

Fixed Costs per Shipment*

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Abstract

Exporting firms do not only decide how much of their products they ship abroad but also at which frequency. Doing so, they face a trade-off between saving on fixed costs per shipments (by shipping large amounts infrequently) and saving on storage costs (by delivering just in time with small and frequent shipments). The firm's optimal choice defines a unique mapping from size and frequency of shipments to fixed costs of shipment and market entry cost. We use a unique dataset of Swiss cross-border trade on the transaction level to analyze the size and shape of the underlying fixed costs. The data suggest that for Swiss exporters the net present value of fixed costs per shipment are economically important, averaging at about 20 000 CHF. This sum is equivalent to 0.38 percent of export values or a fifth of market entry cost, which we estimate to sum to 100 000 CHF. We document that fixed costs per shipment positively correlate with trade barriers like language commonalities, trade agreements and distance have the expected sign and realistic magnitudes.

Keywords: Trade costs, shipment, firm trade.

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1 Introduction

Fixed costs of exporting form a centerpiece of the broad literature following Melitz (2003). These costs divide the set of heterogeneous firms into highly productive exporters and less productive local sellers, generating rich trade patterns, on the aggregate and the firm level alike.

Fixed costs of exporting are generally thought to decompose into the fixed costs of market entry and per-period fixed costs. These two components are equivalent for trade flows in the static setup that is usually explored.¹

In the present paper we introduce and analyze the novel concept of *fixed costs per shipment*. Such fixed costs accrue by organizing the collection, insurance and delivery of goods on a per-shipment basis. Thus, they comprise the monetary equivalent of the time spent to view and bundle orders, fill in customs forms, monitor and coordinate the transportation and the arrival at the receiver. Exporting firms can, for any given quantity of yearly exports, save on fixed costs of shipment by shipping more at a time and paying storage costs at destination. Striking the optimal trade-off between these costs determines the frequency and the size of shipments as a function of standard parameters of demand, technology, and interest rates.

Introducing fixed costs per shipment has at least three novel implications. First, trade theory gains an additional margin through which trade volumes adjust: the traditional intensive margin (on the firm level) decomposes into frequency and the size of shipments. Our theory predicts that rises in trade volumes generally come along with an expansion along both margins: the number of shipments and the value per shipment. An exception to this general rule occurs when fixed costs per shipment change. Under such changes, the total trade volume and the number of shipments increases (decreases), whenever the value per shipment decreases (increases).

Second, the concept of fixed costs per shipment smudges the border between fixed costs of exporting and variable costs of exporting. Specifically, a distinctive characteristic of fixed costs per shipment is their substitutability with storage costs: a firm that saves on fixed costs of shipments by shipping more at a time must incur storage costs at the export destination. The resulting hybrid role of fixed costs per shipment constitutes a challenge for the Melitz (2003) framework and theoretical models that rely on the exogenous dichotomy between fix and variable trade costs.

¹More precisely, the impact of both types of fixed costs on trade flows is identical as long as their net present value coincides.

Third, the fixed costs per shipment incurred per year are roughly proportional to trade volumes, since higher trade volumes generally imply a larger number of shipments. Therefore, fixed costs per shipment are not straight forward to identify. E.g., empirical work analyzing yearly trade data typically subsumes fixed costs per shipment under variable transport costs in estimations based on traditional models. Instead, fixed costs per shipment must be estimated using transaction data, whereas standard empirical strategies are misfit to capture fixed costs per shipment and thus tend to underestimate total fixed costs.

In an empirical part, we use transaction-level data from Swiss exporters to quantify fixed costs per shipment as well as the traditional market entry costs. Our theory implies that two observable variables - the frequency and the size of shipments - constitute sufficient statistics to quantify fixed costs of market entry as well as fixed costs per shipment. Thus, we can infer the fixed costs per shipment purely from the frequency and value of shipments of single firms. The inferred fixed costs per shipment are economically important: on average, their net present value is about 20 000 CHF, which translates into a tariff-equivalent of 0.38% or about a fifth of fixed costs of exporting.

We further exploit the country variation of our data to estimate the impact of some standard determinants of trade costs: *language commonalities*, *trade agreements* and *distance*. All of these determinants have a significant impact on the fixed costs per shipment. Thus, a common *language* is associated with a 43% reduction, trade agreements a 35% reduction and finally, the doubling of bilateral distance with a 6% increase in fixed costs per shipment. In our estimations we control for market size and per capita income, both common determinants of trade flows. Consistent with our theory, however, we do not find a significant impact of these controls on fixed costs per shipment.

The impact of the traditional trade barriers on fixed costs of exporting seem rather modest in comparison: our estimates indicate a somewhat smaller of language commonalities (-18%) and trade agreements (-14%) on fixed costs of market entry, while impact of distance is larger (+13% at a doubling of distance). Overall, market entry cost is estimated to be between 100 000 and 1500 000 CHF, which is somewhat smaller but in the realm of the estimates by Das et al (2007) for Columbian exporters.

Finally, our data allow us to estimate whether the transportation mode correlates with the fixed costs per shipment. Reading the results with due caution, the analysis

suggests that transportation per rail and per ship are associated with very high fixed costs per shipment compared to those fixed costs for transactions on the road.

Quite generally, the structure of trade costs is important. Since the seminal work by Melitz (2003), trade economists can no longer ignore the different role of fixed costs of trade for trade patterns. With the current paper, we specifically argue that the distinction between *fixed costs of market entry* and *fixed costs per shipment* touches upon a list of key aspects of the new New Trade literature.

First, we add to the literature highlighting the different economic consequences of the various types of fixed costs of trade. Originally, Melitz (2003) writes that "...firms are indifferent between paying the one time investment cost f_{ex} , or paying the amortized per-period portion of this cost $f_x = \delta f_{ex}$ in every period..." (δ being the effective discount rate). Chaney (2005), however, points out that out of steady state "it does matter whether the fixed costs of exporting is paid once and for all or at the beginning of each period" and studies the effect of per-period fixed costs on the transitional dynamics of trade liberalization. Ruhl (2008) studies the different responses of trade to transitory and permanent shocks to the terms of trade, heavily relying on the assumption that fixed costs are payed up front. Segura-Cayuela and Vilarrubia (2008) present a model with learning about an ex-ante "unknown per-period cost of presence in the foreign market." In a related paper, Irarrazabal and Opromolla (2009) assume per-period fixed costs to study exporters dynamics under persistent productivity shocks. Burnstein and Melitz (2011) explore the role of sunk costs for the dynamics in response to trade liberalization, generally concluding that macroeconomic dynamics "can vary greatly over time depending on those modeling ingredients." In the present paper we show that per-period fixed costs can neither be subsumed under fixed costs of market entry nor can the interval between two shipments be assumed to be exogenous. Instead, firms adapt the time between two shipments continuously according to the market conditions.

Second, the literature following Melitz (2003) makes strong assumptions on the shape of trade costs. Again, Melitz (2003) writes "that the combination of fix and variable trade costs are high enough to generate partitioning, and therefore that $\tau^{\sigma-1} f_x > f$." (The parameters τ , σ , f_x and f stand for variable trade costs, substitution elasticity between varieties, fixed costs of export market entry and setup costs of the original plant, respectively.) Direct measures of trade costs as the cif/fob ratio typically subsume the fixed costs per shipment under variable transportation costs. Such erroneous accounting can bias the expression on right of

the key inequality $\tau^{\sigma-1} f_x > f$ and lead to flawed estimates. Our analysis emphasizes that the ratio between fix and variable trade costs is indeed the equilibrium outcome of firm optimization regarding transport cost minimization and should be treated as such.

Third, by endogenizing the time between either two shipments for a given firm and export market, we underscore that the definition of a firm's exporter status must rely on a adequate choice of the corresponding time horizon. E.g., firms that ship products only twice a year report zero exports at least every second quarter. This observation raises the question whether such firms should be considered non-exporters every second quarter. That question is central for the literature measuring fixed costs of (re-) entry to export markets. Das et al (2007) write that exporters "tend to continue exporting when their current net profits are negative, thus avoiding the costs of reestablishing themselves in foreign markets when conditions improve." To properly assess such strategic firm decisions, one needs to know the extent to which exporters typically stretch the time between two shipments and the trade-offs they face in doing so. Our analytical framework enables us to address this issue. Looking at the distribution of the number of yearly shipments suggests that the definition of exporter status with yearly data is save, while quarterly and monthly data are inept for most good-country pairs. Moreover, our estimates indicate that the fixed costs per shipment is gradually increasing with the time since the last shipment so that the strategic decision to 'stay active in the market' should affect firms at each point in time.

