Temporary trade and heterogeneous firms*

Gábor Békés and Balázs Muraközy
Institute of Economics, HAS Budapest

19 December 2011

Abstract

Using Hungarian firm-transaction level export data, we show that about one third of firm-destination and about one half of firm-product-destination export spells are short-lived, or temporary, each year. This is in odds with theories where comparative advantage is stable and market entry costs are sunk. We show how endogenous choice between variable and sunk cost trade technologies can explain the empirical importance and some characteristics of temporary trade. We build a model in which the likelihood of temporary trade depends on productivity and capital cost of the firm as well as well-known gravity variables of destinations. These predictions are borne out by the data; the likelihood of permanent trade, defined by a simple filter, rises with firm productivity, financial stability, proximity and GDP of destination countries.

Keywords: export, Hungary, trade instability, fixed cost
JEL: D40, F12
CEFIG Working Paper 6, 2011 (new version)

1 Introduction

Most trade theories predict a stable export activity once comparative advantage justifies it or once the sunk cost of such an activity is paid for. In particular, models of firm heterogeneity building on Melitz (2003) assume the existence of a sunk cost related to the start of exporting. In extensions of the basic model [1],

*__Corresponding author__: Balazs Murakozy: IE-HAS, 1112 Budaorsi ut 45, Budapest, Hungary. Email: murakozy@econ.core.hu. **Acknowledgements**: We wish to thank Peter Harasztosi for excellent research assistance. We are grateful for comments by Gianmarco Ottaviano, Laszlo Halpern, Miklos Koren, Giulia Felice, Stefan Boeters and seminar participants in ERWIT/EFIGE Nottingham, ETSG Copenhagen, EEA Oslo, Uni Perugia, CEU Budapest, CPB Hague, IfW Kiel, Uni Bocconi. The authors gratefully acknowledge financial assistance from the European Firms in a Global Economy: Internal policies for external competitiveness (EFIGE)', a collaborative project funded by the European Commission's Seventh Framework Programme (contract number 225551). This work is part of the "Center for Firms in the Global Economy (CEFIG)" network. The entire responsibility for errors and omissions remains on us.

[1] Such as Helpman et al. (2004), Chaney (2008) Das et al. (2007), Arkolakis (2010), Eaton et al. (2011), Alessandria and Choi (2010)

sunk costs of exports are related to the export of certain products and to certain destinations. As this sunk cost is an investment that can only be recovered from a stable stream of revenues, firms are expected to export a given product to a given destination over a long period of time. In a simple dynamic interpretation of static sunk-cost based trade models, only dramatic shifts in demand or factor prices would lead to a halt of an export project.

However, firms often export their products to a given destination for a short period or in a series of short spells. We will call these unstable relationships temporary trade, while stable trade relartionships will be classified as permanent trade.In our data for Hungary, about half the firm-destination-product specific transactions is temporary in nature. Moreover, temporary trade appears at the firm level as well; about a fifth of firms who ever sell abroad will export in a temporary fashion only. Despite their high share in terms of number of relationships, we found that temporary trade transactions are typically much smaller in value than permanent trade; depending on the level of aggregation used, temporary transactions worth about 2-10% of total exports.

This paper aims at putting unstable trade transactions in the limelight and endeavors to reconcile theory with evidence. We show new evidence regarding the pervasiveness of unstable trade relationships and build a simple model to explain the high frequency of temporary trade relationships that we see in the data.

Why do we propose studying temporary trade which accounts for a small fraction of aggregate trade volumes? Our work can help (i) understand patterns in disaggregate trade data, (ii) distinguish between existing trade theories, and (iii) inform policy. First, the high prevalence (i.e. large number) of small and short-lived trade flows has long puzzled the profession (e.g. Eaton et al. (2011)), and we offer a simple and intuitive explanation. Second, ignoring the choice of trading technology can lead empirical studies to overestimate the magnitude of sunk costs. Third, trade policy may have to focus on promoting stable relationships as opposed to all export activities.

Using balance sheet and customs transactions data on manufacturing firms in Hungary, we study the stability of export spells at the firm-destination and the firm-destination-product level. We classify each firm-destination trade flow as either permanent or temporary by introducing a simple trade relationship stability filter. Permanent trade is an uninterrupted export spell that is at least four years long, while temporary trade can be either a short spell or a non-continuous export relationship. Temporary trade is not limited to specific industries or markets, and all types of firms trade temporarily over time.

To explain the prevalence of temporary trade flows observed in our data, we build a model of heterogeneous firms, extending the proposition of heterogeneity in entry costs at the firm level or demand at the country level. We model how firms, facing uncertainty in terms of their future productivity, may endogenously choose between two different trade technologies. They may pay a large fee - sunk cost - up-front in return for lower costs later, or pay less now but more in each future period. The endogenous choice between variable- and sunk-cost trade technologies can yield, for some firms and destinations, an equilibrium outcome of temporary trade.

This model is useful as it helps understand the seemingly erratic presence of short spells, and provides an explanation for the small shipments present in cross sectional datasets which were not well understood before. This is important as allowing firms to forgo the sunk cost of trade makes short spells quite understandable - even without assuming very large and frequent productivity shocks. Hence, this model of trade technology choice will both better explain firm export dynamics features presented in the data and offer an alternative to learning models (e.g. Aeberhardt et al. (2009)). Furthermore, the model yields a number of predictions which can be matched with evidence from the data. We predict that the likelihood of permanent trade rises with firm performance, proximity and market size of destination countries.

We test the specific predictions of our theory regarding determinants of temporary trade, and find that our empirical results fall in line with the predictions. Using a random effect probit model, we show that the likelihood of temporary trade rises with lower productivity, higher capital cost of the firm, greater distance and larger GDP of destination countries, and that these are in line with our simple model. We extend the analysis to the firm-destination-product level and find that product differentiation increases the probability of a permanent trade relationship. Furthermore, we show that trade liberalization leads to an increase of the extensive margin of both kinds of exporters, and leads to a more positive effect on the intensive margin of permanent exporters.

Our work can also inform how existing trade theories should be confronted with the data. For example, inspired by models which assume that firms will pay an up-front sunk cost that will later be covered by export revenues, several empirical studies have estimated sunk costs of exporting to be significant (Bernard and Jensen (2004))[2]. In fact, studies identifying sunk cost from the different behavior and performance of exporting and non-exporting firms may underestimate the sunk cost as some exporters may have opted for the variable cost trade technology and not paid the sunk cost. Our framework can be used to filter out temporary traders and estimate the model on those firms only that do pay a sunk cost.

Finally, reducing trade costs for a limited period or providing one-off export incentives may only lead to temporary exports without long term positive effects. At the same time, our model suggests that providing incentives in favor of the sunk cost based option is what may generate stable trade flows and long term benefits. This matters for policy, because trade promotion spending often targets small firms and initially small volume export projects.

This paper is organized as follows. In the section 2, we detail our dataset, and present our definition of temporary and permanent trade relationships and describe the prevalence of temporary trade. Section 3 introduces the model

[2] In a simulation of their model on French data, Eaton et al. (2011) find that fixed costs take 59 percent of gross profit in any destination. Roberts and Tybout (1997), Lawless (2010), Moxnes (2010). Furthermore, the availability of trading at a temporary fashion without a high up-front fee offers an alternative explanation to why Eaton et al. (2011) find a large number of small transactions in the presence of high estimated sunk costs.

that links temporary trade to a choice of trade technology. Section 4 introduces the evidence on temporary trade patterns and an extension to firm-destination-product level is discussed in 5. The last section concludes.

2 Data and description of temporary trade

This section first introduces our proposed trade relationship stability filter. After briefly presenting the dataset, we use our filter to show the prevalence of temporary trade in terms of number of transactions, volume and dynamics over time.

2.1 What is temporary trade?

The study of temporary trade is most closely associated with analyses on short spells in trade. Some recent empirical papers emphasize the importance of short term relationships - mostly at a bilateral level. These relationships are not only characteristics of small markets, like Hungary or Colombia but also of large economies such as the US and Germany. Besedes and Prusa (2006), for example, show that the median duration of exporting a product is between two and four years in the United States. Similarly, Nitsch (2009) shows that the same phenomenon can be observed in Germany - the majority of trade relationships exists for only one to three years. Eaton et al. (2011) look at firm-level trade flows in Colombia, only to find a large importance of one-time exporters. Hess and Persson (2010), looking at the duration of EU imports at bilateral trade data, find that even at national level, a large share of trade relationships are short lived, and some stability in importing a product masks shifts in source countries. Focusing at the product level Bernard et al. (2010) demonstrates that in 1997, about quarter of output by stable (producing at least between 1992 and 2002) firms comes from newly (within five years) added products and another quarter of products will be lost within 5 years.

Instead of looking at the duration of an export spell or churning of products, our aim is to classify each firm-destination trade flow in a year as either permanent or temporary. To do that we introduce a simple *trade relationship stability filter*, which will enable us to analyze the determinants of temporary trade. The filter works as follows.

First let us denote the value of a trade flow by firm i to market k at year t as R_{ik}^{t}. Let $t = t_0$ be the base year in which we would like to classify the active trade relationships, i.e. those firm-destination combinations for which $R_{ik}^{t_0} > 0$. For each such i, k combination one can define a spell, $S_{ik}^{t_0}$, which denotes the number of consecutive years, including t, for which firm i exported to market k. Thus, if $R_{ik}^{t_0-2} = 0; R_{ik}^{t_0-1} > 0; R_{ik}^{t_0} > 0$ and $R_{ik}^{t_0+1} = 0$, then $S_{ik}^{t_0} = 2$. Based on this, we say that firm i exports to market k in a *permanent* way if $S_{ik}^{t_0} > \theta$, and the export flow is *temporary* whenever $S_{ik}^{t_0} \leq \theta$, where θ is a positive integer. In practice, θ may represent a period long enough to include some longer than one year trade flows but short enough not to include stable trade relationships.

While this approach is arbitrary to some extent, we find it quite useful and straightforward. It enables one to classify all trade flows in a cross section, and explain whether a flow is temporary by binary dependent variable methods. We consider this as a more natural framework of analysis than for example modelling the length of the spells with duration models because of three reasons. First, as we will argue in the theory section, temporarily exporting firms may have chosen endogenously a different trading technology than permanent exporters, which motivates a binary rather then a continuous framework with respect to time when modelling trade spells. Second, in duration modelling the choice of the time period is a delicate issue: using all spells within a period, for example, may lead to over-representation of short spells and various truncation problems. Third, the interpretation of the results from our approach is quite straightforward: the marginal effect shows how the probability that the flow is permanent changes when the explanatory variable changes.

In this paper, we will report most results with $\theta = 3$, i.e. we require a permanent trade flow to last at least four years. Note that for this exercise to work one needs data for years between $t_0 - \theta$ and $t_0 + \theta$, because this enables one to be sure whether each flow is at least $\theta + 1$ year long. In this way, as we have trade data until 2003, we will classify all trade relationships in $t_0 = 2000$ into either the temporary or permanent category. The choice of this year was motivated by the fact that post-communist transition and the most important structural changes in Hungarian economy already took place before 1997, thus the observed dynamic nature of trade relationships is not a consequence of transition. At the same time, this is an interesting period in time featuring a gradual European integration process and a dynamic export-led growth.

On the choice of the time window, four years of consecutive exporting is long enough to be considered as permanent - in line with the results of Besedes and Prusa (2006), who estimate the duration of trade relationships and find that the survival rates decrease rapidly in the first 4-5 years (to about 45-50%), and remain reasonably stable afterwards. We consider this definition of temporary trade relationship quite conservative. We have also experimented with other definitions, in which temporary trade was somewhat more prevalent[3].

