

Intercontinental Variations of the Import Trade pattern of Norway: *Applications to Best Linear Unbiased Estimable Functions of Hierarchical Econometric Model*

Yohannes Yebabe Tesfay

Senior Statistician and Econometric Researcher
Faculty of Economics, Informatics and Social Change,

Molde University College, 6402 Molde, Norway,

E-mail: yohannesyebabe@gmail.com

Telephone: +4745085680, Telefax: +4794760843

Per Bjarte Solibakke

Professor of Economics

NTNU Aalesund,
Norwegian University of Science and Technology
Larsgårdsveien 2, P.O.Box 1517, 6025 Aalesund, Norway

E-mail: per.b.solibakke@ntnu.no ,

Telephone: +4790035606, Telefax: +4794760843

Abstract

This paper's main purpose is an analysis of the intercontinental variations of Norwegian import expenditures based on yearly import data from 1988 to 2014. We estimate functions for the best linear unbiased estimator (BLUE) of the two-stage non-full rank hierarchical linear econometric model. The results confirm that the top three import-items across continents (in descending order) are machinery and transport equipment, manufactured goods classified mainly by material, and miscellaneous manufactured articles. These three import-items cover more than 60% of the Norwegian imports. Furthermore, the model predicts that Europe is the leading continent for Norwegian imports. The European continent is therefore influential for the Norwegian trade pattern, while other continents show lack of stability and predictability. The results imply that any governmental (or private) trade stability programs have only marginal effects.

Keywords: *generation of best linear unbiased estimable functions, intercontinental variations, import items, hierarchical econometric model and Norway.*

1 Introduction

Scholars of international economics put forward that the participation in the international trade (imports and exports) has positive impacts for the welfare of nations (Krugman 1980, Amiti and Davis 2008). Trade enhances economic development and diminish poverty by improving growth and increasing commercial opportunities and investment (Francisco and Dani 1999, Hans and Ernst 1999).

Economists have shown both theoretically and empirically, benefits of international trade (Samuelson 2001, Feenstra 1994). International trade establishes the extent of globalization with increased spatial interdependencies between elements of the global economy and their level of integration. These interdependencies imply numerous relationships where flows of capital, goods, raw materials and services are established between regions of the world. International trade exhibits a social force and changes the conditions in which wealth is distributed between and within nations. In most cases, this is due to price and wage relative changes ((Tsfay 2015, Bhaduri and Bengal 2012).

International trade also assists to smooth out distortions from long-term excess demand or excess supply conditions in domestic markets. Consequently, international trade may in many real world situations, reduce price fluctuations, volatility and demand/supply shortages. Economists also put forward arguments that international trade play significant role in the increase of the global economy (Helpman 1981). Hence, international trade boosts competitiveness and effectiveness by assisting countries reducing cost of inputs, acquiring financing through investments, highlights value added by national products and upgrade the global value chain (Gereffi et al. 2005).

1.1 Background

According to the Ricardian model of international trade, comparative advantage considered as a necessary and sufficient condition to create mutual benefit for trading partners by encouraging specialization in the specific commodity with a comparative advantage in terms of labor hours used per unit of output (Paul 2001). However, the benefit of international trade is realized by other important factors such as applying of free trade by the trading partners (Martin 2001). Some countries apply the protectionist policies while others apply free trade policies for their foreign trade. However, many scholars of international economics argue that

free trade policy able to maximize the benefit from participation in international trade of the trading partners (Krugman 1994 and 1993).

The fundamental characteristics of international trade that has been going on for centuries, with respect to the exchange of goods and services or for money—remains unchanged. The earliest participation and transactions at the international trade were conducted by traders in face-to-face encounters. However, the recent pattern of international trade is at variance from economic exchange accompanied centuries ago in its transaction volume, speed and diversity of geography. The recent pattern of international trade characterized by its advanced level of complexity of the transaction and economic exchange ((Tesfay 2015, João *et al.* 2007, Bowen *et al.* 1998, Baldwin 1986).

Developments of effective and efficient in transportation and communication facilitated and played important role economic exchange of nations not only increasing its volume, but also extending widening its geographical range. Most international economists argued that the most important factor for the expansion of international trade is maximization of the welfare of nations. However, as trade expanded in geographic scope, good diversity, and quantity, the channels of trade also became more complex. The complexity of international trade transactions is raised not only due to the participation of nations, but also due to the emergence of global supply chains (Arvis *et al.* 2007, Bernard *et al.* 2007, Anderson 1979).

A few large economic blocs, mainly in North America, Europe and few Asian countries like Japan, South Korea and Taiwan, dominate the geography of international trade. For example, economists estimated that the G7 countries account for about half of the global trade, a supremacy that has undergone for over 100 years. However, the existing global trade pattern is being seriously challenged by emerging economies. The developing countries of Asia, east Europe and South America are accounting for a growing portion of global trade. For instance, in the most recent global trade patterns China accounting for the most important exporting nation across the world both in absolute and relative terms. Those geographical and economic changes are also reflected over trans-oceanic trade with Trans-Pacific trade growing faster than Trans-Atlantic trade (Ossa 2011, WTO (2006, 2010, 2011), Shirotori and Molina 2009, Hummels 2007, Carrere and Schiff 2005, Bagwell and Staiger 1999, Chichilnisky 1994).

International economists are interested to make analysis and to predict the trade pattern of the given nation. However, the analysis of the trade pattern of a given country is a function of complicated factors. Some of the traditional factors that affect the trade pattern of the given nations are trade agreements, inflation, demographic change, national income, the impact of government policies, rules and regulations, culture and language, subsidies for exporters/ importers, restrictions on exports/ imports, exchange rates, lack of restrictions on piracy, random events, and transportation cost. The interaction of these factors also plays important role in determining the trade pattern of the same nations (Oatley 2010, Staiger *et al.* 2010, Arvis *et al.* 2007, Deardorff 2000, Feenstra and Gordon 2000, Ethier 1984, Krugman 1993).

More importantly, the emergence of new influential nations in international trade affects the global trade patterns. It is evident that rapid economic intensification and involvement in global trade of these emerging market economies, especially the major players such as China, Russia, India and Brazil, is sometimes perceived as a threat to the economic position of the European Union and North America (WTO 2013, Raymond 2011).

1.2 Problem

Many international economists mentioned several advantages of international trade for the economic development of nations. However, obviously the degree of benefit from international trade is different for different nations (Helpman *et al.* 2008, Balestreri 1997). Regional trade arrangements are increasing in scope and at the same time, some nations are quite open to international trade while the others are more reserved (Karacaovali and Limão 2005, Herzing 2004, Hausman and Rodrik 2003, Grossman and Maggi 1997). Therefore, one agenda for governments is to identify the structure of the regional variations of international trade.

Therefore, this study's main objective is to generate the best linear unbiased estimable functions of the two-stage non-full rank hierarchal model applying them to make an analysis of Norwegian import items across continents. Specifically, the paper tries to give econometric evaluations for comparing and characterizing the intercontinental variation of the import items. The best linear unbiased estimable functions, which are important for the evaluation of the intercontinental import analysis, are multiple comparison tests of the continental variations (the nesting factors) with respect of import items (the nested factors).

2 Literature Review

This paper's main objective is to analyse the intercontinental variations of the Norwegian import trade. The literature review, therefore, involves identifying factors that imply heterogeneity of import/ export trading partners in international trade.

2.1 Factors that affect distribution (equality) of international trade

Recently, the world has countersigned the emergence, partnership, consolidation and diffusion of a new economic pattern. By many nations across the world, this result stems from improving economic conditions based on globalisation. International trade, both in terms of value and tonnage, has been increasing in the global economy. It is essential to look at the structure of global trade, which is not done by nations, but typically commercial enterprises with individuals as end-consumers (UN 2008).

The new economic patterns not only increase bilateral trade, but also reduce stringent macroeconomic national policies, increasing privatization and liberalization, remove barriers to international trade, opening up to foreign direct investments and helping expansion of global supply chains. The development of information technology also plays a fundamental role in accelerating the international trade of the world (Antoine 2008). However, such economic growth can never create equal international trading partners due to several factors.

