Master's degree thesis

LOG950 Logistics

Econometric Evaluation of the Import Trade of Norway

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Number of pages including this page: 169

Molde, May 2014

Molde University College
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Preface

This thesis proposes to show variation, structural changes, concentration and dynamics of Norwegian imports.

This thesis is supervised by Professor Per Bjarte Solibakke.

In this thesis, we employ different econometric models on annually collected data import from 1988 to 2014 from Statistics Norway (www.ssb.no). The data can be downloaded from Statbank Norway (www.ssb.no/en/statistikkbanken).

This thesis composed of three papers to evaluate the import trade of Norway. We have applied a deductive philosophy of analysis to evaluate the Import Trade of Norway. That is we started the evaluation from continental trade pattern level to country level trade pattern analysis. The first paper is intended to evaluate the overall continental and item based trade pattern of Norway by applying two stage non-full rank hierarchical linear econometric model. In addition to showing the overall variations, the model can able to show potential structural changes on the trade pattern. The second paper is proposed to assess the intra-continental and inter-continental variations of the trade pattern of Norway by applying estimable functions of the two stage non-full rank hierarchal linear econometric model. The third paper is trying to estimate the trade concentration of Norway, both continent level and country level using Random Effect Multivariate Analysis of Variance (MANOVA). In this paper, we employed smilingly unrelated regression (SUR) model to analyze the structure of the trade concentration of the Norwegian imports.

The thesis is evaluated by Professor Sjur Westgaard at the Norwegian University of Science and Technology, Trondheim, Norway and Professor Per B Solibakke at the Molde Molde University College.

My MSc study has been financed by the Quota Scholarship from the Norwegian State Educational Loan Fund (Lånekassen).

Summary

In this paper, we have used the two stage non-full rank hierarchical linear econometric model to evaluate the variation of the Norwegian import trade across continents and over time. The model is hypothesized to show structural changes, influential import items and continents of origin. The analysis uses two factors, the origin continents and the items of import.

Using the Heckscher-Ohlin trade model and we set the items of import as the nested and the continents of origin the nesting factor. The fit of the model shows that the expenditure of import trade is heterogeneous over both the destination continent and the import item. The estimation result confirms that the Norwegian import trade is sustainable in the short and long run after controlling for the effect of the import item and the continent of origin. The assessment of structural continental share changes shows considerable dynamics. In this circumstance, most econometric models will fail to capture the trade pattern variation. Therefore, by using statistical and economic criteria, we find that the estimates of the estimable functions for the post 2008 import trade pattern is preferred for evaluation of continental import variations. The estimation results confirm that the import trade of Norway is truly international when we evaluate it with respect of continents. Europe (69.3 %), Asia and Oceania (17.4%), North and Central America (9.1%), South America (2.3%) and Africa (1.9%). The influential items of Norwegian imports are machinery and transport equipment (39.06%), manufactured goods classified chiefly by material (14.97 %), miscellaneous manufactured articles (14.72%), and chemicals and related products (9.67%) and the rest items cover a share of 21.58%.

The analysis of the intra-continental and inter-continental variations of the expenditure of the Norwegian imports by deriving the best linear unbiased estimator (BLUE) of estimable functions of the two-stage non-full-rank hierarchical-linear econometric model showed that the intra-Europe variation of Norwegian import-item expenditures can be characterized as highly configured, stable and standardized. Furthermore, the model predicts that Europe is the leading continent for Norwegian import-items also for the future.

The analysis of concentration and the dynamics of Norwegian imports by applying the two-way MANOVA model suggests that Norwegian import trade shows considerable

dynamics across continents and over business cycles. In order to analyze the structure of the concentration of the Norwegian imports we have applied a seemingly unrelated regression (SUR) model using regressors of revenue collected from export and number of Norwegian export countries. The result shows that the Norwegian import from the continent of Africa is increasing in the extensive margin. The Norwegian import from the continent of Asia and Oceania is increasing in the intensive margin. The Norwegian import from the continent of Europe is increasing in both the extensive and the intensive margin. The Norwegian import from the continent of North and Central America shows stagnation for both the extensive and the intensive margin. The Norwegian import from the continent of South America is increasing in the intensive margin. The overall analysis shows that the Norwegian bilateral trade with European countries benefits Norway.

Acknowledgements

First of all, I want to thank for God, who gave me space to live and time to think. I want also to thank the mother of Jesus Christ, St Marry, St Gabriel, St Mikael all people who worship God and who respect his commandments. Secondly, I want to express my entire appreciation about my supervisor Professor Per Bjarte Solibakke for his innovative ideas, critical evaluation, positive comments, constructive suggestions and on time responses. Without his continuous support, this thesis cannot be realized. I found my supervisor is real example of being an academician. I wish him all the best in his professional career. Equivalently, I would like to thank Associate Professor Arild Hoff for his positive support. Thirdly, I want to thank all my course instructors who conveyed me fundamental value added knowledge in the course matter. I would like to thank all the members of the Made University College. Furthermore, we would like to thank all the scholars referenced in the paper.

I would like to thank my mother Birhan Endalew Berhe, my father Yebabe Tesfay Gebremariam. I would also like to thank my aunt Shashitu Endalew Berhe my uncle Amare Endalew Berhe and all his families, Mr. Kassahun Ayele and all his families, and Mr. Dessalegn Asfaw and all his families for their continuous support.

I would like to thank my academic role model and brother Engineer Samuel Hailemikael; my best friends Mr. Alemayehu Befkadu, Mr. Eyob Tadesse Birke, Mr. Wondosesn Kassahun, Mr. Yonas Amde, Mr. Assefa Nuru, Mr. Hīkā Dhugāsā, Mr. Tewodros Zewdu, Engineer Yonas Kassaw, Mr. Getnet Yitagesu, Mss. Zebib Melke, Mss. Nani Mesfin, Mr. Abebaw Tadesse, Mr. Kassahun Tesfaye, Mr. Tesfa Sintayehu, Mr. Dereje Massa and Mr. Tariku Mekonnen for their unremitting support and reinforcement for the completion of this thesis. Furthermore, I would like to thank all my high Scholl the teachers at Tikur Anbessa High Scholl, Addis Ababa Ethiopia.

Finally, my deepest gratitude goes to my little brothers, Thomas Hailemikael and Lidetu Amare who gave me real adoration. I would also like to thank my former genius students Dr Kaleb Girma, Engineer Abinet Tesfaye, Engineer Lemma Tuffa and Engineer Ayalew Shura for their continuous encouragement.

Molde, May 2014

Yohannes Yebabe Tesfay

Dedication

I would like to dedicate this thesis to the memory of thank my mother Birhan Endalew Berhe, my father Yebabe Tesfay Gebremariam, my aunt Shashitu Endalew Berhe, my uncle Moges Gezahegn; my Brothers Abebe Endalew Berhe, Mr. Ermias Molla, Mr. Ashenafi Molla; and the 30 brave Ethiopian-Christians who killed by ISIS in Libya in April 2015.

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Paper 1

Paper 1

Modelling Variations and Structural Changes of Norway's Import Trade across Continents and over Time: The two stage non-full rank hierarchical linear econometric model approach

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Abstract

This paper proposes to apply a new econometric model to assess Norwegian imports over the world's continents. The paper applies the two-stage non-full rank hierarchical linear econometric model for yearly import data ranging from 1988 2014 (26 years). The econometric model can give important information about the Norwegian import pattern without using other predictor variables. Furthermore, the model incorporates the Hecksher-Ohlin theory of international trade and can show the overall trade pattern and the potential structural changes on the trade pattern. The results suggest first that the Norwegian import expenditure shows heterogeneity across world continents. The continent of Europe has a market share alone of 69.3%. Moreover, more than 95% of Norwegian imports are dependent on imports from the three continents of Europe, Asia and Oceania, and North and Central America. Second, the results suggest potential structural changes over both continents and items for Norwegian imports.

Keywords: *import trade, continental variations, items of import, two-stage non-full rank hierarchical linear econometric model and Norway.*

1. Introduction

In the absence of international trade in today's global economy, hardly any nation can run its economy proficiently and meritoriously, and maintain the standard of living for its population. Therefore, nations by means of accessible domestic resources can produce merchandises subject to both available and sustainable resources. That is, one nation having an abundance of natural resources and another skilled work force, the metaphor is crucial for international cooperation and international trade for the benefits of one to the other (Lionel 1954).

Every nation intentionally participates in the international trade at diverse arenas for the purpose to sell what it produces, to acquire what it lacks, and overall national industries, produce efficiently and effectively relative to potential trade partners. In most countries, international trade represents a significant share of gross domestic product (GDP). By delineating, the international trade is ultimately a transaction and give-and-take (demand and supply) of goods and services across national boundaries. Specifically, international trade is the exchange of capital, goods, and services across international borders or territories; import is defined as an inbound trade and export is defined as an outbound trade (John 1965, McKenzie 1954).

Generally, nations participate in international trade for two fundamental reasons. First, nations trade for economic independence and establish a complementary industrial structure. Consequently, individual nations can benefit from their fundamental differences by reaching an arrangement in the international trade where exchange of goods and services for every nation divide comparatively industrial production of goods or service. Second, economies of scale and the implicit reduction in unit production costs play a central role in bringing nations together in international trade. If each nation specializes industry production and engage in international trade, the obtained large-scale production with reduced unit production costs will generate and improve resource efficiency. In the real world, international trade patterns reflect the combination and interaction of both economic dependence and economies of scale (Ian 1979).

Felbermayer and Kohler (2006) present detailed evidence that the post II-war increase of world trade took place through both the larger quantities traded between countries (the country intensive margin) and an increase in the number of country pairs that engage in trade (the country extensive margin). Growth in trade is therefore driven by changes in both the extensive and intensive margin. Differences at the extensive margin generally contribute more to explaining trade patterns while distance and other non-tariff barriers affect the extensive margin.

The prediction made by Felbermayer and Kohler (2006) is highly realistic and robust. For example in 2008, the World's nations produced goods and services worth about $50 trillion. About 32 percent, about $16 trillion, of this overall World outputs were traded in the international market. Moreover, active international trade make it possible for nations to trade a wide variety of resources, goods and services from distinct and different geographical regions. International trade is therefore a vigorous constituent of a government's growth and affluence schemes (Krugman et al. 2012).

The post-World-War II economic expansion was named the Golden Age of Capitalism, also known as the post-war economic boom (Frances and Alec 1994). According to Crafts and Toniolo (1996), the Golden Age of Capitalism is the period of economic prosperity in the mid-20th century and lasted until the early 1970s. The period recorded high international economic growth. Terborch (2003) mentioned that during the two decades after the Second World War, international trade evolved at the most favourable in the twentieth century. From 1948 and 1968, the total volume of merchandise exports from non-Communist countries raised by a noteworthy 290 per cent. In particular, USA, Western European and East Asian countries experienced extraordinary growth figures.

In international economists named the post-World-War II economic expansion was named the Golden Age of Capitalism, also known as the post-war economic boom (Frances and Alec 1994). According to Crafts and Toniolo (1996), the Golden Age of Capitalism is the period of economic prosperity in the mid-20th century and lasted until the early 1970s. The period recorded high international economic growth. Terborch (2003) mentioned that during the two decades after the Second World War, international trade evolved at the most favourable in the twentieth century. From 1948 and 1968, the total volume of merchandise exports from non-Communist countries raised by a noteworthy 290 per cent. In particular, USA, Western European and East Asian countries experienced extraordinary growth figures.

In the 1970s, international economists observed important factors that negatively affected the growth of international trade. The downfall of the Bretton Woods system in 1971 (Bordo and Eichengreen 1993), the 1973 oil crisis (Perron 1988), and the 1973–1974 stock market crash (Philip 2003), led to the 1970s depression. This twist of fate leads to think and the task of each nation how to maximize their benefits from international trade. The important tasks for each nation are: what is the competitive advantage of the nation in international trade? Which nations are the most important to determine the international trade of that nation? Where is the stage and

the level of participation of the nation in the international trade in the short and long run? What are the possible constraints to cope up with the international trade for a nation? How can the exchange rate changes affect the benefits of participation in international trade? And so on.

1.1 The Problem

The main objective of this paper is the identification of the continental variation of Norwegian import trade with respect of import items. The evaluation of the contemporaneous trade performance is the starting point to improve the understanding of the Norwegian import trade patterns and adapt to future international trends. This paper therefore analyses and explores the most important Norwegian import trade items over time and across the World's continents. An analysis of these factors can shed light on how and why trade performance has differed, shifted, and whether the pre-2008 growth pattern in international trade are likely to continue. Recently, global trade patterns include a shift of market shares towards emerging economies, in particular China. However, developed countries, especially in the EU, retain a clear advantage in high-end goods. The analysis is an attempt to analyse the influence of these shifts.

