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TRADE COSTS AND NORWEGIAN SALMON EXPORT

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Trade costs and Norwegian salmon export

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Abstract: Recent research indicates that transportation costs are more important for foods than other products due to food´s perishability. This paper uses transaction-level data to analyze the effect of trade costs on trade growth of a highly perishable good, fresh farmed salmon. I investigate trade growth, as well as two distinct margins of trade, the number of exporting firms and the shipment frequency. I find that trade growth is influenced by traditional gravity variables, such as distance and GDP. Further, the paper explores how variables, such as internal transportation costs and the exporters' choice of transportation mode, impact export of salmon. To estimate the two margins of trade, two different count data models are estimated. The results indicate that increased transportation costs have a remarkably large negative effect on trade growth of salmon export from Norway, but that this effect is also highly dependent on aggregation level.

Keywords: salmon aquaculture, transaction-level data, gravity, margins of trade, count data models

JEL Classification : F10, F14, Q22

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1. Introduction

During the last decades, trade liberalization and 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. Better transportation and logistics technologies reduces delivery time, and secures delivery of higher quality products to the end user (Coyle et al., 2001). This development has also made producers that are more distant increasingly competitive, even for perishable goods. Transportation costs include the actual physical shipping of a product, unfamiliarity with foreign markets, and time-related costs (Linnemann, 1966). Behar and Venables (2011) argue that trade is being choked off by geographical distance and underline the importance of understanding transportation costs to understand global trade patterns. The objective of this paper is to shed light on how trade costs, in the form of direct and internal transportation costs, and mode of transportation, influence trade of a highly perishable food product such as fresh farmed salmon. Production and trade of salmon have increased dramatically during the last two decades, from less than 100,000 tons in 1985 to 2.5 million tons in 2013, with Norway as the leading producer. Since Norway is a country located in the outskirts of Europe, it is particularly interesting to shed light on transportation costs. Several factors are potentially important, and trade with salmon will be investigated in three dimensions; in terms of export value, the number of exporting firms, and the number of shipments of fresh salmon.

Geographical distance between two markets is the most commonly used proxy for transportation costs. Increased geographical distance increases both the actual freight cost, and potentially the time spent in transit. At the same time, as production methods become increasingly sophisticated, and "just-in-time" production extends to a global level, the choice of transportation method is becoming increasingly important for transportation costs (Behar and Venables, 2011). Such developments call for a better understanding of how transportation costs and transportation mode alter trade values, and the margins of trade, particularly for highly perishable bulk commodities like food. This is even more so since technology development has made the absolute effect from geographical distance more important in recent years (Behar and Venables, 2011).

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). More recently, firm-level exports, and the role of firm heterogeneity, have received much attention, maintaining the importance of many of the same factors. Bernard et al. (2007) and Redding (2011), provide surveys of this literature. In this paper, gravity-models are estimated. I use transaction-level data to investigate how trade costs affect the value of a highly perishable product, such as fresh salmon, as well as two distinct margins of trade of salmon, the number of firms exporting the product, and the shipment frequency of the exporters. The analysis is conducted at two aggregation levels, the country level, and the firm-to-country level.

During the last decades there has been a shift in the composition of agricultural trade from primarily trade in bulk commodities to non-bulk items, including more perishable products (Coyle et al., 2001). It has become possible for exporters of perishable products, such as fish, meat and fruits, to deliver their product with low costs to final consumers thousands of miles away without experiencing loss of freshness and quality. This has made highly seasonal products, like fresh salmon, blueberries and asparagus, available year around. Hornok and Koren (2014) studied export of foods from the U.S. and Spain, and argue that shipping costs are most disruptive for perishable products. They also argue that in the presence of shipment costs, exporters would choose to ship fewer, but larger, shipments. However, this is problematic for highly perishable products, like fresh fish. From empirical studies of trade flows in food, we know that increased transportation costs reduce imports of seafood to the U.S (Rabbani et al., 2011), reduce retailers sales in foreign markets (Cheptea et al., 2012), and has a negative effect on export market participation (Kandilov and Zheng, 2011).

The rest of this paper is organized as follows. A brief literature review of the Norwegian salmon industry is presented in section 2. Data and regression models are discussed in section 3. Section 4 presents the estimation results, while section 5 concludes.

2. The Norwegian Salmon industry

As previously noted, this paper focuses on the export of one single commodity; fresh farmed salmon. There are a number of reasons why it is interesting to study trade with salmon in more detail. It is a rapidly growing industry as production has increased from less than 20 thousand tons in 1980 to about 2.5 million tons in 2014 (FAO, 2015). The industry is 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 (Asche et al., 2009; Roll, 2013), and in the supply chain (Asche et al., 2007). Control over the supply of the product has allowed the producers to target the most valuable markets and improve logistics, in contrast to what is possible in most fisheries. This has changed the market for salmon substantially from a relatively small market in North America and Japan to a large global market (Asche and Bjørndal, 2011).