2.2 Impacts on costs from regulations on trade

Trade costs are the major contributor to international trade patterns and leads to heterogeneity of the international trade. The economic theory of gravity explains the complex bilateral trade patterns among countries. Actual trade is much lower than the gravity model predicts in a frictionless world. The facts provide evidence of trade costs that is much larger than transport and policy alone. Costs that is associated with facilitating international trade are one of the most important factors for the international trade pattern. Hence, these higher facilitating costs are beneficiary for the countries of both importer and exporter. Therefore, there are four major cost components in international trade: [1] transaction costs, [2] tariff and non-tariff costs, [3] transport costs and [4] time costs (Patrick and Ralph 2009, Etro 2006, Carrere and Schiff 2005, Anderson and van Wincoop 2004).

Transaction costs are the costs associated with the economic exchange following the trade. These costs include the collection of information, negotiating and imposing contracts, letters

of credit and similar transactions. Sometimes these costs also included monetary exchange rates if a transaction takes place in another currency (Niehans 1987). In this aspect, some countries are more effective and efficient in the transaction of bilateral trade than others.

Tariff and non-tariff costs are costs that are associated with duties imposed by governments to realize the trade flow. They consist of a direct monetary cost, according to the goods being traded or standards for the good to be allowed entrance into a foreign market. In this aspect, some governments have different strategies on their tariff and non-tariff costs that can encourage or discourage the importer/ exporter trading partners (Roorbach 1993).

Transportation costs are costs associated with the transit of goods between the trading partners. This cost is highly affected by the transportation infrastructure development and means of effective and efficient modes of transportation and distance between the trading partners (Estevadeordal *et al.* 2003, Finger and Yeats 1976). In this aspect, some nations geographically have much closer distance than the others with effective and efficient means of transportation.

Time costs are costs associated delays between the time of order for the exporter nation and the time the product is received by the importer nation. This cost is highly affected by the transportation infrastructure development and means of effective and efficient modes of transportation of the trading partners (Berthelot *et al.* 2004). In this aspect, some nations have much better transportation infrastructure than others. Furthermore, some nations (companies) are strict on the on-time delivery of goods during trade transaction and the others are not.

2.3 Impacts from government regulations on trade

Governments play important role in the foreign trade and policy of the country. Some governments highly exposed to while the others resist both the import and the export trade of the nations by setting rules and regulations. Each nation can act through foreign trade policy to take more of the gain, nevertheless, leading to caustic trade wars with reciprocated losses. Some governments have high attitude the positive impact of international trade and they subsidize the foreign trade of the country either to maximize foreign currency or maximize the welfare of the country. In this aspect, it is quite feasible and observable in the real world that some countries have a different foreign trade policy (Frieden and Lake 1995, Filanlyason and Zakher 1981).

2.4 Impacts of resource and product differentiations on international trade

One of the fundamental explanations from the Heckscher-Ohlin model about why countries participate is due to the variety of resources. Some countries are researched in natural resources and others may have skilled manpower and labour. In similar terms the role of differentiated product and brand also varies from one country to another. Some countries produce quality products and others are not. It is not simply nations will sell what they produce and buy what they have in lack, but also economic dependence, product type and quality also play fundamental role in the country's trade pattern (Besedes and Prusa 2005, Feenstra and Gordon 2000).

We have assessed the major factors that affect the distribution of the trade patterns of nations across the world. The assessment confirms that the potential factors can make the international trade pattern of a given nation is heterogeneous. It is essential to acknowledge such heterogeneity to study the future trade pattern of the country as the major causes for inequity at the international trade.

Furthermore, random events like earthquake, war, hurricane, etc. played a significant role in affecting the pattern of international trade. Therefore, our literature reviews inspire us to quantify the intercontinental variations of the Norwegian import trade. The output of the econometric analysis will be helpful for policy makers and provide highly refined quantitative information.

3 Data and Methodology

3.1 The Norwegian External Trade Dataset

The dataset is from Statistics Norway (www.ssb.no) and is downloaded from Statbank Norway (www.ssb.no/en/statistikbanken) and External Economy (External trade, External trade in goods, 08801). The data are organised yearly ranging from 1988 to the end of 2013 (26 years). The import items listed in these data from Statistics Norway the items may overlap. The data are organised suitable for the objectives set by the hierarchical model (see next section). The factors considered in this study are the *items of import with levels*: [1] Food and live animals, [2] Beverages and tobacco, [3] Crude materials, inedible, except fuels, [4] Mineral fuels, lubricants and related materials, [5] Animal and vegetable oils, fats and waxes, [6] Chemicals and related products n.e.s., [7] Manufactured goods classified chiefly by material, [8]

Machinery and transport equipment, [9] Miscellaneous manufactured articles, and [10] commodities and transactions, and the other factor is the **origin continents with levels**: [1] Africa, [2] Asia and Oceania, [3] Europe, [4] North and Central America, and [5] South America. The endogenous variable is the import items expenditures.

3.2 The hierarchical linear econometric model

The model of a two-way nested model has two independent main factors. Suppose the main factor A has " a " levels and the nested factor B has " ab " levels that grouped into sets of " b " levels each, and " n " (for a complete and balanced case) observations made at each level of the factor B giving a total of " abn " observations. More specifically, given two main factor A which is the nesting factor and B is the nested factor, the levels of B are said to be nested within the levels of A (or simply B is nested within A) if every levels of B appears within each level of A. The two-stage hierarchical linear model is given as ((Tesfay 2015, Douglas 2004, Searle 1971):

$$y_{ijk} = \mu + \alpha_i + \beta_{j(i)} + \varepsilon_{ijk} \quad (1)$$

$i = 1, 2, 3, \dots, a$, is the level of the nesting factor, $j = 1, 2, 3, \dots, b$, is the level of the nested factor, and $k = 1, 2, 3, \dots, n$, the number of replications within each nested factor

where y_{ijk} is the observed value of the k^{th} cell from the j^{th} nested factor within the i^{th} nesting factor, μ is the grand mean of y_{ijk} , $\beta_{j(i)}$ is the j^{th} factor nested under the i^{th} nesting factor effects, α_i is the i^{th} nesting factor effects, and ε_{ijk} is the random error term of the model.

The two-stage hierarchical linear model allows us to compare a given nested factor across different nesting factors. The system of linear equations in matrix form is given as:

$$Y = X \cdot \gamma + \varepsilon \quad (2)$$

where Y is a vector of endogenous variable, X is the design matrix, γ is a vector of parameters and ε is a vector of random error terms.

Model assumptions: Except the invertability of the $X'X$, all the assumptions of the Gauss-Markov assumptions are satisfied (Greene 2012, Douglas 2004, Rao 1973, Searle 1971).

3.3 Model fit for the two-stage non-full rank hierarchical linear model

In order to fit and making econometric inference the two-stage non-full rank hierarchical linear econometric model we need to derive the normal equations of the model based on the sample data. The normal equations are given as follows ((Tesfay 2015, Douglas 2004):

$$X'X\gamma = X'Y \quad (3)$$

Since the $X'X - Matrix$ is not invertible, our normal equations have no-unique solution. As the result we can't estimate the all the model parameters. Therefore, we advance our model fit technique of solving the normal equations using the concept called generalized inverse. The generalized inverse of $X'X$ is a matrix that satisfies the following condition (Tesfay, 2015, Searle 1971):

$$(X'X)(X'X)^-(X'X) = (X'X) \Leftrightarrow (X'X)^-(X'X)(X'X)^- = (X'X)^- \quad (4)$$

Using the generalized inverse of $X'X$ we will solve our normal equations as follows:

$$\gamma^0 = (X'X)^-(X'Y) \quad (5)$$

The predicted value of our endogenous variable Y will have the following solution:

$$\hat{Y} = X(X'X)^-X'Y \quad (6)$$

The solution of the predicted value can help us to decompose the total sum of squares.

Therefore, using the predicted value (see equation 6) we derive the model sum of squares (SSR) of the Two-stage non-full rank hierarchical model as follows (Searle 1971).

$$SSR = \hat{Y}'\hat{Y} = Y'X(X'X)^-X'Y \quad (7)$$

One of the important characteristics of the sum of squares of the model (SSR) is its invariance of the choice of the generalized inverse (Searle 1971). In order to check the fit of the model we decompose the total sum of squares (SST) into the sum of squares due to the model and the random error term:

$$SST = Y'[X(X'X)^-X']Y + Y'[I - X(X'X)^-X']Y \quad (8)$$

where $(X'X)^-$ is the generalized inverse of $X'X$, I is the identity matrix, $Y'Y$ is the total sum of squares (SST), $Y'[X(X'X)^-X']Y$ is the sum of squares of the model (SSR) and $Y'[I - X(X'X)^-X']Y$ is the sum of squares of error (SSE).

