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Perish or prosper: Trade patterns for highly perishable products

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1. **Introduction**

During the last decades trade liberalization, income growth as well as better and cheaper means of transport and logistics have facilitated a global expansion of trade in food and agricultural commodities. Increasingly this trade also includes highly perishable and often seasonal fresh products like fresh fish, berries and cut flowers. Better transportation technologies and logistics reduce delivery time, and secure delivery of high-quality products to the end user (Coyle et al., 2001; Behar and Venables, 2011). This development has made more distant producers competitive also for perishable goods. However, it is a development that challenges the conventional wisdom that shipping costs are most disruptive for perishable products and that increased scale obtained with larger shipments is the main tool to address the increasing cost due to longer distances (Berthelon and Freund, 2008). Several recent studies suggest that the structure of the shipping cost can be important, as there are different types of fixed and variable cost associated with trade that can be important for margins of trade (Melitz, 2003; Lawless, 2010a; Hornok and Koren, 2015). Hornok and Koren (2015) use custom data and provide a finer set of margins of trade than earlier studies, which allows additional insights into the patterns of trade. This can be essential for the understanding of trade patterns for products with particular characteristics such fresh products. In this paper we will show that this is the case for one such product – fresh salmon.

Geographical distance between two markets is the commonly used proxy for transportation costs in the international trade literature, and is a main component of the gravity model.[1] Most

[1] The gravity model is the standard approach to study how trade costs affect trade values. Seminal studies on the gravity model and aggregate trade flows include, but are not limited to, Tinbergen (1962), Krugman (1980), McCallum (1995), and Anderson and van Wincoop (2003). Gravity models have also been frequently used in studies of trade flows in food and agricultural products, especially with a focus on how trade liberalization affects trade costs. Some examples are Zahniser et al. (2002), Jayasinghe, Beghin and Moschini (2010), Raimondi and Olper (2011) and Cheptea, Emlinger and Latouche (2015). Application of the gravity model to seafood markets is rare with the exception of Rabbani, Dey and Singh (2011) and Natale et al. (2015). Emlinger,

gravity studies use annual data at the country level. However, firm-level exports, and the role of firm heterogeneity have received increased attention in recent years. Bernard et al. (2007) and Redding (2011), provide surveys of this literature. As it is firms that trade, this literature is given a more nuanced picture of trade drivers and patterns, and highlights a number of factors and margins that are washed out when using more aggregate data. This is highlighted by Lawless (2010a) who show the importance of different types of trade costs, and Hornok and Koren (2015), who use a number of margins such as shipment size, frequency, and unit value to highlight the importance of factors as per shipment cost.

The objective of this paper is to shed light on how trade costs influence trade of a highly perishable food product; fresh farmed salmon. Production and trade of salmon have increased dramatically during the last decades, from less than 100,000 tons in 1985 to 2.5 million tons in 2014 (FAO, 2015), with Norway (at the northern rim of Europe) and Chile (at the southern end of South America) as the leading producers with about 85% of total production. There are a number of reasons why it is interesting to study trade with fresh salmon in more detail. It is one of the most successful "new" highly traded perishable products in terms of production growth. The industry is also at the forefront when it comes to development of technology, knowledge and innovation in aquaculture, the world´s fastest growing food production technology (Smith et al., 2010; Tveterås et al., 2012). This is largely due to the control with the production process in aquaculture that has allowed substantial productivity growth at the farms (Anderson, 2002; Asche et al., 2009; Roll, 2013), in the supply chain (Asche et al., 2007; Kvaløy and Tveterås, 2008; Olson and Criddle, 2008), as well as rapid product development (Asche et al., 2015). Control with the production process has allowed the

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Jacquet, and Lozza (2008) estimate a gravity model using annual data on the perishable products fruits and vegetables, but in a setting with a number of other trade barriers. Their distance effect is in line with the general literature.

producers to harvest salmon all year, to target the most valuable markets and improve logistics, to a larger extent than what is possible in most fisheries (Anderson, 2002; Asche, 2008).[2] This has changed the market for salmon substantially from a relatively small market in North America and Japan with frozen and canned product as the main product forms to a large global market with fresh as the leading product form (Asche and Bjørndal, 2011).[3]

In this paper, gravity-models are first estimated at the country level with aggregate data that is the mainstay of the gravity literature for comparison with this literature as well as with the results using firm level data. Then two versions of the gravity model as well as five different margins of trade are estimated using firm level data. The paper is organized as follows: A brief literature review of the Norwegian salmon industry and data is presented in Section 2. Model specifications are discussed in Section 3, before empirical results are reported in Section 4. Section 5 provides concluding remarks.