Technology development, as highlighted by Behar and Venables (2011), is a key factor for this development at the production stage, as well as for logistics. There has also been a substantial development in supply chain organization and sales mechanisms improving logistics and facilitating trade (Kvaløy and Tveterås, 2008; Olson and Criddle, 2008; Larsen and Asche, 2011; Oglend, 2013; Straume, 2014). The two largest salmon producing countries, Norway and Chile, export salmon to more than 150 countries. Moreover, with more than 90% of the production 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 (Asche and Bjørndal, 2011).

3. Data and methodology

3.1 Data

The transaction data is collected from the salmon exporters' customs declarations for the period 2003-2009. Statistics Norway has made the declarations available. The data set identifies the traders (exporting firm and importing country), the weight (kilos), and statistical value in Norwegian kroner (NOK), the mode of transportation, and the shipment date for each shipment in the period. The data set contains 483,956 unique transactions from 248 Norwegian exporters, serving 83 different destination markets. The single largest destination market in the data set is France, with Denmark being the second most important.

For the firm-destination level, the average number of trades is 862, with a minimum of one, and a maximum of 4832. Approximately 80 % of the exporters report trade relationships involving only one shipment to a specific country. But these shipments make up only 0.5% of the total export volume. The final destination for the maximum number of shipments is France. Table

1 below, reports average value per shipment, and average total value exported to a given destination.

Table 1: Shipment frequencies and average export values. 2003-2009

# Shipments to destination	Average value per shipment to destination (10,000 NOK)	Average total value to destination (100,000 NOK)
1	2.23	1,039
1< # shipments ≤ 10	2.54	806
10 < # shipments ≤ 1,000	2.24	1,267
1000 < # shipments ≤ 10,000	1.45	4,745
# shipments > 10,000	1.07	17,424

We see that the value, and thereby the size, of each shipment is substantially lower when the number of shipments exceed 10. The corresponding numbers for the total export value to the destination increases as the number of shipments increases. These numbers are calculated as averages over the entire period. Hence, as trade relationships deepen over time, trades becomes more frequent, with lower average values per shipments, but with substantially larger total values.

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, 2003-2009

Mode of transportation	Share of total volume	Share of total value	Share of total transactions	# exporters using mode
Truck	86 %	90 %	75 %	240
Aircraft	14 %	10 %	25 %	82

For the export of fresh salmon, 86 % of the volume is transported by truck and 14 % by air. We see that almost all of the exporters use truck as the mode of transportation for at least one trade, while only 33 % (82 out of 248), use air transport for at least one shipment. As shown above, 75 % of the total number of shipments are by truck. Eaton (2008) argues 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 make slow ship transport useless.

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 GDP. In addition, the exporters are grouped according to the number of employees.

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

	# of exporters	Shipment frequencies
Total	248	483,956
EU	205	305,615
Non-EU	178	178,341
Large GDP	217	362,679
Small GDP	182	121,277
Large exporters	54	279,624
Small exporters	194	204,332

From table 3, we see that 205 of the exporting firms trades with the EU, and 217 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 the various countries, and vice versa. An exporter is large if it has more than 138 employees (the median value of number of employees) over the period. Not surprisingly, there is a large difference between the numbers of shipments by firms to the EU countries compared to non-EU countries. Destinations with a large GDP will represent markets with relatively higher demand than destinations with a small GDP, thus we expect to observe more firm-destination trades to the large destinations. The large exporters are, as anticipated, more active measured by the number of shipments than the smaller exporters.

3.2 Econometric approaches

The purpose of the empirical analysis is twofold. First, gravity models are estimated, using OLS, to explain the value of the traded salmon from Norway to different markets. This analysis is conducted on both the aggregate country-to-country level, as well as on the firm-country level. Second, margins of trade are investigated more closely using count data; i.e. the yearly number of Norwegian exporting firms in a market, and the exporters shipment frequency to different countries.

3.2.1 Baseline model

I estimate the following version of a standard gravity-model:

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

Here, $S_{j,t}$ is the export value of fresh salmon from Norway to destination j in year *t*. $\ln(Distance_j)$ is the log of the geographical distance between Norway and the destination market. $\ln(GDP_{j,t})$ is the log of the GDP in fixed USD-prices in destination market j in year *t*. DEU is a dummy variable for trades to a destination market within the EU. Data for distance is taken from the CEPII-database.[1] Data for GDP is taken from the World Bank Development Indicators (WDI).[2]

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 potential effect from membership in a trade union. We know that a large share of export of salmon from Norway is targeted for EU-

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

countries, so the dummy for trade to an EU-market is expected to be positively correlated with sales.

