227	0.166
Portugal	0.070	0.002	0.455	0.235	0.316	0.157	0.064	0.002	0.455	0.211	0.231	0.183
Morocco	0.057	0.002	0.543	0.218	0.391	0.162	0.052	0.002	0.543	0.200	0.244	0.190
Tunisia	0.052	0.001	0.529	0.298	0.379	0.213	0.049	0.001	0.529	0.290	0.240	0.227
Austria	0.054	0.001	0.462	0.258	0.318	0.182	0.050	0.001	0.462	0.230	0.233	0.210
Poland	0.051	0.003	0.455	0.223	0.307	0.185	0.049	0.003	0.455	0.222	0.251	0.189
Sweden	0.049	0.001	0.445	0.235	0.307	0.154	0.047	0.001	0.445	0.194	0.243	0.200
Denmark	0.050	0.001	0.452	0.195	0.311	0.137	0.047	0.001	0.452	0.161	0.242	0.181
China	0.036	0.003	0.521	0.188	0.353	0.146	0.034	0.003	0.521	0.177	0.262	0.164
RoW	0.194	0.008	0.488	0.273	0.327	0.188	0.162	0.004	0.488	0.227	0.169	0.169
Norway												
Austria	0.031	0.001	0.527	0.263	0.282	0.180	0.032	0.001	0.527	0.081	0.268	0.144
Belgium	0.055	0.001	0.552	0.214	0.313	0.129	0.054	0.001	0.552	0.181	0.240	0.162
Canada	0.039	0.001	0.549	0.222	0.318	0.117	0.037	0.001	0.549	0.138	0.264	0.173
Germany	0.135	0.004	0.541	0.182	0.285	0.166	0.121	0.004	0.541	0.181	0.204	0.168
Denmark	0.193	0.004	0.511	0.163	0.270	0.139	0.168	0.004	0.511	0.153	0.181	0.161
Spain	0.060	0.001	0.533	0.059	0.299	0.131	0.066	0.001	0.533	0.062	0.229	0.125
Finland	0.099	0.002	0.544	0.192	0.273	0.141	0.103	0.002	0.544	0.134	0.208	0.151
France	0.073	0.003	0.524	0.310	0.276	0.168	0.070	0.003	0.524	0.261	0.240	0.206
G. Britain	0.123	0.006	0.506	0.179	0.268	0.131	0.113	0.006	0.506	0.166	0.208	0.152
Italy	0.062	0.002	0.553	0.154	0.297	0.119	0.077	0.001	0.553	0.148	0.221	0.151
Netherlands	0.100	0.002	0.528	0.238	0.274	0.136	0.092	0.002	0.528	0.180	0.217	0.187
Poland	0.055	0.002	0.504	0.071	0.303	0.086	0.053	0.002	0.504	0.057	0.246	0.127

(continued on next page)

Table F.4 *(continued)*

	Data						Model					
	Shares		1st-yr exit rates		Avg exit rates		Shares		1st-yr exit rates		Avg exit rates	
	exp	MNEs	exp	MNEs	exp	MNEs	exp	MNEs	exp	MNEs	exp	MNEs
RoW	0.005	0.000	0.572	0.204	0.364	0.168	0.005	0.000	0.572	0.115	0.339	0.197
Sweden	0.249	0.007	0.484	0.158	0.239	0.151	0.215	0.007	0.484	0.159	0.166	0.146
Singapore	0.035	0.002	0.505	0.150	0.280	0.120	0.034	0.002	0.505	0.126	0.271	0.162
USA	0.077	0.004	0.519	0.130	0.262	0.128	0.074	0.004	0.519	0.125	0.227	0.140

Notes: Share of exporters (MNEs) to market n relative to all firms. Exporter (MNE) exit rates are calculated relative to all exporters (MNEs) in the market. First-year exit rate refers to exit at age zero. RoW refers to the rest of the world, a weighted average among the remaining countries in the sample. Exporters in the data refers to non-MNE exporters. Observations are at the firm-destination-year level.

Table F.5
Calibrated parameters, by country.