2. Industry and data

Technology development, as highlighted by Behar and Venables (2011), is a key factor in fostering trade. Salmon provides a number of examples of innovations in the supply chain organization and sales mechanisms improving logistics and facilitating trade.[4] This has created a global market as the two largest salmon producing countries, Norway and Chile, export salmon to more than 150 countries. Moreover, with more than 90% of the production

[2] It is well known that increased aquaculture production can reduce fishing effort in general (Valderrama and Anderson (2010). The ability to target specific niches can therefore also reduce the incentives for overfishing due to the diversity of consumer preferences as discussed in Quaas and Requate (2013).
[3] This development has also strongly influenced wild salmon fisheries, as farmed salmon is determining wild salmon prices (Asche, Bremnes and Wessells, 1999; Valderrama and Anderson, 2010), but it has also allowed the creation of highly profitable market niches for some wild product (Jardine, Lin and Sanchirico, 2014).
[4] These include coordination (Kvaløy and Tveterås, 2008; Olson and Criddle, 2008), contracts (Larsen and Asche, 2011), futures trading (Oglend 2013; Asche, Misund and Oglend, 2016) and invoicing (Straume, 2014).

occurring in four countries, Norway, Chile, Canada and the UK, it is largely an export driven industry with a highly perishable product, fresh salmon, as the main product.[5]

The empirical analysis will be conducted based on transaction data collected from the salmon exporters' customs declarations for the period 2004-2014 and are made available by Statistics Norway. The relevant HS-code is 3021411. For each transaction, the data set identifies the exporting firm and importing country, the weight in kilos, the export value in Norwegian kroner (NOK), contract form, the mode of transportation, and the shipment date.[6] The data set contains 914,743 unique transactions from 274 Norwegian exporters, serving 102 different destination markets.

The single largest destination market in the data set is France with an export share of 15 % , with Denmark being the second most important. For the firm-destination level, it varies how many destinations each firm is engaged in. As shown in Figure 1 a large share (82 %) of the exporters is active in less than 10 markets, indicating a high degree of specialization in terms of which markets a firm serves. This is a strong indication that market specific fixed costs are present in line with Melitz (2003). Only seven firms (2.4%) are active in more than 50 destination markets. These seven firms make up about 54 % of the total export value. Such high skewness in the distribution of firms across markets is in accordance with the findings in Eaton et al. (2004) for French exporters, and Bernard et al. (2009) for US exporters. Eaton et al. (2004) reports that 20 % of the firms export to more than 10 markets, and 1.5 % to more than 50 markets. Bernard et al. (2009) report an average of 3.3 markets per firm.

Figure 1: Distribution of firms over destination markets

[5] See for example Asche and Bjørndal (2011).

[6] As some countries receive salmon by truck and air, these countries we will have two observations in the same period when both modes are used.