Also, the method can be easily extended, with appropriate indexing, to other levels of aggregation: the bilateral level, the firm level or the firm-product-destination level. In each case, one can classify all cross-sectional units in year t_0 based on the length of their respective spells.

2.2 The dataset

The dataset covers all export data from Hungary, for the 1992-2003 period. The data is structured at a firm-product-destination level with one observation in the database being the export of a product j by firm i to country k in year t.

[3] According to an alternative definition, temporary trade is defined as a trade relationship, in which we can observe at least 1 positive value in a given 4-year period, but the cell is not active for all four years. With this definition, 20-30 percent more relationships will be classified as temporary. Results available on request.

The sample is long enough so that years that are pinned down for analysis (1995, 2000) are followed by (at least) three years in sample as well as preceded by at least three years. This creates a potentially balanced sample, where entry/exit observed in the dataset is only generated by entry/exit from exporting.

The dataset comes from a merger of two sources. Firm level balance sheet and income statement data by APEH, the tax authority. Transaction level data comes from the Customs statistics and contains information on transaction value and quantity. This dataset consists of manufacturing firms and manufacturing products only. Thus, all information is related to direct export by a manufacturing firm. The values of export are calculated as free on board.

The product dimension of the dataset is disaggregated; it is broken down to 6-digit Harmonized System (HS) level. We define a product as a 6-digit category, although using more aggregated (4-digit) categories does not change our results. "Motor cars and vehicles for transporting persons" is an example for a 4-digit category, while "Other vehicles, spark-ignition engine of a cylinder capacity not exceeding 1,500 cc" is an example of 6-digit category.

Data covers exports for 169 countries and over 700 HS6 product categories.

Note that the Hungarian trade structure is close to EU countries as described in Mayer and Ottaviano (2008) even if the concentration and role of large firms is slightly higher in Hungary than in most EU countries. Hungary is one of the most open EU countries in terms of the number of trading firms and traded volume[4]. Certain aspects of the data are comparable to previous findings on US and some European data (Baldwin and Harrigan (2011), Mayer and Ottaviano (2008)) These similarities with other countries suggest the generality of our findings.

2.3 Properties of temporary trade

This section will introduce some key description of the importance of temporary trade regarding both its prevalence and volume and consider some key issues of dynamics over time. In all three points, our results are based on using the trade relationship stability filter on Hungarian data.

First, we have calculated the prevalence i.e. the (unweighted) share of temporary trade flows in terms of number of relationships, which we present in Table 1. The main result is that about 32 percent of firm-destination export relationships was temporary in 2000. The share of temporary trade is even larger at the firm-product-destination level: 56.5 %.[5] This shows that temporary trade is not a curiosity: it is a robust fact of international trade.

Because our definition is arbitrary to some extent, we have conducted a number of checks which confirmed that the share of temporary trade is similar when

[4] For more on the Hungarian dataset and a set of descriptive statistics regarding trading firms, see Békés et al. (2011).

[5] As for the 56.5% of temporary relationships, 20pp are temporary transactions in permanent products, 31.5% are temporary products by permanent firms and 5% of transactions are carried out by temporary firms. From a destination angle, the share of temporary transactions in permanent destinations is 39% and temporary destinations by permanent firms account for 13% of all transactions.

Description	Permanent	Temporary	Temp. share
Firm-destination			
Full sample	11650	5434	31.81%
Products >10 Mn USD*	6630	2279	25.58%
Destinations>10 Bn USD*	11509	5242	31.29%
Only EU25	8663	3425	28.33%
Only non-EU25	2987	2009	40.21%
Base year: 1995	5442	3540	39.41%
4 year definition	9375	5666	37.67%
Firm			
Full sample	3809	731	16.10%
Firm-product destination			
Full sample	29084	37790	56.51%
*Product and destination categories are defined at aggregate level.			

Table 1: Number of observations

we modify the sample or the filter. Indeed, we consider robustness checks along four dimensions: dropping nuisance (i.e. very small) deals, dropping far-away countries, changing the number of years and the base year. First, if we restrict the sample only to significant trade flows, the figure is somewhat smaller, but it is still larger than 25 percent. Second, temporary trade is highly prevalent both in the enlarged European Union and outside it. Note, however, that temporary trade is more frequent for less important trade partners. (Hungary's most important export destinations are members of the enlarged EU). Third, with $\theta = 4$, the share of temporary trade goes up to almost 40 percent. Fourth, in 1995, a period of significant structural reforms, the share of temporary trade was even higher, 37 percent. Our estimates are conservative as we dropped firms that did not operate at every year during the seven-year window around 2000, and all these firms are intrinsically temporary traders. Thus, one may conclude that when looking at the number of trade relationships, temporary trade is important at every level.

Second, let us consider the volume i.e. the dollar value of trade. As a general result, we show that the export value of firms-destination flows that are part of a temporary relationship is rather small in dollar terms. The volume of firm-destination level is just 2% of total trade volume rising to 8.4% when adding the product margin, too. In terms of importance, we may drop the top 1% of firms, the large multinationals which are in many respects outliers in the economy. For instance, motor vehicle export of a major German multinational car company to Germany alone accounts for 11% of total Hungarian direct export volume by manufacturing firms. Taking the top 1% of relationships out or focusing on firms with less than 250 employees, the volume by temporary exporters (at destination level) rises to almost 4%. At the firm-destination-product level, the volume by temporary trade relationships is 8-10%.

Third, we may consider further issues related to dynamics between 1995 and

Description level	Full sample	Less than 250 employees	Without top 1%
Firm-destination	1.86%	4.80%	3.86%
Firm-product-level	4.50%	5.36%	5.19%
Firm-product-destination-level	8.42%	10.71%	10.18%

Table 2: Value of temporary transactions in USD

2000. At the firm level, 27% of temporary firms in 1995 became permanent in 2000, 13,8% remained temporary while the rest exited from trade. At firm-destination level, while the share of exit is larger, the relative importance of becoming permanent exporter remains similar (see Table 13 in Appendix)

A simple hypothesis based on the logic of learning models, in which firms experiment in markets or learn from exporting would posit that firms tend to enter as temporary traders initially, and then, if they are successful, they probably become permanent traders or exit. However, comparing two periods (in our case, 2000 and 1995), we do not find evidence for this proposition. First, a large share (58%) of new trade relationships in 2000 is established as permanent. Second, considering exporters in 2000, new traders are about equally likely to become permanent traders as former (in 1995) temporary traders (58.6% vs 62.8%).

In terms of dynamics, the contribution of temporary trade is rather small with regards to new trade volume generated. As shown in the decomposition of trade growth between 1995 and 2000 in Table 14 (in Appendix), exit, entry and expansion of temporary traders was responsible for just 1.5% of total trade growth. Exit by temporary traders is small in value, and entry of new temporary traders will more than offset it (2.78% vs 1.37%). Note that the most important margin had been the entry by new permanent traders (79.85%).

3 Modelling Temporary Trade

3.1 Relating to previous literature

As argued earlier, traditional trade models overlook the possibility of unstable trade relationship as a mass phenomenon. However, we are not the first to argue that as firms face uncertainty, their trading activity may not be stable; this issue was analyzed both at the firm and at the firm-product level.

Most recent advances in this literature keep the basic story of Melitz (2003) and retain the assumption of a sunk cost related to the start of exporting. In addition, they allow for some sort of shocks, such as productivity, or per period fixed cost, taste changes, or political and appropriation risk. In this short review, we aim at placing our approach in a set of recent advances, looking at sources of instability at the firm level first followed by an overview of points raised by destination as well as product level models.

A number of recent models provide a dynamic extension of the Melitz-model. These models introduce more than one period, a per-period fixed cost and uncertainty in the fixed cost or productivity. In these models firms are heterogeneous in terms of productivity, and uncertainty affects firms differently according to their selected feature.

A basic source of uncertainty is related to firms' overall productivity stemming from human resources, technology or a change in the behavior of competitors. Such a shock would affect the firm's general conduct, its decision to enter or exit foreign (or even domestic) markets. A similarly important source of uncertainty is shocks to the per-period fixed cost. In dynamic extensions of the Melitz model, this may be equivalent to a shock to firm productivity. For instance, in Segura-Cayuela and Vilarrubia (2008), firms pay a per period fixed cost, calculate the value of entry (into an export market) and decide. Here, given the option of waiting, higher uncertainty leads to fewer firm entries. Although not explicitly modelled in the paper, exit would take place if a shock to productivity is so large that it makes future payments of per period fixed costs unlikely to be profitable. In Arkolakis (2010), different firms will choose different marketing strategies owing to optimal value of marginal cost related to marketing spending which is negatively related to the number of additional consumers reached.

Firm-destination level trade dynamics may be modelled in a similar way. If uncertainty is modelled by a shock to the iceberg trade cost (i.e. ad valorem and not per period fixed costs), exit can also happen and it may be destination-specific. In line with this approach, Crozet et al. (2008) suggest that volatile macroeconomic background (such as the exchange rate) will create large shocks, and some previously profitably exporting firms will suddenly exit. As exchange rate or political shocks are country specific, this type of uncertainty will unequally affect a firm's export to different countries.

A second class of models derives trade dynamics from asymmetric information or incomplete contracts rather than uncertainty about costs.

If the attributes of a trading partner cannot be observed by an exporter when they first meet, it can be optimal to 'test' potential foreign partners by starting small. In the learning model of Rauch and Watson (2003), new entrants should only continue the relationship if the potential partner successfully stood this test. In this spirit, Besedes (2006) shows that initial size, risk and search costs play an important role in determining the duration of a trade relationship. Higher reliability and lower search costs lead to larger initial transactions and longer duration. Furthermore, Araujo and Ornelas (2007) argue that in the presence of incomplete contracts, starting in small makes sense, as it is a good way to uncover reliability.

In Aeberhardt et al. (2009) exporting requires the presence of a local distributor in each market, and it takes time to learn about the quality of distributors. Thus, the size of an export shipment of a firm to a destination grows as the relationship matures. In this model with learning, persistence is a consequence of informational friction (i.e. lack of knowledge about distributors) rather than sunk costs. This approach de facto allows firms to invest less in the beginning and pay at every level once the reliability of distribution channel is revealed - i.e. there is a trade-off between the sunk cost and per-period costs.

Yet another approach is to consider firms being heterogeneous in terms of cost structure. Differences in cost structure was endogenized in Arkolakis (2010), where firms may choose a marketing technology in a framework where costly advertising is needed to reach more and more consumers. In Arkolakis and Muendler (2010), firms first incur a broad market-entry cost and then an additional fixed product-entry cost that is in line with the magnitude of the particular overseas presence. Furthermore, these are related to product distribution (wholesale, storage, transportation, retail, etc.) in given markets. If the marginal cost of adding a product in an already overtaken market is small, such a cost structure may lead to high churning. In Eaton et al. (2011, p. 1454), fixed cost both depends on a firm (product)-destination specific shock and destination specific component which is common to all producers.

So far we have only discussed firm-specific shocks while evidence from several countries suggests a majority of export shipments being carried out by multiproduct firms[6]. Temporary trade at the firm-product level may come from shocks, which are related to products and not result in the firm quitting from exporting altogether.

Multiproduct firm models extend the logic of dynamic Melitz models to the firm-product level. In Bernard et al. (2010) each firm decides both entry and exit as well as in which product markets to participate. Firms enter by incurring a sunk entry cost and observe both their firm level initial productivity, product-firm specific consumer taste parameters (also called expertise). In this framework, TFP raises the probability of producing yet another product and therefore, a firm's product range is increasing in its productivity. At the same time, TFP also determines overall profitability and hence entry and exit with taste determining only the composition of the traded bundle. Bernard et al. (2011) extend their earlier model and allow for country-specific product attributes that vary across both products and countries.