	Model with MNEs				Model without MNEs	
	$\log(f_n^x)$	$\log(f_n^m)$	$\log(F_n^x)$	$\log(F_n^m)$	$\log(f_n^x)$	$\log(F_n^x)$
France						
Benelux	−1.77 (1e-03)	−0.24 (0.16)	−139.37 (0.11)	25.81 (17.87)	−1.84 (1e-04)	−58.16 (5e-03)
Switzerland	−3.43 (0.03)	−0.59 (0.36)	−82.54 (0.82)	18.61 (11.33)	−3.41 (1e-03)	−189.52 (0.07)
Germany	−1.01 (0.01)	−0.01 (0.01)	−15.71 (0.20)	13.43 (10.44)	−0.98 (3e-03)	−32.63 (0.11)
Spain	−1.96 (3e-03)	0.06 (0.04)	−77.98 (0.13)	12.61 (10.21)	−1.91 (1e-03)	−79.74 (0.05)
Italy	−1.67 (5e-03)	−0.34 (0.26)	−52.15 (0.15)	25.20 (18.76)	−1.63 (4e-03)	−39.93 (0.10)
Great Britain	−1.92 (0.04)	0.39 (0.26)	−18.44 (0.35)	31.70 (21.50)	−1.87 (4e-05)	−96.53 (2e-03)
United States	−1.89 (0.08)	1.13 (0.74)	−58.19 (2.57)	46.67 (30.42)	−1.58 (1e-03)	−106.38 (0.09)
Portugal	−3.37 (0.02)	−1.12 (0.79)	−13.98 (0.10)	19.74 (13.84)	−3.32 (2e-03)	−84.62 (0.04)
Morocco	−3.54 (0.02)	−0.66 (0.40)	−86.74 (0.47)	15.56 (9.50)	−3.50 (1e-03)	−234.12 (0.10)
Tunisia	−3.43 (0.01)	0.48 (1.64)	−32.80 (0.07)	2.20 (7.49)	−3.41 (1e-03)	−248.04 (0.09)
Austria	−3.78 (0.01)	−0.61 (0.37)	−42.21 (0.14)	16.34 (9.88)	−3.75 (1e-03)	−2357.28 (0.73)
Poland	−2.30 (4e-05)	−0.32 (0.30)	−130.28 (2e-03)	6.87 (6.34)	−2.24 (1e-03)	−15.95 (0.01)
Sweden	−2.28 (0.04)	−0.74 (0.38)	−9.73 (0.17)	21.25 (11.07)	−2.28 (6e-04)	−81.00 (0.02)
Denmark	−3.66 (0.17)	−1.48 (0.77)	−10.70 (0.49)	19.01 (9.92)	−3.68 (8e-04)	−219.66 (0.05)
China	−2.03 (0.03)	1.83 (1.12)	−52.38 (0.74)	10.68 (6.50)	−1.82 (1e-03)	−54.85 (0.04)
RoW	−2.03 (0.01)	−0.34 (1.09)	−47.84 (0.33)	5.13 (16.55)	−2.07 (1e-03)	−148.95 (0.08)
Norway						
Austria	−3.53 (0.01)	1.04 (0.65)	−13.57 (0.04)	19.60 (12.14)	−3.51 (1e-03)	−147.29 (0.04)
Belgium	−2.70 (1e-03)	−0.91 (0.59)	−50.03 (0.02)	11.94 (7.73)	−2.68 (1e-03)	−211.12 (0.08)
Canada	−3.63 (0.01)	−0.82 (0.41)	−135.28 (0.23)	12.61 (6.29)	−3.53 (1e-03)	−201.36 (0.04)
Germany	−2.24 (0.04)	0.10 (0.06)	−35.65 (0.70)	10.38 (6.55)	−2.22 (1e-03)	−80.27 (0.04)
Denmark	−3.59 (5e-04)	0.18 (0.10)	−10.66 (2e-03)	10.42 (6.03)	−3.58 (1e-03)	−147.82 (0.03)
Spain	−2.70 (0.03)	−0.83 (0.88)	−180.63 (2.17)	3.79 (4.02)	−2.68 (5e-06)	−244.65 (5e-04)
Finland	−3.27 (0.15)	0.18 (0.08)	−13.28 (0.61)	15.21 (7.13)	−3.24 (8e-04)	−55.40 (0.01)
France	−2.48 (0.02)	−0.53 (0.34)	−53.13 (0.33)	25.19 (16.01)	−2.44 (1e-03)	−248.24 (0.08)
Great Britain	−2.43 (0.01)	−0.84 (0.61)	−78.16 (0.47)	14.52 (10.43)	−2.39 (1e-03)	−112.52 (0.06)
Italy	−2.64 (0.02)	−1.00 (0.68)	−33.77 (0.21)	10.91 (7.43)	−2.61 (1e-03)	−177.11 (0.09)
Netherlands	−3.07 (0.02)	−1.16 (0.59)	−76.33 (0.46)	37.87 (19.11)	−3.04 (9e-03)	−31.83 (0.10)
Poland	−3.47 (0.03)	1.28 (1.64)	−79.50 (0.68)	2.12 (2.72)	−3.28 (1e-03)	−1796.41 (0.65)
RoW	−2.57 (0.01)	0.25 (0.12)	−208.04 (1.00)	8.22 (3.86)	−2.54 (1e-03)	−182.73 (0.08)
Sweden	−3.06 (0.03)	0.90 (0.61)	−24.46 (0.24)	11.33 (7.72)	−3.03 (1e-03)	−49.66 (0.02)
Singapore	−2.93 (0.02)	0.59 (0.35)	−74.33 (0.62)	7.20 (4.30)	−2.89 (6e-04)	−142.51 (0.03)
United States	−2.30 (0.05)	1.49 (1.03)	−42.18 (0.89)	10.40 (7.19)	−2.27 (9e-05)	−95.28 (4e-03)