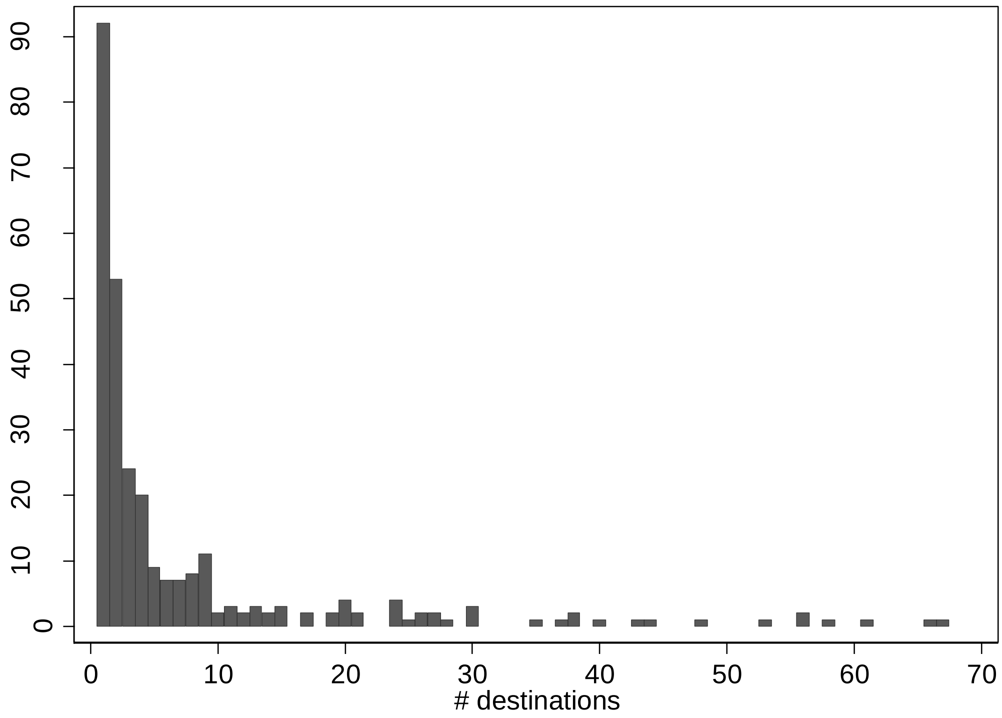


Table 1: Number of exporters by distance

Distance (km)	# exporters	Annual # shipments	Annual volume (tons)	Annual value (billion NOK)	Annual unit value
< 1000	196	4,110	31,913	999	31.63
1000 < distance <=3500	204	5,614	52,799	1.708	32.26
3500 < distance <9000	112	4,586	11,821	418	35.54
> 9000	52	1,422	2,505	93	35.88

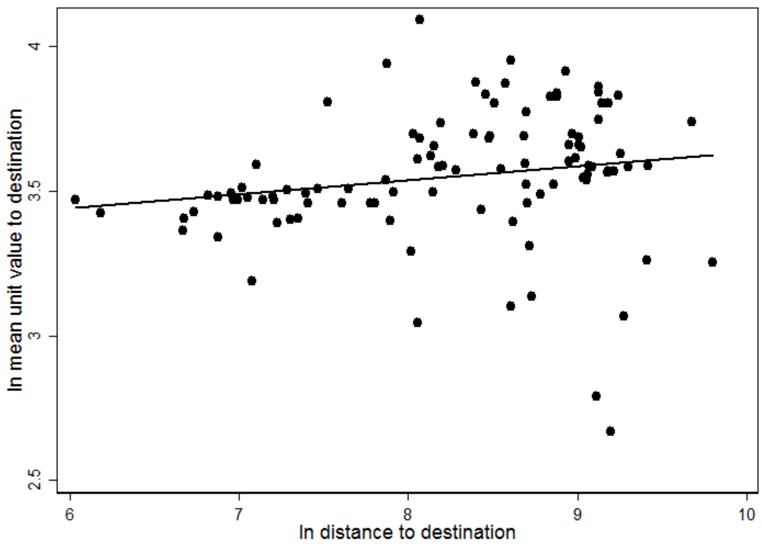
Table 1 show the number of exporters serving markets in four different distance categories with annual averages for some trade characteristics. It is evident that the most distant markets receives a lower volume than close markets. As distance increases after 1000 km (outside of Scandinavia) mean annual volume and value per shipments decrease, while there is a slight increase in mean unit value.

At the firm level, the average number of trades for a firm is 85 per destination, with a minimum of one, and a maximum of 231,648 over the whole period. Approximately 70% of the exporters report trade relationships involving only one shipment to a specific country.

However, these shipments are not very important for total trade as they make up only 0.1% of the total export volume.

There is increasing evidence that Alchian and Allen´s (1964) "shipping the good apples out" hypothesis applies also at the firm level as markets are being sorted by quality (Hummels and Skiba, 2004; Bastos and Silva, 2010; Manova and Zhang, 2012). A main explanation for this relationship is that with increasing unit trade costs, quality becomes relatively cheaper. Moreover, Baldwin and Harrigan (2011) show that heterogeneous quality increase with firms´ heterogeneous costs. In Figure 2, the correlation between the unit price and distance is shown. Even though there is considerable variation in the unit price, there is a clear indication that it is increasing with distance.

Figure 2: Unit price for the various countries



The customs declarations include information about the transportation mode across the Norwegian border. In general, the exporters' choice of transportation mode affects factors, such as the size of the shipment, inventory costs, and the actual freight cost. For a perishable product such as fresh salmon, a major concern for the exporter is to ensure a timely delivery of the product to the final market. Table 2 describes the different modes of transportation for export of fresh salmon.

Table 2: Mode of transportation at the border, 2004-2014

Transport mode	Share of total volume	Share of total value	Share of total transactions	# exporters using mode
Truck	91 %	90 %	74 %	252
Aircraft	9 %	10 %	26 %	115

For the Norwegian exports of fresh salmon, 91 % of the volume is transported by truck and 9 % by air. Almost all exporters use truck as the mode of transportation for at least one shipment, while only 40 % (115 out of 284), use air transport for at least one shipment. Moreover, as 74 % of the shipments are by truck, these shipments are on average larger than those transaction shipped by air.[7] Eaton et al. (2004) argue that, measured by weight, nearly all trade between countries that do not share a border occurs by maritime transport. In this paper, maritime transport is not included as a distinct mode of transportation since most transactions that are registered as maritime transport will be trucks on a ferry. The high perishability makes slow ship transport an irrelevant alternative.