Another consequence of product or destination related shocks is the possibility of sequential exporting as in Albornoz et al. (2010). In this model of learning, a firm's success in foreign markets is uncertain, but correlated across destinations. This setup explains starting small as well as high exit rates of new exporters and, importantly, the rapid expansion of new destinations of surviving firms. It implies that the likelihood of not exiting a market is correlated with not exiting another one.

Another angle is offered by Mayer et al. (2010), where firms export a product mix based on their productivity. In conjunction with Eckel and Neary (2010), firms rank their products by their competence, and shocks as well as competition will affect product mix in an orderly rather than a random fashion. For our perspective this means that there is likely to be a set of products that are exported in a rather stable manner and another set of volatile mix of products (or product-destination) further away from core competency.

Overall, our approach combines the basic world view behind dynamic Melitz-

[6] For EU evidence, see Mayer and Ottaviano (2007), for US evidence see Bernard et al (2007). For descriptive statistics on multi-product firms in Hungary, see Békés et al. 2011.

type models with endogenous trade technology choice. In our case firms are heterogeneous and they face uncertainty in terms of their future productivity and they may choose from two trading technologies, paying a large fee - sunk cost - up-front in return for lower costs later or paying less now but more at every period. This model of trade technology choice will both better explain firm export dynamics features presented in data and offer an alternative to learning models.

3.2 A simple dynamic model

In this section we present a simple model to illustrate the idea of two types of trading technologies. Our aims with this model are twofold. First, it illustrates that short term exports may differ qualitatively from longer term exports because firms exiting in the short run are more likely to use a technology we define as variable cost trading technology. Second, the model illustrates that gravity affects the choice of trading technologies: on larger markets a given firm is more likely to choose what we define a sunk cost trade technology.

We use a number of simplifying assumptions to make the model as tractable as possible. Firms from the (small) home country develop a product, and make their export decision, and we focus on a cohort of firms which starts exporting in a given period. We assume that firms which develop the new product in each period can enter the export market freely in latter periods to exclude real-option value calculations.

In the model, firms are heterogeneous with respect to their productivity (or ability): firm i has a productivity ϕ_i, which is firm-specific but is common to all markets of the firm i. Countries are indexed by $k = (1...K)$ and are endowed with L_k units of labour that are supplied inelastically with zero disutility. The representative consumer in each country derives utility from the consumption of a continuum of l products that we normalize to the interval $[0; 1]$. Consumers have the traditional CES utility for the products.

Consumption of goods in country k is a CES function of goods produced by all countries' firms. There is monopolistic competition a la Dixit and Stiglitz (1977), and the equilibrium price of a product variety is a constant mark-up over marginal cost. Cost in turn depends on both firm ability and transport cost to the destination country k, τ_{ik}. Our model follows an export decision of a firm, i.e. starting to sell the product to a new market. The net revenue for firm i from supplying country k is

$$r_k(\phi_i, \tau_{ik}) = (\tau_{ik})^{1-\sigma} w_k L_k (\rho P_k \phi_i)^{\sigma-1} \tag{1}$$

where $\sigma = 1/(1-\rho)$ is the elasticity of substitution across varieties, L_k is size of labour force in the destination country, w_k is the wage level in the destination country and P_k is the price index of destination country[7]. We can assume that

[7] Most models assume the probability of an external "death by *force majeure* events" independent of productivity or attribute. Here we only consider firms that operate throughout our period of interest and hence, disregard this option. Note that introducing such an option would not change results.

firm ability is distributed according a Pareto distribution with parameters m_0 and $\kappa > 1$. For tractability, we also introduce $\varphi_i \equiv {\phi_i}^{\sigma-1}$.

First we will describe the decision of firm i whether to export to market k. For brevity, we will omit the destination country index, but we will index the variables which may change in time by t.

Our model has three periods. In period 1, a firm decides whether to start exporting, picks one of the two available export technologies, and receives profits accordingly. At periods 2 and 3, the firm may decide to continue or halt exporting; we interpret period 2 as the short-term period and period 3 is the long-term period.

At the beginning of each period, firms face stochastic shocks to their productivity: with probability p, their φ increases with a factor of $d > 0$, thus $\varphi_{it+1} = d\varphi_{it}$, and with probability $1 - p$ productivity falls in a similar proportion: $\varphi_{it+1} = \frac{1}{d}\varphi_{it}$. We also assume that firms discount their profits with $\delta_1 > 0$ and $\delta_2 > 0$ in period 2 and 3, respectively. (As periods can have a different expected length - i.e. long-term is likely to be longer than the short term -, we opted for this general approach rather than a more traditional use if δ and δ^2.) We assume that, while the model is stochastic, all parameters are common knowledge for all firms.

In the first period firms may choose between two trading options called variable cost trade (VCT) technology and sunk cost trade (SCT) technology. Both kinds of firms have to pay a fixed cost in every period, which is normalized to 1. The sunk cost technology also requires an up-front sunk cost investment in period 1, $S > 0$, and its advantage is a low transportation cost, τ. VCT technology firms, on the other hand, do not have to pay a sunk entry cost, but they do not have an established network, which results in larger transportation cost: it is $(\chi^{\frac{1}{\sigma-1}})\tau$, where $\chi > 1$, and $\chi^{\frac{1}{\sigma-1}} > 1$. Note that we assume that the transport cost depends on the elasticity of substitution across varieties, which, in this simplest form of the model, is just a constant. In the model extension in section 5, we will elaborate on the rationale for this formula.

For simplicity, we assume that SCT firms, which have paid the sunk cost, can always export with a transport cost of τ in period 3, even if the firm does not export in period 2. We also assume that compared to the stochastic shock, the transportation cost advantage is not too large: $d > \chi$.

As it was shown previously, the export revenue of a firm, whenever it exports, is a function of φ_{it} and the chosen trade technology. When exporting with VCT technology, the revenue of the firm is determined by: $R^{SCT}(\varphi_{it}) \equiv r^k(\phi_{it}, \chi^{\frac{1}{\sigma-1}}\tau) = \frac{1}{\chi}(\tau)^{1-\sigma} w_k L_k (\rho P_k)^{\sigma-1}\varphi_{it}$. As now we only consider the problem of firms on a specified market, we will denote $R \equiv \frac{1}{\chi}(\tau)^{1-\sigma} w_k L_k (\rho P_k)^{\sigma-1}$, and hence,

$$R^{VCT}(\varphi_{it}) = R\varphi_{it} \tag{2}$$

Note that $R^{VCT}(\varphi_{it})$ is a positive linear function of φ_{it}. Also, revenue with SCT technology is higher than with VCT :

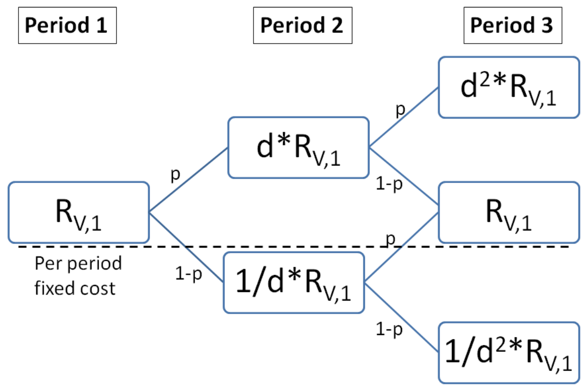

Figure 1: State of nature tree for VCT. $R_{V,1}$ is revenue of VCT firm at first period.

$$R^{SCT}(\varphi_{it}) = \chi R\varphi_{i1} \tag{3}$$

In what follows, we assume that sunk and fixed costs are constant across markets, while it follows from our specification that $R^{SCT}(\varphi_{it})$ and $R^{VCT}(\varphi_{it})$ are increasing in market size. Finally, for simplicity, we assume that firms choose to export when doing it leads to a profit of 0, and choose the sunk-cost technology whenever they are indifferent between the two kinds of export technologies.

Figure 1 shows an example for the mechanics of our model for VCT technology-type firms with initial productivity just above the per period fixed cost. In period 1, the firm observes its initial productivity φ_{i1}, from which it calculates its $R^{VCT}(\varphi_{i1})$ or $R_{V,1}$ for short. The firm will export in this period if this is larger than 1 (denoted by the dash line in the figure), with a first period profit of $\pi_{i1}^{VCT} = R\varphi_{i1} - 1$. In period 2, the firm will receive a shock: with probability p its export revenue increases to $dR\varphi_{i1}$ and with probability $1-p$, it will decrease to $\frac{1}{d}R\varphi_{i1}$. As, the revenue in this latter case is below 1, the firm will export only after a positive shock in period 2 - as shown in the figure with revenue being below the dashed line. If, following a second period positive shock, the firm receives a positive shock in the third period as well, its potential export revenue will increase to $d^2R\varphi_{i1}$ with probability p, and fall back to $R\varphi_{i1}$ with probability $1-p$; it will export in both cases. After a negative shock in the second period, on the other hand, it will only export after a positive first-period shock.

An important consequence of this setup is that the probability of exporting in different periods and the expected export profit only depends on the value of φ_{i1}. If, as in Figure 1, $1 \leq R\varphi_{i1} < d$, the firm will export with probability 1 in

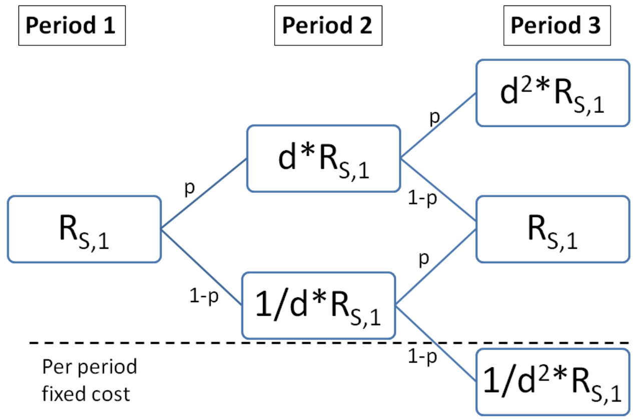

Figure 2: State of nature tree for SCT. $R_{S,1}$ is revenue of SCT firm at first period.

period 1, p in period 2 and $p^2 + p(1-p)$ in period 3. Also, its expected profit, $E\Pi^{VCT}(\varphi_{i1})$, is the discounted sum of expected profits in the three periods. If, however, initial productivity is somewhat larger, e.g. $d \leq R\varphi_{i1} < d^2$ (which would mean that export revenue from initial productivity is higher relative to 1), it will become profitable to export even after a bad shock in the second period, and the firm will only exit in the third period after two bad shocks.

For firms opting for the SCT technology, the setup is similar, save that they pay a sunk cost in the beginning but the threshold of exporting becomes lower as their net revenue is higher for a given productivity level[8]. This is shown for the same firm in Figure 2 with first period revenue of $R^{SCT}(\varphi_{i1})$ or $R_{S,1}$ for short. Note that while the fixed cost is unchanged, revenues are higher in the SCT case as defined in (3).

In what follows, we characterize the behavior of VCT and SCT-type firms, then show how firms choose the export technology and finally we formulate some predictions.

[8]The model could be made explicitly dynamic (i.e. allowing firms to change their status at some point) by substantial complications only. While this is subject to further research, let us refer the readers a set of different models (Buono et al. (2008), Albornoz et al. (2010) or Morales et al. (2011)) highlight dynamic aspects of moving around export markets as well as becoming permanent while being temporary as well. Ruhl and Willis (2008) considers a dynamic discrete choice model with per-period market-level cost when a firm wishes to maintain export market presence.