In the international trade, gravity model is a famous model to give econometric explanation of the determinant of bilateral trade. The model is founded on the philosophy of the Newton Gravitational equation, and use variables such as gross domestic product (GDP), gross national product (GNP) per capita, population size, colony, bilateral exchange rate, common currency, distance between capital cities, common language, and membership of a trading partnership to identify determinants. For example, the negative "gravity" relationship between trade and distance is driven almost entirely by the extensive margin. That is, both the number of trading firms and the number of traded products decline significantly with geographical distance. Moreover, most studies find a strong response to the extensive margin to changes in trade barriers or country size (Alan 1998; Jeffrey 1985).

As this paper analyses empirically the Norwegian import trade variations over both import items and continents of origin, the gravity model has a number of limitations. First, in time series trade data factors like structural change, price volatility, changes in demand (substitutes) are important for a nation's import trade. The gravity model will ignore these factors. Second, the gravity model hypothesised that the strength of the bilateral trade is negatively correlated with the distance between the capital cities of the trading partners. However, the model ignores the fluctuation of transportation cost which is negatively correlated with the geographical coverage of the flow of

goods. Besides, in reality the impact of the import/ export items distance from origin to destination will not addressed by the gravity model. For example, for a long period most of the production of oil in the world took place in the Middle East. Nevertheless, most of the goods that are transporting large distances are traded in the USA. Third, the gravity model becomes illogical for the analysis of the import of high value to volume ratio products and low cost countries. Moreover, in this context, the gravity model ignores an important aspect of the emergence of new competent importer and importer nations. For example, the emergence of China in the global economy made shifts of direction of the international trade. More importantly, the gravity model tried to identify the contributing factors of the bilateral trade between national trading partners. However, in the modern globalized world the economic dependence governs the bilateral trade between the nations. Fourth, the interpretation of the results from the gravity model for countries that have a high or low share in the international trade is similar. In this context the solution of the gravity model for how to characterize the strength of the import trade for a given nation, is weak. Specifically, the solution of the gravity model will push us in the aggregate prediction about the import sector of the given nation. Hence, there will be a lot of hidden trade information. It is the characteristics of strong nations that in order to be competent and consequently improve their shares in the international trade, each nation has their own internal assignment of origin and destination. Among the internal assignments, it is vital to identify the characteristics of the generated import trade expenditure (Mele and Baistrocchi 2012; Huang 2005; Baier and Bergstrand 2001; Anderson 1979; Carolyn. 2000; Paul 2000; Porojan 2000).

Furthermore, economists of international trade use descriptive statistical analysis to see the import and export of the given nation (UNDP 2013). However, the use of statistical analysis is limited to forecast and predict the short and the long run imports and exports trade pattern of a given nation (Prem 1995). Time series econometric models are good for forecasting (Gershenfeld 1999). However, the forecasting powers of time series econometric models are limited if structural breaks can randomly occur in the international trade (Bordo and Eichengreen 1993, Perron 1988, Philip 2003). Therefore, in order to evaluate the continental variation of the import trade of Norway, this paper makes a thorough analysis using the expenditure to import different items (category of similar items) and their destinations (country or continent wise). The analysis framework, once structured, may produce a solution by using the hierarchical model. The important advantages of this model for the analysis of import trade variation for a given country are (1) the model allows determination of the intra and inter variation of the import items across their origin, (2) the model enables precise estimators by providing large degrees of freedom to the items of import. Moreover, based on the characteristics of the expenditure to import items, the

model allows us to (3) quantify the sustainability of the items of imports (nested factors) from the origins (nesting factor), and (4) enables us to compare a given item of imports across different origins (Seltzer et al 2002, Draper 1995, Goldstein 1986, Giesbrecht and Burns 1985, Bryk and Raudenbush 1992).

Furthermore, economists of international trade use descriptive statistical analysis to see the import and export of the given nation (UNDP 2013). However, the use of statistical analysis is limited to forecast and predict the short and the long run imports and exports trade pattern of a given nation (Prem 1995). Time series econometric models are good for forecasting (Gershenfeld 1999). However, the forecasting powers of time series econometric models are limited if structural breaks can occur randomly in international trade (Bordo and Eichengreen 1993, Perron 1988, Philip 2003). Therefore, in order to evaluate the continental variation of the import trade of Norway, this paper makes a thorough analysis using the expenditure of import items (category of similar items) and their origins (country or continent wise). The analysis framework, once structured, may produce a solution by using the hierarchical model. The important advantages of this model for the analysis of import trade variation for a given country are: (1) the model allows determination of the intra and inter variation of the import items across their origin, (2) the model enables precise estimators by providing large degrees of freedom to the items of import. Moreover, based on the characteristics of the expenditure to import items, the model allows us to (3) quantify the sustainability of the items of imports (nested factors) from the origins (nesting factor), and (4) enables us to compare a given item of imports across different origins (Seltzer et al 2002, Draper 1995, Goldstein 1986, Giesbrecht and Burns 1985, Bryk and Raudenbush 1992).

The economics of the international trade can be classified into two broad subfields: the analysis of international trade and the analysis international money. Explorations and analyses of international trade investigate primarily real transactions. That is, the field of international trade concentrates on those transactions that encompass a physical movement of goods or a tangible commitment of economic resources. This study in the field of international trade, attempts to extract rigours information from the Norwegian import trade pattern. The objective is therefore to apply our econometric model to give quantitative information about the import variation based on the expenditure on Norwegian import items across continents. Specifically, the paper tries to give econometric evaluation for: [1]. Assess whether continental or import item effects exist on the expenditure of imported goods. [2]. Identify and quantify potential structural changes on the pattern of the Norwegian import trade. [3]. Quantify short run and long run sustainability of the

general import trade pattern of Norway, and [4]. Identify important import items together with origin continents.

The economics of the international trade can be classified into two broad subfields: the analysis of international trade and the analysis international money. International trade exploration and analysis emphases primarily on the real transactions in the international economy. That is, the field of international trade concentrates on those transactions that encompass a physical movement of goods or a tangible commitment of economic resources. The international monetary analysis focuses on the monetary side of the international economy, that is, on fiscal transactions such as foreign purchases, exchange rates and other related issues (Thompson 2011; Charles 2007). This study is in the field of international trade and attempt to extract rigours information from the Norwegian import trade pattern. The objective of this study is therefore to apply econometric model to have quantitative information about the variation of the import trade of Norway based on the expenditure to import items across continents. Specifically, the paper tries to give econometric evaluation for:

- Evaluate whether continental or import item effects exist on the expenditure of imported goods or not.
- Identifying and quantifying potential structural changes on the pattern of the import trade of Norway.
- Evaluating and quantifying short run and long run sustainability of general import trade of Norway. That is to assess whether the average expenditure of the country's imported goods is consistent or not.
- Evaluating and quantifying the important items of imports with their origin continents.

1.2 Outcomes of the study

This study will apply advanced linear econometric model to assess the overall continental variations of Norway's import trade. We have already seen the benefits of analysing our problem using hierarchical linear model. Consequently, our analysis will provide the following important policy implications:

- Empathy of imperative items of import with respect of the origin continent with efficient estimate of standard error.
- Systematically evaluate dependability and the underlying forces of the trade patterns of the items of import with respect of the origin continent and their implications.
- Providing rudimentary information how to analyse bilateral, trilateral, or multilateral trade of Norway to conduct further research on similar area.

- Providing preliminary econometric framework about how to analyse the balance of payment of Norway's external trade.

2. Literature review

2.1 Globalization and International Trade

The term globalization describes a process by which national and regional economies, the social order, and cultures have become assimilated through the global trade, communications, transportation and immigration. Due to globalization in the last twenty years the breadth and depth of links between nations and between regions has grown enormously (Grossman and Helpman 1991).

The remuneration from globalization for developing nations is a faster catch up to industrialized nations through increased employment and technological advances. Globalization causes nations to get a much wider diversity of products to choose from by a more competitive price, extensive markets and the dropping of international barriers and obstacles by making trade unions. One positive side of globalization is disseminated knowledge and efficient usage of resources for the production of goods and services (Friedman 2000).

Globalization has numerous designations, depending on the subject being explained. For international economists it has a humble definition, notwithstanding one with powerful implications. Globalization occurs when the markets of different countries become more assimilated and interrelated through economic transactions that cross national borders. Economic globalization encompasses the globalization of competition of corporations and industries through technology, markets and production (Brady 2011). The economic globalization is centred on the diminution of international trade regulations as well as prices, tariffs, duties, and other impediments that suppresses global trade. International trade therefore, is the real part of economic globalization that is concerned with the exchange of goods or services across national jurisdictions (Erreygers and Miekee 2012).

International trade has full-fledged enormously since World War II. The international trade from 1955 to 2005 in manufacturing goods alone has grown from $95 billion to $12 trillion. Because of the large amount of money traded on the globe, the participation of many countries has been increasing with time. The growth of international trade causes to intensify completion among nations through technology and efficient utilization of resources (Babones, 2008). International

trade consequently makes evident the scope of globalization with improved spatial interdependencies concerning the fundamentals of the global economy and their degree of integration. These interdependencies point toward copious relationships where flows of goods, services capital, and raw materials are established flanked by regions of the world. International trade is besides matter of considerable contention subsequently it can at time be a troublemaking social and economic strength as it vicissitudes the state of affairs in which prosperity is disseminated within a national economy, predominantly due to ups and downs in prices and wages (Manfred 2009).

The participation of nations, the amount of the transaction, variety of trading goods and services are increasing with time hence international trade played important role in developing the global economy. Therefore, we give attention the theoretical approaches and analysis of how international trade benefits each nation across the globe. A rich body of international trade theory helps to explain patterns of trade at the industry level, taking account of industry and country differences in knowledge and technology (Kamal 2002).

According to David Ricardo the comparative advantage international trade theory explained that the benefit of trade using the concept of opportunity cost. Economists use the term opportunity cost to refer to such a compromise and trade-offs of producing several goods. A nation has a comparative advantage in producing a good if the opportunity cost of producing that good in terms of other goods is lower in that nation than it is in other nations. The motivation that international trade produces this proliferation in world productivity is that it sanctions each nation to dedicate itself to and specialize in producing the product in which it has a comparative advantage. Therefore, the Ricardian model of international trade developed illustrates the potential benefits of trade as trade leads to international specialization, thru all nations kaleidoscopic its labor force commencing industries in which labor is comparatively inefficient to industries in which it is reasonably more efficient (Golub and Hsieh 2000).

The Heckscher-Ohlin model analysed international trade in more rigours way. The Ricardian model assumes the only factor to be considered to analyse international trade was labor of production. This means the Ricardian model assumes, comparative advantage could get to your feet only because of international differences in labor productivity. However, in the real world, despite the fact that trade is partially enlightened by dissimilarities in labor productivity, it likewise more importantly imitates differences in nations' resources. Therefore, in convincing manner the Hecksher-Ohlin model explain the role of resource differences in trade while it is

unnoticed by the Ricardian model (Robert 2004). The contribution of both the Ricardian and the Hecksher-Ohlin models suggest that in the international trade both the import and export are equally important for the economic development of the given nation.

2.2 Overview of Norway's Economy and External Trade

Norway is richly endowed with natural resources including petroleum, fish, forests, hydropower and minerals. Norway's emergence as a major oil and gas producer in the mid-1970s transformed the economy. The Norwegian continental shelf's total recoverable petroleum resources have been estimated at 12.8 billion standard cubic meters of oil of which 5.5 billion has been recovered. Furthermore, Norway controls one of the largest ocean spaces in the world. Consequently, the primary economic activities include oil and gas, hydroelectricity, fish farming and manufacturing (Alsos and Eldring 2008).

The key industrial sectors of Norway are the strategic petroleum sector (Statoil and Aker Solutions), hydroelectric energy production (Statkraft), aluminium production (Norsk Hydro), the largest Norwegian bank (DnB NOR), and telecommunication provider (Telenor). Through these big companies, the government controls approximately 30% of the stock values at the Oslo Stock Exchange (OECD 2012). Because hydropower provides the highest share of Norway's electricity, most of the extracted gas and oil is exported. Today's export makes Norway to one of the largest oil and gas exporters in the world. Norway provides much of Western Europe's crude oil and gas requirements. Norwegian oil and gas exports accounted for a large part of the country's total exports and contributed to a significant amount of the country's GDP (Gonzalez et al 2011). Today Norway ranks one of the richest countries in the world. Next to Luxembourg, the country has the highest GDP per-capita in the world. The average hourly wages in Norway are among the highest in the world. From 2001 to 2006 Norway continued first place in the world in the UNDP Human Development Index and then reclaimed this position in 2009 and 2010. Norway has a very low unemployment rate and the standard of living is among the highest in the world (Bureau of Labor Statistics, 2011).