Finally, the current paper relates to Armenter and Koren (2010), who analyze trade patterns when firms randomly fire their shipments to export markets. While the authors match impressively many patterns of trade data, the authors disregard the endogeneity of frequency and size of shipments by imposing constant size of transactions. By focussing exactly on the trade-off between frequency and size of shipments, the current paper's approach is diametrically opposed to that by Armenter and Koren (2010).

About a decade ago, the continuous rise of trade volumes and a secular decline of tariffs and measured transport costs suggested that trade costs were dead. Baier and Bergstrand (2001) drew renewed attention to trade barriers by highlighting their role as a determinant of the rise in global trade volumes. Shortly after, Anderson and van Wincoop (2004) put forward that trade costs are still substantial in absolute size and in terms of economic impact. Recognizing the importance of trade cost

Jacks, Meissner and Novy (2008) and Novy (2011) offer a novel measure of bilateral trade costs and disentangled parallel but distinct dynamics of bilateral trade costs. The present paper adds to this literature by estimating the different components of trade costs and their respective determinants.

Relating to the crucial assumptions of the Melitz model, other research has addressed the type and nature of trade cost. Das et al (2007) structurally estimate the fixed costs of entry to foreign markets. The authors find that "[a]mong small producers, average entry costs range from \$430,000 U.S. dollars [...] to [...] \$412,000." The corresponding numbers for large producers are \$344,000 to \$402,000. Compared to these substantial numbers, the authors report that annual fixed costs of exporting are close to zero. Anderson and Yotov (2010) have recently analyzed the proportions of trade costs paid by sellers and buyers, showing that the *incidence* of trade costs has important implications for the home bias, the disproportionate predicted share of local trade and the gains from trade. We connect to this literature by introducing the distinction of two different types of fixed costs of trade and by providing the framework to assess them.

The remainder of the paper is structured as follows. Section 2 presents the theoretical model. Section 3 describes the Swiss trade data, which we use to test our theory in Section 4. Finally, Section 5 concludes.

2 The Model

We develop a framework that incorporates the frequency of exports as an endogenous choice variable of firms in a standard Melitz-type model of heterogeneous firms. Doing so, we focus on a static setup, assuming in particular that population sizes, technologies and trade barriers, and consequently output and trade flows are constant.

2.1 Preferences

Consider a world with J countries, indexed by $j = 1, 2, \dots, J$. Every country produces and consumes a continuum of products. Country j 's flow utility function

is

$$u_j = \left(\int_{B_j} q_{jl}^{1-1/\sigma} dj \right)^{\sigma/(\sigma-1)} \quad (1)$$

where q_{jl} is its consumption of product l and B_j is the set of products sold in country j . The parameter σ is the elasticity of substitution across products.

Let Y_j be the income of country j , which equals its expenditure level. Then country j 's demand for product l is

$$q_{jl} = p_{jl}^{-\sigma} \frac{Y_j}{P_j^{1-\sigma}} \quad (2)$$

where p_{jl} is the price of product l in country j and P_j is the country's ideal price index.

2.2 Transport Costs

Firms located in country i can enter country j 's market at the cost of F_{ij} local labor units. We will analyze a static setup so that, just as in Melitz (2003), the cost of market entry may consist of a pure up-front cost or the net present value of per-period fixed costs or a combination of both.

Each shipment of goods from country i to country j is subject to fixed costs $f_{ij} > 0$ and marginal transport costs τ_{ij} . We follow the notational convention that τ_{ij} units of a good must leave the exporting country's port for one unit of the good to arrive in country j . This "iceberg-type" transport costs thus satisfies $\tau_{ij} \geq 1$. Fix and marginal trade costs are constant and accrue at the date of the shipment.

2.3 Production

Firms are heterogeneous and characterized by their draw of marginal unit labor requirements a . The cumulative distribution function $G(a)$ with support $[\underline{a}, \bar{a}]$ describes the distribution of firms, where $0 \leq \underline{a} < \bar{a}$. A firm with draw a located in country i has the opportunity to produce a unique variety l according to

$$q_l = w_i/a$$

2.4 Firm Pricing

Consider a firm located in country i with a productivity draw $1/a$. Maximizing profits, this firm sets its mill-price to

$$\tilde{p}(a) = \frac{\sigma}{\sigma - 1} aw_i \quad (3)$$

where w_i is the prevailing wage in country i . Given that this firm exports to country j the consumer price in country j is a composite of mill-price and all accruing variable costs. The typical iceberg transport costs due to losses in the process of shipping constitutes the standard component of the variable cost. In addition, we assume that there are storage costs for those goods that are consumed some time t' after they are actually shipped to a destination country. In particular, we focus on the costs that accrue due to interest payments that arise between shipment and consumption. Setting r for the world interest rate, the gross interest after $t' \geq 0$ periods is $e^{rt'}$. Consequently, the consumer price in country j at time t' after the shipment is

$$p_{ij}(a) = \tau_{ij} e^{rt'} \frac{\sigma}{\sigma - 1} aw_i \quad (4)$$

Operating profits are the difference between the flow of revenues ($p_{ij}q_{ji}(a)$) and total cost times units delivered. To compute the latter product, we multiply the units leaving the factory gate ($\tau_{ij}q_{ji}(a)$) with costs. The costs are the sum of unit production costs a and unit storage costs $(e^{rt'} - 1)a$. With local demand (2), the flow of operating profits from sales in country j at date $t + t'$ is thus

$$\pi_{ij}(t_1 + t') = \left(p_{ij} - \tau_{ij} e^{rt'} aw_i \right) q_{ji}(a) = \sigma^{-\sigma} \left[\frac{\tau_j e^{rt'} aw_i}{\sigma - 1} \frac{1}{P_j} \right]^{1-\sigma} Y_j. \quad (5)$$

where t_1 is the date of shipment and $q_{ji}(a)$ is the quantity consumed in country j of the good produced by a firm located in country i with productivity $1/a$.

2.5 Firm Profits

Firms do not only decide upon their pricing policy, thereby determining the export volume. In addition, they manage the timing of their shipments. This latter problem is non-standard and requires a word of explanation.

Equation (1) represents the consumer's flow utility. Under positive storage cost, firms suffer losses if they don't ship at the day of consumption. In absence of fixed

costs of shipment, a firm would therefore send a flow of shipments to the destination countries so that its products arrive precisely at the date of consumption.² In presence of fixed costs of shipment, however, such a strategy is infinitely costly, since at each infinitesimal date a discrete cost would arise. Consequently, shipments are discrete.

In our static setup output Y_j , prices P_j and trade costs are constant and we can compute present value of total operating profits of a firm located in country i , which accrue between a shipment at date t_1 and the following shipment at date $t_1 + \Delta$. These profits are³

$$\Pi_{ij}(t_1, \Delta) = \int_0^\Delta e^{-rt'} \pi_{ij}(t_1 + t') dt' = \sigma^{-\sigma} \left[\frac{\tau_{ij}}{\sigma - 1} \frac{aw_i}{P_j} \right]^{1-\sigma} Y_j \frac{1 - e^{-r\sigma\Delta}}{r\sigma}. \quad (6)$$

It will prove useful to normalize the reference span of time - a year - to unity. This means that the interval Δ is expressed as a fraction of years. Consequently, the inverse of Δ (i.e. Δ^{-1}) is the number of shipments per year between two countries.

Clearly, a firm with productivity draw a exports to country j only if the operating profits cover the fixed costs of shipment f_{ij} , i.e. whenever

$$\sigma^{-\sigma} \left[\frac{\tau_j}{\sigma - 1} \frac{aw_i}{P_j} \right]^{1-\sigma} Y_j \frac{1 - e^{-r_i\sigma\Delta}}{r_i\sigma} \geq f_{ij} \quad (7)$$

holds. The expression on the left is increasing in the term Δ . The firms located in country i whose productivity satisfy (7) will generate positive operating profits from exporting to country j - at potentially very long intervals Δ between two shipments. In the limit, the firm whose productivity $1/a$ satisfies (7) with equality would only make a single shipment to the specific destination and the retreat from the market. However, this firm would make zero operating profits and be unable to cover the market entry costs F_{ij} . Therefore, (7) holds with strict equality for all exporters and there is a positive minimal frequency of exports (implying $\Delta_{ij}(a) < \infty$ and $\bar{\gamma}_{ij}(a) > 0$).

We now turn to the optimal frequency of shipments in our stationarity framework. Since Y_j , P_j and r are constant, so will be the intervals Δ between either two

²Notice that this statement is true even in the presence of per-period trade cost.