3.2.2 Extended model

In this paper, the square kilometers in the destination country (*ln size*), the share of urban population (*ln urban population*)[3], as well as a dummy-variable for the mode of transportation for the destination country j, is included in the extended gravity model.

$$(2)\ ln(S_{j,t}) = \beta_0 + \beta_1 ln(Distance_j) + \beta_2 ln(GDP_{j,t}) + \beta_3 DEU + \beta_4 ln(size_j) + \beta_5 ln(urban\ population_{j,t}) + \beta_6 DMode\ + u_{j,t}$$

The log of 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. The share of the population living in the largest cities could mitigate such internal transportation costs. For the exporter, costs are saved if he can concentrate on serving a couple of 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 positively correlated by the share of urban population. Both these two additional variables are taken from the World Bank Development Indicator database. Finally, a dummy for the mode of transportation at the border is included in the model. The dummy takes on the value 1 if the mode of transportation is by air, and 0 otherwise. Table 4 below, summarizes the explanatory variables for models (1) and (2).

Table 4: Descriptive statistics, explanatory variables aggregated data

Variable	*Mean*	*SD*	*Min, Max*	*Max*
Distance (km)	3,202	3,190	417	15963
GDP (100.000.000 USD)	11,898	16,576	11,31	111,609
Dummy, EU	0.63	0.48	0	1
Internal distance (1000 sq.km)	1285	3487	0.028	16,376
Urban population (millions)	24	49	1.03	250
Transportation mode	0.24	0.43	0	1

[3] See Lawless (2010a, 2010b)

3.2.3 Estimation of the margins of trade

Traditionally, the margins of trade are divided into the extensive margin and the intensive margin. The extensive margin of trade, is 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, over time. Hornok and Koren (2014) use the number of shipments as an additional margin of trade.[4] I argue that the number of shipments is an additional element of the intensive margin of trade. This is an expansion of the extensive margin of trade. From table 1, it is evident that as the shipment frequency increases, the average total export value of the trade relationship increases**.** Thus, the intensive margin of trade will expand through an increase in shipment frequency.

To investigate the number of firms exporting salmon, and the number of shipments, (1) and (2) are estimated with these two measures as dependent variables. Both the number of firms exporting to a given destination market, and the number of transactions from a firm to a destination, are count variables. To estimate the number of firms, I choose a Poisson model, while I will use both a Poisson model, as well as a Negative Binomial model, to estimate the shipment frequency. Greene (2008) presents the Poisson regression model as the most widely used to study models where the dependent variables are of a discrete nature.[5]

There is no evidence for over-dispersion for the number of firms, so an appropriate choice is the standard Poisson model. The Negative Binomial model is an appropriate choice as long as the dependent variable is over-dispersed, and does not contain an excess of zeroes. [6]

There is evidence for over-dispersion in the shipment frequency variable (see figure A.1 in the appendix). We count only observed trades between the exporting firm and the importing country. Thus, there are no inclusions of zeros in the data matrix.

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[4] Békés et al. (2014) also proposes the shipment frequency as an additional margin of trade.

[5] See Greene (2008) for some shortcomings of the Poisson model. Microeconomic data are likely to introduce heterogeneity in both the mean and variance of the response variable, and a negative binomial model is suggested as a more flexible model than the Poisson regression model when estimating a model with a discrete dependent variable (Greene, 2008).

[6] In the presence of zeros in the trade matrix Santos Silva and Tenreyro (2006) suggests the Pseudo Poisson Maximum Likelihood (PPML) estimator as an alternative.

4. Empirical results

4.1 Country level exports

Table 5 presents the estimated coefficients for equation (1) at the country level.

Table 5: Value of Norwegian salmon export. Country level.