Tesfay and Solibakke (2014) applied two-stage hierarchical non-full rank linear econometric model to analyse export trade of Norway over five continents. Econometric estimation results prevailed that: First the European continent dominates all other continents over all export items. Secondly, there has been a shift from North and Central America to Asia and Oceania for mainland exports. The results suggest important policy implications for Norwegian authorities

and the need for increased emphasis on new and improved free trade zones for Norwegian mainland merchandise.

3. The 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/statistikkbanken) and External Economy (External trade, External trade in goods, 08801). The data is organised yearly ranging from 1988 to the end of 2012 (25 years). The import items listed in these data from Statistics Norway the items may overlap.

The data is 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 ***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 expenditure to import items.

3.2 The hierarchical linear model: The two way nested classifications

The two-way nested classifications are linear models having two independent factors in which one of the factors is nesting the other factor. More specifically, given two factors A and B, 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 (Douglas 2004 and Leeuw *et al.* 1998). The model for nested classifications is given as (Searle 1971):

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

$i = 1,2,3...a$, is the level of the nesting factor, $j = 1,2,3...b$, is the level of the nested factor, and $k = 1,2,3...n$, 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.

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

$$Y = X\gamma + \varepsilon \qquad (2)$$

where: $X = [L_a \vdots I_a \otimes L \vdots I_{ab} \otimes \ell]$

$$Y = \begin{bmatrix} y_{111} \\ y_{112} \\ \vdots \\ y_{ijt} \\ \vdots \\ y_{knT} \end{bmatrix}, \ell = \begin{bmatrix} 1 \\ 1 \\ \vdots \\ 1 \end{bmatrix}, L = \begin{bmatrix} \ell \\ \ell \\ \vdots \\ \ell \end{bmatrix}, L_k = \begin{bmatrix} L \\ L \\ \vdots \\ L \end{bmatrix}, \quad \gamma = \begin{bmatrix} \mu \\ \alpha_1 \\ \vdots \\ \alpha_k \\ \beta_{1:1} \\ \vdots \\ \beta_{n:k} \end{bmatrix}, \quad \varepsilon = \begin{bmatrix} \varepsilon_{111} \\ \varepsilon_{112} \\ \vdots \\ \varepsilon_{ijk} \\ \vdots \\ \varepsilon_{abn} \end{bmatrix}$$

$$abn \times 1 \quad n \times 1 \quad bn \times 1 \quad abn \times 1 \quad (1+a+ab) \times 1 \quad abn \times 1$$

Important properties of the X-matrix:

- $Rows \quad of \ X = Rows \quad of \ Y = abn$
- $Rank \quad of \ X \le \min\{abn, 1+a+ab\} \Rightarrow Rank \quad of \ X \le 1+a+ab \qquad \forall a,b,n \ge 2$

From the X matrix we see that L_a is a linear combination of $I_a \otimes L$, and the columns of $I_a \otimes L$ are linear combinations of $I_{ab} \otimes \ell$.

$$\therefore Rank[X] = Rank[I_{ab} \otimes \ell] = ab \qquad (3)$$

Here after our primary intention is whether we can estimate the model parameters or nor. In order to reach to a conclusion we need to see the characteristics of the normal equations (Charnes et al. 1976).

We have $Y = X\gamma + \varepsilon$

$$\Rightarrow \varepsilon = Y - X\gamma \ \Rightarrow \varepsilon'\varepsilon = [Y - X\gamma]'[Y - X\gamma] = Y'Y - \gamma' X'Y - YX\gamma + \gamma' X'X\gamma$$

$$\Rightarrow \frac{\partial \varepsilon'\varepsilon}{\partial \gamma} = -2X'Y - YX\gamma^0 + 2X'X\gamma^0 = 0$$

Therefore, our normal equations are:

$$X'X\gamma^0 = X'Y \qquad (4)$$

$Rank \quad of \ X'X = Rank \quad of \ X = ab < 1+a+ab \qquad \forall a,b,n \ge 2$. The result implies that we can't estimate all the model parameters. Therefore, we need to advance our analytical methods. First our goal is to find the standard error of the model using algebraic manipulations on the normal equations. Then, we generate estimable functions from the model and test our hypotheses.

3.2 Model Overall Model fit using Generalized Inverse

From our normal equations we observe that, $Rank \quad of \ X'X = ab$, and the dimension of $X'X = 1+a+ab$. So we systematically decompose the $X'X$ as follows (Rao et al 1971, and Lam 1999):

$$\begin{bmatrix} L'_a L_a & [L_a]'[I_a \otimes L] & [L_a]'[I_{ab} \otimes \ell] \\ [I_a \otimes L]'[L_a] & [I_a \otimes L]'[I_a \otimes L] & [I_a \otimes L]'[I_{ab} \otimes \ell] \\ [I_{ab} \otimes \ell]'[L_a] & [I_{ab} \otimes \ell]'[I_a \otimes L] & [I_{ab} \otimes \ell]'[I_{ab} \otimes \ell] \end{bmatrix} \begin{bmatrix} \mu^0 \\ \alpha_i^0 \\ \beta_{j(i)}^0 \end{bmatrix} = \begin{bmatrix} \sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{n} y_{ijk} \\ \sum_{j=1}^{b}\sum_{k=1}^{n} y_{ijk} \\ \sum_{k=1}^{n} y_{ijk} \end{bmatrix}$$

(5)

Another important property here we need for our analysis is the Eigen value of the $[I_{ab} \otimes \ell]'[I_{ab} \otimes \ell]$ matrix. Applying the rule of matrix multiplication, we have $[I_{ab} \otimes \ell]'[I_{ab} \otimes \ell] = nI_{ab}$. Therefore, the Eigen value of $[I_{ab} \otimes \ell]'[I_{ab} \otimes \ell]$=the Eigen value of nI_{ab}. Using the definition of Eigen value (Bretscher and Otto 1995) we have:

$$\det\left|nI_{ab} - \lambda I_{ab}\right| = 0 \Rightarrow \det\left|I_{ab}(n-\lambda)\right| = 0 \;\Rightarrow (\lambda - n)^{ab} = 0 \text{ and therefore, } \quad \lambda = n \qquad (6)$$

Equation 6 tells for us the Eigen values of $[I_{ab} \otimes \ell]'[I_{ab} \otimes \ell]$ are the sample size. This has extremely important contribution from the two stage non-full rank nested classification for our econometric modelling. First, the sample size contributes precision for the estimates of the standard error of the model (Savoy 1997 and Jolliffe 1982). In addition, since the Eigen values of the model's information matrix is equal to the sample size. Therefore, only by adjusting the sample size we can see the characteristics of the model parameters and this will aid us to evaluate structural changes on the import trade of Norway. Second, the sample size "n" is the expected value of the n-independently distributed chi-square values, which is the distribution of variance (Simon 2002, Mood et al 1974). This directly shows that the information matrix of the two stage non-full rank nested classification is the key to meet the objective that we already set.

In order to estimate the standard error of the model we first find at least one solution for our normal equations using the generalized inverse of $X'X$. By definition (Adi et al., 2003) a matrix $(X'X)^-$ is the generalized inverse of $X'X$ if and only if:

$$(X'X)(X'X)^-(X'X) = X'X \qquad (7)$$

The rank of the matrix $X'X$ is *ab* (we have *ab* orthogonal contrasts). Since the incidence matrix is not of full rank, there are infinitely many solutions to the normal equations. However, the regression sum of squares is invariant (unaffected) by the choice of one of the solutions (Searle, 1971). Using the generalized inverse of $X'X$ solves the normal equation. One of the generalized inverses is given as:

$$(X'X)^- = \begin{bmatrix} 0_{(a+1)x(a+1)} & 0_{(a+1)x(ab)} \\ 0_{(ab)x(a+1)} & ([I_{ab} \otimes \ell]'[I_{ab} \otimes \ell])^{-1} \end{bmatrix} \qquad (8)$$

Therefore, it is indispensable to apply the two stage non-full rank nested classification for our econometric modelling to evaluate the overall variation of the import trade of Norway. The generalized inverse that we set in equation 7 yields the solution:

$$\gamma^0 = [0, \quad 0, \quad \cdots \quad 0, \bar{y}_{11.}, \quad \bar{y}_{12.}, \quad \cdots \quad \bar{y}_{ij.}, \cdots \quad \bar{y}_{ab.}] \tag{9}$$

In order to make inferences the two-way nested non-full rank model, we first find the sums of squares of interest, their degree of freedom and respective probability distribution (Lam 1999, Rao et al. 1971 and Searle 1971). Table 2 gives the information.

3.3 Estimable functions and testing hypothesis

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*. Mathematically a linear function $\mathrm{L}\gamma$ is estimable if (Searle 1971):

$$\mathrm{L}\gamma = \mathrm{K}\,\mathrm{E}(\mathrm{Y}) \text{ , for some matrix } \mathbf{K} \tag{9}$$

Since $\mathrm{E}(\mathrm{Y}) = \mathrm{X}\gamma$, the definition of estimability implies that $\mathrm{L}\gamma$ is estimable if there exists a matrix K such that $\mathrm{L} = \mathrm{KX}$. This directly implies that the rows of X form a generating set from which all estimable functions can be constructed. Since estimability is not related to the particular value of a parameter estimate, but to the row space of X, we can test only hypotheses that consist of estimable functions. Further, because estimability is not related to the value of γ

(Searle 1971, p. 181), the choice of a generalized inverse in a situation with rank-deficient $\mathrm{X}'\mathrm{X}$ matrix is immaterial, since:

$$\mathrm{L}\hat{\gamma} = \mathrm{KX}\hat{\gamma} = \mathrm{KX}(\mathrm{X}'\mathrm{X})^{-}\mathrm{X}'\mathrm{Y} \tag{10}$$

where $\mathrm{X}(\mathrm{X}'\mathrm{X})^{-}\mathrm{X}'$ is invariant to the choice of a generalized inverse $(\mathrm{X}'\mathrm{X})^{-}$ of $\mathrm{X}'\mathrm{X}$. Therefore, the function $L\gamma$ is estimable if and only if $\mathrm{L}(\mathrm{X}'\mathrm{X})^{-}\mathrm{X}'\mathrm{X} = \mathrm{L}$ (Searle 1971). If X is full rank, the Hermite matrix $(\mathrm{X}'\mathrm{X})^{-}\mathrm{X}'\mathrm{X}$ is the identity, which implies that all linear functions are estimable in the full-rank case. In addition, linear combinations of estimable function are also estimable. Based on the definition of estimable functions we will generate estimable function from non-full rank hierarchical linear models as follows. We have that $y_{ijk} = \mu + \alpha_i + \beta_{j(i)} + \varepsilon_{ijk}$ where $\varepsilon_{ijk} \sim N(0, \sigma^2)$. The expected value of the endogenous variable is estimable:

$E(y_{ijk}) = (\mu + \alpha_i + \beta_{j(i)}) + (\varepsilon_{ijk})$. Since $E(\varepsilon_{ijk}) = 0$, the linear function $\mu + \alpha_i + \beta_{j(i)}$ is estimable. The point best linear unbiased estimator (BLUE) of the estimable function is $\bar{y}_{ij.} = \left(\sum_{k=1}^{n} y_{ijk} / n \right)$ with one (1) degree of freedom. The variance of the BLUE is given as σ^2 / n. In order to test the significance of estimable function we use the *F*-statistics given by $n[\bar{y}_{ij.}]^2 / \hat{\sigma}^2$ with one (1) and $abn - ab$ degrees of freedom (Lam 1999, Rao *et al.* 1971, and Searle 1971).

3.4 Model Adequacy Checking

It is always necessary to check the model whether it fulfils the theoretical assumptions of the model. The entire model adequacy is done by analysis on residuals ($\hat{\varepsilon}_{ijk} = y_{ijk} - \hat{y}_{ijk}$). Generally we have two basic categories, the data problem and the statistical problems. In particular, the data problem consists of the existence of out liars and the statistical problems consist of distribution assumption, Heteroscedasticity and autocorrelation. We use the Jarque–Bera test is to test whether our observation come from normal distribution or not. The hull hypothesis (H_0) of this test is that the observations are come from normal distribution against the alternative hypothesis (H_1) that the observations are not come from normal distribution. The Jarque–Bera test statistic is given as: $\chi^2_{cal} \sim \frac{abn}{6}\left[\hat{S}^2 + \frac{1}{4}\left(\hat{K} - 3\right)^2 \right]$, where: $\hat{S}$ and $\hat{K}$ are sample skewness and kurtosis of residuals, respectively. The asymptotic distribution of the Jarque–Bera statistic is a chi-square distribution with two degrees of freedom. Therefore, we reject our null hypothesis if $\chi^2_{cal} > \chi^2_{\alpha,2}$.