To get a better understanding of the dynamics between the final destination markets, the number of exporters to different markets, shipment frequencies, and different destinations are grouped according to whether they are members of the EU, and by the size of their Gross Domestic Product (GDP), where GDP is the most common measure of market size in the gravity literature. In addition, the exporters are grouped according to the number of employees as a measure of firm size. Table 3 shows that 216 of the exporting firms trade with the EU, and 250 of the exporting firms trade with countries with "Large GDP." A destination market has a large GDP if the GDP is above the first quartile of the distribution of the GDP of

[7] The dataset uniquely identifies transportation mode in each observation.

the various countries. The five largest exporters make up 50 % of the total export value. These five exporters are classified as large, the rest as small exporters. Not surprisingly, there is a large difference between the numbers of shipments by firms to the EU countries compared to non-EU countries. The largest average unit prices are observed to markets outside of the EU. The large exporters are, as anticipated, more active measured by the number of shipments than the smaller exporters. More interestingly, the largest exporters ship salmon with substantially lower average value and average weight per shipment than the smaller exporters. The average unit value is also largest for the small exporters.

Table 3: Descriptive statistics, number of exporters and shipment frequencies

	# exporters	Number of shipments	Average value per shipment	Average weight (tons) per shipment	Average unit value (NOK) per shipment
EU	216	489,570	247,164	7.8	32.0
Non-EU	192	425,173	196,526	5.9	34.4
Large GDP	250	694,775	251,348	7.4	32.8
Small GDP	182	219,968	173,540	5.3	33.9
Large exporters	5	532,553	193,257	6	32.8
Small exporters	269	382,190	265,946	8.2	33.5

Additionally, the analysis also needs the gravity variables. Data for distance is taken from the CEPII-database,[8] and GDP data is taken from the World Bank Development Indicators (WDI).[9] Data on monetary and time trade costs per shipment are obtained from the World Bank's Doing Business Survey. Data for internal distance and share of urban population within a country are obtained from The World Bank's Development Indicators (WDI). Table 4 summarizes the explanatory variables used in the various model specifications. Given the frequency of

[8] The CEPII-database is found at http://www.cepii.fr/cepii/en/bdd_modele/bdd.asp.
[9] The WDI-database is found at http://data.worldbank.org/data-catalog/world-development-indicators.

these data, the transactions data will be aggregated to a monthly level for the empirical analysis.[10]

Table 4: Descriptive statistics, explanatory variables. Firm-country level.

Variable	Mean	SD	Min, Max	Max
Distance (km)	3,310	3,253	417	17991
GDP (100.000.000 USD)	14,638	18,444	3.8	147,966
Dummy, EU	0.53	0.49	0	1
Quality	-0,47	7.06	-15.0	20.0
Time Cost	11	6.2	4	112
Monetary cost	1062	459.1	367	6452
Internal distance (1000 sq.km)	1346	3658	0.028	16,400
Urban population (millions)	55	105	0.02	742
Transportation mode	0.31	0.46	0	1

3. Model Specifications

The empirical analysis is conducted in two parts. First, standard gravity models are estimated to explain the trade patterns for salmon from Norway to different markets. This analysis is conducted at the aggregate country-to-country level that is the most common approach in the literature, as well as on the firm-to-country level. Second, several margins of trade are investigated more closely using the firm data.

The baseline gravity model is given as:

$$(1)\ \ln(S_{j,t}) = \beta_0 + \beta_1 \ln(Distance_j) + \beta_2 \ln(GDP_{j,t}) + \beta_3 EU_{j,t} + u_{j,t}$$

Here, $S_{j,t}$ is the export value of fresh salmon from Norway to destination j in period *t*. $Distance_j$ is the log of the geographical distance between Norway and the destination market. $GDP_{j,t}$ is the Gross Domestic Product (GDP) in real US$-prices in destination market j in

[10] In our analysis we aggregate the data to monthly units.

period t. $EU_{j,t}$ is a dummy variable for trades to a destination market within the European Union[11].

From a standard gravity-model perspective, the geographical distance is included to capture transportation costs. As distance increases, so do transportation costs, and sales are expected to drop. *GDP* measures the economic size of the destination market, and is expected to be positively correlated with sales. The EU-dummy captures the effect from the free trade agreement Norway has with the EU. We know that a large share of export of salmon from Norway is targeted for EU-countries, so the dummy for trade to an EU-market is expected to be positively correlated with sales.