3.3 VCT technology firms

A VCT technology firm exports whenever its export revenue is not lower than the per-period fixed cost: $R\varphi_{it} \geq 1$. We will calculate the exit rates and the expected profitability for each φ_{it} to be able to predict the optimal trading technology choice and the exit rate.

Because of the discrete nature of the stochastic process in the model, the expected profit is not a smooth function of φ_{it}. To handle this, it is useful to classify the firms into three categories according to the first time they may stop exporting. Naturally, firms with $R\varphi_{i1} < 1$ do not start exporting, and we will not deal with them here. Second, as we have seen in Figure 1, firms with $1 \leq R\varphi_{i1} < d$ stop exporting in period 2, as their potential export revenue may sink under the fixed costs with probability $1 - p$. Third, the potential export revenue of firms with $d \leq R\varphi_{i1} < d^2$ is always higher than the fixed cost in period 2, but may stop exporting in period 3 after two bad shocks with probability $(1-p)^2$. Finally, firms with a very high potential export revenue, i.e. $R\varphi_{i1} \geq d^2$ always export in all three periods.

To derive the expected profit from exporting, consider a firm for which $1/R \leq \varphi_{i1} < d/R$. The export revenue of this firm is the discounted sum of export revenues in all periods and states of the world:

$$E\Pi^{VCT}(\varphi_{i1}) = AR\varphi_{i1} - B \tag{4}$$

where $A = \left[1 + \delta_1 pd + \delta_2 p^2 d^2 + \delta_2 p(1-p)\right]$ and $B = \left[1 + \delta_1 p + \delta_2 p^2 + \delta_2 p(1-p)\right]$.

Consider now a firm with higher productivity, where $d/R \leq \varphi_{i1} < d^2/R$. This firm may only exit in the long run; and hence, the expected export profit includes the second period revenue even after a bad shock before the second period:

$$E\Pi^{VCT}(\varphi_{i1}) = AR\varphi_{i1} - B + \delta_1(1-p)\left(\frac{1}{d}R\varphi_{i1} - 1\right) \tag{5}$$

Note that the function is continuous in $\varphi_{i1} = d/R$, because in that point the firm is indifferent in period two after a bad shock.

Finally, firms with the highest productivity always export. Accordingly, their expected profit is

$$E\Pi^{VCT}(\varphi_{i1}) = AR\varphi_{i1} - B + \delta_1(1-p)\left(\frac{1}{d}R\varphi_{i1} - 1\right) + \delta_2(1-p)^2\left(\frac{1}{d^2}R\varphi_{i1} - 1\right) \tag{6}$$

This function is also continuous when $\varphi_{i1} = d^2/R$. Also, $E\Pi^{VCT}(\varphi_{i1})$ is (weakly) convex in φ_{i1}, as an increase in φ_{i1} has two positive effects: export is profitable in more states of nature, and the profit increases from already profitable states of nature.

3.4 SCT technology firms

The problem of SCT technology firms is very similar to VCT-type firms:

$$E\Pi^{SCT}(\varphi_{i1}) = \begin{cases} \chi AR\varphi_{i1} - B - S & \text{if } \frac{1}{\chi R} \leq \varphi_{i1} < \frac{d}{\chi R} \\ \chi AR\varphi_{i1} - B + \delta_1(1-p)\left(\frac{1}{d}\chi R\varphi_{i1} - 1\right) - S & \text{if } \frac{d}{\chi R} \leq \varphi_{i1} < \frac{d^2}{\chi R} \\ \chi AR\varphi_{i1} - B + \delta_1(1-p)\left(\frac{1}{d}\chi R\varphi_{i1} - 1\right) + \\ \delta_2(1-p)^2\left(\frac{1}{d^2}\chi R\varphi_{i1} - 1\right) - S & \text{if } \frac{d^2}{\chi R} \leq \varphi_{i1} \end{cases} \tag{7}$$

Similarly to $E\Pi^{VCT}(\varphi_{i1})$, this function is continuous and increasing in φ_{i1}.

Using these functions for VCT and SCT technology firms, the following proposition shows that when comparing two firms with the same φ_{i1} but with different trading technologies, the VCT technology firm is more likely to exit earlier and hence, be classified as a temporary trader.

Proposition 1 *For any given $\varphi_{i1} \geq 1/R$, the probability that an SCT technology firm exit in period 2 is not larger than the probability that a VCT-type firm exits.*

Proof. Let us analyze the problem for different intervals. (i) When $\frac{1}{R} \leq \varphi_{i1} < \frac{d}{\chi R}$, the probability of exit in period 2 for both types of firms is $1-p$. (ii) If $\frac{d}{\chi R} \leq \varphi_{i1} < \frac{d}{R}$, the probability of exit in period 2 for an SCT technology firm is 0, while it is $1-p$ for VCT-type firms. (iii) if $\varphi_{i1} \geq \frac{d}{R}$, neither firm type exits in period 2. ■

3.5 Technology choice

Naturally, a firm chooses SCT technology whenever the expected profit from it is higher than that from the VCT, i.e. $E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1}) \geq 0$. To characterize this choice, we analyze the behavior of the left-hand side of this equation.

First, we assume that the sunk cost is large enough to ensure that it is not profitable to export with the sunk cost technology whenever it is not profitable to export with the variable cost technology. This means, that $S > \chi A - B$. The motivation for this assumption is that otherwise VCT would clearly be dominated by SCT for all firms.

One consequence of this assumption is that, when $\varphi_{i1} < 1/R$, it is not profitable to export at all. For larger productivity draws, the following proposition holds.

Lemma 2 *When $\varphi_{i1} \geq 1/R$, the $E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1})$ function is continuous and (strictly) monotonically increasing. Also, $\lim\limits_{\varphi_{i1}\to\infty} E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1}) = \infty$.*

Proof. The continuity is the consequence of the fact that the two expected profit functions are continuous.

The monotonicity is also intuitive. As the function is the sum of two functions which are linear in different intervals, it can also be represented in such a way. Taken into account that $1 < \chi < d$, the endpoints of the relevant intervals for φ_{i1} are $1/\chi R, 1/R, d/\chi R, d/R, d^2/\chi R, d^2/R$. Differentiating the $E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1})$ function separately for each interval, we get positive derivatives for all intervals.

When $\varphi_{i1} \geq d^2/R$, the function is $(\chi - 1) A(\varphi_{i1})+\delta_1(1-p)\left(\frac{1}{d}(\chi - 1) R\varphi_{i1} - 1\right)+ \delta_2(1-p)^2\left(\frac{1}{d^2}(\chi - 1) R\varphi_{i1} - 1\right) - S$. The last term is a constant, and the first three terms are positive and positive linear functions of φ_{i1}, thus the limit of the $E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1})$ function is ∞. ■

The intuition behind the monotonicity property is that there are two reinforcing effects when φ_{i1} increases. First, it becomes profitable to export in more and more branches of the tree in Figure 1. This means that the higher the φ_{i1} of SCT technology firms, the more states of nature they can enjoy their transport cost advantage in (assuming, that they have paid the sunk cost). Second, the profit in branches where the firm already exports increases faster with the SCT technology because of the lower transport cost.

The result regarding the limit property of $E\Pi^{SCT}(\varphi_{i1})-E\Pi^{VCT}(\varphi_{i1})$ comes from the fact that the only effect of productivity increase is that profits in each branch increase when $\varphi_{i1} \geq d^2/R$, and both types of firms export at all branches of the tree. Because of the transportation cost advantage, SCT technology firms benefit more from this advantage.

The main consequence of these results is that there is a cut-off value, φ^*_{i1} such that all firms below this choose the VCT technology, and firms with a higher export revenue potential choose the SCT technology:

Proposition 3 *When $S > \chi A - B$, there is a cut-off φ^*_{i1},where $E\Pi^{SCT}(\varphi^*_{i1}) - E\Pi^{VCT}(\varphi^*_{i1}) = S$. All firms with $1/R \leq \varphi_{i1} < \varphi^*_{i1}$ choose the VCT technology, and firms with $\varphi_{i1} \geq \varphi^*_{i1}$ choose the SCT technology.*

Proof. As $E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1})$ is a strictly monotonously increasing continuous function when $\varphi_{i1} > 1/R$, also $E\Pi^{SCT}(1/R) - E\Pi^{VCT}(1/R) < 0$ when $S > \chi A - B$; and $\lim_{\varphi_{i1}\to\infty} E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1}) = \infty$, there should be one and only one φ^*_{i1}, where $E\Pi^{SCT}(\varphi_{i1})-E\Pi^{VCT}(\varphi_{i1}) = S$. For $\varphi_{i1} < \varphi^*_{i1}$, $E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1}) < 0$, thus it is more profitable to choose the VCT technology. Conversely, when $\varphi_{i1} \geq \varphi^*_{i1}$, $E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1}) \geq 0$, it is more profitable to use the SCT technology. ■

Given the cut-off φ^*_{i1}, we can calculate the share of firms entering with either type of technologies. According to our assumption, the distribution of $\phi_{i1} = \varphi_{i1}^{\frac{1}{\sigma-1}}$ is Pareto with parameters with m_0 and $\kappa > 1$. Without loss of generality, we can assume that $m_0 = 1/R^{\frac{1}{\sigma-1}}$, the lowest productivity exporter, because we are interested in the share of SCT firms across exporters rather than all firms. The share of firms entering with VCT technology is $n_{VCT} =$

$F(\varphi_{i1}^{*\frac{1}{\sigma-1}}) = 1 - \left(\frac{1}{R\varphi_{i1}^{*\frac{1}{\sigma-1}}}\right)^{\kappa}$, and naturally the share of firms entering with the SCT technology is $n_{SCT} = \left(\frac{1}{R\varphi_{i1}^{*\frac{1}{\sigma-1}}}\right)^{\kappa}$. Using this, we can calculate the average ϕ_{i1} for both kinds of firms: it is $\frac{\kappa\varphi_{i1}^{*\frac{1}{\sigma-1}}}{\kappa-1}$ for SCT-type firms and $\frac{1/R^{\kappa}}{1-\left(1/R\varphi_{i1}^{*\frac{1}{\sigma-1}}\right)^{\kappa}}\frac{\kappa}{\kappa-1}\left(R^{\kappa-1}-\frac{1}{\varphi_{i1}^{*\frac{\kappa-1}{\sigma-1}}}\right)$ for VCT-type firms.

3.6 Predictions of the model

We discuss four key predictions of the model. First we show that on average VCT-type firms are more likely to exit in the short term than SCT-type firms both because of their lower revenue conditional on productivity and because of the composition effect. This means that temporary exporters on average behave differently from permanent traders because of their different initial technology choice. Second, we show that the probability that a particular firm exports with the SCT technology is an increasing function of market size. Third, we analyze the effect of trade liberalization on the margins of trade, and show that it leads to an increase in the number of both VCT and SCT firms, and that the increase in average exports of SCT firms is larger than that of VCT firms. Fourth, we show that the share of SCT-traders and thus of temporary trade increases if firms discount the future less steeply, i.e. if δ_1 and/or δ_2 is larger. Throughout this analysis we will assume that a cut-off value exists, i.e. the sunk cost is large enough ($S > \chi A - B$). We define firms who export in the first period but exit in the second period as temporary traders.

Proposition 4 *On average, VCT technology exporters are more likely to exit in period 2 (temporary trader)*

Proof. Consider VCT technology type firms. Such a firm will only exit in the second period if it gets a bad shock, and its initial productivity is between $1/R$ and d/R; for firms in this interval the probability of exit is $1-p$. If $\varphi_{i1} \geq d/R$ the firm will not stop exporting in period 2. SCT technology firms behave similarly: they exit in period 2 with probability $1-p$ but for them the condition is: $\frac{1}{\chi R} < \varphi_{i1} \leq \frac{d}{\chi R}$. As a consequence, we have to check 3 cases.