Table 1: Decomposition of Sum of squares and their distributional properties

Source of Variation	Formal Formula	Simplified form	Degree of Freedom	Distribution
$R(\mu)$	$\frac{1}{abn}Y'[1]'[1]Y$	$abn(\bar{y}_{...})$	$Rank[1]'[1]=1$	$\frac{R(\mu)}{Rank[1]'[1]=1} \sim \chi^2_{Rank[1]'[1]=1}$
$R(\mu,\alpha,\beta)$	$Y'[X(X'X)^{-}X']Y$	$n\sum_{i=1}^{a}\sum_{j=1}^{b}\bar{y}^2_{ij.}$	$Rank[X'X)^{-}]$	$\frac{R(\mu,\alpha,\beta)}{Rank[X'X)^{-}]} \sim \chi^2_{Rank[X'X)^{-}]}$
$R(\mu,\alpha)$	$\frac{1}{bn}Y'[I_a \otimes L]'[I_a \otimes L]Y$	$bn\sum_{i=1}^{a}\bar{y}^2_{i..}$	$Rank[I_a \otimes L]$	$\frac{R(\mu,\alpha)}{Rank[I_a \otimes L]} \sim \chi^2_{Rank[I_a \otimes L]}$
$R(\alpha \mid \mu)$	$R(\mu,\alpha)$ - $R(\mu)$	$bn\sum_{i=1}^{a}\bar{y}^2_{i..} - abn(\bar{y}_{...})$	$Rank[I_a \otimes L]-1$	$\frac{R(\mu,\alpha,)-R(\mu)}{Rank[X'X^{-}]-1} \sim \chi^2_{Rank[X'X^{-}]-1}$
$R(\alpha,\beta \mid \mu)$	$R(\mu,\alpha,\beta)$ - $R(\mu)$	$n\sum_{i=1}^{a}\sum_{j=1}^{b}\bar{y}^2_{ij.} - abn(\bar{y}_{...})$	$Rank[X'X^{-}]-1$	$\frac{R(\mu,\alpha,\beta)-R(\mu)}{[Rank\quad (X'X)^{-}]-1} \sim \chi^2_{[Rank\ \ (X'X)^{-}]-1}$
$R(\beta \mid \mu,\alpha)$	$R(\mu,\alpha,\beta)$ - $R(\mu,\alpha)$	$n\sum_{i=1}^{a}\sum_{j=1}^{b}\bar{y}^2_{ij.} - bn\sum_{i=1}^{a}\bar{y}^2_{i..}$	$Rank[X'X^{-}]-Rank[I_a \otimes L]$	$\frac{R(\mu,\alpha,\beta)-R(\mu)}{Rank[X'X^{-}]-Rank[I_a \otimes L]} \sim \chi^2_{Rank[X'X^{-}]-Rank[I_a \otimes L]}$
SSE	$Y'[I_{abn}]Y$ - $R(\mu,\alpha,\beta)$	$\sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{n}y^2_{ijk} - n\sum_{i=1}^{a}\sum_{j=1}^{b}\bar{y}^2_{ij.}$	$Rank[I_{abn}]-Rank[X'X^{-}]$	$\frac{Y'[I_{abn}]Y-R(\mu,\alpha,\beta)}{Rank[I_{abn}]-Rank[X'X^{-}]} \sim \chi^2_{Rank[I_{abn}]-Rank[X'X^{-}]}$
SST	$Y'[I_{abn}]Y$	$\sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{n}y^2_{ijk}$	$Rank[I_{abn}]=abn$	

Sum of the squares about the mean= $R(\mu)$, Regression sum of squares = $R(\mu,\alpha,\beta)$, Sum of squares of the nesting factor= $R(\mu,\alpha)$, Sum of squares of the nesting factor after fitting the mean= $R(\alpha \mid \mu)$, Sum of the squares of the nested factors after fitting the nesting factor and the mean= $R(\beta \mid \mu,\alpha)$, Sum of the squares after fitting the mean= $R(\alpha,\beta \mid \mu)$, Error sum of squares=SSE and Total sum of squares=SST

We employ the Bartlett's test of Heteroscedasticity. The test statistic is appropriate whether there exist significant variance difference of k-different sub-populations with equal variances. The null hypothesis, (H_0): that all the *k* sub-population variances are equal against the alternative hypothesis (H_1): not all the *k* sub-population variances are equal. The test statistic of the Bartlett's test of Heteroscedasticity is given as:

$$\chi^2_{cal} = \frac{(N-k)\ln\left(S_p^2\right) - \sum_{i=1}^{k}(n_i-1)\ln\left(S_i^2\right)}{1+\frac{1}{3(k-1)}\left[\sum_{i=1}^{k}\left(\frac{1}{n_i-1}\right)-\left(\frac{1}{N-k}\right)\right]}$$, where: $N=\sum_{i=1}^{k} n_i$, $S_p^2 = \frac{1}{N-k}\sum_{i=1}^{k}(n_i-1)S_i^2$, and

S_i^2 for $i = 1,2,3,....k$ are sample variances. According to Snedecor *et al.* 1989, the null hypothesis is rejected if $\chi^2_{cal} > \chi^2_{k-1,\alpha}$. The important sign and consequence of the existence Heteroscedasticity is increasing the means square error (MSE) of the fitted model. As a result, important parameters may be insignificant. Therefore, to control such consequences we apply variance minimization technique, like standardization of the endogenous variable. Finally, whenever we use a time series data we encounter the problem of autocorrelation. This problem causes to underestimate the variance of the random error term and increase the coefficient of determination. As a result the model information gives a false confidence to the researcher (Samprit *et al.* 2013, Judge 1985). In this case either we randomize the observations to eliminate the time pattern of the observations before analysis. Or, we use the Ljung–Box test of autocorrelation that simultaneously detects the existence and the order of autocorrelation on the time series (Davidson 2000). The Ljung–Box test procedure is given as (James 1994): the Null Hypothesis H_0: The time series data are independently distributed. The alternative hypothesis H_a: The time series data are dependently distributed with autocorrelation structure of order *h*. The test statistic of Ljung–Box is given as: $Q = n(n+2)\sum_{l=1}^{h}\frac{\hat{\rho}_l^2}{n-l}$, where *n* is the sample size, $\hat{\rho}_l$ is the sample autocorrelation at lag l, and *h* is the number of lags being tested. The null hypothesis is rejected for α level of significance if $Q > \chi^2_{1-\alpha,h}$.

After identifying the order of autocorrelation we specify a reasonable model as: $y_{ijk} = \mu + \alpha_i + \beta_{j(i)} + \varepsilon_{ijk}$, where $\varepsilon_{ijk} = \rho_{ij}\varepsilon_{ijk-1} + v_{ijk}$, $|\rho_{ij}| < 1$, and $v_{ijk} \sim iiD(0, \sigma_v^2 I_{abn-1})$. Then we apply the Cochrane-Orcutt transformation (Cochrane and Orcutt 1949) to eliminate

the autocorrelation structure of the model by multiplying the first order autocorrelation coefficient ρ_{ij} the by taking first lag the model as follows.

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

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

Subtract the second equation from the first gives:

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

$$y_{ijk} - \rho_{ij} y_{ijk-1} = (1-\rho_{ij})\mu + (1-\rho_{ij})\alpha_i + (1-\rho_{ij})\beta_{j(i)} + \nu_{ijk}$$

$$y^*_{ijk} = \mu^* + \alpha^*_i + \beta^*_{j(i)} + \nu_{ijk} \ ,$$

where $y^*_{ijk} = y_{ijk} - \rho_{ij} y_{ijk-1}$, $\mu^* = (1-\rho_{ij})\mu$, $\alpha^*_i = (1-\rho_{ij})\alpha_i$, $\beta^*_{j(i)} = (1-\rho_{ij})\beta_{j(i)}$. If the coefficients of autocorrelation (i.e. ρ_{ij}) of the population are not given then we will estimate the coefficient as: $\hat{\rho}_{ij} = \dfrac{\sum_{k=2}^{n} \hat{\varepsilon}_{ijk}\hat{\varepsilon}_{ijk-1}}{\sum_{k=1}^{n} \hat{\varepsilon}^2_{ijk-1}}$. This y^*_{ijk} equation suggests that the problem of autocorrelation is eliminated due to the Cochrane-Orcutt transformation. We fit the model by iterating over these equations until the problem of autocorrelation eliminated at any order. Finally, we can identify observations, which cause outlier problem by transforming the residuals into studentized residuals and standardized residuals (Cook *et al.* 1982). Moreover, the Ljung–Box test statistic can detect serial correlation and suggest whether the observations contain outliers or not.

4. Results and discussions

4.1 Adequacy of non-full rank hierarchical linear model

A model is a simplified representation of reality. In this study we employ the non-full rank hierarchical linear model to evaluate the continental variation of import trade of Norway. However, before we make econometric inference using the model it is essential to prioritize checking appropriateness of the model, hence inadequate models will not reflect the reality. In this study the model adequacy checking includes all the assumption that use to describe our original model. This includes checking for: [1]. normality, [2]. a constant variance (homoscedasticity), [3] assumption of data independence (absence of autocorrelation) and [4] absence of outliers.

The normality assumption of the random error term of the model makes to the endogenous variable to become normally distributed random variable. Consequently, the distributions of the sum of squares (see Table 1), the distribution of estimable functions are derived from the normality distributional assumption of the random error term. Therefore, checking the normality assumption is our critical step to move to the next steps of our econometric analysis on the variation of the import trade of Norway. We have applied the Jarque–Bera test of normality test. The test result is given in Table 2.1. The result of Table 2.1 gives us information about estimate of location (skewness) and estimate of scale (kurtosis). The Jarque–Bera test of normality prevails that at 5% level of significance we do not reject the null hypothesis. That is, the random error terms statistically follows the normal distribution.

{*Insert* Table 2.1 *about here*}

In econometric analysis the constant variance (homoscedasticity) assumption plays important role in providing the most efficient estimator of the model parameters. The primary indicator of the violation of this assumption is the existence of large mean square error (MSE), which is an unbiased estimator of the population variance$[\sigma^2]$. Therefore, controlling this violation of assumption will lead us to decrease mean square error (MSE) and increase the power of the model of explaining the endogenous variable.

Our econometric analysis on the continental variation of the import trade of Norway, we will check the constant variance assumption by considering the estimates of sub-population variances using based on the continental categories. Therefore, applying the Bartlett's Test of Heteroscedasticity is reasonable to assess whether the random error terms have common constant variance (homoscedastic) or not. The Bartlett's test of Heteroscedasticity is done on the residuals that estimated from the fit of the non-full rank hierarchical linear model is given in Table 2.2. According to the Table 2.2 at 5% level of significance we do not reject the null hypothesis. This confirms that the random error terms are statistically having constant common variance.

{*Insert* Table 2.2 *about here*}

In the presence of autocorrelation the analysis will under estimate the population variance $[\sigma^2]$. This makes the estimates of the estimable functions from the non-full rank hierarchical linear model suggesting misinformation for the main point of interest on the variation of the import trade. Detecting the exact mathematical autocorrelation structure is one of the most

challenging tasks in econometric analysis. Due to the fact that detecting autocorrelation lies determining the mathematical structure and systematic pattern of random variables.

The primary indicator of autocorrelation problem is that the residuals follow systematic patterns (data dependence). The statistical test we employ in this study to detect the autocorrelation problem is the Ljung-Box test. The Ljung-Box test result is given in Table 2.3. According to Table 2.3, we observe that at the 5 % level of significance except the import of items from Africa (Mineral fuels, lubricants and related materials; and Commodities and transactions), Asia and Oceania (Crude materials, inedible, except fuels; Mineral fuels, lubricants and related materials; and Crude materials, inedible, except fuels), and North and Central America (Animal and vegetable oils, fats and waxes; Machinery and transport equipment; and Commodities and transactions) all the Norwegian items of import across continents show serial correlation. This means that our assumption of independence of observations is wrong. In fact, some of the items of import of Norway call for past memories up to 18-years. Controlling the autocorrelation problem will therefore be one of the critical model diagnostics. Furthermore, the stationarity test of the Ljung-Box statistic suggest that all the items of import are non-stationary, showing that there are net growth of expenditure in some of the items of import and net decline on the other items of import.