A number of studies have extended the basic gravity model by introducing additional variables to explain additional cost elements associated with different trade patterns. Lawless (2010a) uses data from World Bank's Doing Business Survey to capture the effect from administrative costs of trade on trade value and on the margins of trade. The literature also indicates that many of the trade costs are per-shipment costs (Hummels and Skiba, 2004; Irarrazabal, Moxnes and Opromolla, 2015). For exports at the firm level, Kropf and Sauré (2014) show that per-shipment costs are important for the shipment frequency. Hornok and Koren (2015) also investigate how per-shipment costs affect trade and find that per-shipment costs are associated with less frequent and larger shipments. Hummels and Schaur (2013) emphasize the importance of time to export (e.g. handling and custom clearance procedures) as an important trade costs. This is particularly relevant for non-storable perishable goods such as fresh salmon as the time it takes to export from the producer to the final buyer can be a critical success factor, as delays may reduce quality or shelf life. To capture per-shipment costs we follow Hornok and Koren (2015) and use the number of days to clear customs for imports, and the cost of importing a container as measures for per-shipment costs. Days

[11] The dummy equals one if the country is a member of EU in the respective year.

required to import are a time cost (*Time cost*), while the cost of importing a container is a monetary cost (*Monetary cost*).

The area (measured in square kilometers) of the destination country is included to supplement geographical distance as the proxy for transportation costs. This variable adds the role of internal transportation costs in the destination country. The share of the population living in large cities could mitigate such internal transportation costs as costs are reduced if one can concentrate on serving a few large cities relatively to many smaller distant cities. Following Lawless (2010b), it is expected that sales will be negatively impacted by increased internal transportation costs, and therefore positively correlated by the share of urban population. To account for these factors we augment our baseline model by the square kilometers in the destination country (*Size*) and the share of urban population (*Urban population*) to domestic capture market characteristics influencing transportation costs. A dummy-variable is also used to capture the mode of transportation for the destination country $j;\ DMode$. In order to capture this effect we divide the observation set into two parts. One that relates to transactions that use trucks for transportation, and for those we set *DMode* to 0, For the other transactions that, use aircraft, we set *DMode* to 1..

With all these additional variables, the most general model to be estimated is then given as:

(2) $ln(S_{j,t}) =$
$\beta_0 + \beta_1 \ln(Distance_j) + \beta_2 \ln(GDP_{j,t}) + \beta_3 EU_{j,t} + \beta_4 \ln(Time\ cost_{j,t}) + \beta_5 \ln(Monetary\ cost_{j,t}) +$
$\beta_6 ln(Size_j) + \ \beta_7 ln(Urban\ population_{j,t}) + \beta_8 DMode_t \ + u_{j,t}.$

This equation will be estimated in addition to the baseline gravity model in equation (1) at the country-to-country level and the firm-to-country level. To show the impact of the different groups of trade cost variables, a set of intermediate models where each of these groups of variables are added to the baseline model will be estimated.

This equation will be estimated in addition to the baseline gravity model in equation (1). To show the impact of the different groups of trade cost variables, a set of intermediate models where each of these groups of variables are added to the baseline model will be estimated[12].In the next section we first present the results from estimating (1)-(2) at the country-to-country level. Thereafter we estimate (1)-(2) based on the firm-to-country level data.

Traditionally, the margins of trade are divided into an extensive and intensive margin. The extensive margin of trade is commonly measured as the number of firms exporting, or as the number of products being exported (Lawless, 2010a). The most common interpretation of the intensive margin of trade is the evolvement of trade values within established trade relationships. Hornok and Koren (2015) decompose the total export value into several additional margins, such as number of shipments, average shipment size and unit price as additional intensive margins of trade. Several of these margins are potentially important for perishable products. For instance, a higher shipment frequency facilitates better quality. To investigate the different margins in more detail, equation (2) is estimated with various margins as dependent variables.

4. Empirical results

4.1 Country level exports

We commence our empirical analysis by estimating the models at the country-to-country level as this is the most common approach in the literature. Table 5 reports the results. For the baseline model (Model 1), the results show a large significant negative effect from increased geographical distance on the total export sales of salmon. The distance coefficient in the baseline model is substantially larger than the average distance elasticity in the literature. In reviews of the literature, Anderson and van Wincoop (2004) and Disdier and Head (2008)

[12] In line with Hornok and Koren (2015) we do not account for zeros in trade.

both report that the distance parameter is normally about -0.9. Hence, this finding underlines that the highly perishable nature of fresh salmon matters and suggests that distance is much more important for perishable products. As expected, there is a strong positive relationship between GDP as a measure of market size in the destination market and export sales.[13] While our parameter estimate is high, there is much less consensus in the literature with respect to what is a strong impact of market size than it is for distance. There is also increased trade to EU-countries.