The degree of freedom of the SSR and SSE are " ab " and " $abn - ab$ ", respectively. The mean of the sum of squares are distributed with non-central and central Chi-square distributions as follows, respectively (Hazewinkel 2001, Searle 1971). Therefore, the ratio of the mean square

of the model and the mean square of the error follows F-distribution with the degree of freedom of the numerator and the denominator is are " ab " and " $abn - ab$ ", respectively as follows (DeGroot 1986).

$$F_{cal} = \left(\frac{SSR}{SSE} \right) \left(\frac{abn - ab}{ab} \right) \sim F_{ab, abn - ab, \alpha} \quad (9)$$

The null and the alternative hypothesis of the model fit are given as:

$$H_o : \mu = \alpha_i = \beta_{j(i)} = 0 \text{ for all } i = 1, 2, 3, \dots, a \text{ and for all } j = 1, 2, 3, \dots, b$$

$$H_a : \mu \neq 0 \text{ or } \alpha_i \neq 0 \text{ or } \beta_{j(i)} \neq 0 \text{ for some } i \in \{1, 2, 3, \dots, a\} \text{ and for some } j \in \{1, 2, 3, \dots, b\}.$$

We reject the null-hypothesis if $F_{cal} > F_{ab, abn - ab, \alpha}$.

3.4 Estimable functions for the two-stage non-full rank hierarchical linear model

In non-full rank linear models, we cannot estimate all model parameters, and consequently, we are at a loss to test every hypotheses of interest. In order to determine the testability of our hypotheses, we need to identify which linear functions are estimable functions. The concept of estimability of functions is important in the theory and applications of linear models because hypotheses of interest are often expressed as linear combinations of the parameter estimates. Estimable functions are functions that are exactly equal to a linear function of the expected values of the response variable Y . Furthermore, a linear combination of estimable function is also estimable (Tsfay, 2015, Fabio 1999, Magnus and Neudecker 1988, Searle 1987).

Based on the definition of estimable functions we will generate an estimable function from non-full rank hierarchical linear models in the following sub-sections.

3.5 Estimable functions using the expected value of response variables

This estimable function is helping us to identify the model parameters that have significant impact of the endogenous variable (Y). According to Searle (1987), the expected value of the endogenous variable (Y) is estimable. Therefore, in order to identify the estimable functions lets compute the expected value of endogenous variable, Y as follows:

$$E[Y] = E(\mu + \alpha_i + \beta_{j(i)} + \varepsilon_{ijk}) = E(\mu + \alpha_i + \beta_{j(i)}) + E(\varepsilon_{ijk})$$

Since the parameters are fixed and the expected value of the random error term is zero,

$$E(\mu + \alpha_i + \beta_{j(i)}) + E(\varepsilon_{ijk}) = \mu + \alpha_i + \beta_{j(i)} + E(\varepsilon_{ijk}) = \mu + \alpha_i + \beta_{j(i)} \quad (10)$$

Therefore, the linear combination of parameters $\mu + \alpha_i + \beta_{j(i)}$ is estimable. Our next task is to find the estimator of $\mu + \alpha_i + \beta_{j(i)}$. To find the best linear unbiased estimator (BLUE) point

estimator of the estimable function lets compute expected value of the statistic $\bar{y}_{ij.} = \sum_{k=1}^n y_{ijk} / n$

as follows (Sheldon 2007, Richard 1991, Searle 1987, 1971):

$$E(\bar{y}_{ij.}) = E\left(\sum_{k=1}^n y_{ijk} / n\right) = \frac{1}{n} \left(\sum_{k=1}^n E(\mu + \alpha_i + \beta_{j(i)} + \varepsilon_{ijk}) \right) = \frac{1}{n} \left(\sum_{k=1}^n (\mu + \alpha_i + \beta_{j(i)}) + E(\varepsilon_{ijk}) \right). \text{ Since } E(\varepsilon_{ijk}) = 0, \text{ } E(\bar{y}_{ij.}) = \frac{1}{n} [n(\mu + \alpha_i + \beta_{j(i)})] = \mu + \alpha_i + \beta_{j(i)} \quad (11)$$

Therefore, the expected value of $\bar{y}_{ij.} = \sum_{k=1}^n y_{ijk} / n$ is unbiased and linear estimator of

$\mu + \alpha_i + \beta_{j(i)}$. According to Knight (2000) the point estimator is also the efficient estimator of the estimable function. The variance of the point estimator is derived as follows:

$$\text{Var}(\bar{y}_{ij.}) = \text{Var}\left(\sum_{k=1}^n y_{ijk} / n\right) = \frac{1}{n^2} \text{Var}\left(\sum_{k=1}^n y_{ijk} / n\right) = \frac{1}{n^2} \left[\text{Var}\left(\sum_{k=1}^n (\mu + \alpha_i + \beta_{j(i)} + \varepsilon_{ijk})\right) \right]$$

Since the estimable function is a constant,

$$\text{Var}(\bar{y}_{ij.}) = \frac{1}{n^2} \left[\text{Var}\left(\sum_{k=1}^n (\varepsilon_{ijk})\right) \right] = \frac{1}{n^2} \left[\sum_{k=1}^n \text{Var}(\varepsilon_{ijk}) + \sum_{k \neq k'}^n \text{Cov}(\varepsilon_{ijk}, \varepsilon_{ijk'}) \right]$$

Since the random error terms are assumed to be independent and homoscedastic,

$$\text{Var}(\bar{y}_{ij.}) = \frac{1}{n^2} \left[\sum_{k=1}^n \text{Var}(\varepsilon_{ijk}) \right] = \text{Var}(\bar{y}_{ij.}) = \frac{1}{n^2} \left[\sum_{k=1}^n \sigma^2 \right] = \frac{1}{n^2} [n\sigma^2] \Rightarrow \text{Var}(\bar{y}_{ij.}) = \frac{\sigma^2}{n} \quad (12)$$

In order to test the significance of the estimable function, which defined in equation 11, we use the F-distribution that expresses as:

$$F_{cal} = \frac{\left(\sum_{k=1}^n y_{ijk} / n \right)^2}{\left(\frac{1}{n} \right) \left(\frac{SSE}{abn - ab} \right)} \sim F_{1, abn - ab, \alpha} \quad (13)$$

The estimable functions are statistically significant if $F_{cal} > F_{1, abn - ab, \alpha}$.

3.6 Estimable functions for inter-variability of the endogenous variable

Suppose $E[y_{ijk}] = \mu + \alpha_i + \beta_{j(i)}$ and $E[y_{i'jk}] = \mu + \alpha_{i'} + \beta_{j(i')}$ for $j \neq j'$ are estimable functions from the two-stage hierarchical linear model. The linear combination, simply by taking the difference of the two estimable functions, $E[y_{ijk}] - E[y_{i'jk}] = \beta_{j(i)} - \beta_{j(i')}$, is also an estimable function.