³One arrives at the same expression when assuming that a competitive speditour buys the quantity $Q_j = \tau_j \int_0^{\Delta t} x_j(t) dt$ for the mill price (3).

shipments. Setting

$$\gamma_{ij}(a) = e^{-r\Delta_{ij}(a)} \quad \text{and} \quad A_{ij}(a) = \sigma^{-\sigma} \left[\frac{\tau_{ij} a w_i}{(\sigma - 1) P_j} \right]^{1-\sigma} Y_j \quad (8)$$

the expression for net profits per shipment (6) simplifies to $A_{ij}(1 - \gamma^\sigma)/r\sigma - f_j$. For a firm of productivity $1/a$ located in country i and selling into market j the present value of operating profits is thus

$$PV_{ij} = \sum_{k \geq 0} \gamma_{ij}^k \left\{ \frac{A_{ij}}{r\sigma} (1 - \gamma_{ij}^\sigma) - f_{ij} \right\} = \frac{1}{1 - \gamma_{ij}} \left\{ \frac{A_{ij}}{r\sigma} (1 - \gamma_{ij}^\sigma) - f_{ij} \right\} \quad (9)$$

where we have suppressed the dependence on a .

2.6 Frequency of Shipments

Taking derivatives of (9) with respect to Δ determines the profit-maximizing frequency of exports

$$(\sigma - 1) \bar{\gamma}_{ij}^\sigma - \sigma \bar{\gamma}_{ij}^{\sigma-1} + 1 - r\sigma f_{ij}/A_{ij} = 0 \quad (10)$$

The expression on the left hand side of (10) is decreasing in $\bar{\gamma}_{ij}$ as long as $\bar{\gamma}_{ij} \in (0, 1)$. Further, at $\bar{\gamma}_{ij} = 1$ the expression on the left is negative, while it is positive for $\bar{\gamma}_{ij} = 0$ (by $A_{ij} > r\sigma f_{ij}$, implies by (9)). Hence, there is a unique $\bar{\gamma}_{ij}(a) \in (0, 1)$ solving (10).

Having established uniqueness of the optimal frequency of shipment, we can turn to comparative statics. To this aim, notice that the expression on the left hand side of (10) is decreasing in γ every parameter change that increases f_{ij}/A_{ij} must be compensated by a decrease in γ or equivalently, by an decrease in the frequency $1/\Delta_{ij} = -r/\ln(\bar{\gamma}_{ij})$. Using expression (8) we can summarize these observations in the following proposition.

Proposition 1 *The frequency of firm exports from country i to country j ($1/\Delta_{ij}$) increases with firm productivity ($1/a$) export market size (Y_j) and demand elasticity (σ) but decreases with the toughness of competition ($1/P_j$), with country i 's wage rate (w_i), with iceberg-type trade costs (τ_{ij}) and the fixed costs of trade (f_{ij}).*

Proof: The statement remaining to be shown concerns σ . Taking derivatives of *LHS*, the expression on the left of (10), with respect to σ yields

$$\begin{aligned} \frac{d}{d\sigma} LHS &= [\bar{\gamma}_{ij}^\sigma - \bar{\gamma}_{ij}^{\sigma-1} - r f_{ij}/A_{ij}] + \ln(\bar{\gamma}_{ij}) [(\sigma - 1) \bar{\gamma}_{ij}^\sigma - \sigma \bar{\gamma}_{ij}^{\sigma-1}] \\ &= [1 - \bar{\gamma}_{ij}^\sigma] / \sigma - \ln(\bar{\gamma}_{ij}) [\sigma \bar{\gamma}_{ij}^{\sigma-1} - (\sigma - 1) \bar{\gamma}_{ij}^\sigma] > 0 \end{aligned}$$

where the inequality holds by $\bar{\gamma}_{ij} \in (0, 1)$. Since *LHS* is decreasing in $\bar{\gamma}_{ij}$, the implicit function theorem implies that $\bar{\gamma}_{ij}$ and therefore $1/\Delta_{ij}$ is increasing in σ . ■

The proposition shows that all factors that traditionally promote trade (productivity and size of export market) increase the frequency of shipment. At the same time, factors that tend to hinder trade (trade costs and toughness of competition in export markets) decrease the frequency.

An interesting and novel aspect comes to the substitution elasticity σ , higher levels of which tend to increase the frequency of shipments. The intuition of this result is the following. A lower frequency of shipments implies that the lag between delivery and consumption increases, which raises the average consumer prices via the channel of higher storage costs. But consumers reduce demand more strongly in reaction to such price increases when their demand elasticity σ is high. Consequently, the negative impact of storage costs on firm profits is more pronounced at higher elasticities and therefore optimizing firms chose to ship their goods at higher frequencies.

Finally, Proposition 1 allows us to make a statement about the qualitative difference between fixed costs of shipment and the traditional types of fixed costs. Specifically, applying the envelope theorem to (9), the derivative of PV_{ij} w.r.t f_{ij} can be shown to equal $-1/(1 - \gamma_{ij})$. Recall that in the static Melitz (2003) framework, trade flows and firm profits are unaffected whether fixed costs are paid up-front or period-by-period fixed costs. As long as the net present value is unchanged, the equilibrium outcome is the same. This equivalence translates partially to the concept to fixed costs per shipment. The translation is partial since γ_{ij} changes with firm productivity $1/a$. In particular, Proposition 1 implies that γ_{ij} is increasing in $1/a$ so that higher productivity firms, with higher export volumes, pay also more fixed costs per shipment (in terms of net present value). This observation shows that the total value of fixed costs per shipment, being neither independent of trade volumes nor perfectly proportional to trade volumes, are effectively a hybrid form of fixed costs and marginal trade costs.

2.7 Value per Shipment

We turn now to the value of a single shipment. By integrating demand (2) over time, using prices (4) and expression (8) we can compute the total value of a shipment from country i to country j ⁴

$$x_{ij} = \frac{A_{ij}}{r_i} (1 - \bar{\gamma}_{ij}^\sigma) \quad (11)$$

To analyze how x_{ij} varies with the model's parameters, we take implicit derivatives of (10) to get

$$\frac{d\bar{\gamma}_{ij}}{dA_{ij}} = \frac{r f_{ij}}{A_{ij}^2} \frac{1}{(\sigma - 1) \bar{\gamma}_{ij}^{\sigma-2} (1 - \bar{\gamma}_{ij})}$$

We can use this expression together with (11) to compute⁵

$$\frac{d}{dA_{ij}} \ln(x_{ij}) = \frac{1}{A_{ij}} \frac{\sigma - 1 + \bar{\gamma}_{ij}^\sigma - \sigma \bar{\gamma}_{ij}}{(\sigma - 1) (1 - \bar{\gamma}_{ij}) (1 - \bar{\gamma}_{ij}^\sigma)} \quad (12)$$

It is easy to check that the expression in the numerator is positive for $\bar{\gamma}_{ij} \in (0, 1)$ so that x_{ij} is increasing in A_{ij} . Finally, since by Proposition 1 any increase in f_{ij} decreases $\bar{\gamma}_{ij}$, otherwise leaving x_{ij} from (11) unchanged, the value of shipment is increasing in the fixed costs of trade. We can formulate the corresponding results for the value of each shipment.

Proposition 2 *The value per shipment to country j (x_{ij}) increases with productivity ($1/a$), market size (Y_j) and the fixed costs of shipment (f_{ij}) but decreases with the toughness of competition ($1/P_j$), wage in the exporter country (w_i) and iceberg-type trade costs (τ_{ij}).*

Proposition 2 shows, parallel to Proposition 1, that all factors that promote trade (productivity and size of export market) increase the value per shipment. Here again, whenever trade volumes increase – e.g. via an increase in foreign demand – they do so along intensity of shipment margin. The proposition also shows that the toughness of competition and variable trade decrease the frequency tend to reduce the value per shipment. Thus, the mentioned parameters that generally promote (curb) trade do increase (reduce) the size of shipment.

⁴See Appendix.

⁵See Appendix.

Taking the two propositions together, firms tend to increase and reduce trade volumes in parallel along two margins – frequency and size of shipment.

One exception in this general statement concerns fixed costs per shipment. Contrary to its effect on frequencies an increase in the fixed costs per shipment does *increase* the per-shipment value. This result is not surprising: when fixed costs are high, firms tend to avoid the accruing costs by compensating, at the margin, with higher inventories. This contrasts the impact of fixed costs per shipment on frequency. In particular, a comparison between Proposition 1 and Proposition 2 shows that, whenever the frequency and the value of exports move in opposite directions, then these dynamics must be driven by an underlying change in the fixed costs per shipment.