	(1) Baseline model	*(2) Extended model*
ln Distance	*-1.803****	*-1.568****
	(0.267)	*(0.336)*
ln GDP	*1.569****	*1.923****
	(0.088)	*(0.208)*
Dummy, EU	*1.872****	*1.699****
	(0.485)	*(0.639)*
ln size	-	*-0.689****
	-	*(0.100)*
ln urban population	-	*-0.065*
	-	*(0.332)*
Transportation mode	-	*0.655*
	-	*(0.450)*
Constant	*-11.144****	*-12.802****
	(3.185)	*(3.751)*
Observations	*481*	*381*
R-squared	*0.543*	*0.614*
F-test	*120.5*	*89.0*
Year FE	*Yes*	*Yes*

Robust standard errors in parentheses.
**** p<0.01, ** p<0.05, * p<0.10*

For the baseline model, the results show a large significant negative effect from increased geographical distance on the total export sales of salmon. The average distance coefficient in the baseline model is substantially larger than the average distance elasticity of -0.9 reported in Disdier and Head (2008) from their meta-analysis of 103 gravity model papers. However, this finding is not too surprising given the highly perishable nature of fresh salmon. The larger the distance, the more effective supply chains must be in order to ensure loss of quality. As expected, there is a significant positive relationship between the GDP in the destination market and export sales. Anderson and van Wincoop (2004) survey a number of gravity studies on aggregate data, and also argue that the "normal" coefficient on the distance variable is about -0.9, that GDP is a significant variable, and that distance and GDP together account for about

70% of the observed variations in trade. Islands trade more, and landlocked countries trade less, than their coastal counterparts. 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. From table 5, we also see that sales of Norwegian salmon increases when the destination is a country within the European Union.

Turning to the extended model reported in column two of table 3, there is still a highly negative effect from distance on sales, and a positive effect on sales from GDP in the destination country. The EU-dummy is significant, as in the baseline model.

It is important to note that the sample used in the extended model differs somewhat from the sample in the baseline model. This is because WDI lacks some data for countries for the additional explanatory variables included in (2).[7] None of the dropped countries is among the 15 most important destination markets.[8] The results further show that large internal transportation costs affect export sales negatively. There is no significant effect from the urban population variable, or from transportation mode.

4.2 Firm-level exports

The distribution of firms across destination markets are skewed. Many firms export only to a small number of markets. The mean number of markets penetrated by the firms are 48, with a minimum of one, and a maximum of 60. Figure A.2 in the appendix, describes the number of firms active over different categories of destinations. It is evident from the figure, that a large share (76 %) of the exporters are active in the range of 1-10 markets. Only five firms (0.02%) are active in the range of 51-60 destination markets. Such high skewness in the distribution of firms across markets are in line 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. More recently, firm-level exports, and the role of firm heterogeneity, have received attention, maintaining the importance of many of the same factors (see e.g. Bernard et al. (2007) and Redding (2011) for surveys of this literature).

[7] Countries that drop out of the sample when additional explanatories are included are: Bahrain, Belize, Barbados, Cote d'Ivore, Colombia, Costa Rica, Cyprus, Estonia, Georgia, Iceland, Laos, Sri Lanka, Lithuania, Latvia, Luxemburg, Macedonia, Malta, Oman, Qatar, Slovakia, Slovenia, Togo and Tunisia.

[8] See Straume (2014) for a comprehensive list of the largest destination markets for export of fresh salmon from Norway.

In table 6 below, equations (1) and (2) are estimated at the firm-country level. Export sales are calculated as firm-destination specific sales, and firm fixed effects are introduced in the model.

Table 6: Gravity model of Norwegian salmon export - Firm level.

	(1) Baseline model	*(2) Extended model*
ln distance	*-1.085****	*-1.467****
	(0.070)	*(0.100)*
ln GDP	*0.636****	*0.429****
	(0.028)	*(0.066)*
Dummy, EU	*0.014*	*0.194*
	(0.139)	*(0.186)*
ln size	-	*-0.278****
	-	*(0.031)*
ln urban population	-	*0.417****
	-	*(0.092)*
Transportation mode	-	*0.629****
	-	*(0.159)*
Constant	*-5.548****	*-0.894*
	(0.750)	*(1.113)*
Observations	*5,621*	*4,992*
R-squared	*0.433*	*0.452*
F-test	*15.96*	*15.31*
Firm FE	*Yes*	*Yes*
Year FE	*Yes*	*Yes*