One of the important properties of estimable functions is that any linear combination of estimable function is estimable. Suppose $E[y_{ijk}] = \mu + \alpha_i + \beta_{j(i)}$ and $E[y_{i'jk}] = \mu + \alpha_{i'} + \beta_{j(i')}$ for $i \neq i'$ are estimable functions from the two-stage hierarchical linear models. Therefore, the function $E[y_{ijk}] - E[y_{i'jk}] = (\alpha_i - \alpha_{i'}) + (\beta_{j(i)} - \beta_{j(i')})$ is also estimable function. The best linear

unbiased estimator of $(\alpha_i - \alpha_{i'}) + (\beta_{j(i)} - \beta_{j(i')})$ is $\bar{y}_{ij.} - \bar{y}_{i'j.} = \sum_{k=1}^n y_{ijk} / n - \sum_{k=1}^n y_{i'jk} / n$. The

variance of the BLUE of $(\alpha_i - \alpha_{i'}) + (\beta_{j(i)} - \beta_{j(i')})$ is derived as follows (Sheldon 2007, Richard 1991, Searle 1987, 1971):

$$\begin{aligned} \text{Var}(\bar{y}_{ij.} - \bar{y}_{i'j.}) &= \text{Var}\left(\sum_{k=1}^n y_{ijk} / n - \sum_{k=1}^n y_{i'jk} / n\right) \\ &\Rightarrow \text{Var}(\bar{y}_{ij.} - \bar{y}_{i'j.}) = \frac{1}{n^2} \text{Var}\left(\sum_{k=1}^n y_{ijk} - \sum_{k=1}^n y_{i'jk}\right) \\ &\Rightarrow \text{Var}(\bar{y}_{ij.} - \bar{y}_{i'j.}) = \frac{1}{n^2} \text{Var}\left(\sum_{k=1}^n (\mu + \alpha_i + \beta_{j(i)} + \varepsilon_{ijk}) - \sum_{k=1}^n (\mu + \alpha_{i'} + \beta_{j(i')} + \varepsilon_{i'jk})\right) \\ &\Rightarrow \text{Var}(\bar{y}_{ij.} - \bar{y}_{i'j.}) = \frac{1}{n^2} \text{Var}\left(\sum_{k=1}^n ((\alpha_i - \alpha_{i'}) - (\beta_{j(i)} - \beta_{j(i')}) + (\varepsilon_{ijk} - \varepsilon_{i'jk}))\right) \end{aligned}$$

Since $(\alpha_i - \alpha_{i'}) - (\beta_{j(i)} - \beta_{j(i)})$ is constant, $\text{Var}(\bar{y}_{ij.} - \bar{y}_{i'j.}) = \frac{1}{n^2} \text{Var}\left(\sum_{k=1}^n (\varepsilon_{ijk} - \varepsilon_{i'jk})\right)$

$$\Rightarrow \text{Var}(\bar{y}_{ij.} - \bar{y}_{i'j.}) = \frac{1}{n^2} \left(\sum_{k=1}^n (\text{Var}(\varepsilon_{ijk}) + \text{Var}(\varepsilon_{i'jk})) - \sum_{k \neq k'}^n \text{Cov}(\varepsilon_{ijk}, \varepsilon_{i'k'}) \right).$$

Since the random error terms assumed to be independent and homoscedastic,

$$\text{Var}(\bar{y}_{ij.} - \bar{y}_{i'j.}) = \frac{1}{n^2} \left(\sum_{k=1}^n (\text{Var}(\varepsilon_{ijk}) + \text{Var}(\varepsilon_{i'jk})) \right) = \frac{1}{n^2} (n\sigma^2 + n\sigma^2) = \frac{2\sigma^2}{n} \quad (14)$$

In order to test the significance of the estimable function, which defined as $(\alpha_i - \alpha_{i'}) + (\beta_{j(i)} - \beta_{j(i')})$, we use the F-distribution, which expresses as:

$$F_{cal} = \frac{\left(\sum_{k=1}^n y_{ijk} / n - \sum_{k=1}^n y_{i'jk} / n \right)^2}{\left(\frac{2}{n} \right) \left(\frac{SSE}{abn - ab} \right)} \sim F_{2, abn - ab, \alpha} \quad (15)$$

The estimable functions are statistically significant if $F_{cal} > F_{2, abn - ab, \alpha}$.

4 Empirical Results and Discussions

4.1 Preliminary Assessment

Before performing analysis on the intercontinental variations of the Norwegian import trade based on expenditure on the import items, it is necessary to perform a preliminary assessment on the overall continental variations. The assessment will help to analyse the intercontinental variations of the Norwegian import trade. The overall structure of the Norwegian imports across continents is analysed using the estimable function defined in equation 12 (see equation 12 section 3.5). Table 1 reports the results from the estimable functions for the import expenditure (in million NOK) across the world's continents.

{Insert Table 1 about here}

4.2 Expenditures on imports items from the continent of Africa

From the estimation result, we observe that only two out of the ten import items from the continent of Africa are significantly affecting the Norwegian import expenditures. The items with their estimated expenditure and estimated share, respectively are firstly, crude materials, inedible, except fuels with 5,124.50 million NOK, and 1.04% and, secondly mineral fuels, lubricants and related materials with 1,917.43 million NOK, and 0.39%. The significant items of import from the continent of Africa, contribute only 1.43% of the overall Norwegian imports. The estimated expenditure for the remaining eight items, accounts to 2,265.63 million NOK covering a share of 0.46%. The estimation result of the two-stage hierarchical linear econometric model shows that Africa contributes with 9,307.56 million NOK (1.89%) of Norwegian imports. The results confirm that African exports to Norway are the least influential of the Worlds' continents.

4.3 Expenditures on imports items from the continent of Asia and Oceania

From the estimation result, we observe that six out of the ten import items from the continent of Asia and Oceania are significantly affecting the Norwegian import expenditures. The items with their estimated expenditure and estimated share, respectively are as follows. (1) food and live animals with 1,983.13 million NOK, and 0.40%), (2) beverages and tobacco with 1,903.48 million NOK, and 0.39%, (3) chemicals and related products n.e.s. with 3,372.95 million NOK, and 0.68%, (4) manufactured goods classified chiefly by material with 10,312.90 million NOK, and 2.09%, (5) machinery and transport equipment with 43,904.87 million NOK, and 8.91% and (6) miscellaneous manufactured articles with 22,999.19 million NOK, and 4.67%. The six import items from Asia and Oceania cover 17.14% of the overall Norwegian imports. The expenditure for the remaining four items is 1245.70 million NOK covering a share of 0.25%. The overall estimation results show that the Norwegian import from the continent of Asia and Oceania is 85,722.20 million NOK (17.39%). These results show that Asia and Oceania are the second most influential World continent.

4.4 Expenditures on imports items from the continent of Europe

The estimation results show that none of the import items from the continent of Europe contribute significantly to the Norwegian import expenditures. These items with their estimated expenditure and estimated share respectively are as follows. (1) food and live animals, with 21,204.06 million NOK, and 4.30 %, (2) beverages and tobacco with 4,755.89, and 0.97%, (3) crude materials, inedible, except fuels with 10,665.70, and 2.16%, (4) mineral fuels, lubricants and related materials with 26,587.45 million NOK, and 5.40%, (5) animal and vegetable oils, fats and waxes with 2,979.56, million NOK, and 0.60%, (6) chemicals and related products n.e.s. with 39,107.03 million NOK, and 7.94%, (7) manufactured goods classified chiefly by material with 60,208.54 million NOK, and 12.22%, (8) machinery and transport equipment with 130,328.57 million NOK, and 26.45%, and finally (9) miscellaneous manufactured articles with 44,683.35 million NOK, and 9.07%. The nine items from the continent of Europe contribute with 69.10 percent of the overall Norwegian imports. The single insignificant import item from Europe is commodities and transactions with an estimated expenditure and share of 1,181.50 million NOK and 0.24%, respectively.

4.5 Expenditures on imports items from the continent of North and Central America

From the estimation result, we observe that seven out of the ten import items from the continent of North and Central America significantly affect the Norwegian import expenditures. These

items with their estimated expenditure and estimated share respectively are as follows. (1) food and live animals with 1,890.29 million NOK, and 0.38%, (2) crude materials, inedible, except fuels (11,170.4 million NOK, and 2.27%, (3) mineral fuels, lubricants and related materials with 1,973.77 million NOK, and 0.40%, (4) chemicals and related products n.e.s. with 4,792.98 million NOK, and 0.97%, (5) manufactured goods classified chiefly by material with 2,376.35 million NOK, and 0.48%, (6) machinery and transport equipment with 17,677.49 million NOK, and 3.59%, and finally (7) miscellaneous manufactured articles with 4,436.45 million NOK, and 0.90%. The seven items from the continent of North and Central America contribute with 8.99% of the overall Norwegian imports. The expenditure to the remaining four items from the continent of North and Central America report 387.20 million NOK covering the share of only 0.08 %. In general, the estimation result of the two-stage hierarchical linear econometric model shows that the Norwegian import from the continent of North and Central America is 44,705.00 million NOK (9.07%). The result shows that North and Central America are the third most influential World continent for Norwegian imports.