2.8 Entry to Export Markets

Firms incur fixed costs of entry to an export market whenever that costs fall short of the present value of exporting to the relevant market. We can combine equations (9) and (10) to compute P_{ij} the present value of exporting, which must exceed the market entry cost:⁶

$$P_{ij} = \frac{A_{ij}}{r} \bar{\gamma}_{ij}^{\sigma-1} \geq F_{ij} \quad (13)$$

In combination with (8) and (10), condition (13) fixes the minimal productivity $1/\tilde{a}_{ij}$ of exporters from country i to country j .⁷ At constant σ , F_{ij} and f_{ij} this implies for the minimum exporter productivity $1/\tilde{a}_{ij}$.⁸

$$\tilde{a}_{ij} = \text{const} \cdot \frac{P_j}{\tau_{ij} w_i} Y_j^{1/(\sigma-1)} \quad (14)$$

Equation (14) shows that The cutoff-productivity for exporters from country i to country j ($1/\tilde{a}_{ij}$) is increases with variable trade costs τ_{ij} and the toughness of competition $1/P_j$ but decreases with the size of the export market Y_j . This finding confirms the standard results of the Melitz (2003) framework: firms endogenously select into export markets and only the firms that can generate the highest profits export to the markets that are difficult to penetrate. Consequently, exporters tend

⁶See Appendix.

⁷Notice that, as fixed costs of market entry become negligible ($F_{ij} \rightarrow 0$) the minimal frequency of exports tends to zero ($\bar{\gamma}_{ij} \rightarrow 0$ or $1/\Delta t_{ij} \rightarrow 0$). In that case, (10) determines the minimal productivity via $A_{ij} = r\sigma f_{ij}$.

⁸See Appendix.

to be the most productive and the corresponding markets the most profitable ones.

2.9 Aggregate Yearly Trade Flows

We will now take a brief look at aggregate yearly trade flows. Since the interval Δ_{ij} is expressed as a fraction of years, the yearly exports to country j of a firm with productivity $1/a$ located in country i are (compare (11))

$$\frac{x_{ij}}{\Delta_{ij}(a)} = A_{ij}(a) \frac{1 - \bar{\gamma}_{ij}^\sigma(a)}{r_i \Delta_{ij}(a)}$$

where we have expressed the dependence of $\bar{\gamma}_{ij}$ and Δ_{ij} on a explicitly. Notice that the term $(1 - \bar{\gamma}_{ij}^\sigma(a))/(r_i \Delta_{ij}(a))$ is decreasing in $r_i \Delta_{ij}(a)$ and $\Delta_{ij}(a)$ shrinks in productivity a . Consequently, firm exports increases with firm productivity by more than in the traditional Melitz (2003) framework. Specifically, at constant frequency of export (constant $(1 - \bar{\gamma}_{ij}^\sigma(a))/(r_i \Delta_{ij}(a))$), firm productivity affects the export volumes by the factor $a^{1-\sigma}$ (compare (8)). In addition to this standard result, the term $(1 - \bar{\gamma}_{ij}^\sigma(a))/(r_i \Delta_{ij}(a))$ tends to increase export volumes. The reason for this additional effect of productivity is the following: with an increase in productivity, firms can adjust their optimal frequency of shipments, which gives their exports an additional margin, thus increasing export volumes.

Finally, the aggregate volume of exports from country i to country j is

$$T_{ij} = \int_0^{\tilde{a}_{ij}} \frac{x_{ij}}{\Delta_{ij}(a)} dG(a) \quad (15)$$

where \tilde{a}_{ij} from (13) is the cost of the marginal firm that just exports from country i to country j at zero net present value.

3 Inferring Trade Costs

With the help of firms' optimal shipment frequency, we are able to derive expressions for the three parts of trade costs: fixed costs of shipment, variable transportation costs and market entry costs.

3.1 Fixed Costs per Shipment

To derive an expression for the fixed costs per shipment we start by combining the optimality condition (10) and the value per shipment (11) to eliminate A_{ij} , which renders

$$f_{ij} = \frac{(\sigma - 1)\bar{\gamma}_{ij}^\sigma - \sigma\bar{\gamma}_{ij}^{\sigma-1} + 1}{1 - \bar{\gamma}_{ij}^\sigma} \frac{x_{ij}}{\sigma} \quad (16)$$

It is noteworthy that the expression of fixed costs per shipment depends neither on firm productivity, variable trade costs nor on market characteristics of the exporting or importing country. The only relevant parameters are the value per shipment x_{ij} , the frequency Δ_{ij} , the interest rate r and the elasticity σ . In fact, it is intuitive that, once total trade volume (x_{ij}/Δ_{ij}) is known, its decomposition into single shipments does not depend on characteristics of the countries but exclusively on the parameters governing the trade-off between higher trade costs (f_{ij}) and higher storage costs (r). As discussed in connection with Proposition 1, the elasticity σ impacts this trade-off through the consumers' sensitivity to absorb marginal storage costs. Therefore, σ enters expression (16) as well.

In sum, the parameters f_{ij} , r and σ are sufficient to determine the decomposition of total trade into x_{ij} and Δ_{ij} – or reversely, f_{ij} can be inferred from the observables x_{ij} and Δ_{ij} , given that r and σ are known.

3.2 Variable Transport Costs

With the expression (8), we can restate (11) as

$$x_{ij} = \left[\frac{\sigma\tau_{ij}aw_i}{(\sigma - 1)P_j} \right]^{1-\sigma} Y_j \frac{(1 - \bar{\gamma}_{ij}^\sigma)}{r\sigma} \quad (17)$$

which is a version of the gravity equation on the firm level. Notice that in this expression firm productivity $1/a$ appears explicitly, in contrast to expression (11) for fixed costs per shipment. Thus, estimates of the variable trade costs τ_{ij} must involve firm dummies and country dummies as long as firm productivity $1/a$ and ideal price index P_j are unobserved. Alternatively, estimates could base information about the marginal costs as in the data used in Das et al (2007).

In sum, and very much in line with the standard Melitz (2003) framework, variable trade costs can be inferred from trade flows once firm productivity, market size and the prevailing price index are known.

3.3 Market Entry Costs

Since no firm can be expected to have exactly the productivity that makes it the marginal exporter, the costs of market entry can only be proxied by an upper bound through (13). Specifically, we can use (11) to reformulate condition (13) as $x_{ij}\bar{\gamma}_{ij}^{\sigma-1}/(1 - \bar{\gamma}_{ij}^{\sigma}) \geq F_{ij}$. Taking logs and exploiting (8) leads to

$$(\sigma - 1)r\Delta_{ij} + \ln(x_{ij}) - \ln(1 - \bar{\gamma}_{ij}^{\sigma}) \geq \ln(F_{ij}) \quad (18)$$

For firms with the cutoff productivity level this inequality binds. Thus, for each country pair, the lowest value of the expression on the right observed throughout the universe of exporters constitutes an upper bound on the fixed costs of exporting.

4 Data

4.1 The Universe of Swiss Trade Data

The source of our data is the Swiss Customs (Oberzolldirektion) which records every legal transaction of cross-border trade. If a pharmaceutical firm sends two boxes of the same drug to the same destination on the same day, but involving two different custom forms, then two distinct transactions are recorded. We refer to these transactions as shipments.

The data span the period between the years 2005 and 2009 and report single cross-border transactions using an 8-digit goods classification system (tariff number). Year and month of the transaction are recorded.⁹ Our core variable is the value of each shipment in Swiss francs.

We only consider the goods that enter the official Swiss trade statistics – officially labeled *Total 1*. This definition excludes precious metals and antique furniture; we also exclude energy as well as all goods whose type of transportation is recorded as *self-propelled*.¹⁰ This restriction leaves us with 8036 (8759) goods classes and 243

⁹Days are reported as well but not reliably so: the majority of shipments are recorded on the first day of the corresponding month.

¹⁰Trade in energy comprises all goods transported via pipelines, which are recorded as one shipment per quarter and classification. Trade of self-propelled goods are in units. The restriction eliminates 0.204% of all observations for imports and 0.268% for exports. These correspond to 2.9% and 8.31% of export and import values, respectively.

(239) countries appearing at least once in the export (import) data over the full range of five year.

Tables 1a and 1b report the distribution of exports and imports in terms of values of shipments and number of shipments. The dimension of the distribution are goods (Columns 2 and 3 of each table), countries (Columns 4 and 5) and good-country-pairs (Columns 6 and 7).

According to Columns 2 and 3 of Table 1a, the top 0.1 percentile of goods accounts for 29% of the value of Swiss exports and 4.3% of all Swiss export shipments (aggregating export destinations). The top one percentile makes well over 50% of the value of Swiss exports and 19% of all export shipments while the top five percent account for close to 80% of the value of Swiss exports and close to 50% of all export shipments. Columns 4 and 5 report the distribution along the country dimension (indicating aggregates over all export goods): the top 1 percentile of countries (that is, Germany and U.S.) accounts for 20% of the value of Swiss exports and 29% of all export shipments. The according numbers for the 5th percentile are 72% for both, values and shipments.