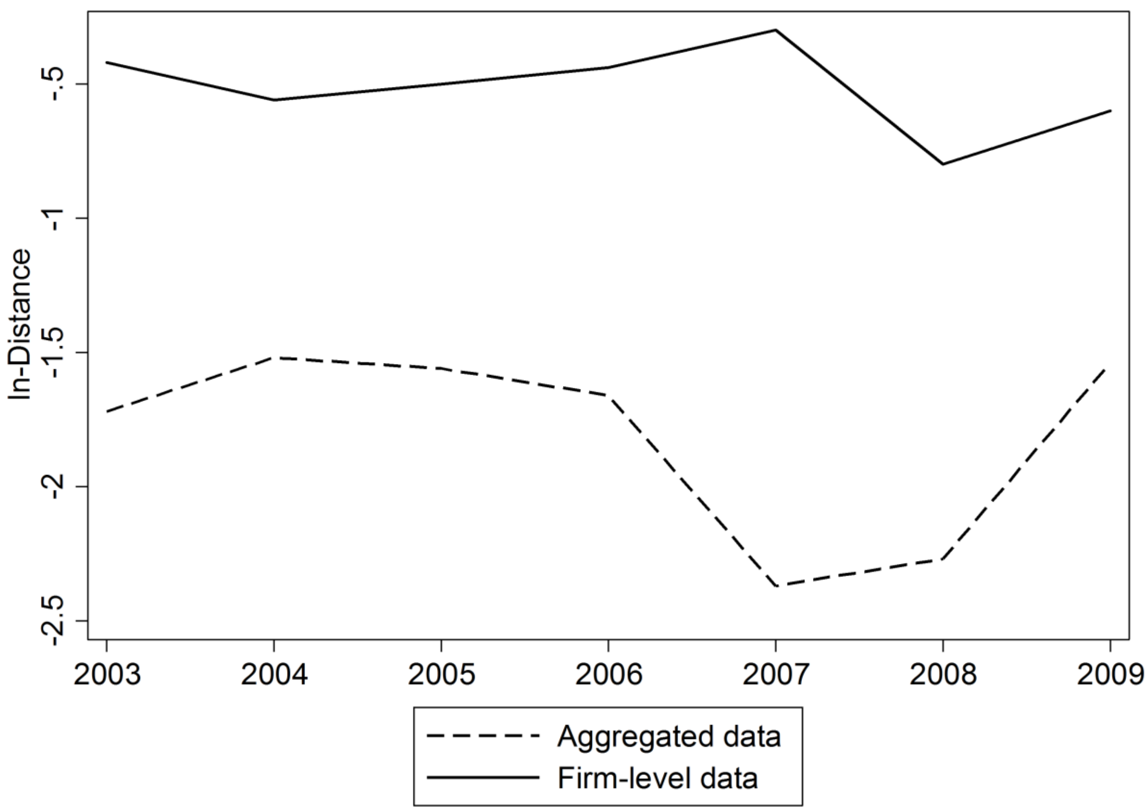
Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.10$

First, there is still a significant negative effect from the distance variable on sales, and a positive effect from the economic size of the destination market. However, the magnitude of the estimated parameter of distance is substantially lower than in the country-to-country model. Hence, the firm effects capture a substantial part of the distance effect. This indicates that some firms specialize in long-distance exports. At the firm level, there is no significant effect from the EU-dummy on export sales, but the positive sign on the variable is as expected. In addition, we see that increased internal transportation costs in the destination markets significantly lower export sales on the firm-destination level. There are two other interesting effects found when turning from the aggregate to the firm level. First, we see that export to countries with large urban areas increases sales. Second, we see that there is a now a highly significant positive effect on export sales from the dummy for choice of transportation mode. This dummy is constructed so that it takes on the value one if the mode of transportation is air cargo, and zero if truck is the preferred mode of transportation.

Following the results presented in tables 5 and 6 above, it can be concluded that increased transportation costs, when used as a proxy for geographical distance, have a negative impact on export sales. Our findings are in line with those of Lawless (2010b) for aggregated Irish exports.

Further, it is of interest to check if the negative effect from distance has changed over time. Figure 1 below, presents the estimated distance coefficient over time.

Figure 1: Distance coefficient over time



I ran the benchmark regression in equation (1) for each year, and plotted the distance coefficient in figure 3. From the figure, it is evident that there is a much larger variation in the distance coefficient for the aggregated data than for the firm-level data. For aggregated data, it seems like this variable is becoming increasingly important after 2006, but with an adjustment again towards the "normal" in 2009. On average, the distance coefficient, over time, for the firm-level regression is substantially different from the average effect of -0.9 presented in Disdier and Head (2008).

4.3 Shipment frequency and trade growth

In this section, trade growth of salmon export is decomposed into the number of active exporters (extensive margin), and the yearly number of shipments from the individual firms to a given destination market (intensive margin). When domestic fish farms seeks to sell some of the harvested stock on the foreign market, they need to gain a price high enough to cover their variable- and fixed-costs of exporting. Increased trade costs should thus have a negative impact on the number of exporting firms. Adjusting the number of shipments is a way for the exporters to react to uncertainty in the destination market, and adds flexibility to the firms' export activity. Higher shipment frequencies deepen trade relationships, as shown in table 1.