Table 5: Gravity model of Norwegian salmon exports. Country-to-country level data.

	(1) Baseline model	(2) With per-shipment costs	(3) Other trade costs	(4) Full model: value	(5) Full model: weight
ln distance	-1.708***	-2.056***	-1.942***	-2.149***	-1.576***
	(0.049)	(0.054)	(0.056)	(0.059)	(0.044)
ln GDP	1.211***	1.213***	1.169***	1.127***	0.621***
	(0.024)	(0.024)	(0.041)	(0.048)	(0.032)
Dummy, EU	1.082***	0.726***	0.437***	0.350***	-0.239***
	(0.107)	(0.111)	(0.106)	(0.108)	(0.080)
Time cost	-	-0.140*	-	0.144*	0.183***
	-	(0.081)	-	(0.084)	(0.058)
ln Monetary cost	-	-2.602***	-	-2.055***	-1.247***
	-	(0.092)	-	(0.090)	(0.065)
ln size	-	-	-0.764***	-0.621***	-0.286***
	-	-	(0.022)	(0.023)	(0.017)
ln urban population	-	-	0.903***	0.774***	0.362***
	-	-	(0.062)	(0.069)	(0.045)
Transportation mode	-	-	-0.940***	-0.874***	-0.844***
	-	-	(0.075)	(0.076)	(0.069)
Constant	-15.833***	8.745***	-15.311***	2.493**	13.977***
	(0.872)	(0.999)	(0.744)	(0.978)	(0.660)
Observations	8,636	7,752	8,636	7,752	7,752
Adj-R^2	0.443	0.503	0.524	0.560	0.548
F-test	75,75	113,5	105.5	121,5	88.95
Month_Year FE	Yes	Yes	Yes	Yes	Yes

Robust standard errors clustered on firms in parentheses
**** p<0.01, ** p<0.05, * p<0.10*

[13] Jayasinghe et al. (2010) argue that next to tariffs, geographical distance is the trade cost that has the largest negative impact on the export of U.S. corn seeds.

The third, fourth and fifth columns in Table 5 report the results for the extensions of the baseline model. In Models (2) and (3) per-shipment costs, internal trade costs, and transport mode are included and finally in Model 4 the most general gravity model is reported. The distance and GDP parameters are relatively stable over the various models, and the EU-dummy is significant in all cases. Except for time cost, the additional trade cost variables are important. Higher monetary cost, larger internal transportation costs and air transport influence exports negatively. Furthermore, large urban populations have a positive effect on trade.

There exist a global market for salmon with a common price determination process (Asche, Bremnes and Wessells, 1999; Asche and Bjørndal, 2011), as may be expected for a relatively homogenous product. Moreover, if quality becomes relatively cheaper with higher transportation costs (Hummels and Skiba, 2004), it is not obvious that trade value is the best dependent variable. We will therefore also estimate the gravity model with exported quantity as the dependent variable, as reported in the final column of Table 5 (Model 5). With the exception of the EU-dummy all parameters have the same sign as in the gravity model with traded value as the dependent variable. However, most parameters have a lower magnitude. Still, the distance effect at -1.576 is substantially higher than in the general literature.

4.2 Firm-level exports

The results for the gravity models estimated at the firm-country level are reported in Table 6. With trade value as the dependent variable, the baseline model is reported as Model 1, and the extended model is reported as Models 2-4. Model 5 is the gravity model with traded quantity as dependent variable. The results are more in line here for the two different dependent variables than at the country-to-country level, as the magnitudes of the parameter estimates are closer.

Table 6: Gravity model of Norwegian salmon export – Firm-to-country level data.