Table 1a: Export-Distribution along the Good / Country Dimension

Percentile	Goods		Countries		Good-Country Pairs	
	Percent Values	Percent no. Shipm.	Percent Values	Percent no. Shipm.	Percent Values	Percent no. Shipm.
0.1	28.15%	6.37%	.	.	38.29%	11.30%
0.2	35.43%	7.24%	.	.	46.92%	18.26%
0.5	45.31%	13.78%	20.08%	28.28%	59.18%	29.79%
1	53.81%	22.88%	30.13%	33.62%	68.86%	41.48%
2	63.65%	35.50%	46.19%	50.34%	78.26%	54.51%
5	77.84%	56.86%	71.55%	73.04%	89.02%	71.72%
10	88.51%	73.76%	84.61%	83.96%	94.83%	83.58%
20	96.24%	89.18%	95.38%	94.63%	98.28%	92.63%
50	99.76%	98.96%	99.73%	99.44%	99.86%	98.83%
100	100%	100%	100%	100%	100%	100%

Table 1b: Import-Distribution along the Good / Country Dimension

Percentile	Goods		Countries		Good-Country Pairs	
	Percent Values	Percent no. Shipm.	Percent Values	Percent no. Shipm.	Percent Values	Percent no. Shipm.
0.1	15.82%	1.75%	.	.	29.78%	12.83%
0.2	21.05%	4.63%	.	.	37.66%	20.83%
0.5	30.77%	12.18%	33.34%	44.69%	50.34%	33.32%
1	39.06%	21.20%	44.91%	56.95%	61.26%	45.40%
2	48.74%	31.09%	59.69%	69.83%	72.66%	59.29%
5	64.08%	49.25%	84.17%	90.08%	86.27%	76.86%
10	76.79%	64.81%	93.25%	96.23%	93.76%	87.93%
20	88.83%	81.52%	98.46%	99.06%	98.06%	95.60%
50	98.73%	97.07%	99.96%	99.97%	99.86%	99.47%
100	100%	100%	100%	100%	100%	100%

Table 1b replicates the numbers from Table 1a for Swiss imports. By and large, the table shows a similar pattern. As a noteworthy difference, imports are less concentrated to the top percentiles of goods than exports while, conversely, exports are relatively less concentrated along the country dimension. The former observation reflects a balancing of the Swiss demand and consumption basket, the latter feature may reflect the fact that Switzerland's specialized goods niche products are required in all countries. Both properties can be expected for a small open and industrialized economy.

Two additional features of our data are worth to mention. First, the data include the transportation type of shipments, distinguishing between the seven classes *train*, *road*, *waterway*, *airfreight*, *postal service*, *pipeline/transmission-line* and *self-propelled*. These categories, however, do not reflect the predominant transportation

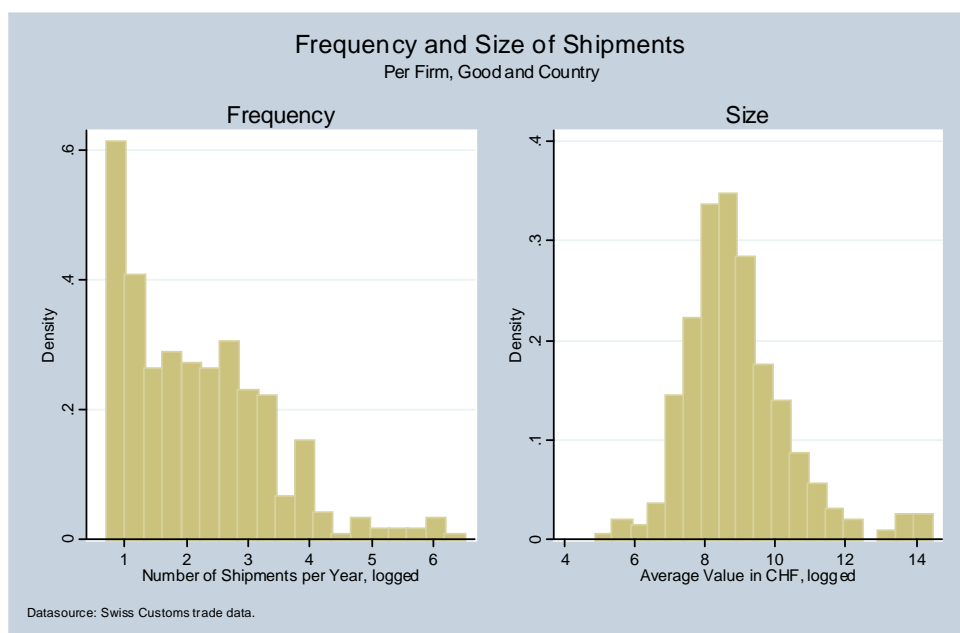


Figure 1: Average frequency and size of shipments of Swiss exports (both logged) for the period 2006-2007 for selected combinations of firm, good and destination country. Data cover 29 firms that export 38 different good classes. Selection is based on good classes for which subset of firm-level export data covers at least 95% of total trade volume in each of both years.

type used for the entire shipment, but rather the type used to pass the Swiss custom. Therefore, records of waterway are relatively scarce representing 0.4% (0.1%) of all export (import) shipments and 1.9% (1.3%) of all values respectively. The transportation-mode must therefore be interpreted with caution. The majority of records are road transportation representing 75.2% (86.1%) of all shipments and 62.8% (77.3%) of all values followed by airfreight representing 21.3% (9.0%) of all shipments and 30.8% (13.5%) of all values.

Second, our data is special in that it comprises transactions of any positive value. In this dimension, it is quite distinct from the commonly used US custom data, which only reports transactions valued at or above the threshold of \$2500. When considering transactions below 2500 CHF, these transactions account for 66.1% (73.7%) of all transactions for exports (imports) and 2.7% (5.2%) of the total trade volume reported in the data.¹¹

¹¹Over the period considered, the US Dollar was above parity to the Swiss franc so that the threshold applied by U.S. customs would be even stricter.

4.2 Firm Level Data

Our theory is based on firm decisions and must be tested using firm level data. Unfortunately, the universe of trade data does not include a firm identifier. However, a subset of the transaction data is collected through an electronic system that incorporates the names of the exporting and importing firms or individuals.¹² We refer to the dataset of export as the *subset of firm level data*. The electronic system was introduced in the year 2003 and is a novel tool to Swiss Customs and firms use it on a voluntary basis. Therefore, the corresponding data cover neither a constant share of exports nor do firms which use the system necessarily report all of their transactions through it.

For the years 2005 to 2009 covered by our data, the subset of data identifying firms aggregate to a total of 21.8, 24.5, 40.4, 43.0, and 43.9% of total export volumes (in CHF) for each of the five years. In order to exploit the useful information of the subset of firm data, we identify the good categories in which "almost all" transactions are recorded in the subset of firm level data. In particular, we focus on good categories for which the subset reports more than 95% of total export value within each of the years.

We exclude the year 2005 from our analysis as its inclusion would limit the coverage of firm data too severely. Moreover, we exclude observations of the years 2008 and 2009 since for these years our model's assumption of a steady economic environment is clearly violated.¹³

Overall, we deal with the years 2006 and 2007, to which we apply the criterion of 95% coverage described above to select firm level data of Swiss exports. Within the thus identified subset we exclude goods that are only shipped by product unit. As such, we eliminate the categories "motor vehicles for the transport of goods (less than 1200 kg)" (tariff number 8704.3110) and "motor vehicles for the transport of goods (between 1200-1600 kg)" (tariff number 8704.3120), within which each transaction obviously represents one vehicle. Following the same reasoning, we also eliminate the category "lamp-holders, plugs and sockets (between 0.3 and 3kg)" (tariff number 8536.6952) and the category "articles of goldsmiths' and silversmith's wares" (tariff number 7114.1990). Further, we eliminate the firms that export the

¹²As firm names are not standardized in the dataset provided by Swiss Customs, we need to clean the data from different versions of spelling in order to obtain proper firm identifiers. We restrict this process to firms for which there are at least than 24 observations.

¹³The Baltic Dry Index, a direct measure of commodity shipping prices, fell between May 20th and December 3rd 2008 from 11,793 to 663 points. See <http://www.bloomberg.com/>.