4.6 Expenditures on imports items from the continent of South America

The estimation results show that only two out of the ten import items from the continent of South America significantly affect the Norwegian import expenditures. These items with their estimated expenditure and estimated share respectively are as follows. (1) food and live animals with 4,113.89 million NOK, and 0.83% and (2) crude materials, inedible, except fuels with 5,143.15 million NOK, and 1.04%. The continent of South America cover therefore 1.88% of the overall Norwegian import items. The expenditure to the remaining eight items is 2,108.06 million NOK covering a share of only 0.43%. The estimation results show that the Norwegian imports from the continent of South America is 11,365.11 million NOK (2.31%). The result shows that South American exporters show low influence to Norwegian imports.

4.7 Item-based intercontinental variation of the Norwegian imports expenditures

In section 4.1 we have seen that the import expenditures to miscellaneous manufactured articles, mineral fuels, lubricants and related materials, manufactured goods classified chiefly by material, machinery and transport equipment and food and live animals from different origin continents are found to be significantly items of the import sector of Norway. This inspires us to conduct a multiple comparison to identify the magnitude of expenditure differences to import the item across the different continents. The test result will be helpful to determine the future trade pattern of Norway. The intercontinental variation of the Norwegian import expenditures

estimates the estimable function, which is defined as $E[y_{ijk}] - E[y_{i'jk}] = (\alpha_i - \alpha_{i'}) + (\beta_{j(i)} - \beta_{j(i')})$.

In order to perform multiple econometric comparison of the Norwegian import items expenditures across continents (i.e. inter-continental variation), we will test the hypothesis:

Null hypothesis (H_0): Expenditure of importing the j^{th} item from the i^{th} and i'^{th} continents has no significant difference on the Norwegian import trade, i.e. $(\alpha_i - \alpha_{i'}) + (\beta_{j(i)} - \beta_{j(i')}) = 0$

Alternative hypothesis (H_1): Expenditure of importing the j^{th} item from the i^{th} and i'^{th} continents has significant difference on the Norwegian import trade, i.e. $|(\alpha_i - \alpha_{i'}) + (\beta_{j(i)} - \beta_{j(i')})| > 0$.

For the hypothesis the i 's are continents: $i = 1, 2, 3, 4, 5$ and j 's are import items: $j = 1, 2, 3 \dots 10$. In the following sub-sections, we investigate and analyse the test results. The hypothesis results are reported in Table 2.

{Insert Table 2 about here}

4.8 Intercontinental variation of the import expenditures on miscellaneous manufactured articles

The estimates of the estimable function for the two-stage non-full rank hierarchical model shows that the import of miscellaneous manufactured articles contributes with a share of 14.7% (see Table 1) of the overall Norwegian import expenditures. The item is the third most influential item overall import items. The import of miscellaneous manufactured articles from the continents of Europe, Asia and Oceania, and North and Central America are the most significant items of Norwegian imports across the continents. Table 2 contains multiple comparisons of import expenditures over items and across the three continents. At the 5% level of significance, we find that the continent of Europe is the most influential continent. The estimation result shows that the expenditure on miscellaneous manufactured articles from the European continent exceeds the expenditure from the continent of Asia and Oceania, and North and Central America with 21,684.16 and 40,246.90 million NOK, respectively. Furthermore, the import expenditures on the items from the continent of Asia and Oceania exceed the import expenditures from the continent of North and Central America by 18,562.73 million NOK. Therefore, our result shows that in descending order, the most influential import continent for

the item miscellaneous manufactured articles, are Europe, Asia and Oceania, and North and Central America.

4.8 Intercontinental variation of import expenditures on mineral fuels, lubricants and related materials

The estimates of the estimable function for the two-stage non-full rank hierarchical model shows that the import of mineral fuels, lubricants and related materials has a share of 6.28 % (see Table 1) of the overall Norwegian import expenditures. The import of mineral fuels, lubricants and related materials from the continents of Europe, Africa, and North and Central America are the significant items of Norwegian imports across continents. Table 2 reports multiple comparisons of import-item expenditures across the three continents. At the 5% level of significance, we find that the continent of Europe is the most influential continent for this import-item. The estimation result reports that the import expenditure for mineral fuels, lubricants and related materials from the continent of Europe exceeds the expenditures used for items from the continent of North and Central America, and Africa by 24,613.67 and 24,670.02 million NOK, respectively. Furthermore, the import expenditures used for the item from the continent of North and Central America is statistically equal to the expenditure from the continent of Africa. Therefore, we have shown that in descending order the most influential continent for the Norwegian import of miscellaneous manufactured articles are Europe, North and Central America and Africa.

4.9 Intercontinental variation of import expenditures on manufactured goods classified chiefly by material

The estimates of the estimable function for the two-stage non-full rank hierarchical model reports that the import of manufactured goods classified chiefly by material, contributes with a share of 14.97 % (see Table 1) of the overall Norwegian import expenditures. The item is therefore the second most influential import item. The import of manufactured goods classified chiefly by material from the continents of Europe, Asia and Oceania, and North and Central America are the significant items of Norwegian imports across continents. Table 2 shows multiple comparisons of import-item expenditures across the three continents. At the 5% level of significance, we find that the continent of Europe is the most influential continent for the import item. The estimation result shows that the import expenditures for manufactured goods classified chiefly by material from the continent of Europe exceeds the import expenditures from the continent of Asia and Oceania, and North and Central America by 49,895.64 and

57,832.18 million NOK, respectively. Furthermore, the import expenditure from the continent of Asia and Oceania exceeds the expenditure from the continent of North and Central America by 7, 936.54 million NOK. Therefore, we have shown that in descending order, the most influential continent for the Norwegian import of manufactured goods classified chiefly by material are Europe, Asia and Oceania, and North and Central America.

4.10 Intercontinental variation of import expenditures on machinery and transport equipment

The estimates of the estimable function for the two-stage non-full rank hierarchical model shows that the import of machinery and transport equipment contribute with a share of 39.07% (see Table 1) of the total Norwegian import expenditure. The item is therefore the most influential Norwegian import item. The import of machinery and transport equipment by material from the continents of Europe, Asia and Oceania, and North and Central America are the significant items of Norwegian imports across continents. Table 2 reports multiple comparisons of import item expenditures across the three continents. At the 5% level of significance, we find that the continent of Europe is the most influential continent for the import item. The estimation results show that the import expenditure for machinery and transport equipment from the continent of Europe exceeds the import item expenditures from the continent of Asia and Oceania, and North and Central America by 86,423.70 and 112,651.08 million NOK, respectively. Furthermore, the import item expenditures from the continent of Asia and Oceania exceed the expenditure from the continent of North and Central America by 26,227.37783 million NOK. Therefore, we have shown that in descending order, the most influential continent for the Norwegian import of machinery and transport equipment are Europe, Asia and Oceania, and North and Central America.

4.11 Intercontinental variation of import expenditures on food and live animals

The estimates of the estimable function for the two-stage non-full rank hierarchical model reports that the import expenditure for food and live animals contributes with a share of 6.08 % (see Table 1) of the total Norwegian import expenditures. The import expenditure on the item food and live animals from the continents of Europe, Asia and Oceania, North and Central America, South America are the significant items of Norwegian imports across the continents. Table 2 contains multiple comparisons of import-item expenditures across the four continents. At the 5% level of significance, we find that the continent of Europe is the most influential continent. The estimation results show that the import expenditure for food and live animals

from the continent of Europe exceeds the expenditure from the continent of South America, Asia and Oceania, and North and Central America by 17,090.17, 19,220.94, 19,313.77 million NOK, respectively. However, the import expenditure from South America, Asia and Oceania and North America are statistically equal. Therefore, we have shown that in descending order, the most influential continent for the food and live animals are Europe, South America, Asia and Oceania, and North and Central America.

4.12 Intercontinental variation of import expenditures on crude materials, inedible, except fuels

The estimates of the estimable function for the two-stage non-full rank hierarchical model reports that the import of crude materials, inedible, except fuels contributes with a share of 6.7% (see Table 1) of the total Norwegian import expenditures. The import of crude materials, inedible, except fuels from the continents of Europe, North and Central America, South America, and Africa are the significant items of Norwegian imports across continents. Table 2 reports multiple comparisons of import item expenditures across the three continents. At the 5% level of significance, we find that the continent of Europe is the most influential continent. The estimation results show that the import expenditure for crude materials, inedible, except fuels from the continent of Europe and the continent of North and Central America, are the leading continents. Moreover, they are statistically equivalent. The multiple comparison tests show that the import item expenditures on the items from North and Central America exceeds the expenditures from the continent of South America and Africa by 6,027.29 and 6,045.94 million NOK, respectively. The import expenditure from South America and Africa are statistically equivalent. Therefore, we have shown that in descending order, the most influential continent for the item crude materials, inedible, except fuels are North and Central America, Europe, South America and Africa.