(1) if $\frac{1}{R} \leq \varphi_{i1}^{*} < \frac{d}{\chi R}$, all VCT-type firms exit with a probability $1-p$. SCT firms below $\frac{d}{\chi R}$ also exit with probability $1-p$; the share of such firms from all SCT-type firms is $1 - \left(\frac{1}{R\varphi_{i1}^{*\frac{1}{\sigma-1}}}\right)^{\kappa}$, thus the share of exiting SCT-type firms is $(1-p)\left[1 - \left(\frac{1}{R\varphi_{i1}^{*\frac{1}{\sigma-1}}}\right)^{\kappa}\right]$ which is smaller than the probability that a VCT-type firm exits, i.e. $1-p$.

(2) if $\frac{d}{\chi R} \leq \varphi_{i1}^* < \frac{d}{R}$. Similarly to case (1), all VCT-type firms exit with a probability $1-p$. On the other hand, no SCT-type firm exits even after a bad shock.

(3)if $\frac{d}{R} \leq \varphi_{i1}^*$. Now only those VCT-type firms exit with probability $1-p$ for which $\varphi_{i1} < \frac{d}{R}$. The share of these firms is non-zero. On the other hand, no SCT-type firm exits in period 2. ■

This proposition shows our central argument: temporary and permanent traders differ from each other qualitatively, because they are likely to have chosen different trading technologies.

Next, we model the effect of market size, L_k on trade technology choice. As in this theorem we distinguish between different markets, we will index the relevant variables with k.

Proposition 5 *If a firm with productivity φ_{i1} exports to any market k with VCT, there is ceteris paribus a threshold market size, $L^*_{\varphi_{i1}}$, such that the firm exports with VCT to markets with $L_k < L^*_{\varphi_{i1}}$ and exports with SCT to markets with $L_k \geq L^*_{\varphi_{i1}}$.*

Proof. For this proposition we have to show that φ_{i1}^* is decreasing in L_k, and that the firm chooses the SCT when $L_k \to \infty$. As we know that $E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1}) < 0$ on a given market L_k, there will be a threshold regarding L.

Note first that $R_k = (\tau_{ik})^{1-\sigma} w_k L_k (\rho P_k \phi_i)^{\sigma-1} = aR$ is a positive linear function of L_k. We have to investigate all relevant intervals of the $E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1})$ function separately and solve for φ_{i1}^* on each interval separately. Having differentiated the expression for φ_{i1}^* with respect to aR it is clear that φ_{i1}^* is decreasing with market size.

Second, when $L_k \to \infty$, it will be true for each firm that $\varphi_{i1} > d^2/R$, in which case $E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1}) = (\chi-1)\,K(\varphi_{i1}) + \delta_1(1-p)\left(\frac{1}{d}(\chi-1)\,R\varphi_{i1} - 1\right) + \delta_2(1-p)^2\left(\frac{1}{d^2}(\chi-1)\,R\varphi_{i1} - 1\right) - S$, the limit of which is ∞ w.r.t. L, therefore SCT technology is more profitable in the limit. ■

In a similar spirit, we extend the previous result to the transport cost.

Proposition 6 *If a firm with productivity φ_{i1} exports to any market k with VCT, there is ceteris paribus a threshold transportation cost, $\tau^*_{\varphi_{i1}}$, such that the firm exports with VCT to markets with $\tau_k > \tau^*_{\varphi_{i1}}$ and exports with SCT to markets with $\tau_k \leq \tau^*_{\varphi_{i1}}$.*

Proof. Analogous to the previous proof. ■

The empirical content of these propositions is that a firm is more likely to choose SCT on a larger market than on a smaller one. Indeed, when modeling whether a firm is permanent trader, controlling for productivity or firm fixed effects, these propositions predict a positive coefficient for GDP and a negative coefficient for distance.

Interestingly, our model does not predict that the share of SCT firms on a larger market is larger. This is a peculiarity of the Pareto distribution. On larger markets, the productivity threshold of the sunk cost technology is lower but so is the threshold for exporting at all. Because of the characteristics of the Pareto distribution, the inflow of new exporters is exactly such that the share of SCT firms remains unchanged relative to a smaller market.

However, empirically it is true that the share of permanent traders is an increasing function of market size without controlling for productivity or firm fixed effects. Our model would only provide this prediction with assuming some other productivity distribution function or 'tilting the table' for the SCT in larger markets, assuming for example that its transportation cost advantage is increasing with market size.[9]

Based on the intuition of the previous results we may formulate a proposition about the effect of trade liberalization on the different margins.

Proposition 7 *Trade liberalization leads to an increase in the number of both VCT and SCT exporters (extensive margin). Exports/firm (the intensive margin) increases for SCT-type firms if $\sigma > 2$, and the growth of the intensive margin is smaller for VCT-type firms than for SCT firms.*

Proof. The threshold productivity of exporting, $\widehat{\phi}_{i1}$, (where firms are indifferent between exporting and exporting with the VCT) is given by $A(\tau_{ik})^{1-\sigma} w_k L_k (\rho P_k \widehat{\phi}_{i1})^{\sigma-1} \equiv B$. By taking logarithms of both sides and differentiating w.r.t transportation cost yields $\frac{\partial \ln \widehat{\phi}_{i1}}{\partial \ln \tau_{ik}} = 1$, thus, at the margin a 1 % decrease in transportation cost leads to a 1 percent decrease in the threshold. Similarly, differentiating the threshold between the VCT and SCT technologies, φ^*_{i1}, yields $\frac{\partial \ln \varphi^*_{i1}}{\partial \ln \tau_{ik}} = 1$. Taking into account the properties of the Pareto distribution, this means that the number of VCT and SCT firms increases in the same proportion at the margin as a result of trade liberalization.

Consider now the intensive margin of SCT firms. There are two effects here. First, all previous SCT-type firms export more by $-\frac{\partial \ln(\tau_{ik})^{1-\sigma}}{\partial \ln \tau_{ik}} = (\sigma - 1)\varepsilon$ percent. Second, the threshold falls by $\varepsilon = \partial \ln \tau_{ik}$ percent, leading to a composition effect which has a negative effect on the intensive margin, reducing the average productivity by ε percent. When $\sigma = 2$, the revenue is a linear function of productivity, hence the two effects are equal: the intensive margin does not change. When $\sigma > 2$, however, higher productivity firms have a larger weight in average revenue than in the average productivity, thus a decrease of ε in average productivity as a consequence of the change in the threshold leads to a smaller proportional decrease in average revenue. As a result, when $\sigma > 2$, the intensive margin increases as a consequence of trade liberalization - and note that in most estimates σ is estimated to be around 5[10].

Consider now VCT firms. Here there is a third effect as well: the highest productivity formerly VCT firms become SCT firms, which has a negative effect

[9] Another such 'trick' would be to assume that there is no transportation cost for SCT-firms. While it is a completely realistic assumption in the export vs. FDI choice in Helpman et al. (2004), here it seems less attractive.

[10] For example, Lai and Trefler (2002) estimates σ for several countries and models and finds σ to be between 4.7 and 7.2.

on average productivity and revenues. Thus the increase in the intensive margin is smaller for VCT firms than for SCT firms. ■

The logic of the extensive margin result is straightforward: the decrease in trade cost makes both exporting in general and SCT trade in particular more impressive. For small changes and Pareto distribution the number of firms exporting with both technologies increases in similar proportions. The logic of the intensive margin result is that for SCT-type firms, when σ is large enough, the increase in the exports of the most productive firms is larger than the composition effect coming from some less productive firms switching to the SCT technology. In case of VCT firms, however, there are two composition effects: some less productive firms become exporters and the most productive of these firms become SCT firms. Note, that if σ is large, it is easily possible that the intensive margin of these firms decreases.

Finally, we turn to the question of the discount factor, and show that the larger it is (i.e. the less steeply a firm discounts future), the higher the share of permanent traders is. The intuition of this result is clear: the lower discount decreases the return of investing into the SCT technology.

Proposition 8 *The share of SCT-type traders is increasing in δ_1 and δ_2. Also, the share of temporary traders is a non-decreasing function of δ_1 and δ_2.*

Proof. As S does not depend on the discount factors, it is enough to show that (i) $E\Pi^{SCT}(1/R)-E\Pi^{VCT}(1/R)$ is smaller when the discount factors are smaller, and that (ii) the derivative of $E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1})$ is non-increasing in the discount factors. These together mean that, with some abuse of notation, if $\delta_1 < \delta_1'$, for all R_{i1}, $E\Pi^{SCT}(\varphi_{i1}, \delta_1) - E\Pi^{VCT}(\varphi_{i1}, \delta_1) \geq E\Pi^{SCT}(\varphi_{i1}, \delta_1') - E\Pi^{VCT}(\varphi_{i1}, \delta_1')$, and the same is true for $\delta_2 < \delta_2'$. From this one can conclude that φ_{i1}^* is a non-increasing function of the discount factors. Because of Proposition 1 this also means that the share of temporary traders is a non-decreasing function of the discount factors.

(i) $E\Pi^{SCT}(1) - E\Pi^{VCT}(1) = (\chi-1)R(1+\delta_1 pd + \delta_2\left[p^2d^2 + p(1-p)\right]) - S$. Differentiating this w.r.t. δ_1 yields $(\chi-1)Rpd > 0$. Differentiating w.r.t δ_2 yields $(\chi-1)R\left[p^2d^2 + p(1-p)\right] > 0$.

(ii) The proof comes from calculating the derivatives of $E\Pi^{SCT}(\varphi_{i1}) - E\Pi^{VCT}(\varphi_{i1})$ for each interval. ■

4 Empirical evidence

The model presented earlier considers a firm starting to export and exiting based on its technology choice and productivity shocks. However, as trade technology choice - in contrast with trade spells - is not observable in our database, we use the trade relationship stability filter introduced in section 2 to test predictions. This cross-section tool, based on a seven-year panel dataset, allows us to consider all trading firms and not only those who start trading at a given base year. As we have shown that there is a strong connection between trade technology choice and the length of trade flows, we are convinced that showing that our predictions describe well the difference between permanent and temporary trade will provide empirical support to our framework.

This section presents evidence regarding trade patterns. We have four predictions generated from the model.

(E1) More productive firms are more likely to trade at permanent fashion, controlling for market characteristics (Proposition 3)

(E2) Trade with larger and closer markets are more likely to be permanent, controlling for firm characteristics. (Propositions 6 and 5)

(E3) Firms with higher capital cost (i.e higher discount rate) are, ceteris paribus, more likely to trade temporary. (Proposition 8)

(E4) Trade liberalization leads to increasing in extensive margins of both kinds of exporters, and leads to a more positive effect on the intensive margin of permanent exporters. (Proposition 7)

We will test these hypotheses by modelling the probability that a firm-destination relationship is permanent in nature. We first present the empirical strategy based on the model outlined in the previous section. This is followed by results and some robustness checks. Finally we extend our setup to discuss effects of trade liberalization.

4.1 Empirical model

The model in the previous section allowed us making predictions regarding the likelihood of temporary trade as a function of a set of firm, destination and firm-destination variables. We estimate the probability that a trade relationship by firm i to country k is permanent in nature as:

$$\Pr(T_{ik}) = F(\alpha + \boldsymbol{\beta}'\mathbf{F}_i + \boldsymbol{\gamma}'\mathbf{M}_k + \mu_i + \lambda_k + \epsilon_{ik}) \tag{8}$$

where $\mathbf{F}_i$ refers to firm level characteristics (ability, capital cost) and $\mathbf{M}_j$ includes destination market features (size, distance), μ_i are firm level fixed effects, and λ_k are destination-level random effects.