	(1) Baseline model	(2) Including per-shipment costs	(3) Other trade costs	(4) Full model	(5) Full model - weight
ln distance	-0.850***	-0.913***	-0.829***	-0.811***	-0.683***
	(0.047)	(0.048)	(0.065)	(0.068)	(0.044)
ln GDP	0.588***	0.614***	0.570***	0.621***	0.288***
	(0.027)	(0.031)	(0.064)	(0.077)	(0.052)
Dummy, EU	0.198**	0.027	-0.185	-0.288**	-0.214**
	(0.098)	(0.106)	(0.118)	(0.119)	(0.091)
Time cost	-	-0.178**		0.139	0.116
	-	(0.086)		(0.116)	(0.074)
Monetary cost	-	-0.309***		-0.498***	-0.308***
	-	(0.112)		(0.106)	(0.077)
ln size	-	-	-0.312***	-0.303***	-0.173***
	-	-	(0.022)	(0.025)	(0.016)
ln urban population	-	-	0.357***	0.315***	0.279***
	-	-	(0.081)	(0.093)	(0.061)
Transportation mode	-	-	-0.884***	-1.153***	-1.049***
	-	-	(0.115)	(0.120)	(0.109)
Constant	-8.119***	-5.531***	-9.869***	-7.421***	6.331***
	(0.883)	(0.978)	(1.036)	(1.137)	(0.691)
Observations	54,233	49,256	54,233	49,256	49,256
Adj-R^2	0.345	0.340	0.368	0.365	0.414
F-test	75.61	68.25	98.70	94.53	162.74
Firm FE	Yes	Yes	Yes	Yes	Yes
Month_Year FE	Yes	Yes	Yes	Yes	Yes

Robust standard errors clustered on (firms,country) in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

The distance effect is relatively stable in all model specifications with a parameter in the -0.7 to -0.8 range. This is substantially lower than for the country-to country model. However, this is a common feature when using firm level data. Lawless (2010c) and Bernard, Moxnes and Ulltveit-Moe (2014) report distance parameters around -0.4, and Hornok and Koren (2015) reports parameter values in this range for Spain and an even lower magnitude for the US. Hence, as with the country-to-country level data, our estimates of the distance effect are about twice as high as what is reported in the general trade literature. This strongly suggests that the distance do matter more for perishable products.

There is a positive and significant effect from the market size in the destination country. When it comes to the per-shipment costs, the increased monetary costs have a significant negative effect on export values, while the time cost is significant only for quantity. Also here the increased internal transportation costs in the destination markets significantly reduce export sales while the reduction in cost associated with urban areas increases sales. The use of airfreight as transportation mode reduces exports. The EU-dummy shows a negative and significant effect on export sales. This indicates that even though EU-markets are very important for the aggregated sales value of salmon, more distant markets outside of the EU provides a larger scale for those firms that serves them.

4.3 Extensive and intensive margins

In this section we report the extensive margin as number of active exporters. In addition several intensive margins (number of shipments, shipment size by weight and value, and unit price) are reported. The results are given in Table 7.

Table 7: Margins of trade. Firm to country level data.

Dependent variable:	(1) ln # exporters	(2) ln # shipments	(3) ln mean weight	(4) ln mean value	(5) ln price
ln distance	-0.434***	-0.108***	-0.009**	-0.018**	0.031***
	(0.019)	(0.028)	(0.004)	(0.009)	(0.003)
ln GDP	0.095***	0.290***	0.007	0.016	0.007
	(0.025)	(0.027)	(0.005)	(0.010)	(0.004)
Dummy, EU	-0.132***	-0.115**	-0.008	-0.016	0.017***
	(0.037)	(0.048)	(0.008)	(0.015)	(0.005)
Time cost	-0.126***	0.006	0.009	0.022	0.016***
	(0.039)	(0.046)	(0.008)	(0.016)	(0.006)
Monetary cost	-0.347***	-0.186***	-0.007	-0.014	0.012***
	(0.029)	(0.043)	(0.010)	(0.019)	(0.004)
ln size	-0.102***	-0.116***	0.001	0.002	-0.001
	(0.008)	(0.010)	(0.002)	(0.004)	(0.001)
ln urban population	0.236***	0.040	-0.001	-0.006	-0.011**
	(0.028)	(0.033)	(0.006)	(0.011)	(0.005)
Transportation mode	-0.111***	-0.257***	-0.035***	-0.069***	0.054***
	(0.036)	(0.063)	(0.010)	(0.019)	(0.006)
Constant	3.661***	-3.966***	9.369***	21.726***	2.661***
	(0.284)	(0.426)	(0.099)	(0.191)	(0.055)
Observations	49,256	49,256	49,256	49,256	49,256
Adj-R^2	0.564	0.365	0.830	0.834	0.799
Firm FE	Yes	Yes	Yes	Yes	Yes
Month_Year FE	Yes	Yes	Yes	Yes	Yes

Robust standard errors clustered on (firms,country) in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

The first margin reported is numbers of firms serving a market (Model 1). Increased geographical distance strongly reduces the number of active firms, and the number of exporters' increases as the market size increases. These results are in line with the findings of Bernard et al. (2007). Melitz (2003) show the importance of trade costs when a potential exporter considers a specific foreign market. The results show that particularly the monetary trade cost is important for the number of exporters, although all the different trade costs appear to be important, including a substantial reduction in costs associated with urban areas. The strong impact of the distance variable and trade costs on the number of exporters may also suggest that the increased evidence of deeper relationships that is associated with the geographical expansion of the salmon market is due to rapidly increasing costs associated with distance.[14]

The second margin reported is shipment frequency (Model 2). The most interesting result here is that market size has a strong positive effect on shipment frequency. The magnitude of the distance effect is much smaller for this margin, although still statistically significant. Two other elements of trade cost are also important, monetary cost and internal market size. Transport mode is strongly significant indicating a reduction in shipments when much more costly air transport is used.