5 Conclusions and Recommendations

5.1 Conclusions

In this paper, we applied estimable functions for the two-stage non-full rank hierarchical linear econometric model to evaluate the intercontinental variations of Norwegian import trade. The fitted model's estimation results help us to conclude the following points on Norwegian import expenditures.

The intercontinental variations analysis suggests that the import expenditures for miscellaneous manufactured articles (in descending order from Europe, Asia and Oceania, and North and Central America), mineral fuels, lubricants and related materials (in descending order from Europe, North and Central America and Africa), manufactured goods classified chiefly by material (in descending order from Europe, Asia and Oceania, and North and Central America), machinery and transport equipment (in descending order from Europe, Asia and Oceania, and North and Central America), food and live animals (in descending order from Europe, South America, Asia and Oceania, and North and Central America) and crude materials, inedible, except fuels (in descending order North and Central America, Europe, South America and Africa) over all continents of origin, are the significant items of Norwegian import expenditures.

Six import items from the continent of Asia and Oceania (all except crude materials, inedible, except fuels, mineral fuels, lubricants and related materials, animal and vegetable oils, fats and waxes, commodities and transactions) are significantly affecting the Norwegian import trade in the short run. The test results of comparison suggest that in descending order the most influential items of import from the continent are machinery and transport equipment, miscellaneous manufactured articles, manufactured goods classified chiefly by material, chemicals and related products n.e.s., food and live animals and beverages and tobacco.

Nine import items from the continent of Europe (all except commodities and transactions) are significantly affecting the Norwegian import trade in the short run. The test results of comparison suggest that (in descending order) the most influential items of import from the continent are machinery and transport equipment, manufactured goods classified chiefly by material, miscellaneous manufactured articles, chemicals and related products n.e.s., mineral fuels, lubricants and related materials, food and live animals, crude materials, inedible, except fuels, beverages and tobacco, and animal and vegetable oils, fats and waxes.

Seven import items from the continent of North and Central America (all except beverages and tobacco, animal and vegetable oils, fats and waxes and commodities and transactions) are significantly affecting the Norwegian import trade in the short run. The test results of comparison suggest that the most influential items of import from the continent (in descending order) are machinery and transport equipment, crude materials, inedible, except fuels, chemicals and related products n.e.s., miscellaneous manufactured articles, manufactured

goods classified chiefly by material, and mineral fuels, lubricants and related materials, and food and live animals.

Finally, only two import items from the continent of South America (crude materials, inedible, except fuels and food and live animals) are found to significantly affect the Norwegian import trade in the short run. The test results of comparison suggest that the import of crude materials, inedible, except fuels is the most influential item of import from the continent of South America.

5.2 Recommendations and Policy Implications

The top three Norwegian items of import across continents (in descending order) are machinery and transport equipment, manufactured goods classified chiefly by material and miscellaneous manufactured articles (3M's). The three items cover more than 60% of the Norwegian import expenditures. Furthermore, the model predicts that the European continent is the leading contributor of Norwegian import items. Therefore, even considering structural changes for the European continent, it will be the most influential continent for Norway in the future trade patterns.

The most important output from the analysis of the two-stage non-full rank hierarchical model linear econometric model is the model's ability to identify stability and predictability of future trade patterns. The model identified unique characteristics for the Norwegian imports from the continent of Europe. All the Norwegian import items show both stability and predictability of growth rates. Furthermore, Tesfay and Solibakke (2015) identifies similar characteristics for Norwegian exports to the continent of Europe. These results show firstly the benefits from international trade. Secondly, the practice and the realization of bilateral Norwegian trades with European trading partners are strong. Thirdly, the significant items of Norwegian imports and exports are different. Therefore, the analysis of the two-stage non-full rank hierarchical model linear econometric model for the Norwegian external trade is a typical example explained by the Heckscher-Ohlin theory of international trade.

Most of the import items from other continents show a lack of stability and predictability of the future trade patterns. The results imply that trade stability efforts made by the government (or firms) have low effects. The causes of trade stability can be the degree of bilateral relationship, exchange rate, transportation cost, etc. Therefore, we recommend to the

Norwegian government or concerned bodies to conduct research on [1] the impact of exchange rate and transportation cost, and [2] a country level analysis of the Norwegian external trade. Finally, we recommend that the Norwegian government or any other concerned bodies apply the detailed econometric result from this paper for the future planning of imports and balance of payment across continents.

6 References

- Amiti, M. and D.R. Davis (2008). Trade, Firms and Wages: Theory and Evidence, CEPR Discussion Paper No. DP6872, Centre for Economic Policy Research, London, June.
- Anderson, J (1979). 'A Theoretical Foundation for the Gravity Equation', *The American Economic Review*, 69 (1), 106-116.
- Anderson, J and van E Wincoop (2004). 'Trade costs', *Journal of Economic Literature*, 42 (3), 691-751.
- Antoine Bouët (2008). The Expected Benefits of Trade Liberalization for World Income and Development. International Food Policy Research Institute.
- Arvis, J, M Mustra, J Panzer, L Ojala and T Naula (2007). Connecting to Compete: Trade logistics in the global economy', The World Bank, Washington.
- Balestreri E. (1997). The performance of the Heckscher-Ohlin-Vanek model in predicting endogenous policy forces at the individual level. *Can. J. Econ.* 30:1-17
- Bagwell K, Staiger RW. (1999). An Economic Theory of GATT. *The American Economic Review*, 89:215-248
- Bernard, A, J Jensen, S Redding and P Schott (2007), 'Firms in International Trade', *Journal of Economic Perspectives*, 21 (3), 105-130.
- Besedes, T. and Prusa, T., (2005). Is trade in differentiated goods different? NBER Working Paper No. 9936
- Bhaduri, R., and W. Bengal (2012). International Trade is the Lifeline of Development, *The Journal of Research in Commerce*, 1(1): 1-6.
- Bowen, H. P., Hollander A. and Viane J-M. (1998). *Applied International Trade Analysis*. London: Macmillan Press.
- Carrere, C and M Schiff, (2005). On the Geography of Trade: Distance is Alive and Well', *Revue Economique* 56 (6), 1249-1274.
- Chichilnisky G. (1994). North-South Trade and the Global Environment. *American Economic Review*. 84:851-74
- Deardorff, Alan V. (2000). "Factor Prices and the Factor Content of Trade Revisited: What is the Use?" *Journal of International Economics*, 50(1): 73-90.
- DeGroot M.H. (1986). *Probability and Statistics (2nd Ed)*, Addison-Wesley. ISBN 0-201-11366-X, p. 500
- Douglas A., 2004, *Multilevel modeling (3. repr. ed.)*. Thousand Oaks, CA: Sage.

- Ethier, Wilfred J. (1984). Higher Dimensional Issues in Trade Theory. In Handbook of International Economics, edited by R. W. Jones, and P. B. Kenen, 131-184. Amsterdam: Elsevier.
- Etro, Federico (2006). Simple models of competition, page 6, Dept. Political Economics -- Università di Milano-Bicocca,
- Estevadeordal, A, Frantz, B and Taylor A, (2003) The rise and fall of world trade, 1870-1939, Quarterly Journal of Economics, 118 (2): 359-407
- Finger, J.M. and Yeats, Alexander (1976), "Effective Protection by Transportation Costs and Tariffs: A Comparison of Magnitudes", Quarterly Journal of Economics, 169-176.
- Fabio H. N. (1999). A comment about estimable functions in linear models with non-estimable constraints. Revista Colombiana de Estadística Vol22 No. 2. pp. 1 a 3.
- Feenstra, R. C. and Gordon H. H. (2000). Aggregation Bias in the Factor Content of Trade: Evidence from U.S. Manufacturing." American Economic Review, 90(2)
- Feenstra R. C (1994). New product varieties and the measurement of international prices American Economic Review, 84 (1) , pp. 157-177
- Filanlyason, J., Zakher M. (1981). The GATT and the regulation of Trade Barriers: Regime Dynamic and Functions; International Organization, Vol. 35, No. 4, 1981
- Frieden, J., Lake, D. (1995). International political economy: perspectives on global power and wealth, London: Routledge
- Greene, W.H. (2012). Econometric Analysis (7th ed.), Prentice HALL
- Grossman, G. and Maggi, G. (1997). 'Free Trade vs. Strategic Trade: A Peek into Pandora's Box', NBER Working Paper, No. W621.
- João Amador, Sónia Cabral and José Ramos Maria (2007). International Trade Patterns Over The Last Four Decades: How Does Portugal Compare With Other Cohesion Countries?. Estudos e Documentos de Trabalho Working Papers available at: www.bportugal.pt/en-US/BdP%20Publications%20Research/WP200714.pdf
- Hausman, R. and Rodrik, D. (2003). 'Economic development as self-discovery', Journal of Development Economics 72, 2: 603-633.
- Hazewinkel, Michiel, (2001). Chi-squared distribution", Encyclopedia of Mathematics, Springer, ISBN 978-1-55608-010-4
- Helpman, E, M Melitz and Y Rubinstein (2008), 'Estimating Trade Flows: Trading Partners and Trading Volumes', Quarterly Journal of Economics, 123 (2), 441-487.