Our left hand side variable $T_{ik} = 1$ if a relationship is permanent, and $T_{ik} = 0$ if temporary.

To investigate (8) we estimate linear probability and probit models with destination-level random effects and different sets of fixed effects. Motivated by the methodology in Harrigan and Deng (2008) and Mayer et al. (2010), we opt for this approach to allow for using transaction level approach as well as product and/or firm level fixed effects as a control for heterogeneity.

In terms of measurement, productivity (or ability) is proxied by Total Factor Productivity or TFP, firm size, export to total sales share and a dummy is used for multi-product firms. GDP and GDP per capita are all measured in logs at a standard fashion. Transport cost is simply measured by distance with data from CEPII. Further, we use industry dummies at two-digit nace level. For details on variables, see Table 7 in the Appendix.

Capital cost is proxied by credit risk and we chose an index used by banks to assess credit risks suggested by BIS (2006) and investigated by Forlani (2010).

The Solvency Ratio (SR) is the ratio of net assets of the firm plus long-term debts to total assets plus leftover stock. It measures the ability of a firm to service its debt and to accomplish long-term development[11]. The higher the ratio of internal and secured funding, the smaller the likelihood of payment problems, and hence, the lower the capital cost for the firm.

$$SR = \frac{\text{Equity + Reserves + Profits +LT debt}}{\text{Total Assets + Stock of goods}}$$

Another cause for lower capital cost would be sales to take place within a multinational group where the internal funding may be cheaper and the sunk cost of exporting set lower. Unfortunately, the data is unable to detect within group sales, i.e. when Audi Hungary exports to its German parent or another subsidiary in Spain. We use a foreign ownership dummy, which may be considered as a proxy to presence of within group sales, and hence, should imply a greater likelihood of permanent trade. Of course, foreign share being both related to within group sales and cost of capital may be hardly disentangled.

As introduced in section 3, firms are assumed to avoid a sudden death shock. In terms of empirical exercise, we omitted firms who exported in 2000 but either (i) were born after 1996 or (ii) exited before 2004. Thus, all firms studied were operating during our 7-year window of 1997-2003. As a result, we excluded 27.3% of firms which corresponds to 20.3% of relationships (for details, see Table 9 in Appendix). Given that all these firms are intrinsically temporary traders, our results regarding the importance of temporary trade are conservative.

Next, we present our baseline results and some robustness checks.

4.2 Results

To test predictions E1-E3, we estimated (8) using a random effect probit model. Table 3 presents the results. The first column includes the key variables, productivity (TFP), credit cost (solvency ratio) as well as the gravity variables: GDP (total GDP and GDP per capita) and transport cost (distance). All coefficients presented are marginal effects.

Evidence is in line with model predictions. Baseline results (column 1) suggest that more productive and better financed firms are more likely to trade at a permanent level. In terms of export markets, market size (total GDP) is positively correlated with the probability to export at a permanent fashion, while high trade cost (proxied by distance) acts as hindrance. In the extended model (column 2) control variables are added to better model firm ability. Size, export share and product scope (proxied by a multi-product dummy) all enter significantly with the expected positive sign while other results hardly change.

One may argue that the success of trade affects firm size or productivity, creating a simultaneity problem. To solve this, instead of values for 2000, we used values for 1997 in the third column - with no apparent difference (column 3). Finally, to test separately for firm specific or destination specific variables,

[11] As an alternative, in line with BIS, we used the Financial Independence Index (FII), which is simple net assets (equity, reserves, profits) to the total assets - with no affect on results.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Probit	Probit	Probit, Lag	Lin.prob	Lin.prob
GDP (ln)	0.119***	0.134***	0.119***	0.053***	0.071***
	(0.013)	(0.015)	(0.013)	(0.008)	(0.008)
GDP pcapita (ln)	0.108***	0.100***	0.090***	0.018	0.022
	(0.023)	(0.027)	(0.024)	(0.013)	(0.015)
Distance (ln)	-0.258***	-0.336***	-0.252***	-0.119***	-0.145***
	(0.017)	(0.021)	(0.018)	(0.008)	(0.010)
TFP	0.218***	0.056***	0.180***	0.015**	
	(0.011)	(0.013)	(0.013)	(0.006)	
Solvency Ratio	0.125***	0.186***	0.084***	0.061***	
	(0.033)	(0.035)	(0.031)	(0.010)	
Foreign-owned, D		0.085***		0.025***	
		(0.025)		(0.009)	
Export share		0.650***		0.201***	
		(0.036)		(0.031)	
No. employees		0.131***		0.040***	
		(0.008)		(0.002)	
Multi-product firm, D		0.630***		0.232***	
		(0.088)		(0.041)	
Fixed effects	Nace2	Nace2	Nace2	Nace2	Firm
Observations	16 660	16 633	13 674	16 633	17 084
R-squared	0.05(a)	0.09(a)	0.04(a)	0.12	0.09
Number of dest	169	169	167	169	169
log likelihood	9660	9167	7748		

(a) Pseudo R squared is noted for Probit models

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

Table 3: Firm-destination level random effect probit and linear probability models, dependent variable: T=1 if relationship permanent, 0 if temporary

destination and firm fixed effects were introduced in a linear probability model. Results remained unchanged (columns 4 and 5).

To see economic impact, we evaluate the basic probit model at sample means (see Table 7 in the Appendix for values). At those values, the probability to be a permanent exporter is 74.4%. One standard deviation increase in productivity raises this probability by 2.4 percentage points. If the GDP of a destination rises by one standard deviation, the probability to export there at a permanent fashion rises by 2.5 pp. Similarly, a one standard deviation increase in per capita income has an effect of 0.7pp.

Several robustness checks have been carried out regarding firm scope, product size and destination importance, see section 7.3 and Table 12 in the Appendix. Our results were robust to excluding a large number of unimportant destination markets, small shipments and single-product firms.

4.3 Margins of trade

In this subsection we test our predictions (E4) about the effects of trade liberalization. As Hungary underwent significant liberalization between 1995 and 2000, we have chosen these two dates to compare the intensive and extensive margins of permanent and temporary trade flows. For this, we simply calculated the number of firm-destination export flows separately for total, temporary and permanent trade as a measure for the extensive margin, and divided total trade volume with this to yield a proxy for the intensive margin. Table 4 present the change in intensive and extensive margins between 1995 and 2000.

The results are in line with our predictions. First, and most importantly, the reaction to trade liberalization of temporary and permanent trade is different. Second, both extensive margins increased, but this increase was larger for permanent trade. (While our model predicted both temporary and permanent extensive margins to increase, it does not predict a greater increase of temporary trade; this may be a consequence of the Pareto distribution function, as discussed earlier.) Third, while the intensive margin of permanent trade increased by 25 %, it *decreased* by a similar amount for temporary trade. This is very much in line with our prediction that trade liberalization leads to entry of less productive exporters, and to a switch by the most productive temporary exporters to permanent trade.

Our results have some consequences for empirical work. Simple extensive-intensive margin calculations can be misleading as a result of different composition effects and the qualitative difference between short- and long-term trade. One possible solution for this is to use a similar filter to distinguish between the dynamics of permanent and temporary trade.

5 Extension to transaction level

So far we have taken the simplified view of looking at firm-destination level models. However, most product creation and destruction happens within firms

Margin	Decomposed factor	2000 vs 1995
Total mfg firms' trade	Volume (m USD)	162.1%
Extensive margin	Number of relationships	89.7%
Intensive margin	Average size ('000 USD)	38.2%
Permanent mfg firms' trade	Volume (m USD)	169.2%
Extensive margin	Number of relationships	114.0%
Intensive margin	Average size ('000 USD)	25.8%
Temporary mfg firms' trade	Volume (m USD)	9.7%
Extensive margin	Number of relationships	52.5%
Intensive margin	Average size ('000 USD)	-28.1%

Table 4: Decomposing the extensive and intensive margin with the filter

(Broda and Weinstein (2010), Bernard et al. (2010)). This phenomenon may be observed in our case, we find that 56.5% of all firm-destination-product relationships are temporary.

Before turning to firm-destination-product level analyses, note that temporary trade is highly prevalent across products or broad economic categories. Table 5 shows the shares of various types of trade relationships by two classification methods. It presents categories where temporary trade is the most and least frequently present.

First, relationships were grouped by the products and aggregated up to the 2-digit level of Harmonised Systems (HS2). This is the level that describes broad industries such as textiles or metals. As shown in the table, temporary trade is highly prevalent in all categories despite considerable heterogeneity. This confirms that temporary trade is not an industry specific phenomenon.

	Most prevalent		Least prevalent	
HS2	Animal products	78%	Plastics, rubbers	46%
BEC	Cat 7: other	75%	Cat 2: ind. supplies	50%

Table 5: Share of temporary trade by good categories. Figures come from national aggregates.

Second, we considered the UN's Broad Economic Categories (BEC), a classification which groups tradable goods by the main end use. Temporary trade turns out to be highly prevalent in all categories, especially capital goods and raw materials. This suggests that temporary trade is present in all steps of the production process from raw materials to consumer goods.

As shown by Table 11 (in the Appendix), for most industries (at two-digit level), the share of permanent trade ranges around 40%. However, there are also some differences between sectors with 30% permanent relationship share (transport vehicles and electrical equipment/computers) and sectors with 50% share (basic metals, chemicals). This is related to both firm features and product composition. Industries differ in firm size and ownership and both these variables affect trade stability. Actual product diversity (heterogeneity) within a product category (basic metal vs electrical equipment) matters as well (see next section). Industrial differences explain about 1.6% of variation in temporary-permanent trade when firm level controls are applied as in Table 3.

While differences across product and industry categories prevail, it is important to note that temporary trade is not a feature for a particular group of products.

5.1 Transaction level setup

Our model can easily be extended to the transaction, i.e. firm-destination-product level. This time the decision of firm i may be exporting a specific product j for the first time or exporting product j to a specific new destination k. In this case, the sunk cost of doing so must be contrasted to other cost factors (as in Bernard et al. (2010)). The net revenue now also depends on the product feature and σ_j, the elasticity of substitution in the CES function, which may vary by product characteristics as well.

The transport cost under VCT technology is assumed to be factor $\chi^{\frac{1}{\sigma_j - 1}}$ of the transport cost under SCT. Thus, the difference between VCT and SCT depends on σ_j. As a higher σ_j implies more product homogeneity and $\chi^{\frac{1}{\sigma_j - 1}}$ is negatively related to σ_j, the more differentiated a product, the larger the difference between transport cost with VCT and SCT technologies.

This assumption is based on the idea that transport cost is made up of two components: haulage and distribution/retail. Haulage depends on the weight of the product and is irrelevant for the choice of trade technology. However, distribution and retail, both in terms of actual transport and marketing costs, depend on how special products are. Transporting bulk products such as wheat is likely to take place in a very standardized fashion using simple warehouses. Differentiated products, instead, will be shipped via multi-modal transport routes, with its specifications being frequently checked on site. When investing in a trade relationship, a methodology may be devised whereby some specifications and testing framework are given at the beginning. Thus, this latter component will differ in terms of trade technology choice; variable trade cost technology implies higher per unit costs than sunk cost technology.

As a consequence, a new prediction from model suggests that:

(E5) Products with higher sunk cost relative to fixed and variable trade costs (heterogeneous goods) are more likely be traded permanently.

To estimate the role of product specificity, we simply build on the three categories suggested by Rauch (1999): heterogeneous, homogeneous and quoted priced goods. As a proxy to relative costs, we introduce a dummy for the Rauch index of heterogeneity, which equals 1 if the good is classified as heterogeneous, and 0 otherwise.