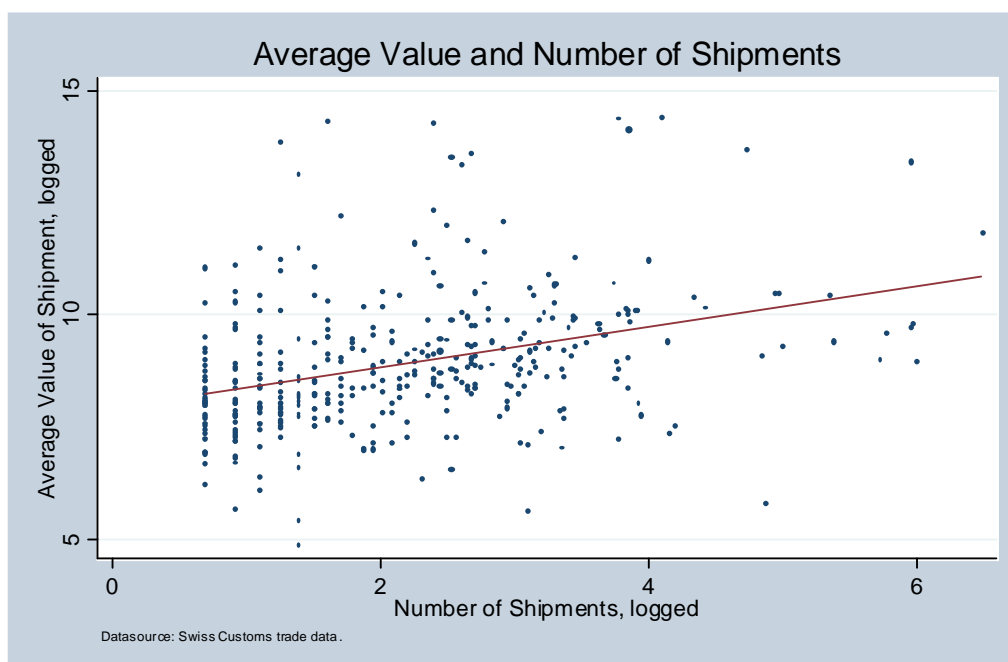


Figure 2: Scatterplot between average frequency and size of shipments (both logged) for selected combinations of firm, good and destination country of Swiss exporters for the period 2006-2007. See also note of Figure 1.

category "wood in chips or particles" (tariff number 4401.2200) and firms, typically apparel exporting firms, whose transactions are in majority small shipments to individuals. Finally, we eliminate firm-good-destination combinations with less than two shipments per year.

Filtering the data according to the thus defined criteria leaves us with 29 firms that export 38 different goods. Three of the firms export exactly two distinct goods and two of which export exactly three distinct goods. These firms account for 17,211 individual transactions of a total value of 1'791'624'536 CHF.

Based on these shipments, and for each combination of firm-good-destination, we compute the frequency (average yearly number) and the average value per shipment. This gives us 384 observations for 62 countries. Figure 1 plots a histogram of both variables.

Figure 2 graphs a scatterplot of these two variables. The figure shows that, in line with the Propositions 1 and 2 above, the two margins frequency and size of shipment tend to co-move.

4.3 Control Variables

The following additional data are used as control variables in the estimations below: language commonality, a trade agreements, distance from Switzerland and GDP as well as GDP per capita data.

World Bank WDI database provides the trade partners' GDP as well as GDP per capita data (both in constant US dollars). Distance, defined as distance from Switzerland's capital (Bern) to the trading partner's capital, is provided by the Center for International Prospective Studies (CEPII)¹⁴. A common language dummy is constructed using data from the CIA World Fact Book. We set this dummy to one if one of the official Swiss languages is an official language in a partner country as well or if an official Swiss language is spoken by at least 25% of the population of the respective partner country. Data on Swiss trade agreements is available from the Swiss federal office of economics (SECO).¹⁵ Using this data we construct an indicator function for trade agreements which is one if the agreement is in office for at least half of a respective period of analysis.

5 Estimations

In the following empirical section we aim to use the expressions (16) and (18) to estimate the two types of trade costs: fixed costs of shipment and fixed costs of market entry. We ignore per period fixed costs and variable transport costs. We do so because first, per period fixed costs are not distinguishable from market entry costs within the static setup we focus on and, moreover, are estimated to be negligible by existing studies (see Das et al (2007)). Second, as discussed in connection with equation (17), we are unable to estimate variable transport with our data due to the lack of proxies for the ideal price index and firm productivity.

All of the relevant expressions for our exercise involve the demand elasticity and the interest rate. The former can generally be estimated (see e.g. Broda and Weinstein (2004)) but performing such an exercise is beyond the scope of the present paper. Instead, in our benchmark we assume the interest rate as well as the substitution elasticity σ to vary within the conventional ranges $r \in [.05, .1]$ and $\sigma \in [2, 10]$.

¹⁴French: Centre d'Etudes Prospectives et d'Information Internationale.

¹⁵French: Secrétariat d'Etat à l'économie.

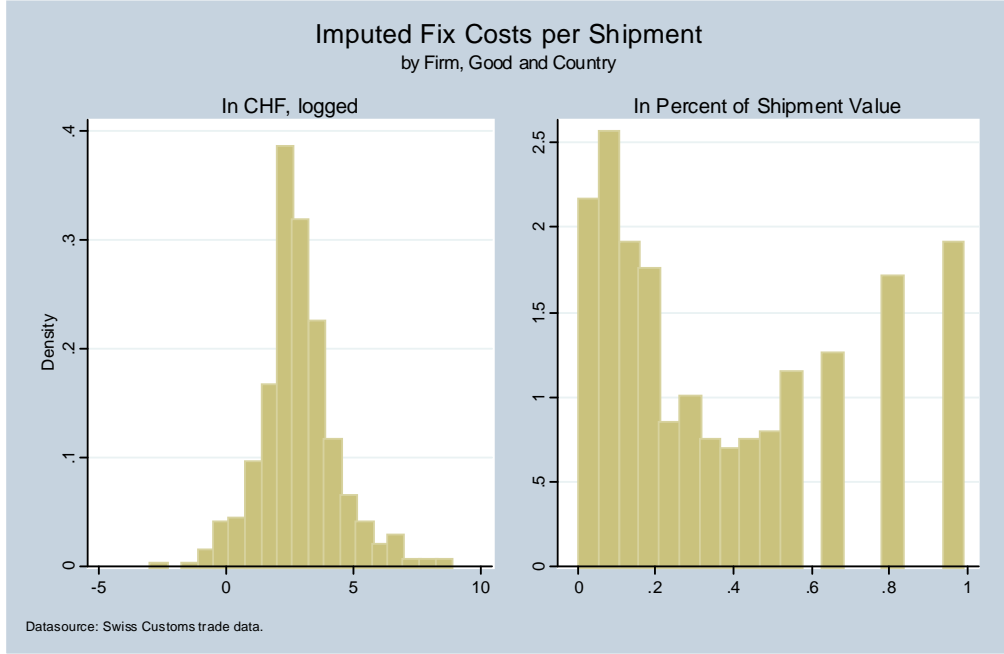


Figure 3: Histogram of fixed costs per shipment imputed by (16) for selected combinations of firm, good and destination country of Swiss exporters for the period 2006-2007. See also note of Figure 1.

5.1 Fixed Costs per Shipment

We estimate fixed costs per shipment by exploiting the logged version of equation (16):

$$\ln(f_{ij}) = \ln((\sigma - 1)\bar{\gamma}_{ij}^{\sigma} - \sigma\bar{\gamma}_{ij}^{\sigma-1} + 1) - \ln(1 - \bar{\gamma}_{ij}^{\sigma}) + \ln(x_{ij}) - \ln(\sigma)$$

Since we use Swiss export data, we have $i = CH$. The logged imputed

Expressed in terms of net present value, the fixed costs per shipment amount to 0.38% of export value on average – or a net present value of 19 792 CHF. Figure 3 plots the histogram of the fixed costs per shipment in CHF (left panel, logged) and in percent of export value (right panel). The latter ranges from zero to values close to one percent. These benchmark values are economically significant in view of the previous estimates. Thus, Das et al (2007) recently estimate fixed costs of market entry to range between 300'000 and 400'000 USD. Taking the latter estimates at face value, our imputed fixed costs range between 5% and 7.5% of the market entry costs (assuming a USD/CHF exchange of roughly one).

We aim to extract the determinants and drivers of the fixed costs per shipment. Specifically, we formulate an empirical model as

$$\ln(f_{ijs}) = \alpha + \beta X_{ij} + \sum_{s \in S} \gamma_s D_s + \varepsilon_{ijs}$$

where matrix X_{ij} stands for a set of economic variables, which we can reasonably suspect to impact fixed costs of shipments: dummies for common language, bilateral trade agreements as well as distance; dummies for the transportation modes, i.e. railway, air and mail. Further, D_s are dummies of our good category, which we include to capture good-specific effects like the durability of goods, e.g. affecting storage costs. Finally ε_{ijs} is a measurement error, assumed to be normally distributed. We perform OLS estimations with clustered error estimation to correct for heteroskedasticity bias.