{*Insert* Table 2.3 *about here*}

Finally, the model adequacy checking will check for the data problem of, detecting outlier problems. The important signs of Heteroscedasticity and outlier are quite similar. However, the difference is that Heteroscedasticity is a statistical problem while the outlier problem is a data problem. We checked the outlier problems by transforming the residuals into standardize residuals. The plot of standardize residuals from the non-full rank hierarchical linear model fit is given in Figure 1. In Figure 1 we observe that the standardize residuals lies between -2.000 and +3.000. In most econometric analysis this interval is acceptable as the model controls the observations. Furthermore, to concretize our argument conclusion we referee the last column of the Ljung-Box test statistics, which counts no outlier in any of the items of imports. This result shows that there is no observation that can be categorised as an outlier.

{*Insert* Figure 1 *about here*}

4. 2 Fitting the non-full rank hierarchical linear model

In this study we employ the non-full rank hierarchical linear model to evaluate the continental variation of import trade of Norway. Before we make further econometric analysis and

elucidation, we have to check whether the two stage non-full rank hierarchical linear model is suitable or not. The methodology is using two factors for the non-full rank two-stage hierarchical linear model, i.e. the nesting and the nested factors. The degree of freedom of the nesting factor is "$a = 5$". The degree of freedom of the nested factor is "$a(b-1) = 45$". Hence, by providing a much higher degree of freedom, the model specification gives an advantage for the precise estimation for the nested factor relative to the nesting factor. In our case, the two factors are the origin continents and the import items. The first and the most important task for model fitting is the selection of the nesting and nested factors from the items of import and the origin continents of the import items.

In order to decide we have to call on theoretical models of international trade. The Heckscher-Ohlin theory gives detailed explanations about the reason why countries trade goods and services with each other. The theory emphasizes being about the difference of resources among countries will lead them to participate in the international trade. Critical examinations of this theory help us to give higher priority for the item of import than its origin. Therefore, we set the continental categories as the nesting factor and the items import as the nested factor. The observations are the expenditure to imports (in millions of Norwegian Kroner).

The fit of the model adequacy test prevails that our structure of econometric analysis is properly set. The assessment of model adequacy checking of the non-full rank two stage hierarchical linear model confirms that there is a problem of autocorrelation on most of the import items from their origin continents. To control for the problem we apply the Cochrane-Orcutt recursive autoregressive estimation (Cochrane and Orcutt. (1949).

After applying the Cochrane-Orcutt recursive autoregressive estimation and removing the problem of autocorrelation, we fit the continental variation of the imports. The overall fit of the non-full rank hierarchical linear model is given in Table 3.1.

{Insert Table 3.1 *about here}*

At the 5 % level of significant we found that the non-full rank two stage hierarchical linear model is appropriate to analyze and evaluate the continental variation of the Norwegian import trade. This confirms that our econometric framework of setting the nesting and the nested factor is found to be adequate. Furthermore, the result gives as indication that the

expenditure of import trade of Norway may heterogeneity either the destination continent or the item of import. Moreover, the result of Table 3.1 inspires us to do further analysis and investigate the continental or the import items effects on the expenditure of Norwegian imports. In order to meet our objective, we further decompose the sum of square of the non-full rank hierarchical linear model according to the rules of decomposition of sum of squares (see Table 1). The test result of the significance of the effect of items of import and origin continental is given in Table 4.

{Insert Table 4 *about here}*

From Table 4, we observe first that the average expenditure $\left(R\left(\mu\right)\right)$ of the import sector of Norway is significant over time. The result confirms that the import trade of Norway is sustainable in both short and long run after controlling for the effect of import item from any origin continent. Second, the effect of import items and origin continental on the expenditure of imports corrected for the mean $\left(R\left(\alpha,\beta\,|\,\mu\right)\right)$ is statistically significant. The implication is that at least one of the origin continental categories and/or import items does have a significant impact over the others on the overall import trade. Third, the effect of import items corrected for the continental effects and the mean $\left(R\left(\beta\,|\,\mu,\alpha\right)\right)$ is statistically significant. The result confirms that at least one of the import items significantly contributes over the others in the import trade controlling for the continental effects (or adjusting for the effects of the origin continent). The result suggests that the import sector can exist without considering the impact of origin continent. Moreover, the items of import have different contribution to the import sector of the country within/or across the destination-continent. Fourth, the continental effects (adjusted for the mean $\left(R\left(\alpha\,|\,\mu\right)\right)$ and without adjusting for the mean $\left(R\left(\alpha,\mu\right)\right)$ are statistically significant. The implication is that at least one of the origin continents does have a significant effect over other origin continents on the overall import trade. This is an indicator indicating that the import trade of Norway is heterogeneous trade with respect to expenditure of the import sector.

The finding from Table 4 demonstrates the importance of making detailed estimation of the continent of origin or items of import on the expenditure. However, as we have seen in our methodology, the rank of our information matrix of the normal model equations is not a full rank matrix. Therefore, model specification does not allow us to estimate all the model parameters. Therefore, we advance our estimation technique of identifying a linear

combination of the model parameters that can be estimated. These linear combinations of model parameter are called estimable functions. The estimable function of the non-full rank hierarchical linear model defined as $\mu + \alpha_i + \beta_{j(i)}$ will give us detailed information about the impact of the import items from their continents of origin.

4.3 Assessment of structural changes in the import trade of Norway

In section 4.1 we have performed model adequacy checking and diagnostics for the data and statistical problems. In this study we employ the non-full rank hierarchical linear model to evaluate the continental variation of import trade of Norway. The model adequacy result of normality using the Jarque–Bera statistic, reports a chi-square z-value of 0.002 (*p*-value > 0.4995). The result shows at 5% level of significance that the random error terms statistically follows a normal distribution. The Bartlett's test of Heteroscedasticity reports a chi-square value of 0.1127 (*p*-value > 0.9984) and therefore confirms at 5% level of significance that the random error terms are statistically homoscedastic. The standardized residuals ranging between -2 to 3 report no outlier problems for observations in the data set. However, the Ljung–Box Q-statistic reports that most of the Norwegian import items are serially correlated. This means that our assumption of independence of observations is false. In fact, some of the items of import of Norway call for past memories up to 18-years.

Our assessment identified that there is a series autocorrelation problem. Consequently, we applied the Cochrane-Orcutt recursive autoregressive estimation method to control the autocorrelation problem. So, we are free from statistical problems. However, we face another big challenge to find and quantify potential structural change of the trade pattern of Norway across continents. The main purpose of examining structural change is

Economists of international trade are interested with the concept of structural change on the trade pattern of countries. The contextual meaning of structural change in the international trade is the change in: [1] composition of items of import, [2] origin continent of the item or [3] composition of items of import and origin.

International economists interested to know the potential structural changes in the trade pattern of the nation. Then, they try to give their interpretation and analysis about the possible benefit (loss) from the structural change of the trade pattern of the country. If structural

changes existing, then the prediction power of any model is limited. For example, when we apply time series econometric analysis, we need to have large time series (sample size) observations to precisely estimate the model parameters. The estimates of the model parameters will be helpful to forecast the future pattern of the foreign trade of the country. However, if these structural changes are significant forecast of the future trade patterns may not be appropriate. Applying econometric analyses, the prediction power of econometric models will most likely be lower when there are structural changes in the data set. As we have introduced in our methodology (see equation 6), the Eigen values of the information matrix from the non-full rank hierarchical linear model are identical to the sample size "*n*". This means that all the important information about the model parameters of the non-full rank hierarchical linear model is examined by the Eigen values of the information matrix, i.e. the sample size "*n*". Therefore, the specification of the model will help us to examine potential structural changes of the import trade across continents. Just by adjusting the sample size "*n*" we can see the characteristics of the model parameters and aid us to evaluate structural changes.

In literature we can find a number of factors that cause structural change on the pattern of import trade of the given country. Structural changes have both negative and positive impacts on the economy of participant countries in the international trade. Due to that examining these factors and their implications are the important issues of the international economists. In this study we give much emphasis on to identify the existences potential structural change on the items of import of Norway across world's continents. By applying a double phase (i.e. continent wise and time wise) bootstrapping technique on the available we will makes the analysis to investigate and quantify potential structural changes.

Here we proposed to identify the existences potential structural change on the import trade of Norway by observing the nature of estimable functions as a function of Eigen values of the information matrix of the non-full rank hierarchical linear model. To support our analysis we systematically fit the model by taking and categorizing observations of the continental trade pattern of Norway as the post 1988, the post 1993, the post 2003, and the post 2008. The fit of the non-full rank hierarchical linear model trade pattern is given in Table 3.1, Table 3.2, Table 3.3, Table 3.4 and Table 3.5. As it can be seen from these tables, at 5% level of significance all the models are statistically adequate. This confirms that the non-full rank hierarchical linear model is appropriately evaluating the progress and the time evolution of

the pattern of the import trade of Norway. Critical observation of the five tables gives us access to the following information. The mean square error (MSE) changes as we analyse the import trade by omitting observations from the very past. This is a primary indicator that there exists at least one important structural change on the import sector. Furthermore, the minimum MSE of model fit is obtained for the post 2008 trade pattern of Norway. This indicates that the import trade of Norway has stabilized in these recent times.

{Insert Table 3.2, Table 3.3, Table 3.4 and Table 3.5 *about here}*

Using matrix algebra and the outputs from these tables we will systematically identity and quantify potential structural changes on the pattern of the import trade of Norway. By solving the characteristic functions of information matrix of the normal equations of the post 1988, the post 1993, the post 2003, and the post 2008 trade pattern of Norway we found that the non-zero Eigenvalues of information matrices are 26, 21, 16, 11 and 6, respectively. Eigenvalues of the information matrices of the normal equations from the non-full rank hierarchical linear model are decreasing with the trade pattern. Therefore, in order to analyse the progressive structural changes (i.e. from past to the recent trade patterns), we transform the Eigenvalues into the maximum Eigenvalue minus Eigenvalues, i.e. $Max\{\lambda\}-\lambda$. The estimates of estimable functions, i.e. $\mu+\alpha_i+\beta_{j(i)}$ of the post 1988, post 1993, post 2003, and post 2008 trade patterns of Norway are given are given in Table 5.1, Table 5.2, Table 5.3, Table 5.4 and Table 5.5, respectively. Using these estimates results of the estimable functions we will assess and quantify potential structural changes on the trade pattern of Norway.

{Insert Table 5.1, Table 5.2, Table 5.3, Table 5.4 and Table 5.5 *about here}*

4.3.1 Structural changes in continental share of imports

The progress of structural changes on the continental share of the Norwegian imports is given in Figure 3. From Figure 2.1 we can see that the continent of Europe was responsible to cover from 71 percent to 72 percent of imports in the post 1988 to 2003 trade patterns. However, in the post 2008 trade pattern the share of Europe declines by approximately 2.6 percent. The continent of North and Central America was responsible for approximately 10 percent of imports in the post 1988 to 1993 trade patterns. However, in the post 1993 trade pattern the share of North and Central America declines by near 1 percent. In contrast, the continent of South America was responsible to cover nearly 2 percent of imports in the post 1988 to 2003 trade patterns. In the post 2003 trade pattern the share for South America is slightly improved by approximately 0.4 percent. The continent of Africa was responsible to cover from nearly

1.5 percent of imports in the post 1988 to 2003 trade patterns. However, in the post 2003 trade pattern the share of Africa is slightly improved by approximately 0.5 percent. The continent of Asia and Oceania was responsible from 14 to 15.4 percent of imports in the post 1988 to 1998 trade patterns. However, in the post 2003 trade pattern the share of Asia Oceania is improved by approximately 2.6 percent.

{*Insert* Figure 2.1 *about here*}

The assessment of structural changes of continental share of Norway showed considerable dynamics. We have found that the share of Europe and North and Central America is declining while the share of the other continents is increased, especially the content of Asia and Oceania. These findings need further assessment to answer why the import trade and the continental shares has showed structural changes. To find an appropriate answer to our inquiry of structural changes, we need to perform an extended analysis of the number of significant items of Norwegian import in section 4.3.2.

4.3.2 Structural changes on number of significant items of import

Our structural change analysis prevails that there is a potential change in the continent wise number of significant items of Norwegian import. Figure 2.2 gives us information about the continent wise number of significant items of import. From Figure 2.2 we observe that the total number of continent showing significant Norwegian import items from 1988 to 2013 was 17 of which 8, 4, 3, 1 and 1 were from the origin of Europe, North and Central America, Asia and Oceania, South America and Africa, respectively. This composition was the same for the 1993 to 2013 trade pattern.

In the 1998 to 2013 trade pattern the items of import from the continent in South America increased from one to two. In the 2003 to 2013 trade patterns structural changes on the number of significant items of import is observed in the origin continents of Europe (from 8 to 9) and in Asia and Oceania (from 3 to 4). Finally, the composition of the imports showed dramatic structural change from 2008 to 2013 in the origin continents in Africa (from 1 to 2), in Asia (from 4 to 6), and in North America (from 4 to 7). This gives us a total of 26 significant items of imports for the post 2008 trade.