At the transaction level, we can test for some further potential differences not directly related to our model.

First, given the nature of product and destination specific fixed costs, a firm shall find it cheaper to sell a product in a country if it knows the market (other products are sold there) or it has experience (it sells the product in other markets). In other words, permanent trade is more likely in *key* products (that are sold at several markets) and *key* markets (where several product categories are sold).

Second, there are several other product-level explanations for an unstable trade relationship. Most importantly, firms do actually export "unusual" items: fixed assets or inventories[12]. These goods are likely to have not even been produced by the firm, but instead had been purchased earlier as inputs to the firm. Our data suggest that asset and inventory sales is responsible for more than 22% of temporary trade transactions, while its importance at permanent trade transactions is just 2.2% - one-tenth of the value for temporary trade. We created two variables to capture assets and inventories (that are not core products of the firm).

Third, there may be items that are too large to be sold every year. Aircraft, ships or telecommunication network equipment may be exported infrequently[13]. Lumpy export of these items would be picked up as temporary trade - as an 'on and off' pattern. Hence, we distinguish the most valuable (highest unit value) items from all products by defining a dummy if the unit value of a particular item is within the highest 10% of values within the product category.

We estimate the probability that the relationship of firm i supplying product j to country k is permanent:

$$\Pr(T_{ijk}) = F(\alpha + \boldsymbol{\beta}'\mathbf{F}_i + \boldsymbol{\gamma}'\mathbf{M}_{ik} + \boldsymbol{\delta}'\mathbf{P}_{ij} + \mu_i + \vartheta_j + \lambda_k + \epsilon_{ijk}) \qquad (9)$$

where $\mathbf{F}_i$, $\mathbf{M}_{ik}$ are the same as before, $\mathbf{P}_{ij}$ stands for product (and firm-product) features (e.g. heterogeneity), μ_i represents firm fixed effects, ϑ_j product fixed effects and λ_k destination random effects. In all regressions, we control for possible differences in costs according to use of goods, relying on UN's Broad economic category dummies (Consumer, Capital, Parts, Intermediates, Raw materials, other). Our left hand side variable is now $T_{ijk} = 1$ if a transaction (firm-destination-product) level relationship is permanent, and $T_{ijk} = 0$ if temporary.

The model is estimated with a linear probability model with destination random effects.

5.2 Transaction level results

Table 6 presents results from the transaction level specification using linear probability model with destination random effects. The first two columns include 4-digit NACE industry dummies, the third column has HS6 product fixed effects, the fourth firm fixed effects and the fifth has firm-product specific fixed effects.

[12] Regarding trade of assets and inventories, details are available on request.

[13] Armenter and Koren (2010) notes that in 2005 the biggest US shipments categories included aircraft ($42 million), spacecraft ($5 million), tanker ships ($15 million) and floating drilling platforms ($5 million).

First of all, results confirm earlier results from firm-destination level analysis (column 1). More productive firms with lower capital costs are more likely to trade a product at a permanent fashion. Further, gravity variables remain important when product heterogeneity is allowed.

Then, the positive and significant coefficient of Rauch differentiated product dummy suggests that products, of which trade is expected to be more costly or contract-intensive are likely to be exported at a more permanent fashion. By the same token, products that are unlikely to be the actual product of the firm (assets and inventories) are indeed more likely to be traded at temporary fashion. Finally, key products (i.e. products that are sold in more than just the actual market) and key markets (i.e. destinations where the firm sells more than just the actual product) are more likely to be permanently traded.

All these results are confirmed when firm level controls are added (in column 2). The random (destination) effect linear probability is extended by product fixed effects (column 3) and firm fixed effects (column 4). As a final test on gravity variables firm-product fixed effects are introduced (column 5). Key results on GDP and distance as well as firms size or export share as proxy to ability remain unchanged. TFP looses all its effect when extra controls are added (columns 2,3) confirming a close relationship between measured TFP and product mix (Altomonte and Békés (2010)).

6 Conclusions

This paper defined a trade relationship stability filter and used it to tell apart two distinct export strategies: permanent and temporary trade. Our theoretical contribution was to allow heterogeneous firms to choose between sunk cost and variable cost trade technologies. In a simple model with endogenous technology choice we provided a number of predictions which were matched with evidence from Hungarian data. We showed that temporary trade is highly prevalent in terms of number of relationships at every layer of firm-product-destination level trade relationships. Trade relationships in more specialized products by more productive firms with lower capital cost, to larger and closer destinations are more likely to be stable. Three suggestions may be drawn from our analysis.

First, sunk cost models work very well for a large share of export volume. At the same time, allowing firms to extract less from an export sale but avoid paying a large one-off cost, can make the large number of short spells quite understandable - even without assuming very large and frequent productivity shocks. This observation can reconcile evidence of both large estimated sunk cost, intensive exit and re-entry and a large number of small shipments.

Second, our results suggest that a policy change such as trade liberalization will affect the margins of trade differently for permanent traders and temporary traders. As a result, distinction between these groups contributes to a better forecast of impacts of large shocks on the extensive margin, and even better estimates of reallocation.

Third, when policy aims at boosting exports in search for positive external-

	(1)	(2)	(3)	(4)	(5)
	Lin. prob	Lin. prob	Lin. prob	Lin. prob	Lin. prob
GDP (ln)	0.029***	0.028***	0.047***	0.040***	0.068***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.010)
GDP per capita (ln)	0.041***	0.040***	0.004	0.013	-0.001
	(0.013)	(0.012)	(0.014)	(0.011)	(0.017)
Distance (ln)	-0.068***	-0.073***	-0.101***	-0.079***	-0.117***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)
TFP	0.019***	-0.006	-0.005		
	(0.005)	(0.006)	(0.006)		
Solvency Ratio	0.034***	0.036***	0.042***		
	(0.010)	(0.010)	(0.008)		
Foreign-owned, D		0.040***	0.047***		
		(0.008)	(0.008)		
Export share		0.108***	0.084***		
		(0.022)	(0.023)		
Number of employees		0.017***	0.012***		
		(0.003)	(0.003)		
Multi-product firms, D		0.014	0.013		
		(0.045)	(0.038)		
Rauch diff. good, D	0.028	0.032*		0.032*	
	(0.019)	(0.018)		(0.017)	
High value items, D	-0.089***	-0.093***		-0.057***	
	(0.023)	(0.023)		(0.022)	
Assets, D	-0.199***	-0.201***	-0.177***	-0.121***	
	(0.023)	(0.021)	(0.011)	(0.018)	
Inventories, D	-0.060**	-0.075***	-0.084***	-0.168***	
	(0.025)	(0.023)	(0.013)	(0.012)	
Key product (D)	0.244***	0.231***	0.184***	0.265***	
	(0.016)	(0.016)	(0.016)	(0.016)	
Key market (D)	0.025***	0.003	0.036***	0.061***	0.180***
	(0.008)	(0.010)	(0.010)	(0.009)	(0.009)
Fixed effects	NACE4	NACE4	Prod	Firm	Firm-Prod
Observations	65 385	65 312	65 312	66 911	66 911
R-squared	0.108	0.116	0.0717	0.0796	0.0840
Number of dest	169	169	169	169	169

BEC Dummies included. Robust standard errors in parentheses
** p<0.01, ** p<0.05, * p<0.1

Table 6: Firm-destination-product level random effect linear probability model, dependent variable: T=1 if relationship permanent, 0 if temporary

ities (employment, learning, spillovers, tax revenue etc.), considering our setup, it can chose among reducing the sunk cost (S),reducing the transport cost (τ) or increasing the discount factor (δ). While all may be considered as measures boosting trade, in our setup they will have different consequences. Reducing the transport cost will affect the net revenue for supplying a good to a given country. As we have shown (in prediction E4), this leads to an increase in the number of both VCT and SCT exporters (extensive margin), while the intensive margin increases mainly for SCT-type firms. Instead, if policy-makers cut the sunk cost it will make permanent trade relatively more likely and create a more stable trade flow. Finally, if policy decreases the discount factor (eg. improve provision of capital, improve foresight and predictability of institutions) more firms will choose the SCT and hence, export at a permanent fashion. Thus, in our model, it is the reduction of the sunk cost of trade as well as improvement of financial conditions that make more permanent traders.

References

Aeberhardt, R., I. Buono, and H. Fadinger (2009). Learning and the dynamics of exporting: Theory and evidence from french firms. Vienna Economics Papers 1006, Uni Vienna.

Albornoz, F., H. F. C. Pardo, G. Corcos, and E. Ornelas (2010). Sequential exporting. Discussion papers, Department of Economics, University of Birmingham.

Altomonte, C. and G. Békés (2010). Trade complexity and productivity. WP 12, CEFiG.

Araujo, L. and E. Ornelas (2007). Trust-based trade. Discussion Papers 820, CEP.

Arkolakis, C. (2010). Market penetration costs and the new consumers margin in international trade. *118*(6), 1151–1199.

Arkolakis, C. and M.-A. Muendler (2010). The extensive margin of exporting products: A firm-level analysis. NBER Working Papers 16641, National Bureau of Economic Research, Inc.

Armenter, R. and M. Koren (2010). A balls-and-bins model of trade. DP 7783, CEPR.

Baldwin, R. and J. Harrigan (2011). Zeros, quality and space: Trade theory and trade evidence. *American Economic Journal: Microeconomics, 3*(2), 60–88.

Békés, G., P. Harasztosi, and B. Muraközy (2011). Firms and products in international trade: Data and patterns for hungary. *Economic Systems 35*(1), 4–24.

Bernard, A. and B. J. Jensen (2004). Why some firms export. *The Review of Economics and Statistics 86*(2).

Bernard, A. B., S. J. Redding, and P. K. Schott (2010). Multiple-product firms and product switching. *American Economic Review 100*(1), 70–97.

Bernard, A. B., S. J. Redding, and P. K. Schott (2011). Multi-product firms and trade liberalization. *Quarterly Journal of Economics forthcoming.*

Besedes, T. (2006). A search cost perspective on duration of trade. *Review of International Economics 15*(5), 835–849.

Besedes, T. and T. J. Prusa (2006). Ins, outs, and the duration of trade. *Canadian Journal of Economics 39*(1), 266–295.

BIS (2006). *International Convergence of Capital Measurement and Capital Standards: A Revised Framework - Comprehensive Version.* Basel: Bank for International Settlements.

Broda, C. and D. E. Weinstein (2010). Product creation and destruction: Evidence and price implications. *American Economic Review 100*(3 (June)), 691–723.

Buono, I., H. Fadinger, and S. Berger (2008). The micro dynamics of exporting: Evidence from french firms. University of München.

Chaney, T. (2008). Distorted gravity: The intensive and extensive margins of international trade. *American Economic Review 98*(4), 1707–1721.

Crozet, M., P. Koenig, and V. Rebeyrol (2008). Exporting to insecure markets: A firm-level analysis. Working paper 2008-13, CEPII.

Das, S., M. J. Roberts, and J. R. Tybout (2007). Market entry costs, producer heterogeneity, and export dynamics. *Econometrica 75*(3 (May)), 837–873.

Dixit, A. and J. E. Stiglitz (1977). Monopolistic competition and optimum product diversity. *American Economic Review 67*, 297–308.

Eaton, J., S. Kortum, and F. Kramarz (2011). An anatomy of international trade: Evidence from french firms. *Econometrica 79*(5), 1453–1498.

Eckel, C. and J. P. Neary (2010). Multi-product firms and flexible manufacturing in the global economy. *Review of Economic Studies 77*(1), 188–217.

Forlani, E. (2010). Liquidity constraints and firms export activity. Development Working Papers 291/April, Centro Studi Luca dÁgliano, University of Milano.