Eaton et al. (2008) employ trade data from Colombia in the period 1996-2005 to analyze the number of transactions at the firm-destination level. They find great heterogeneity in the number of transactions across firms. As much as 35 % of the firms report only one single transaction over the period. For firms that report multiple transactions, the time between shipments is less than a month. Some of this dispersion is explained by geographical distance to the destination market. The further away the destination is, the less shipments are sent to the destination. Such a result indicates the presence of a fixed cost of exporting, indicating a marginal cost that is declining with shipment volume. The authors argue that at the aggregate level, the number of transactions is an important source of variations in exports.

When analyzing the number of shipments from the exporter, Eaton et al. (2008) emphasize the importance of investigating if the exporters use of different transportation modes is important for the number of shipments. Eaton et al. (2008) further argue that the variability in exports for firms involved in seafood activities, to a higher extent, is explained by the transaction margin than for firm exports in other sectors. Asche and Straume (2015) find that if salmon exporters expand their intensive margin through an increased number of shipments, such a strategy may promote more long-lasting trade relationships.

Table 7 below, shows how the number of active exporters are impacted by changes in the set of gravity-variables used in section 4.2.

Table 7: The number of firms.

	(1) Baseline model - Poisson	(2) Extended model – Poisson
ln Distance	-0.435***	-0.548***
	(0.009)	(0.014)
ln GDP	0.171***	0.095***
	(0.003)	(0.007)
Dummy, EU	-0.214***	-0.205***
	(0.018)	(0.021)
ln size		-0.041***
		(0.004)
ln Urban population		0.156***
		(0.011)
Transportation mode		0.014
		(0.018)
Constant	2.586***	3.505***
	(0.075)	(0.114)
Observations	5,621	4,992
Pseudo-R2	0.360	0.362
Year FE	Yes	Yes
Firm FE	Yes	Yes

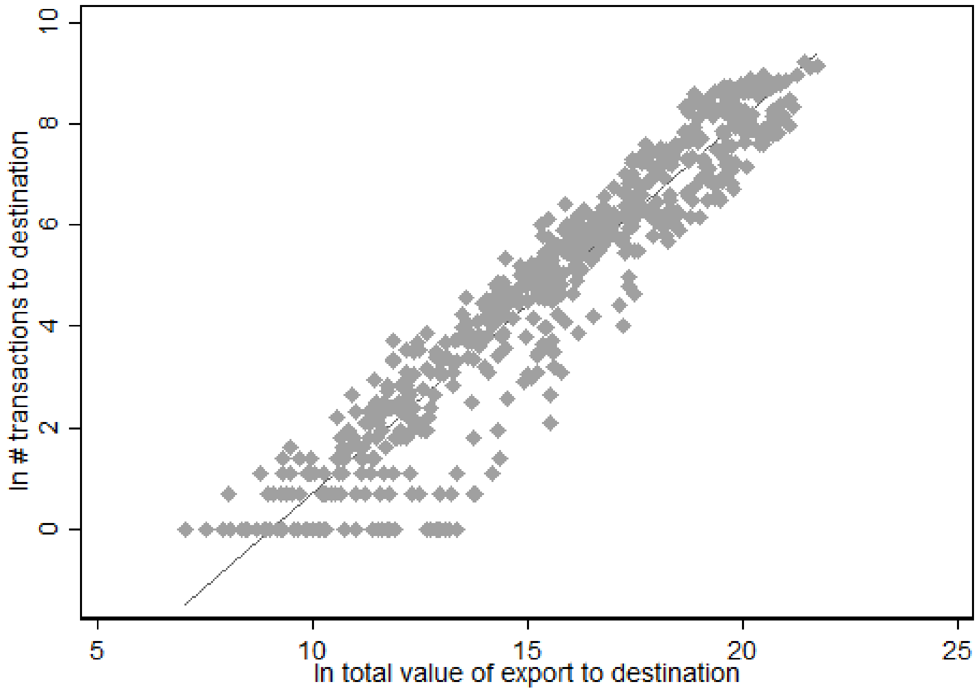
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Increased geographical distance reduces the number of active firms, and the number of exporters' increases as the GDP in the destination market increases. These results are in line with the findings of Bernard et al. (2007). When the destination country is a EU-country, the number of exporting firms decreases. This result can indicate that it is the largest Norwegian salmon exporters that are able to penetrate the EU markets. One benefit from penetrating these geographically closest markets may be deeper relationships, and a larger use of contracts (Kvaløy and Tveteras, 2008; Larsen and Asche, 2011), resulting in large traded volumes and values. All results mentioned so far are common for both the baseline model, as well as for the extended model.