{*Insert* Figure 2.2 *about here*}

The analysis of structural change with respect of continent wise number of significant items of import of Norway is increased with $\{Max\{\lambda\} - \lambda\}$. This will guide us the total number of

important continent wise items of import of Norway will be increased in the future, especially from the continent of Asia and Oceania, South America or Africa. This result confirm that one of the primary reasons for the decline for the continent of Europe and North America, is the increase in the number of significant items of imports from especially the continent of Asia and Oceania, Asia and Oceania, South America and Africa. The estimates of estimable functions of the Norwegian import trade confirm that the share of the import of commodities and transactions is insignificant for the continent of Europe. This confirms that the peak number of important items of the Norwegian from the continent of Europe will not be exceeding the nine items.

Our finding of the existence of potential structural changes on continent wise number of significant items of imports encourages establishing a hypothesis about whether structural changes occur on item wise shifts of import across continents. Therefore, in the next sections we will deal with make appropriate analysis to investigate potential structural changes on the import trade of Norway.

4.3.3 Item wise structural changes of Norwegian imports across continent

i. **Structural Change of Pattern of imports from Europe to Asia and Oceania**

The number of significant items that imported from Europe changes from eight in the post 1998 period to nine in the post 2003 period. This makes the continent of Europe is the most important continent of the Norwegian imports with respect to the number of significant items of imports. However, the number of significant items that imported from Asia and Oceania progressively and positively changes from three in post 1988 period to four to post 2003 period and then to six in the post 2008 period. This tells us there is an indication that some of the items of imports from the continent of Asia and Oceania may exceed the imports from the continent of Europe. The structural change analysis of the items of import from Europe to Asia is given in Figure 2.3. According to the results of Figure 2.3 we observe that there are feasible and significant structural changes of trade patterns from the continent of Europe to the continent of Asia and Oceania. These are item wise potential structural changes are:

- The import of Chemicals and related products from the continent of Europe is exceeded by the import of Machinery and transport equipment from the continent of Asia and Oceania in the post 2003 period trade patterns.

- The import of Miscellaneous manufactured articles from the continent of Europe is almost equivalent to the import of Machinery and transport equipment from the continent of Asia and Oceania in the post 2008 period trade patterns. The result also suggests that in the near future the import of Machinery and transport equipment from the continent of Asia and Oceania expected to exceed the import of Miscellaneous manufactured articles from the continent of Europe.
- The import of Food and live animals from the continent of Europe is exceeded by the import of miscellaneous manufactured articles from the continent of Asia and Oceania in the post 1998 period trade patterns.
- The import of Crude materials, inedible, except fuels from the continent of Europe is almost equivalent to the import of manufactured goods classified chiefly by material from the continent of Asia and Oceania in the post 2008 period trade patterns. The result also suggests that in the near future the import of manufactured goods classified chiefly by material from the continent of Asia and Oceania expected to exceed the import of Crude materials, inedible, except fuels from the continent of Europe.

{*Insert* Figure 2.3 *about here*}

ii. Structural Change of Pattern of imports from Europe to North and Central America

The number of significant items imported from Europe is stable at nine in the trade patterns of the post 2003 period. However, the number of significant items that imported from North and Central America changes from four in seven 7 to in the post 2003 period trade pattern. This mobilizes us to make an assessment of structural changes of the items of imports from the continent of Europe to North and Central America. The structural change analysis of the items of import from Europe to Asia is given in Figure 2.4. According to the results of Figure 2.4 we found there are feasible and significant structural changes of trade patterns from the continent of Europe to the continent of North and Central America and vice versa. These are item wise potential structural changes are:

- The import of Machinery and transport equipment from the continent of North and Central America is exceeded by the import of Mineral fuels, lubricants and related materials from the continent of Europe in the post 1993 period trade patterns.

- The import of Machinery and transport equipment from the continent of North and Central America is exceeded by the import of Food and live animals from the continent of Europe in the post 1998 period trade patterns.
- The import of Crude materials, inedible, except fuels from the continent of Europe is exceeded by the import of Crude materials, inedible, except fuels from the continent of North and Central America in the post 2003 period trade patterns.

{*Insert* Figure 2.4 *about here*}

iii. Structural Change of Pattern of imports from North and Central America to Asia and Oceania

The number of significant items that imported from North and Central America changes from four in the post 1998 period to seven in the post 2008 period. This makes the continent of North and Central America is the second most important continent of the Norwegian imports with respect to the number of significant items of imports. The number of significant items that is imported from Asia and Oceania changes from three in post 1988 period to six in the post 2008 period for the Norwegian import trade patterns. This makes it possible for us to assess structural changes for the import items from the continent of North and Central America to Asia and Oceania and vice versa. The structural change analysis of the import items from North and Central America to Asia and Oceania and vice versa is given in Figure 2.5. According to these results we find that there are feasible and significant structural trade pattern changes from the continent of North and Central America to the continent of Asia. These are item wise potential structural changes are:

- The import of Machinery and transport equipment from the continent of North and Central America is exceeded by the import of miscellaneous manufactured articles from the continent of Asia and Oceania in the post 1998 period trade patterns.
- The import of Crude materials, inedible, except fuels from the continent of North and Central America is will expect to be the same level to the import of Manufactured goods classified chiefly by material from the continent of Asia and Oceania in the near future trade patterns.

{*Insert* Figure 2.5 *about here*}

iv. Other structural change of Pattern of imports

Our analysis also identified important structural changes of the trade patterns of Norway from the continents of North and Central America, South America and Africa. The structural change analysis of the items of import from North and Central America to South America, North and Central America to Africa, South America to Africa or vice versa is given in Figure 2.6. According to the results of Figure 2.6 we found there are feasible and significant structural changes of trade patterns from the three continents. These are item wise potential structural changes are:

- The import of Crude materials, inedible, except fuels from the continent of South America was over the item for the continent of Africa in the post 1988 period to the 2003 period. However, in the post 2008 period trade patterns the import of the item from these two continents is the same level and expected to switch the post 1988 period trade pattern in the near future.
- The import of Miscellaneous manufactured articles from the continent of North and Central America is exceeded by the import of Crude materials, inedible, except fuels from the continent of Africa in the post 1998 period trade patterns.
- The import of Miscellaneous manufactured articles from the continent of North and Central America was over the Food and live animals from the continent of South America in the post 1988 period to 2008 period. However, the trend showed that the import item Food and live animals will in the near future be at the same level as the import item Miscellaneous manufactured articles.

{*Insert* Figure 2.5 *about here*}

4.4 Econometric evaluation of influential import items of Norway across continents

In section 4.2 we identified that the effects of item of import and effects of continents have significant impact on the Norwegian expenditure to import goods from across continents. Furthermore, in section 4.3, the structural change analysis confirmed that there are important significant changes occurred on the Norwegian imports with content wise number of significant items of import, continent wise share and item of imports regard, continent wise. This confirmed that the pattern of Norwegian import trade showed dynamics. Consequently, considering the very past trade pattern of the pattern of Norwegian import trade across continents may or may not be important to predict the future import trade pattern of the country.

The analysis of Table 3.1, Table 3.2, Table 3.3, Table 3.4 and Table 3.5 give the model fits for the trade patterns of Norway for the post 1988 period, the post 1993 period, the post 1998 period, the post 2003 period and the post 2008 period, respectively. The non-zero Eigenvalues of the information matrices of the model are 26, 21, 16, 11 and 6, respectively. The adjusted coefficients of determination of the models for their respective Eigenvalues are 85.15 percent, 90.07 percent, 94.21 percent, 96.59 percent, and 99.02 percent, respectively. Furthermore, the fits of the modes are all adequate hence free from statistical and data problems. Therefore, each the model fits has a potential to predict the import trade pattern of Norway. Although each the model have potential to predict the Norwegian import trade pattern, there are factors that not allow us to not make econometric interpretation from the estimated of the estimable function that presented in the analysis of Table 5.1, Table 5.2, Table 5.3, Table 5.4 and Table 5.5. First, there is evidence of structural change in the trade patterns. Second, we need economic criteria for the selection of model that best predicts the trade pattern.

We have plotted the mean square error (MSE) the model against the Eigenvalues of the information matrix of the estimable functions man. This will tell us the evaluation of estimates of the population variance of the trade pattern of Norway across continents. The economic criteria are done by plotting the prediction power of the model against Eigenvalues of the information matrix of the estimable functions. The plot of MSE and against $Max\{\lambda\}-\lambda$ and the plot of power of model against $Max\{\lambda\}-\lambda$ is given in Figure 3.1. From the Figure 3.1 (left) we see that the minimum MES is obtained at $Max\{Max\{\lambda\}-\lambda\}$ i.e. at $Min\{\lambda\}=6$ which is the estimates from the trade patter of the post 2008. From the Figure 3.1(right) we see that the maximum prediction power of the model is again obtained at $Max\{Max\{\lambda\}-\lambda\}$ i.e. at $Min\{\lambda\}=6$ which are the estimates from the trade patter of the post 2008. The prediction power of the fit of the non-full rank hierarchical linear model of the post 2008 trade pattern is dependent on twenty-six continents wise items of import that covered 98.54 percent of the actual import trade of Norway. Therefore, the estimates of the estimable function of the post 2008 period trade pattern are best to predict the future trade pattern than the other fitted models with respect of both statistical and economic criteria.

{*Insert* Figure 3.1 *about here*}

In order to identify the least influential continents that affect the expenditure of Norway with respect to the items of import we will test the following hypothesises. The general frame of econometric hypotheses is set as:

Null hypothesis (H_o): *the import of the* j^{th} *item from the* i^{th} *continent has no significant impact on the overall Expenditure of the Norwegian import trade,*

Alternative hypothesis (H_1): *the import of the* j^{th} *item from the* i^{th} *continent has significant impact on the overall Expenditure of the Norwegian import trade,*

$$i = 1, 2, 3, 4, 5 \text{ and } j = 1, 2, 3 \ldots 10$$

The test results are given in Table 5.5. The estimates from the estimable functions of the two stage nested non-full rank model shows that 98.54 % of the import trade sector of Norway can be quantified. From the estimation result of Table 5.5 confirmed that, the import trade is dependent on: First, the imports of Machinery and transport equipment from the continents of Europe, Asia and Oceania, and North and Central America report shares of 26.45%, 8.91% and 3.59%, respectively. The expenditure estimates of the import items from these three continents are 191,910.9 million NOK. *Second*, the imports of manufactured goods classified chiefly by material from the continents of Europe, Asia and Oceania, and North and central report shares of 12.22%, 2.09% and 0.48%, respectively. The expenditure estimates of import items from these three continents are 72,897.8 million NOK. *Third*, the imports of Miscellaneous manufactured articles from the continents of Europe, Asia and Oceania, and North and central report shares of 9.07%, 4.67% and 0.90%, respectively. The expenditure estimates of import items from these three continents are 72119.0 million NOK. *Fourth*, the imports of Chemicals and related products from the continents of Europe, North and Central America, and Asia and Oceania report shares of 7.94%, 0.97%, and 0.68%, respectively. The expenditure estimates of import items from these three continents are 47273.0 million NOK. *Fifth*, the imports of Crude materials, inedible, except fuels from the continents of North and Central America, Europe, South America and Africa 2.27%, 2.16%, 1.04% and 1.04%, respectively. The expenditure estimates of import items from these four continents are 32103.8 million NOK. *Sixth*, the imports of Mineral fuels, lubricants and related materials from the continents of Europe, North and Central America, and Africa report shares of 5.40%, 0.40% and 0.39%. The expenditure estimates of import items from these three continents are 30478.7 million NOK. *Seventh*, the imports of Food and live animals from the continents of Europe, South America, Asia and Oceania and North and Central America

report shares of 4.30%, 0.83%, 0.40% and 0.38%, respectively. The expenditure estimates of import items from these four continents are 29191.4 million NOK. *Eighth*, the imports of Beverages and tobacco from the continents of Asia and Oceania and Europe report shares of 0.39% and 0.97%, respectively. The expenditure estimates of import items from these two continents are 6659.36 million NOK. *Last*, the import of Animal and vegetable oils, fats and waxes from the continents of Europe report shares of 0.6%. The expenditure estimates of import items from the continent of Europe are 2979.6 million NOK. Import items cover the rest, 1.46% of the import trade, across continents. Furthermore, across all the continents the imports of Commodities and transactions are insignificant.