The next two margins (Models 3 and 4) are the average shipment size by weight and value. The distance parameter and the trade mode indicate negative impacts of these variables, although the magnitudes of the parameters are relatively small. The various trade cost measures and market size are not statistically significant and do not seem to play any role for shipment size.

The unit price is the final margin we investigate (Model 5). As expected, there is a significant positive relationship between distance and unit price, and one is "shipping the good salmon out" as the most distant markets get the highest quality. Moreover, there is a positive

[14] Kvaløy and Tveteras (2008) and Larsen and Asche (2011) provides evidence of deeper vertical relationships in salmon supply chains.

relationship for monetary and time related trade costs and airfreight, and a negative relationship for urban population (where higher population reduced trade cost), indicating that also these costs promote higher quality.

For all the intensive margins, the most striking result is the small magnitude of the distance parameters, even though they are all statistically significant and with the exception of unit price, negative. This is in sharp contrast to Hornok and Koren (2015), and suggests that the margins have different influences for a fresh product. That shipment size is only weakly influenced by distance and not at all by other trade costs and market is size, while shipment frequency is strongly influenced by market size worth emphasizing. This indicates that salmon exporters do not increase shipment size at all to counter higher transportation costs in larger markets, they increase shipment frequency.

5. Conclusions

In recent years, trade has increased substantially for a number of highly perishable products. One will expect that the factors influencing the trade patterns with these products are weighted differently from what is the case for storable products. In particular, shipping time becomes more important because of the perishability. This suggest that distance may be a larger impediment to trade and also that it is harder to exploit economies of scale in transportation as the fewer shipments that are associated with larger shipments also increase transportation time, potentially reducing quality. In this paper, the standard gravity model and an expanded version of the gravity model as well as a number of margins of trade is used to investigate the trade patterns for one successful highly perishable product – fresh salmon from Norway. The analysis is conducted at the standard country-to-country level as well as at the firm-to-country level.

In the country-to-country level analysis, transportation cost as measured by distance matters substantially more than what is reported in the literature for storable products. At magnitudes between -1.57 and -2.14, the distance parameter is about twice the size of the about -0.9 that is normally reported in the literature. When variables that capture per shipment cost and potential transportation costs within a market is included are introduced, they further increase the importance of transportation costs. On the other hand, the presence of urban areas reduces transportation cost and increase trade. At the firm-to-country level, the magnitude of the distance effect is reduced. This is in line with other studies using disaggregated data, and the effects reported here remains about twice as strong as what is reported in this literature. As most firms serve relatively few markets, this is a strong indication that a substantial part of the cost is a market specific investment that is captured by the firm specific effects, and underlines the importance of the fixed cost component in serving a market, as suggested by Melitz (2003).

Another important feature of the trade patterns is the number of exporting firms operating in various destinations, the extensive margin. The results indicate that border-to-border as well as transportation costs inside the importing country have a strong negative impact on the number of firms operating in a given destination market. When it comes to the exporters' intensive margins, the distance effect becomes very small. For shipment size, other trade costs are all statistically insignificant. Together with a strong market size effect on shipment frequency, this indicates that increased trade results in higher shipping frequency. One cannot exploit economies of scale by increasing shipment size. With the important role of transportation costs, it is as expected that quality sorting is important and quality increase with distance.

The results provide clear indications that trade patterns for a highly perishable product like fresh salmon is very different from storable bulk commodities. Distance cannot to the same degree be overcome by exploiting scale, even though trade costs appear to be reduced to some extent by targeting larger markets and urban areas. The most striking insight is that with increased market size the shipment frequency increases while there is no impact on shipment size, increasing the average freshness of the product available in the market. Hence, the trade-off between quality and potential losses due to unsold products and transportation cost associated with scale appears to be tilted in favor of freshness. While the observed trade patterns deviate in important aspects from the trade patterns of bulk products, the differences all make sense when accounting for the fact that the traded product is relatively high valued and highly perishable. While not directly generalizable, the results are accordingly likely to provide insights also for the trade with other high value fresh products like blue berries, asparaguses and cut flowers where one also has observed a rapid increase in trade in recent years.

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