Table 2 reports our estimates. Columns I - III present the results for specifications where the variables *Common Language*, *Trade Agreement* and *Distance* of the destination country from Switzerland (measured in km between capitals and logged) enter separately in the regression. All three coefficients are significant at the 5 percent level and have the expected sign: while setup cost tends to decrease with language commonalities and under trade agreements, it increases in distance. Columns IV - VI shows that these results remain largely unchanged when controlling for GDP and per capita GDP of the destination country (both logged). The estimations suggests that the effect of a common official language is huge, implying a reduction of fixed costs per shipment of about 43% ($\exp(-.535)/1 \approx 0.586$). Similarly, the establishment of a trade agreement would imply a reduction of this type of costs of about 35% ($\exp(-.426)/1 \approx 0.653$); and finally, a doubling of bilateral distance increases the respective shipment costs by about 6%.¹⁶

¹⁶Here and in the following regressions, the estimated coefficients remain largely unchanged in terms of magnitude when changing the demand elasticity and interest rate in the ranges [2,10] and [0.05,0.1]. Signs and significance levels are unaffected.

Table 2 - Fixed Costs of Shipment - Swiss Exports

	I	II	III	IV	V	VI	VII
Dependent Variable: Imputed Fixed Costs of Shipment							
Language	-0.532** [0.217]			-0.535** [0.219]			-0.327 [0.208]
Trade Agr.		-0.395** [0.190]			-0.426** [0.185]		-0.147 [0.175]
Log Distance			0.0601*** [0.0226]			0.0636** [0.0239]	0.0413 [0.0276]
Log GDP				-0.0396 [0.0503]	-0.0576 [0.0519]	-0.0777 [0.0554]	-0.0573 [0.0463]
Log GDP p.c.				0.164 [0.166]	0.195 [0.174]	0.127 [0.177]	0.185 [0.180]
Constant	2.971*** [0.103]	3.021*** [0.127]	2.594*** [0.114]	2.363 [1.651]	2.604 [1.713]	3.372* [1.772]	2.482 [1.519]
Observations	384	384	384	375	375	375	375
R-squared	0.483	0.478	0.489	0.486	0.483	0.495	0.500
Cluster Groups	62	62	62	60	60	60	60
Good Dummies	yes	yes	yes	yes	yes	yes	yes

* significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in brackets.

Interestingly, fixed costs per shipment tend to decrease in destination GDP (without being significant, however). This effect might be driven by the fact that larger economies (such as the USA) cannot be treated as a single region as shipments to the East Coast and the West Coast cannot be naturally bundled into one shipment but require, instead, different shipments. These effects can increase the number of shipments at any given trade volume and hence decrease the imputed fixed costs of shipment. Conversely, fixed costs per shipment tend to increase in destination GDP per capita, which might be explained by higher wages and thus higher total costs of the procedure of customs clearance at the destination ports. Consistent with our theory, however, neither GDP nor GDP per capita significantly impacts the fixed costs of exporting.

Table 3 reports the results of regressions including dummies for the different types transportation *Train*, *Air* and *Water*. The dummy for transportation on the road is dropped and the coefficients are therefore to be read relative to predominant transportation with trucks. These dummies capture the transportation type that occurs most frequently within the respective combination of firm-good-country. As we pointed out in the previous section, the coefficients on the transportation dummies are to be read with caution, as they capture the transportation mode at the moment the goods cross the Swiss borders. Nevertheless, the estimation results appear to make sense: the coefficient on *Train* and *Water* suggests that, other things equal,

shipping goods by truck involves much smaller fixed costs per shipment than those that accrue when organizing and loading containers ready for transport via rail or waterway. This result is not surprising, as the main advantage of transportation by truck are flexibility and decentralized operating conditions. Indeed, the point estimates suggest that the corresponding fixed costs are roughly eight and 20 fold for the rail and the plane, respectively ($\exp(2.143) \approx 8.53$ and $\exp(3.081) \approx 21.78$). The differences between fixed costs per shipment per plane and per road are much smaller and not significant.

Table 3 - Fixed Costs of Shipment - Swiss Imports

	I	II	III	IV	V	VI	VII
Dependent Variable: Imputed Fixed Costs of Shipment							
T.M. Rail	2.054* [1.173]			2.143* [1.201]			2.218* [1.295]
T.M. Air		-0.727 [0.866]			-0.711 [0.811]		-0.717 [0.798]
T.M. Water			2.983** [1.204]			3.081** [1.195]	3.139** [1.272]
Log GDP				-0.0694 [0.0629]	-0.0619 [0.0654]	-0.0702 [0.0626]	-0.0791 [0.0645]
Log GDP p.c.				0.0998 [0.166]	0.103 [0.167]	0.111 [0.165]	0.0991 [0.165]
Constant	2.816*** [0.0963]	2.867*** [0.111]	2.821*** [0.0934]	3.655* [2.031]	3.472 [2.115]	3.571* [2.054]	3.935* [2.069]
Observations	384	384	384	375	375	375	375
R-squared	0.472	0.465	0.481	0.477	0.469	0.486	0.496
Cluster Groups	62	62	62	60	60	60	60
Good Dummies	yes	yes	yes	yes	yes	yes	yes

* significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in brackets.

Of course the choice of the means of transport is endogenous – e.g. heavy and bulky goods are unlikely to be shipped by plane. This observation implies that our estimates of the coefficients on the transport type are subject to a potential endogeneity bias. Remember, however, that all regression include good dummies, so that the respective estimates rely on the variation within the good classes, not across goods. An arising bias is therefore unrelated to good composition.

5.2 Market Entry Costs

We now turn to the analysis of the entry costs to export markets. To this aim, we use condition (18), which binds for the marginal exporter

$$\ln(F_{ij}) = (\sigma - 1)r\Delta_{ij} + \ln(x_{ij}) - \ln(1 - \bar{\gamma}_{ij}^\sigma) \quad (19)$$

When we proxy the fixed costs of market entry with the minimum of the expression of the right, our firm data are far too few observations to provide a reasonable upper bound. To circumvent this lack of data we use to the full trade data set without firm identifiers under one assumption. Specifically, we assume that, within each broad sector and for each good-country pair, the good that is least exported (generating the lowest observation for the right hand expression in (19)) there is only one exporter.

Under this assumption, we can, at the cut-off, identify the good with one firm and calculate the right hand side using our full set of trade data. In particular, the minimum value of the right hand side of (19), calculated by identifying goods with firms, constitutes a proxy for the left hand side.

We do not only exploit the country dimension, but also the dimension of *sectors*, which we define by the two-digit level of our tariff number. There are 95 sectors and 5778 country-sector pairs for export and 3676 corresponding pairs for import data. Since the number of exported goods per trade partner is generally larger than the number of imported goods per trade partner, there are less observations on the good-sector level for import data. Finally, keep excluding the years of the financial crises and the Great Trade Collapse (2008 and 2009) but include the first year of our dataset 2005, which was previously dropped due to scarcity of firm level data.

We compute the right hand side in (19) for the standard values $\sigma = 5$ and $r = .05$. To eliminate potential bias through outliers in the observations of our proxy (19), we also take averages over the two and three smallest observations, respectively. This change of definition does not alter our qualitative results.

The average of our proxies of market entry cost is 98 270 CHF for exports and 149 711 CHF for imports. These estimates are considerably lower than the ones estimated in Das et al (2007), which range between 300 000 and 400 000 USD for Colombian exporters. Nevertheless, our proxies range within the same order of

magnitude.¹⁷ Moreover, Das et al (2007) infer entry costs of exporters and non-exporters and, indeed, write that "entrants tend to get favorable entry cost draws, so average entry costs incurred are considerably lower." Since we base our estimate on active exporters only, this effect may explain part of the difference between our results and those in Das et al (2007). A further potential explanation may be based of Swiss efficiency of exporting procedures, which may be characteristic for an economy that is paradigmatic for a small open economy.

Table 4a - Fixed Costs of Market Entry 2005-2007 - Swiss Exports

	I	II	III	IV	V	VI
Dependent Variable: Imputed Fixed Costs of Shipment						
Language	-0.344*** [0.0461]			-0.193*** [0.0482]	-0.0805* [0.0477]	-0.126*** [0.0474]
Trade Agr.		-0.365*** [0.0351]		-0.211*** [0.0394]	-0.0125 [0.0397]	0.0288 [0.0395]
Log Distance			0.183*** [0.0151]	0.121*** [0.0176]	0.172*** [0.0176]	0.122*** [0.0184]
Log GDP					-0.144*** [0.00883]	-0.104*** [0.00976]
Log GDP p.c.						-0.163*** [0.0179]
Constant	13.04*** [0.301]	13.14*** [0.300]	11.59*** [0.325]	12.22*** [0.337]	15.51*** [0.382]	16.46*** [0.395]
Observations	5778	5778	5654	5654	5441	5395
R-squared	0.277	0.283	0.290	0.296	0.337	0.350
Good Dummies	Yes	Yes	Yes	Yes	Yes	Yes

* significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in brackets.