The estimation results from the estimable function of the non-full rank hierarchical linear model have identified that the Norwegian import trade are truly international when we evaluate it with respect of continents. However, the continent of Europe is the most influential continent with an estimated share of 69.3 %. The continent, Asia and Oceania, North and Central America, South America and Africa covers import of 17.4%, 9.1%, 2.3% and 1.9%, respectively. The most influential item for Norway across continents is Machinery and transport equipment with an expected expenditure of 192500.2 million NOK. This number covers a share of 39.06 % of the total expenditure of Norwegian imports. The next top three influential items of Norwegian imports are manufactured goods classified chiefly by material, Miscellaneous manufactured articles, and Chemicals and related products. The expected expenditure from the import of these items are 73785.4, 72542.6 and 47638.4 Million NOK making shares of 14.97 %, 14.72% and 9.67 %, respectively. The estimated expenditures for the rest of the imports are 106334.9 million NOK, which covers a share of 21.58%.

5. Conclusions and Policy Implications

5.1 Conclusions

In this paper, we have used the two stage non-full rank hierarchical linear econometric model to evaluate the variation of the Norwegian import trade across continents and over time. The model is hypothesised to show structural changes, influential import items and continents of origin. The model adequacy checking has tested for normality, constant variance (homoscedasticity), data independence and absence of outliers. The model adequacy and diagnostics results confirm statistically that the observations follow normal distributions and

satisfy the constant variance assumptions. Furthermore, the model captures extreme values and outlier problems are therefore absent. However, most import items show serial correlation showing memories up to 18 years. Therefore, to eliminate the problem of serial correlation and to find efficient estimators of estimable model functions we apply the Cochrane-Orcutt recursive autoregressive estimator. After applying the Cochrane-Orcutt recursive autoregressive estimation and therefore removing the problem of autocorrelation, we fit the continental variation of Norwegian imports.

The parameters of model specification are hierarchical structured. Hence, factors nest the nesting factors. More importantly, the model gives advantage for the precise estimation of the nested factor over the nesting factors. The selection of nesting and nested factor from origin continents and import items where one of the most important tasks of the paper. To solve such dilemmas we have used the international Heckscher-Ohlin trade model and we set the items of import as the nesting and the origin continents as the nested factor. The fit of the two stage non-full rank hierarchical linear econometric model shows that the expenditure of import trade is heterogeneity over both the destination continent and the import item. To assess the overall variation of the trade pattern we decompose the model's sum of square according to the rules of decomposition of the sum of squares. The test result confirms that the Norwegian import trade is sustainable in the short and long run after controlling for the effect of the import item from any continent of origin. Furthermore, at least one of the continental categories and/or import items does have a significant impact over the others on the overall Norwegian import trade.

Another challenge is the identification of the influential origin continents and import items for the estimation of model parameters and identifying potential structural changes in the trade pattern. In order to mitigate the problem we have estimated the estimable function of the non-full rank hierarchical linear model, defined as $\mu + \alpha_i + \beta_{j(i)}$. We have applied double phase (time wise and continent wise) bootstrapping technique to analyses the potential structural changes in the trade patterns.

The assessment of structural changes of continental share of Norway showed considerable dynamics. We have found that the share of Europe and North and Central America is declining while the share of the other categories of contents is increasing. Especially the

content of Asia and Oceania is increasing. In the post 1988 trade pattern we have identified 17-continent wise import items that account for 94.5 percent of the Norwegian import expenditure. However, in the post 2008 trade patterns 26-continent wise import items account for 98.5 percent of the expenditure. This confirms that the import's extensive margin is increasing with time. Structural changes of the trade pattern occur across all the origin continents for some import items with different levels of impact on the expenditure.

By using the statistical and economic criteria we find that the estimates of estimable functions of the import trade of the post 2008 trade pattern is the best to evaluate the continental variations of the import. The estimation results confirm that the import trade of Norway is truly international when we evaluate it with respect of continents. However, the continent of Europe is the most influential continent of the import trade with an estimated share on 69.3 %. The continent of Asia and Oceania, North and Central America, South America and Africa covers 17.4%, 9.1%, 2.3% and 1.9%, respectively. The most influential item of Norwegian across continents is Machinery and transport equipment covering a share of 39.06 % of the total import expenditure. The next top three influential items of Norwegian imports are manufactured goods classified chiefly by material, Miscellaneous manufactured articles, and Chemicals and related products covering shares of 14.97 %, 14.72% and 9.67 %, respectively. The rest items cover a share of 21.58%.

5.2 Recommendations and Policy Implications

This paper has applied the two-stage hierarchical linear econometric model to evaluate the continental variation of Norwegian imports. The estimation results have important managerial policy implications and suggest several policy recommendations. The estimation results show important implications for Norwegian import trade. First the European continent dominates all other continents over all import items. Moreover, the Norwegian import trade is determined by the import of goods from the continents of Asia and Oceania and North and Central America. Therefore, the Norwegian government has to acknowledge the need for further research on Norwegian imports to make effective and efficient bilateral coordination with the countries that affects the import trade.

According to the econometric assessment by Tesfay and Solibakke (2014) non-of the items of exports has significant impact on the revenue of the Norwegian export trade from the continent of South America and Africa. However, this paper identified that these continents

significantly affect the Norwegian import sector. Hence, the Norwegian government should revise its policy for South American and African countries.

One of the most important advantages of the two-stage hierarchical linear econometric model is its ability to identify potential structural changes. The finding of structural changes in the pattern of the import trade shows the full dynamics across all continents. Especially, the structural changes from the continent of Europe to Asia and Oceania and from North and Central America to Asia and Oceania seem to be the most important Norwegian changes. In this aspect there are a number of econometric hypotheses that can be generated and tested: [1] Countries that cause continental structural changes, [2] Welfare maximization of the structural changes for the Norwegian economy. [3] The impacts from structural changes to Norwegian exports and balance of payments. New and extensive analyses have to be conducted for all of these econometric hypotheses.

This study identified heterogeneity on continent wise Norwegian imports. The estimation results identified that the import share from Europe and North and Central America is declining and the share of the other continents, especially Asia and Oceania are increasing. Therefore, for the new and extended knowledge of the Norwegian import trade patterns, research has to conduct on the intra-continental and inter-continental variations.

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Table 2.1: Jarque–Bera test of Normality

Observation	Missing Value	Transformation	Seasonal and Non-Seasonal Differencing	Standardization	Distribution			Estimate of Location (skewness)	Estimate of Scale (kurtosis)	Jarque–Bera-Chis-square calculated	P-value
					Type	Location (skewness)	Scale (kurtosis)				
1300	0	None	None	Not applied	Normal	estimated	estimated	-0.003001	3.0000092	0.000195	0.499513

Table 2.2: Bartlett's test of Heteroscedasticity

Bartlett's Test of Sphericity[a]	Pooled standard deviation	Approx. Chi-Square	DF	Significance
	8497156.84	0.1127	2	0.9984
Tests the null hypothesis that the observations have equal variance.				

Table 2.3: Result of the Ljung-Box test of autocorrelation, stationarity and outlier

Continents	Items of items of import	Number of Predictors	Model Fit statistics	Ljung-Box Q(18)			Number of Outliers
			Stationary R-squared	Statistics	DF	Sig.	
Europe	Food and live animals	0	0.0000	111.630	18	0.00000**	0
Europe	Beverages and tobacco	0	0.0000	117.134	18	0.00000**	0
Europe	Crude materials, inedible, except fuels	0	0.0000	105.925	18	0.00000**	0
Europe	Mineral fuels, lubricants and related materials	0	0.0000	110.746	18	0.00000**	0
Europe	Animal and vegetable oils, fats and waxes	0	0.0000	82.294	18	0.00000**	0
Europe	Chemicals and related products n.e.s.	0	0.0000	137.319	18	0.00000**	0
Europe	Manufactured goods classified chiefly by material	0	0.0000	135.157	18	0.00000**	0
Europe	Machinery and transport equipment	0	0.0000	137.682	18	0.00000**	0
Europe	Miscellaneous manufactured articles	0	0.0000	149.763	18	0.00000**	0
Europe	Commodities and transactions	0	0.0000	41.217	18	0.00100**	0
Africa	Food and live animals	0	0.0000	74.211	18	0.00000**	0
Africa	Beverages and tobacco	0	0.0000	83.129	18	0.00000**	0
Africa	Crude materials, inedible, except fuels	0	0.0000	108.264	18	0.00000**	0
Africa	Mineral fuels, lubricants and related materials	0	0.0000	10.492	18	0.91500	0
Africa	Animal and vegetable oils, fats and waxes	0	0.0000	102.827	18	0.00000**	0
Africa	Chemicals and related products n.e.s.	0	0.0000	22.770	18	0.20000**	0
Africa	Manufactured goods classified chiefly by material	0	0.0000	29.691	18	0.04100**	0
Africa	Machinery and transport equipment	0	0.0000	32.816	18	0.01800**	0
Africa	Miscellaneous manufactured articles	0	0.0000	162.159	18	0.00000**	0
Africa	Commodities and transactions	0	0.0000	2.885	18	1.00000	0
North and Central America	Food and live animals	0	0.0000	87.250	18	0.00000**	0
North and Central America	Beverages and tobacco	0	0.0000	31.466	18	0.02500**	0
North and Central America	Crude materials, inedible, except fuels	0	0.0000	84.221	18	0.00000**	0
North and Central America	Mineral fuels, lubricants and related materials	0	0.0000	37.916	18	0.00400**	0
North and Central America	Animal and vegetable oils, fats and waxes	0	0.0000	26.154	18	0.09600	0

Table 2.3 continued

North and Central America	Chemicals and related products n.e.s.	0	0.0000	132.800	18	0.00000**	0
North and Central America	Manufactured goods classified chiefly by material	0	0.0000	38.664	18	0.00300**	0
North and Central America	Machinery and transport equipment	0	0.0000	27.086	18	0.07700	0
North and Central America	Miscellaneous manufactured articles	0	0.0000	68.764	18	0.00000**	0
North and Central America	Commodities and transactions	0	0.0000	13.360	18	0.77000	0
South America	Food and live animals	0	0.0000	79.321	18	0.00000**	0
South America	Beverages and tobacco	0	0.0000	62.666	18	0.00000**	0
South America	Crude materials, inedible, except fuels	0	0.0000	156.367	18	0.00000**	0
South America	Mineral fuels, lubricants and related materials	0	0.0000	40.798	18	0.00200**	0
South America	Animal and vegetable oils, fats and waxes	0	0.0000	52.075	18	0.00000**	0
South America	Chemicals and related products n.e.s.	0	0.0000	51.876	18	0.00000**	0
South America	Manufactured goods classified chiefly by material	0	0.0000	31.521	18	0.02500**	0
South America	Machinery and transport equipment	0	0.0000	33.540	18	0.01400**	0
South America	Miscellaneous manufactured articles	0	0.0000	118.060	18	0.00000**	0
South America	Commodities and transactions	0	0.0000	63.947	18	0.00000**	0
Asia and Oceania	Food and live animals	0	0.0000	113.792	18	0.00000**	0
Asia and Oceania	Beverages and tobacco	0	0.0000	113.160	18	0.00000**	0
Asia and Oceania	Crude materials, inedible, except fuels	0	0.0000	22.647	18	0.20500	0
Asia and Oceania	Mineral fuels, lubricants and related materials	0	0.0000	11.613	18	0.86700	0
Asia and Oceania	Animal and vegetable oils, fats and waxes	0	0.0000	22.128	18	0.22600	0
Asia and Oceania	Chemicals and related products n.e.s.	0	0.0000	77.708	18	0.00000**	0
Asia and Oceania	Manufactured goods classified chiefly by material	0	0.0000	109.201	18	0.00000**	0
Asia and Oceania	Machinery and transport equipment	0	0.0000	103.814	18	0.00000**	0
Asia and Oceania	Miscellaneous manufactured articles	0	0.0000	121.851	18	0.00000**	0
Asia and Oceania	Commodities and transactions	0	0.0000	90.461	18	0.00000**	0

** Significant at 5% level of significance

Table 3.1: ANOVA for two stage non-full rank linear model of the post 1988 Continental Variation of the import trade of Norway

Source of Variation	SS	DF	MS	F-Cal	P-value
Model	3.178 E+11	50	6.357E+9	150.1304	0.00000**
Error	5.293 E+10	1250	4.234 E+7		
Total	3.708 E+11	1300			
R-square	0.8572				
Adjusted R-Square	0.8515				
Mean Square Error (MSE)	42,343,918.708				
Dimension of information matrix of estimable function	56				
Characteristics function of information matrix of estimable function	$f(\lambda) = \lambda^6 (26 - \lambda)^{50}$				
Rank of information matrix of estimable function	50				
Nullity of information matrix of estimable function	6				
Additional degree of freedom acquired for the MSE	6				