- Helpman, E. (1981). "International Trade in the Presence of Product Differentiation, Economies of Scale, and Imperfect Competition: A Chamberlin-Heckscher-Ohlin Approach," *Journal of International Economics*.
- Herzing, M. (2004). *Essays on Uncertainty and Escape in Trade Agreements*, Dissertation at Stockholm University. Stockholm, Sweden.
- Hummels, D (2007). 'Transportation Costs and International Trade in the second era of Globalization', *Journal of Economic Perspectives* 21 (3), 131–154
- Karacaovali, B. and Limão, N. (2005). 'The Clash of Liberalization: Preferential versus Multilateral Trade Liberalization in the European Union', *The World Bank Policy Research Working Papers Series N. 3493*
- Knight K. (2000). *Mathematical Statistics*, Chapman and Hall, New York.
- Krugman, P. (1994). *Peddling Prosperity: Economic Sense and Nonsense in the Age of Diminished Expectations*, New York, W.W. NORTON & Company, 1994.
- Krugman, P. (1993). The Narrow and Broad Arguments for FREE TRADE, *American Economic Review, Papers and Proceedings*, 83(3),
- Krugman, P. (1980). Scale Economies, Product Differentiation and the Pattern of Trade. *American Economic Review*.
- Magnus, J. R. & Neudecker, H. (1988). *Matrix Differential Calculus with Applications in Statistics and Econometrics*, John Wiley & Sons, New York.
- Martin, T. L. (2001). Protection or free trade: An analysis of the ideas of Henry George on international commerce and wages - *International Trade. The American Journal of Economics and Sociology*, 60, 119-136.
- Niehans, Jürg. (1987). "Transaction costs," *The New Palgrave: A Dictionary of Economics*, v. 4, pp. 677–80.
- Oatley T. (2010). *Real Exchange Rates and Trade Protectionism*, Business and Politics. 12
- Ossa R. (2011). A "New Trade" Theory of GATT/WTO Negotiations. *Journal of Political Economy* 119:122-152
- Patrick and Ralph. (2009), "Protectionism? Tariffs and Other Barriers to Trade", in *International Trade: Free, Fair and Open?*, OECD Publishing.
- Rao, C.R. (1973). *Linear statistical inference and its applications* (2nd ed.). New York: John Wiley & Sons.
- Raymond J. Ahearn. (2011). *Rising Economic Powers and the Global Economy: Trends and Issues for Congress*. Congressional Research Service. Available at www.crs.gov

- Richard W. H. (1991). Random variables, mean and the expected value. The art of probability for scientists and engineers. Addison-Wesley. p. 64 ISBN 0-201-40686-1.
- Roorbach, G. (1993). Tariffs and Trade Barriers in Relation to International Trade; Proceedings of the Academy of Political Science, Vol. 15, No 2, 1993
- Samuelson, Paul. (2001). "A Ricardo-Sraffa Paradigm Comparing the Gains from Trade in Inputs and Finished Goods". Journal of Economic Literature 39 (4): 1204–1214. doi:10.1257/jel.39.4.1204.
- Searle, S. R. (1987), Linear Models for Unbalanced Data, John Wiley & Sons, NY
- Searle, S. R. (1971). Linear Models, John Wiley & Sons
- Sheldon M.R. (2007). Expectation of a random variable. Introduction to probability models (9th ed.). Academic Press. p. 38 ff. ISBN 0-12-598062-0.
- Staiger, Robert and Alan Sykes, (2010). Currency manipulation and world trade, World Trade Review. 9(4): 583-627.
- Tesfay, Yohannes Yebabe (2015). A new econometric model to analyse variations and structural changes in international trade: applications to the Norwegian import trade across continents and over time." International Journal of Trade and Global Markets 8.4: 343-370.
- Tesfay, Yohannes Yebabe, and Solibakke, Per Bjarte (2015). "Econometric Modelling of the Variations of Norway's Export Trade across Continents and over Time: The Two-Stage Non-Full Rank Hierarchical Linear Econometric Model Approach." Economics Research International 2015.
- WTO (2013). International Trade Statistics 2013. Available at www.wto.org/statistics
- WTO (2011). Panel Report on "China - Measures Related to the Exploitation of Several Raw Materials". Geneva, WTO.
- WTO (2010). World Trade Report 2010: Trade in Natural Resources. Geneva, WTO.
- WTO (2006). World Trade Report 2006: Subsidies, Trade and the WTO. Geneva, WTO.

Table 1: Estimates of the Estimable functions of Norwegian imports across Continents

Source of variation	Items of Import	Estimates of Expenditure	Estimates of Share	SS	DF	MS	F-Cal	P-Value
Model	All Items of Import	492801.50		1.72E+11	50	3.43E+09	606.49	0.0000**
Africa	Food and live animals	843.82	0.17%	4272232	1	4272232	0.76	0.19283
Asia and Oceania	Food and live animals	1983.13	0.40%	23596804	1	23596804	4.17	0.0244**
Europe	Food and live animals	21204.06	4.30%	2.70E+09	1	2.70E+09	476.87	0.0000**
North and central America	Food and live animals	1890.29	0.38%	21439242	1	21439242	3.79	0.0310**
South America	Food and live animals	4113.89	0.83%	1.02E+08	1	1.02E+08	17.95	0.0000**
Across Continents	Subtotal food and live animals	30035.20	6.08%					
Africa	Commodities and transactions	1.58	0.00%	15.0575	1	15.0575	0	0.49935
Asia and Oceania	Commodities and transactions	3.92	0.00%	92.08084	1	92.08084	1.63E-05	0.4984
Europe	Commodities and transactions	1181.50	0.24%	8375628	1	8375628	1.48	0.156109
North and central America	Commodities and transactions	14.27	0.00%	1221.997	1	1221.997	0	0.4941
South America	Commodities and transactions	8.57	0.00%	440.738	1	440.738	0	0.4965
Across Continents	Subtotal Commodities and transactions	1209.84	0.24%					
Africa	Beverages and tobacco	44.77	0.01%	12028.18	1	12028.18	0	0.48162
Asia and Oceania	Beverages and tobacco	1903.48	0.39%	21739310	1	21739310	3.84	0.0299**
Europe	Beverages and tobacco	4755.89	0.97%	1.36E+08	1	1.36E+08	23.99	0.0000**
North and central America	Beverages and tobacco	170.32	0.03%	174044.6	1	174044.6	0.03	0.4305
South America	Beverages and tobacco	124.69	0.03%	93284.58	1	93284.58	0.02	0.4489
Across Continents	Subtotal Beverages and tobacco	6999.14	1.43%					
Africa	Crude materials, inedible, except fuels	5124.50	1.04%	1.58E+08	1	1.58E+08	27.85	0.0000**
Asia and Oceania	Crude materials, inedible, except fuels	923.03	0.19%	5111855	1	5111855	0.9	0.1714
Europe	Crude materials, inedible, except fuels	10665.70	2.16%	6.83E+08	1	6.83E+08	120.65	0.0000**
North and central America	Crude materials, inedible, except fuels	11170.44	2.27%	7.49E+08	1	7.49E+08	132.34	0.0000**
South America	Crude materials, inedible, except fuels	5143.15	1.04%	1.59E+08	1	1.59E+08	28.06	0.0000**
Across Continents	Subtotal Crude materials, inedible, except fuels	33026.82	6.70%					
Africa	Mineral fuels, lubricants and related materials	1917.43	0.39%	22059319	1	22059319	3.9	0.0289**
Asia and Oceania	Mineral fuels, lubricants and related materials	172.36	0.03%	178252	1	178252	0.03	0.4296
Europe	Mineral fuels, lubricants and related materials	26587.45	5.40%	4.24E+09	1	4.24E+09	749.75	0.0000**
North and central America	Mineral fuels, lubricants and related materials	1973.77	0.40%	23374711	1	23374711	4.13	0.0251**
South America	Mineral fuels, lubricants and related materials	279.37	0.06%	468274.4	1	468274.4	0.08	0.3869
Across Continents	Subtotal Mineral fuels, lubricants and related materials	30930.39	6.28%					
Africa	Animal and vegetable oils, fats and waxes	72.00	0.01%	31099.97	1	31099.97	0.01	0.47048
Asia and Oceania	Animal and vegetable oils, fats and waxes	146.39	0.03%	128582.2	1	128582.2	0.02	0.4401
Europe	Animal and vegetable oils, fats and waxes	2979.56	0.60%	53266732	1	53266732	9.42	0.0013**
North and central America	Animal and vegetable oils, fats and waxes	202.61	0.04%	246311.4	1	246311.4	0.04	0.4174
South America	Animal and vegetable oils, fats and waxes	732.93	0.15%	3223151	1	3223151	0.57	0.2255
Across Continents	Subtotal Animal and vegetable oils, fats and waxes	4133.49	0.83%					