Notes: We report the mean across firms and the standard deviation in parentheses. f_n^x are per-period fixed export costs; f_n^m are per-period fixed MNE costs; F_n^x are sunk export costs; and F_n^m are sunk MNE costs. RoW refers to the rest of the world, a weighted average among the remaining countries in the sample. Observations are at the firm-destination-year level.

Table F.6
The size of calibrated costs, by country.

	as % of sales, for median firm				in U.S. dollars, for median firm			
	f_n^x	f_n^m	F_n^x	F_n^m	f_n^x	f_n^m	F_n^x	F_n^m
France								
Benelux	11.01	6.79	0.00	21.06	8830	205,842	0.00	638,135
Switzerland	11.31	8.66	0.00	55.71	12,553	33,159	0.00	213,276
Germany	11.39	5.22	0.00	18.20	4352	80,915	2e-03	282,359
Spain	11.57	7.63	0.00	32.03	8287	92,670	0.00	389,021
Italy	11.63	6.66	0.00	15.97	5777	213,567	0.00	512,280
Great Britain	11.70	9.39	0.00	26.30	8370	22,514	6e-04	63,046
United States	11.78	8.99	0.00	31.07	4974	40,516	0.00	139,986
Portugal	12.46	6.40	3e-04	23.23	14,266	60,584	0.35	219,868
Morocco	12.84	9.16	0.00	56.99	17,386	52,341	0.00	325,568
Tunisia	13.01	2.91	0.00	5.40	17,960	18,348	0.00	34,035
Austria	12.91	9.71	0.00	42.02	20,201	85,821	0.00	371,341
Poland	13.08	7.57	0.00	31.17	7957	31,397	0.00	129,220
Sweden	13.03	8.21	8e-03	40.79	5732	130,430	3.00	648,281
Denmark	12.81	7.81	0.01	56.84	17,469	133,961	17.0	974,969
China	13.27	5.39	0.00	31.83	6631	9798	0.00	57,832
RoW	10.59	0.66	0.00	0.75	6978	4823	0.00	5473
Norway								
Austria	16.83	13.26	7e-04	24.11	30,496	77,831	1.00	141,491
Belgium	16.18	10.44	0.00	28.02	13,407	94,436	0.00	253,452
Canada	16.44	12.67	0.00	48.47	30,546	265,412	0.00	1,015,487
Germany	14.88	12.02	0.00	35.39	8630	105,001	0.00	309,053
Denmark	14.17	12.53	0.01	48.70	19,603	142,325	17.0	553,133
Spain	16.04	5.37	0.00	10.24	18,407	39,316	0.00	75,000
Finland	15.07	12.77	8e-04	53.01	21,411	109,579	1.00	454,963
France	15.76	13.51	0.00	20.58	14,444	171,443	0.00	261,018
Great Britain	14.94	9.34	0.00	22.56	13,655	159,250	0.00	384,529
Italy	16.02	9.47	0.00	30.21	17,626	265,489	0.00	847,150
Netherlands	15.26	13.05	0.00	31.85	21,429	397,897	0.00	971,450
Poland	15.84	7.12	0.00	34.89	36,785	58,509	0.00	286,703
Sweden	18.24	13.93	0.00	30.93	10,684	99,398	0.00	220,688
Singapore	13.50	10.61	0.00	30.28	15,358	44,970	0.00	128,388
United States	16.77	12.27	0.00	39.89	24,313	100,846	0.00	327,887
RoW	15.70	8.56	0.00	19.51	12,670	56,992	0.00	129,848

Notes: f_n^x are per-period fixed export costs; f_n^m are per-period fixed MNE costs; F_n^x are sunk export costs; and F_n^m are sunk MNE costs. The fixed and sunk export (MNE) cost values in each destination are means across random draws, conditional on positive measure of exporters (MNEs). Median firm refers to the firm with median export (MNE) sales in destination n. The values in U.S. dollars for different percentiles are calculated using the values of sales in the data, transformed to U.S. dollars using an average of the annual exchange rate observed over our sample period, from Penn World Tables 9.0 (Feenstra et al., 2015). Monetary values for French MNEs are estimated assuming that the median pc of the MNE sales distribution is proportional to the median pc of the export sales distribution, with the proportionality factor calculated using the ratio of export to MNE sales for each percentile, for Norway. RoW refers to the rest of the world, a weighted average among the remaining countries in the sample.

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