When internal transportation costs are introduced in the model, we see that large internal transportation costs reduced the number of firms. A large urban population in the destination market increases the number of active exporters. There is no significant effect found from transportation mode.

To motivate the second margin of trade, the shipment frequency, the correlation between the number of shipments and the value of salmon export to different markets at the most aggregated level, are described in figure 2 below.

Figure 2: Number of transactions and value of export to destination. 2003-2009.



There is a strong positive correlation between the number of shipments to a destination country and the total export value to the destination. This is as expected, and clearly underlines the importance of studying this element of the extensive margin to get a better understanding of which factors determine shipment frequencies at the firm level.

For the estimation results presented in table 8 below, the dependent variable in equations (1) and (2) above, are here replaced by the yearly number of shipments from exporting firm *i* to destination *j*. The first two columns report the results from a Poisson regression for both the baseline and the extended models, while the two last columns reports the results from a negative binomial regression on the two models.

Table 8: The number of shipments

	(1) Baseline model - Poisson	(2) Extended model – Poisson	(3) Baseline model – Negative binomial	(5) Extended model – Negative binomial
ln Distance	-0.141***	-0.448***	-0.318***	-0.832***
	(0.053)	(0.073)	(0.031)	(0.044)
ln GDP	0.359***	0.311***	0.317***	0.212***
	(0.018)	(0.037)	(0.014)	(0.030)
Dummy, EU	0.644***	0.724***	0.132**	0.264***
	(0.096)	(0.131)	(0.059)	(0.073)
ln size	-	-0.182***	-	-0.130***
	-	(0.019)	-	(0.013)
ln Urban population	-	0.193***	-	0.208***
	-	(0.053)	-	(0.039)
Transportation mode	-	0.555***	-	1.070***
	-	(0.120)	-	(0.073)
Constant	-8.602***	-6.351***	-5.700***	-1.478***
	(0.559)	(0.743)	(0.371)	(0.543)
Alpha	-	-	0.336***	0.266***
	-	-	(0.015)	(0.016)
Observations	5,621	4,992	5,621	4,992
Pseudo-R2	0.56	0.59	-	-
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

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

Overall, we see that there is no significant differences between the effects from the set of explanatory variables on the dependent variable in these regressions, though some minor differences in significance levels do exist.

As distance to the destination and the internal transportation costs increases, the shipment frequency decreases. This is indicated through the elasticity of the distance variable, which is well below unity, and thereby suggests a diminishing effect on the number of shipments with respect to distance. This finding is in line with Hornok and Koren (2014) who argue that the presence of trade costs are associated with less frequent shipments for food products, and especially for perishable products. As distance increases, the exporters may prefer to ship less frequently, but in larger shipments. Further, we see that the large destination economies receive shipments that are more frequent, and there is more shipment activity to EU-destinations than to destinations outside the EU. Trade to large urban areas increases the shipment activity. Finally, the use of air transport results in more frequent shipments than the use of trucks.

The results presented in section 4 tell us that increased trade costs have a clear negative effect on the margins of trade. The Norwegian exporter may promote deeper trade relationships if they concentrate on trade towards relatively close geographical markets, which may very well be within the EU. For trade towards more distant markets, exporters will experience the possibility for deeper relationships if they ship the goods by air transport to urban areas with a dense population.

5. Conclusion

Transportation costs are important to consider when the pattern of trade for a commodity shall be explained. This is in particular true for highly perishable commodities like seafood. In this paper, Norwegian transaction-level data has been used to study the impact of transportation costs on the export value, and margins of trade, for fresh salmon in a gravity model setting. The analysis is conducted at the country level as well as at the firm level.

The results highlight the effect of aggregation level for the analysis as much as the importance of distance. When geographical distance is used as a proxy for transportation costs, it is shown to have a significant negative effect on trade values. Importantly, much of the distance effect is caused by aggregation of the data. The effect of distance on export value is almost cut in half when we turn our analysis from the country to the firm level. In addition, export values increase by the economic size (GDP) of the destination market.

Another important feature of the trade flow is the number of exporting firms operating to various destinations. In the literature, this is often referred to as the extensive margin. The results indicate that border-to-border as well as transportation costs inside the importing country have a negative impact on the number of firms operating in a given destination market. These effects are highly significant. The exports of salmon destined for the most important market, the European market seems to be predominantly carried out by the largest exporters. When it comes to the exporters' shipment frequencies, referred to as an element of the intensive margin of trade, the results are much the same as for the extensive margin. Trade costs have a negative effect on the intensive margin of trade.