Harrigan, J. and H. Deng (2008). China's local comparative advantage. WP 13963, NBER.

Helpman, E., M. Melitz, and S. Yeaple (2004). Export versus fdi with heterogenous firms. *American Economic Review 94*(1), 300–316.

Hess, W. and M. Persson (2010). Exploring the duration of eu imports. Working Paper Series 849/Aug, Research Institute of Industrial Economics.

Lai, H. and D. Trefler (2002). The gains from trade with monopolistic competition: Specification, estimation, and mis-specification. NBER Working Papers 9169, National Bureau of Economic Research, Inc.

Lawless, M. (2010). Geography and firm exports: new evidence on the nature of sunk costs. *Review of World Economics 146*(4), 691–707.

Mayer, T., M. J. Melitz, and G. I. Ottaviano (2010). Market size, competition and the product mix of exporters. Research series 2010-202 (Oct), National Bank of Belgium.

Mayer, T. and G. Ottaviano (2008). The happy few: The internationalisation of european firms. *Intereconomics: Review of European Economic Policy 43*(3), 135–148.

Melitz, M. J. (2003). The impact of trade in intra-industry reallocations and aggregate industry productivity. *Econometrica 71*(6), 1695–1725.

Morales, E., G. Sheu, and A. Zahler (2011). Estimating a structural model of export entry. Harvard University.

Moxnes, A. (2010). Are sunk costs in exporting country specific? *Canadian Journal of Economics 43*(2), 467–493.

Nitsch, V. (2009). Die another day: Duration in german import trade. *Review of World Economics 145*(1), 133–154.

Olley, S. G. and A. Pakes (1996). The dynamics of productivity in the telecommunications equipment industry. *Econometrica 64 (6) 64*(6), 1263–1298.

Rauch, J. E. (1999). Networks versus markets in international trade. *Journal of International Economics 48*(1), 7–35.

Rauch, J. E. and J. Watson (2003). Starting small in an unfamiliar environment. *International Journal of Industrial Organization 21*(7), 1021–1042.

Roberts, M. J. and J. R. Tybout (1997). The decision to export in colombia: An emprical model of entry with sunk cost. *American Economic Review 87*(4), 545–64.

Ruhl, K. and J. L. Willis (2008). New exporter dynamics. NYU Stern.

Segura-Cayuela, R. and J. M. Vilarrubia (2008). Uncertainty and entry into export markets. Banco de Espana Working Papers 0811, Banco de Espana.

7 Appendix

7.1 Descriptive and additional statistics

In Table 7, variables descriptions and basic descriptive statistics are presented. Table 8 presents the number of firms per nationally aggregated destination-product level for the year 2000. Table 9 describes the loss of firms from the sample due to entry in 1997-99 or exit in 2001-2003 or both late entry and early exit (short presence). When considering all firms in the sample, we lost 15.6% of firms owing to late entry and 8.6% owing to early exit and 3.1% due to short presence. Relationships are firm-destination specific[14].

Industry dummies are either at the 2-digit or the 4-digit level of NACE rev1.1 sectors and Broad economic category dummies (Consumer, Capital, Parts, Intermediates, Raw materials) are based on UN definitions. Product fixed effects (HS2, HS6) are based on UN Harmonized Systems definitions.

[14]Note that we miss some data for 187 firms and over 2000 firm-destination pairs and hence the difference for regressions.

Variable	At the firm level Description	N. Obs	Mean	SD
Firm-destination level				
TFP	Total Factor Productivity is measured by a modified Olley and Pakes (1996) defined in Altomonte and Békés (2010)	4405	0.589	1.051
Number of employees	Number of employees comes from the balance sheet, includes all full time employees, and is in logs	4454	103.2	402.3
Export to sales	Export to total sales share is defined by balance sheet of the firm.	4540	0.409	0.382
Multiproduct d	Multiproduct dummy equals to 1 if the firm sells more than one HS6 product to the same country.	4540	0.950	0.220
Multi-destination d	Multi-destination dummy equals to 1 if the firm sells the same product to more than one country	4540	0.824	0.381
Foreign d	Foreign ownership is defined by a dummy=1 if non-domestic residents hold more than 10% of equity.	4540	0.400	0.490
Solvency Ratio	The Solvency Ratio (SR) is the ratio of net assets of the firm (equity, reserves, profits) plus long-term debts to total assets plus leftover stock (intermediate inputs and unsold final output). It is defined in relative terms to industry median.	4471	-0.078	0.541
Firm-destination level				
Ln Distance	Distance (CEPII)	17084	6.907	1.003
Ln GDP	GDP (overall)	17084	19.522	1.604
Ln GDP/capita	GDP/capita	17084	9.616	0.756
Firm-product-destination level				
Rauch heterogeneity	Rauch index of heterogeneity (dummy, 1 if heterogeneous products, 0 for wholesale or reference priced), conservative measure is used. See Rauch (1999)	66911	0.888	0.315
Same prod, other count	Firm exports the same product to different country (dummy)	66911	0.542	0.498
Same count, other prod	Firm exports other products to the same country (dummy)	66911	0.878	0.327
Large item d	Large items are defined as products whose unit value is above 90% of product range average. Unit values are defined as USD volume over units given for the actual HS6 product category.	66911	0.020	0.140
Asset d	Assets are exported capital goods, when	66911	0.037	0.188
Inventory d	Inventories are exported intermediate goods, when the profile of the firm is not the production of such goods. Theseare likely to have been inventories such as parts, raw materials.	66911	0.085	0.279

Table 7: Variables - descriptive stats

No of firms/cell	No. Cells	Percent
1	15938	25.1%
2	8982	14.1%
3	6276	9.9%
4	4432	6.9%
5	3275	5.1%
6	2616	4.1%
7	2499	3.9%
8	1600	2.5%
9	1746	2.7%
10	1530	2.4%
More	14483	22.8%

Table 8: Number of observations

	Firms	Relationships
Late entry	939	2633
Early exit	518	2023
Short presence	184	393
Not in sample	1641	5049
In sample	4540	19754
Total	6187	24803

Table 9: Share of temporary trade by good categories

Model	(1) Probit	(2) Probit	(3) Probit	(4) Lin.prob
TFP	0.064***	0.015***	0.019***	0.016**
	(0.007)	(0.004)	(0.004)	(0.006)
Export share in sales		0.211***	0.216***	0.236***
		(0.013)	(0.014)	(0.014)
N. of employees (log)		0.033***	0.037***	0.039***
		(0.003)	(0.003)	(0.003)
Multi-product firms (Dummy)		0.194***	0.206***	0.341***
		(0.033)	(0.036)	(0.032)
Solvency Ratio	0.013	0.019***	0.020**	0.039***
	(0.011)	(0.007)	(0.008)	(0.013)
Foreign-owned (Dummy)		0.024***	0.026***	0.013
		(0.008)	(0.008)	(0.010)
Sector dummies	Nace2	Nace2	Nace4	Nace2
Observations	4 353	4 335	3 986	4 335
(Pseudo) R-squared	0.0926	0.312	0.340	0.237
Log-likelihood	-1670	-1255	-1162	

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

Table 10: Linear Probability and Probit models, dependent variable: T=1 if firm is permanent trader, 0 if temporary

7.2 Firm level results

The model introduced in section 3.2 can be simplified by assuming that there is only one market and there are no destination specific shocks. Thus, firms may be permanent or temporary exporters as such. We have seen that even at this aggregated level, there is quite some variation.

We estimate firm i export status:

$$\Pr(T_i) = F(\alpha + \boldsymbol{\beta}'\mathbf{F}_i + \mu_i + \epsilon_i) \tag{10}$$

where $\mathbf{F}_i$ refers to firm level characteristics (ability, capital cost) and μ_i are industry dummies, respectively. Our left hand side variable $T_i = 1$ if a firm is permanent exporter, and $T_i = 0$ if temporary exporter.

To measure the effect of firm level variables, we both use probit and linear probability models, only to see very little difference. Firm level results confirm that the key question is the impact of firm ability and cost of capital: Firms are more likely to be permanent traders when more productive and have lower capital cost.

nace	Industry	Sh. of perm.trade
15	Food, beverages & tobacco	34%
17	Textiles	44%
18	Wearing apparel; fur	44%
19	Leather, footwear	42%
20	Wood and wood products	42%
21	Pulp, paper and paper products	35%
22	Publishing, printing	35%
24	Chemicals and chemical products	55%
25	Rubber and plastic products	47%
26	Other non-metallic mineral products	50%
27	Basic metals	52%
28	Fabricated metal products, exc. machinery	38%
29	Machinery and equipment	37%
30	Office machinery and computers	32%
31	Electrical machinery and apparatus	47%
32	Radio, television and comm. equipment	36%
33	Medical, precision and optical instruments	45%
34	Motor vehicles, trailers and semi-trailers	45%
35	Other transport equipment	25%
36	Furniture; manufacturing n.e.c.	44%

Table 11: Share of temporary trade by industries, firm-destination-product

7.3 Robustness test

We have carried out several robustness tests to the baseline results presented in section 4.2. After repeating the baseline specification (*Base*), we first present the possible impact of nuisance items, as we omitted small shipments worth less than 10.000USD (labelled as *Non_ small)*. This has somewhat reduced the size of coefficients but has not qualitatively affected results. Second, we dropped "exotic" destinations, keeping the 100 most important markets only (*Top100*).The results are basically unchanged from the baseline model, suggesting that it is not far-away, peculiar locations that drive results.

Third, we divided our sample into exports by single (*SProd*) and multi-product (*MProd*) firms. There is a fairly small number of relationships of single-product firms at this level of aggregation. While firm level variables show limited variation, GDP and distance matters even within single product firms.

	(1)	(2)	(3)
VARIABLES	multiprod	Non_small	top100 dest
GDP (ln)	0.133***	0.156***	0.131***
	(0.015)	(0.019)	(0.029)
GDP per capita (ln)	0.100***	0.165***	0.184***
	(0.027)	(0.033)	(0.058)
Distance (ln)	-0.336***	-0.394***	-0.363***
	(0.021)	(0.026)	(0.040)
TFP	0.054***	0.017	0.036
	(0.013)	(0.020)	(0.022)
Solvency Ratio	0.188***	0.314***	0.186***
	(0.035)	(0.053)	(0.055)
Foreign-owned, D	0.088***	0.111***	0.094**
	(0.025)	(0.037)	(0.041)
Export share	0.638***	0.494***	0.787***
	(0.037)	(0.056)	(0.057)
Number of employees	0.133***	0.134***	0.155***
	(0.008)	(0.012)	(0.013)
Multi-product firms, D		0.545***	0.814***
		(0.142)	(0.131)
Observations	16,379	9,899	6,750
Number of dest	169	145	50
log likelihood	-9024	-3959	-3395
Pseudo R-squared	0,08	0,08	0,11

Destination RE included. Standard errors in parentheses,
*** p<0.01, ** p<0.05, * p<0.1

Table 12: Random Effect probit, dependent variable: T=1 if relationship permanent, 0 if temporary

	2000				
		Non-exporter	Temporary	Permanent	Total
1995	Non-exporter	0	41.41	58.59	100
	Temporary	76.07	8.86	15.00	100
	Permanent	21.07	2.99	75.94	100
	Total	17.13	26.36	56.51	100

Table 13: Decomposition of trade growth between 1995 and 2000, 100 = total value change in USD.

.

	2000			
		Non-exporter	Temporary	Permanent
1995	Non-exporter		2.78	79.85
	Temporary	-1.37	0.06	1.06
	Permanent	-4.60	-0.17	22.39

Table 14: Contributions to trade growth volume (1995 -2000), firm-destination level