Table 1 continued

Source of variation	Items of Import	Estimates of Expenditure	Estimates of Share	SS	DF	MS	F-Cal	P-Value
Africa	Chemicals and related products n.e.s.	95.99	0.02%	55283.14	1	55283.14	0.01	0.46067
Asia and Oceania	Chemicals and related products n.e.s.	3372.95	0.68%	68260784	1	68260784	12.07	0.0003**
Europe	Chemicals and related products n.e.s.	39107.03	7.94%	9.18E+09	1	9.18E+09	1622.07	0.0000**
North and central America	Chemicals and related products n.e.s.	4792.98	0.97%	1.38E+08	1	1.38E+08	24.37	0.0000**
South America	Chemicals and related products n.e.s.	269.42	0.05%	435509.3	1	435509.3	0.08	0.3908
Across Continents	Subtotal Chemicals and related products n.e.s.	47638.37	9.66%					
Africa	Manufactured goods classified chiefly by material	444.31	0.09%	1184444	1	1184444	0.21	0.32384
Asia and Oceania	Manufactured goods classified chiefly by material	10312.90	2.09%	6.38E+08	1	6.38E+08	112.8	0.0000**
Europe	Manufactured goods classified chiefly by material	60208.54	12.22%	2.18E+10	1	2.18E+10	3844.83	0.0000**
North and central America	Manufactured goods classified chiefly by material	2376.35	0.48%	33882336	1	33882336	5.99	0.0083
South America	Manufactured goods classified chiefly by material	443.32	0.09%	1179213	1	1179213	0.21	0.3242
Across Continents	Subtotal Manufactured goods classified chiefly by material	73785.42	14.97%					
Africa	Machinery and transport equipment	420.83	0.09%	1062594	1	1062594	0.19	0.33255
Asia and Oceania	Machinery and transport equipment	43904.87	8.91%	1.16E+10	1	1.16E+10	2044.5	0.0000**
Europe	Machinery and transport equipment	130328.57	26.45%	1.02E+11	1	1.02E+11	18015.23	0.0000**
North and central America	Machinery and transport equipment	17677.49	3.59%	1.87E+09	1	1.87E+09	331.44	0.0000**
South America	Machinery and transport equipment	168.46	0.03%	170281.1	1	170281.1	0.03	0.4312
Across Continents	Subtotal Machinery and transport equipment	192500.22	39.07%					
Africa	Miscellaneous manufactured articles	342.33	0.07%	703123.9	1	703123.9	0.12	0.36236
Asia and Oceania	Miscellaneous manufactured articles	22999.19	4.67%	3.17E+09	1	3.17E+09	561.03	0.0000**
Europe	Miscellaneous manufactured articles	44683.35	9.07%	1.20E+10	1	1.20E+10	2117.64	0.0000**
North and central America	Miscellaneous manufactured articles	4436.45	0.90%	1.18E+08	1	1.18E+08	20.88	0.0000**
South America	Miscellaneous manufactured articles	81.30	0.02%	39657.98	1	39657.98	0.01	0.4667
Across Continents	Subtotal Miscellaneous manufactured articles	72542.61	14.73%					

Table 2: Inter-continental multiple comparisons of significant Norwegian import items across continents

Items of Import	Comparison of the effect of import items to continent i to continent i'	Difference	SS	DF	MS	F-Cal	P-Value
Miscellaneous manufactured articles	Europe Vs. Asia and Oceania	21684.16267	2821217463	2	1410608732	249.3537	0.00000**
	Europe Vs. North and Central America	40246.89617	9718875906	2	4859437953	859.0042	0.00000**
	Asia and Oceania Vs. North and Central America	18562.7335	2067450450	2	1033725225	182.7319	0.00000**
Mineral fuels, lubricants and related materials	Europe Vs. North and Central America	24613.67467	3634997884	2	1817498942	321.2798	0.00000**
	Europe Vs. Africa	24670.015	3651657841	2	1825828920	322.7523	0.00000**
	North and Central America Vs. Africa	56.340333	19045.39874	2	9522.699368	0.001683	0.99830
Manufactured goods classified chiefly by material	Europe Vs. Asia and Oceania	49895.6405	14937449645	2	7468724823	1320.249	0.00000**
	Europe Vs. North and Central America	57832.18417	20067369153	2	10033684577	1773.657	0.00000**
	Asia and Oceania Vs. North and Central America	7936.543667	377932352.3	2	188966176.1	33.4036	0.00000**
Machinery and transport equipment	Europe Vs. Asia and Oceania	86423.69783	44814333283	2	22407166641	3960.921	0.00000**
	Europe Vs. North and Central America	112651.0757	76141589094	2	38070794547	6729.785	0.00000**
	Asia and Oceania Vs. North and Central America	26227.37783	4127252088	2	2063626044	364.7877	0.00000**
Food and live animals	Europe Vs. South America*	17090.17333	1752444148	2	876222073.8	154.89	0.00000**
	Europe Vs. Asia and Oceania*	19220.93567	2216666207	2	1108333104	195.9203	0.00000**
	Europe Vs. North and Central America	19313.77183	2238130695	2	1119065347	197.8175	0.00000**
	South America Vs. Asia and Oceania	2130.762333	27240888.72	2	13620444.36	2.40769	0.09037
	South America Vs. North and Central America	2223.5985	29666341.74	2	14833170.87	2.622064	0.07312
	Asia and Oceania Vs. North and Central America	92.836167	51711.32342	2	25855.66171	0.004571	0.99540
Crude materials, inedible, except fuels	North and Central America Vs. Europe*	504.742	1528586.919	2	764293.4597	0.135104	0.87275
	North and Central America Vs. South America	6027.291167	217969432.9	2	108984716.4	19.26526	0.00000**
	North and Central America Vs. Africa	6045.9425	219320524.3	2	109660262.1	19.38467	0.00000**
	Europe Vs. South America	5522.549167	182991295.8	2	91495647.91	16.17371	0.00000**
	Europe Vs. Africa	5541.2005	184229417.9	2	92114708.94	16.28314	0.00000**
	South America Vs. Africa*	18.651333	2087.233336	2	1043.616668	0.000184	0.99981
Chemicals and related products n.e.s.	Europe Vs. North and Central America	34314.04267	7064721145	2	3532360572	624.4163	0.00000**
	Europe Vs. Asia and Oceania	35734.0755	7661544911	2	3830772456	677.1667	0.00000**
	North and Central America Vs. Asia and Oceania	1420.032834	12098959.5	2	6049479.749	1.069368	0.34187
Beverages and tobacco	Europe Vs. Asia and Oceania	2852.409667	48817445.45	2	24408722.73	4.314737	0.01390**

** Significant at 5% level of significance, Estimates of the estimable function of the deference is in million NOK