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Appendix

Figure A.1: distribution of the number of shipments

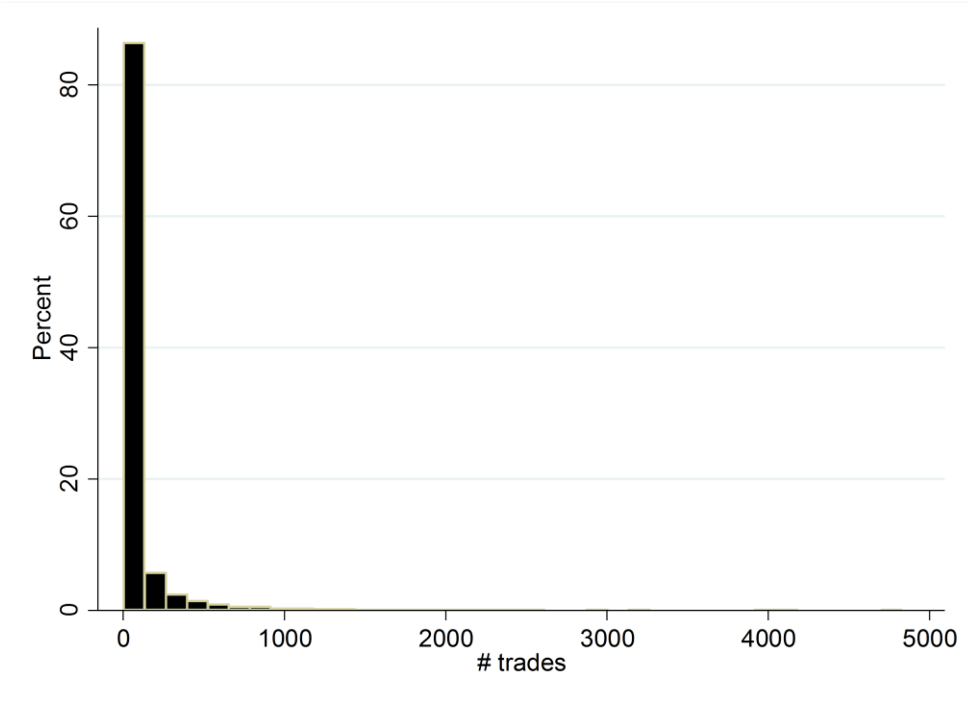
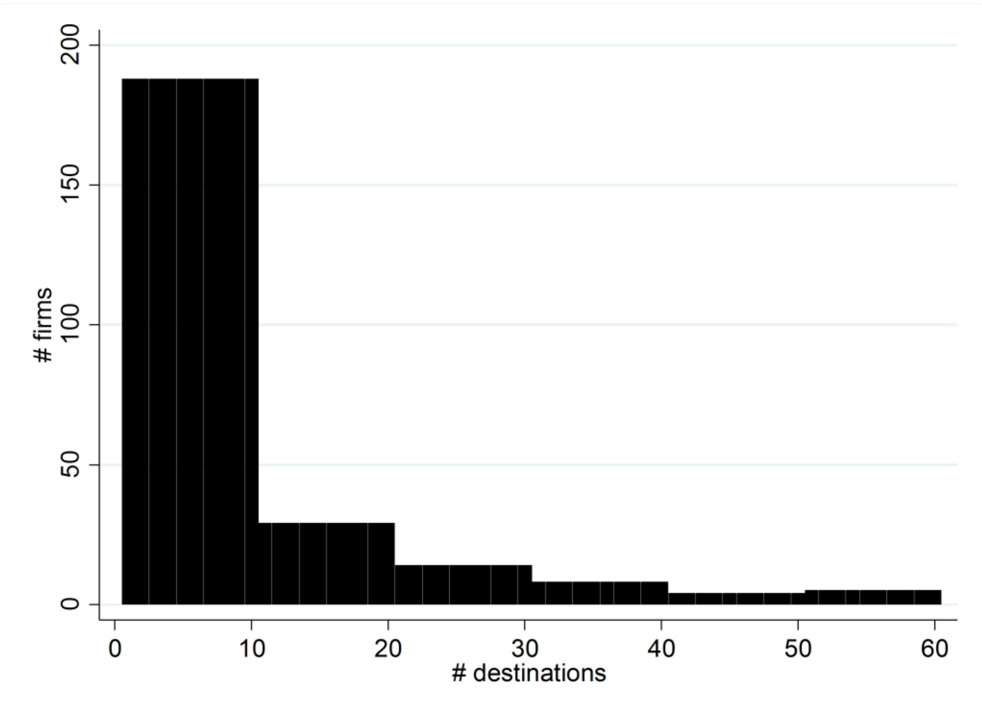


Figure A.2: Distribution of firms over destination markets



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