¹⁷When defining market entry costs over the lowest two or three observations, our estimates reach 145651 (222195) and 185109 (282438) for imports (exports).

Table 4b - Fixed Costs of Market Entry 2005-2007 - Swiss Imports

	I	II	III	IV	V	VI
Dependent Variable: Imputed Fixed Costs of Shipment						
Language	-0.740*** [0.0620]			-0.512*** [0.0662]	-0.250*** [0.0650]	-0.257*** [0.0651]
Trade Agr.		-0.589*** [0.0488]		-0.359*** [0.0570]	-0.0549 [0.0571]	-0.0408 [0.0575]
Log Distance			0.265*** [0.0211]	0.115*** [0.0262]	0.254*** [0.0263]	0.234*** [0.0287]
Log GDP					-0.253*** [0.0140]	-0.239*** [0.0156]
Log GDP p.c.						-0.0569* [0.0303]
Constant	12.54*** [0.300]	12.65*** [0.300]	10.43*** [0.335]	11.85*** [0.363]	17.26*** [0.462]	17.60*** [0.506]
Observations	3676	3676	3640	3640	3562	3560
R-squared	0.242	0.242	0.247	0.267	0.331	0.332
Good Dummies	Yes	Yes	Yes	Yes	Yes	Yes

* significant at 10%; ** significant at 5%; *** significant at 1%. Robust standard errors in brackets.

Based on our proxies for market entry costs, we repeat the estimations reported in Tables 2 and 3, which were conducted for fixed costs per shipment. Doing so, we can now rely on export and import data, since we are not using firm level data. Table 4a reports the regression results of our proxy of F_i on the dummy variables *Common Language*, *Trade Agreement*, and *Distance* from our previous estimates for our export data. Columns I - IV represent our standard specifications; the fixed costs are proxied with the lowest values of (19) separately for each export market. The estimates of the coefficients on *Common Language* and *Trade Agreement* are statistically significant with the expected negative sign, though considerably smaller than those of the regressions of the fixed costs per shipment in Table 2. Also the impact of *Distance* is significant in the specifications of Column III and IV.

To eliminate the potential influence of market size, we Columns V and VI successively include the destination GDP and the destination GDP per capita (both in logs). As in the regression with fixed costs per shipment, the estimated coefficients on *Trade Agreement* are lower now cease to be significant.

Table 4b report the results of the parallel regressions for import data. While the coefficients on *Common Language* and *Trade Agreement* are large now, the results do, by and large, confirm the ones in Table 4a based on export data

5.3 Discussing Both Types of Fixed Costs

Having estimated fixed costs per shipment and market entry costs, we can compute the net present value of the former as a ratio of the latter. This ratio indicates that the total value of fixed costs per shipment is roughly a fifth of the value of market entry costs ($19792/98270 \approx 0.2014$). This number is economically significant, particularly so in comparison with previous estimates of per period fixed costs of exporting. Thus, referring to per period fixed costs, Das et al (2007) write that "these costs, on average, are negligible." By comparison, our estimates of the fixed costs per shipment are very large. Too large, in any case to be ignored in trade models that react sensitively to the shape and size of trade costs.

When fixed costs per shipment are large, the natural question arises why they do not proxied by per period fixed costs, thus entering standard estimates of the latter. Indeed, as an omitted variable fixed costs per shipment could be expected to induce an upward bias of per period fixed costs. The obvious reason why such a bias is unlikely is the fact that fixed costs per shipment rise roughly proportionately with export volumes and therefore tend to be subsumed in variable costs in standard estimations. In sum, when properly accounting for fixed costs per shipment, the estimated size of variable transport costs is likely to be reduced.

Introducing fixed costs per shipment and endogenizing the period between two export transactions also raises the question whether there are scale or learning effects that reduce fixed costs over time (as Segura-Cayuela and Vilarrubia (2008) regarding per period fixed costs). In such a setting, shipments could occur more frequently to reap the benefits of learning. Conversely, shipping goods too infrequently could be suboptimal as such a strategy would raise the overall trade costs. These considerations also direct the attention to parallel questions regarding fixed costs of market entry. Thus, Das et al (2007) find that maintain their exporter status under adverse market conditions to avoid "the costs of reestablishing themselves in foreign markets when conditions improve." Once we think about endogenous frequency, we may wonder about the definition of reentry. Does the full amount of market entry costs accrue when a firm reenters a market it did not supply for six one, two or five year? Given that these reentry costs are continuous in time of absence, they would surely impact the firms' optimal strategy concerning size and frequency of shipments.

6 Conclusion

This paper has analyzed the role, size and determinants of fixed costs per shipment. Our theory rests on the assumption that exporting firms optimally trade off the fixed costs of exporting and storage costs at export markets. Conceptually, we have shown that fixed costs per shipment introduce a new margin along which trade volumes expand and contract. Further, being substitutable with storage costs, they smear the border between fix and variable costs of trade. Moreover, we have presented a method to infer different types of trade costs – fixed costs per shipment, variable transport costs and fixed costs of market entry – from cross-border trade data on the transaction level. This methodology enables us to disentangle and analyze the two types of fixed costs of exporting, using disaggregated Swiss export and import data. Our findings suggest that fixed costs per shipment are economically significant and considerably larger than the per-period fixed costs estimated in earlier studies. In particular, our estimates of the net present values of fixed costs per shipment are around 20 percent of fixed costs of market entry.

A Appendix

A.1 Proofs

Proof of (11) According to the concept of iceberg costs, the value of goods boarded for shipment consists of the product consumed quantity q_j and τ_j . Thus,

$$x_{ij} = \int_0^{\Delta t_{ij}} \tau_{ij} \tilde{p} q_{ji}(a, t') dt' = \left[\frac{\sigma}{\sigma-1} \frac{\tau_j a w_i}{P_j} \right]^{1-\sigma} Y_j \frac{1 - \bar{\gamma}_{ij}^\sigma}{\sigma r_i} = \frac{A_{ij}}{r_i} (1 - \bar{\gamma}_{ij}^\sigma)$$

Proof of (12)

$$\begin{aligned} \frac{d}{dA_j} \ln(x_j) &= \frac{1}{A_j} - \frac{\sigma \bar{\gamma}_j^{\sigma-1} r \sigma f_j}{1 - \bar{\gamma}_j^\sigma} \frac{1}{A_j^2 (\sigma-1) \sigma \bar{\gamma}_j^{\sigma-2} (1 - \bar{\gamma}_j)} \\ &= \frac{1}{A_j (\sigma-1) (1 - \bar{\gamma}_j) (1 - \bar{\gamma}_j^\sigma)} \left((\sigma-1) (1 - \bar{\gamma}_j) (1 - \bar{\gamma}_j^\sigma) - \bar{\gamma}_j \frac{r \sigma f_j}{A_j} \right) \\ &= \frac{1}{A_j (\sigma-1) (1 - \bar{\gamma}_j) (1 - \bar{\gamma}_j^\sigma)} \left(\sigma - 1 + \bar{\gamma}_j^\sigma - \sigma \bar{\gamma}_j \right) \end{aligned}$$

(Used (10) in the last step.)

Proof of (13) Use (9) to check

$$F_{ij} = \frac{1}{1 - \bar{\gamma}_{ij}} \left\{ A_{ij} \frac{1 - \bar{\gamma}_{ij}^\sigma}{r_i \sigma} - f_{ij} \right\} = \frac{1}{1 - \bar{\gamma}_{ij}} \frac{A_{ij}}{r_i \sigma} \left\{ 1 - \bar{\gamma}_{ij}^\sigma - r_i \sigma f_{ij} / A_{ij} \right\} = \frac{A_{ij}}{r_i} \bar{\gamma}_{ij}^{\sigma-1}$$

where the last step follows from (10).

Proof of (14) Rewrite (10) as

$$\bar{\gamma}_{ij}^{\sigma-1} [(\sigma-1) \bar{\gamma}_{ij} - \sigma] = \frac{r_i \sigma f_{ij}}{A_{ij}} - 1$$

Using (18), this implies

$$\frac{A_{ij}}{r} \frac{\sigma}{\sigma-1} \left[1 + \frac{f_{ij} - A_{ij}/r}{F_{ij}} \right]^{\sigma-1} = F_{ij}$$

Given that the cutoff productivity is unique, this equation implies that A_{ij} be constant if fixed costs of exporting f_{ij} and F_{ij} are constant. Hence, (18) implies (8).

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