** Significant at 5% level of significance

Table 4: ANOVA for tests of significance of Continental and Item effects

Source of Variation	SS	DF	MS	F-cal	P-value
SSR	3.178 E+11	50	6.357E+9	150.13	0.00000**
$R(\mu)$	5.056E+10	1	5.057E+10	1194.24	0.00000**
$R(\alpha, \beta \mid \mu)$	2.673E+11	49	5.455E+9	128.82	0.00000**
$R(\mu, \alpha)$	1.390E+11	5	2.780E+10	656.49	0.00000**
$R(\alpha \mid \mu)$	8.842E+10	4	2.211E+10	522.05	0.00000**
$R(\beta \mid \mu, \alpha)$	1.789E+11	45	3.975E+9	93.87	0.00000**
SSE	5.293 E+10	1250	4.234 E+7		
SST	3.708 E+11	1300			

See Table 1 for abbreviations in table 4.
** Significant at 5% level of significance

Table 5.1: Estimates of Estimable Function and their significance of the post 1988 trade pattern of Norway across Continents

Continental variation	Items of Import	Estimates of Estimable Function	Estimates of Share	SS	DF	MS	F-cal	P-Value
Africa	Crude materials, inedible, except fuels	2,511.4027	0.81%	1.640E+8	1	1.64E+08	3.87	0.0293**
Asia and Oceania	Machinery and transport equipment	23,763.4820	7.62%	1.468E+10	1	1.47E+10	346.74	0.0000**
Asia and Oceania	Miscellaneous manufactured articles	11,992.6191	3.85%	3.739E+9	1	3.74E+09	88.31	0.0000**
Asia and Oceania	Manufactured goods classified chiefly by material	5,471.3088	1.75%	7.7831E+8	1	7.78E+08	18.38	0.0000**
Europe	Machinery and transport equipment	85,161.8302	27.31%	1.886E+11	1	1.89E+11	4453.20	0.0000**
Europe	Manufactured goods classified chiefly by material	42,635.6072	13.67%	4.726 E+9	1	4.73E+10	1116.16	0.0000**
Europe	Miscellaneous manufactured articles	32,527.3887	10.43%	2.751E+10	1	2.75E+10	649.65	0.0000**
Europe	Chemicals and related products n.e.s.	25,322.1899	8.12%	1.667E+10	1	1.67E+10	393.72	0.0000**
Europe	Mineral fuels, lubricants and related materials	13,413.6149	4.30%	4.678E+9	1	4.68E+09	110.48	0.0000**
Europe	Food and live animals	12,560.0457	4.03%	4.102 E+9	1	4.1E+09	96.86	0.0000**
Europe	Crude materials, inedible, except fuels	8,747.5037	2.81%	1.989E+9	1	1.99E+09	46.98	0.0000**
Europe	Beverages and tobacco	2,383.7613	0.76%	1.477E+8	1	1.48E+08	3.49	0.0375**
North and Central America	Machinery and transport equipment	14,157.7567	4.54%	5.211E+9	1	5.21E+09	123.08	0.0000**
North and Central America	Crude materials, inedible, except fuels	7,060.5918	2.26%	1.296E+8	1	1.3E+09	30.61	0.0000**
North and Central America	Miscellaneous manufactured articles	2,967.7466	0.95%	2.290E+8	1	2.29E+08	5.41	0.0115**
North and Central America	Chemicals and related products n.e.s.	2,395.3150	0.77%	1.492E+7	1	1.49E+08	3.52	0.0366**
South America	Crude materials, inedible, except fuels	3,033.5596	0.97%	2.393E+8	1	2.39E+08	5.65	0.0100**
Across Continents	Rest of imports	15,739.65	5.05%	3.62E+08	33	1.1E+07	0.254	0.6004

** Significant at 5% level of significance

Estimable functions are measured in million NOK

Table 3.2: ANOVA for two stage non-full rank linear model of the post 1993 Continental variation of the import trade of Norway

Source of Variation	SS	DF	MS	F-Cal	P-value
Model	3.21E+11	50	6.42E+09	191.4318	0.00000**
Error	3.36E+10	1000	3.4E+07		
Total	3.55E+11	1050			
R-square	0.9054				
Adjusted R-Square	0.9007				
Mean square error (MSE)	33554792.13				
Dimension of information matrix of estimable function	56				
Characteristics function of information matrix of estimable function	$f(\lambda) = \lambda^6 (21-\lambda)^{50}$				
Rank of information matrix of estimable function	50				
Nullity of information matrix of estimable function	6				
Additional degree of freedom acquired for the MSE	6				

** Significant at 5% level of significance

Table 5.2: Estimates of Estimable Function and their significance of the post 1993 trade pattern of Norway across Continents

Continental variation	Items of Import	Estimates of Estimable Function	Estimates of Share	SS	DF	MS	F-Cal	P-Value
Europe	Machinery and transport equipment	96022.5079	27.64%	1.94E+11	1	1.94E+11	5770.47	0.0000**
Europe	Manufactured goods classified chiefly by material	46756.8655	13.46%	4.59E+10	1	4.6E+10	1368.22	0.0000**
Europe	Miscellaneous manufactured articles	35281.0363	10.16%	2.61E+10	1	2.6E+10	779.02	0.0000**
Europe	Chemicals and related products n.e.s.	28341.9594	8.16%	1.69E+10	1	1.7E+10	502.72	0.0000**
Asia and Oceania	Machinery and transport equipment	27154.6279	7.82%	1.55E+10	1	1.5E+10	461.48	0.0000**
Europe	Mineral fuels, lubricants and related materials	15250.4619	4.39%	4.88E+09	1	4.9E+09	145.56	0.0000**
North and Central America	Machinery and transport equipment	14671.1206	4.22%	4.52E+09	1	4.5E+09	134.71	0.0000**
Europe	Food and live animals	14215.6482	4.09%	4.24E+09	1	4.2E+09	126.47	0.0000**
Asia and Oceania	Miscellaneous manufactured articles	13896.1502	4.00%	4.06E+09	1	4.1E+09	120.85	0.0000**
Europe	Crude materials, inedible, except fuels	9532.4765	2.74%	1.91E+09	1	1.9E+09	56.87	0.0000**
North and Central America	Crude materials, inedible, except fuels	7929.1536	2.28%	1.32E+09	1	1.3E+09	39.35	0.0000**
Asia and Oceania	Manufactured goods classified chiefly by material	6336.8617	1.82%	8.43E+08	1	8.4E+08	25.13	0.0000**
South America	Crude materials, inedible, except fuels	3452.5306	0.99%	2.5E+08	1	2.5E+08	7.46	0.0035**
North and Central America	Miscellaneous manufactured articles	3245.2425	0.93%	2.21E+08	1	2.2E+08	6.59	0.0058**
North and Central America	Chemicals and related products n.e.s.	2772.1978	0.80%	1.61E+08	1	1.6E+08	4.81	0.0165**
Europe	Beverages and tobacco	2752.3617	0.79%	1.59E+08	1	1.6E+08	4.74	0.0172**
Africa	Crude materials, inedible, except fuels	2747.8715	0.79%	1.59E+08	1	1.6E+08	4.73	0.0173**
Across Continents	Rest of imports	16990.07	4.89%	4.2E+08	33	1.3E+07	0.38	0.6466

** Significant at 5% level of significance

Estimates of the mean expenditure is in million NOK

Table 3.3: ANOVA for two stage non-full rank linear model of the post 1998 Continental variation of the import trade of Norway

Source of Variation	SS	DF	MS	F-Cal	P-value
Model	3.070E+11	50	6.14E+09	261.46	0.00000**
Error	1.76E+09	750	2.35 E+07		
Total	3.246+11	800			
R-square	0.9457				
Adjusted R-Square	0.9421				
Mean Square Error (MSE)	23481649.5				
Dimension of information matrix of estimable function	56				
Characteristics function of information matrix of estimable function	$f(\lambda) = \lambda^6 (16 - \lambda)^{50}$				
Rank of information matrix of estimable function	50				
Nullity of information matrix of estimable function	6				
Additional degree of freedom acquired for the MSE	6				

** Significant at 5% level of significance

Table 5.3: Estimates of Estimable Function and their significance of the post 1998 trade pattern of Norway across Continents

Continental variation	Items of Import	Estimates of Estimable function	Estimates of Share	SS	DF	MS	F-Cal	P-Value
Europe	Machinery and transport equipment	108050.8	27.72%	1.87E+11	1	1.87E+11	7955.13	0.0000**
Europe	Manufactured goods classified chiefly by material	51329.44	13.17%	4.22E+10	1	4.22E+10	1795.25	0.0000**
Europe	Miscellaneous manufactured articles	38612.73	9.90%	2.39E+10	1	2.39E+10	1015.90	0.0000**
Europe	Chemicals and related products n.e.s.	31565.1	8.10%	1.59E+10	1	1.59E+10	678.90	0.0000**
Asia and Oceania	Machinery and transport equipment	31249.95	8.02%	1.56E+10	1	1.56E+10	665.41	0.0000**
Europe	Mineral fuels, lubricants and related materials	17809.42	4.57%	5.07E+09	1	5.07E+09	216.12	0.0000**
Asia and Oceania	Miscellaneous manufactured articles	16167.63	4.15%	4.18E+09	1	4.18E+09	178.11	0.0000**
Europe	Food and live animals	16052.61	4.12%	4.12E+09	1	4.12E+09	175.58	0.0000**
North and Central America	Machinery and transport equipment	15815.08	4.06%	4E+09	1	4.00E+09	170.43	0.0000**
Europe	Crude materials, inedible, except fuels	10182.38	2.61%	1.66E+09	1	1.66E+09	70.65	0.0000**
North and Central America	Crude materials, inedible, except fuels	9069.396	2.33%	1.32E+09	1	1.32E+09	56.05	0.0000**
Asia and Oceania	Manufactured goods classified chiefly by material	7253.388	1.86%	8.42E+08	1	8.42E+08	35.85	0.0000**
South America	Crude materials, inedible, except fuels	4130.641	1.06%	2.73E+08	1	2.73E+08	11.63	0.0003**
North and Central America	Miscellaneous manufactured articles	3513.176	0.90%	1.97E+08	1	1.97E+08	8.41	0.0021**
North and Central America	Chemicals and related products n.e.s.	3295.221	0.85%	1.74E+08	1	1.74E+08	7.40	0.0037**
Europe	Beverages and tobacco	3262.322	0.84%	1.7E+08	1	1.7E+08	7.25	0.0040**
Africa	Crude materials, inedible, except fuels	3211.724	0.82%	1.65E+08	1	1.65E+08	7.03	0.0045**
South America	Food and live animals	2437.388	0.63%	95053793	1	95053793	4.05	0.0263**
Across Continents	Rest of imports	16828.19	4.32%	3.21E+08	32	1E+07	0.43	0.6651

** Significant at 5% level of significance

Estimates of the mean expenditure is in million NOK

Table 3.4: ANOVA for two stage non-full rank linear model of the post 2003 Continental variation of the import trade of Norway

Source of Variation	SS	DF	MS	F-Cal	P-value
Model	2.61151E+11	50	5.22E+09	312.78	0.00000**
Error	8.3493E+9	500	1.67E+07		
Total	2.695E+11	550			
R-square	0.9690				
Adjusted R-Square	0.9659				
Mean square error (MSE)	16698600				
Dimension of information matrix of estimable function	56				
Characteristics function of information matrix of estimable function	$f(\lambda)=\lambda^{6}(11-\lambda)^{50}$				
Rank of information matrix of estimable function	50				
Nullity of information matrix of estimable function	6				
Additional degree of freedom acquired for the MSE	6				

** Significant at 5% level of significance

Table 5.4: Estimates of Estimable Function and their significance of the post 2003 trade pattern of Norway across Continents

Continental variation	Items of Import	Estimates of Estimable function	Estimates of Share	SS	DF	MS	F-Cal	P-Value
Europe	Machinery and transport equipment	119915.3	27.43%	1.582E+11	1	1.58E+11	9472.407	0.0000**
Europe	Manufactured goods classified chiefly by material	57245.83	13.09%	3.6E+10	1	3.6E+10	2158.733	0.0000**
Europe	Miscellaneous manufactured articles	41826.88	9.57%	1.92E+10	1	1.92E+10	1152.45	0.0000**
Asia and Oceania	Machinery and transport equipment	35801.14	8.19%	1.41E+10	1	1.41E+10	844.316	0.0000**
Europe	Chemicals and related products n.e.s.	35175.79	8.05%	1.36E+10	1	1.36E+10	815.0775	0.0000**
Europe	Mineral fuels, lubricants and related materials	21638.97	4.95%	5.15E+09	1	5.15E+09	308.4496	0.0000**
Asia and Oceania	Miscellaneous manufactured articles	19128.53	4.37%	4.02E+09	1	4.02E+09	241.0318	0.0000**
Europe	Food and live animals	18022.13	4.12%	3.57E+09	1	3.57E+09	213.9556	0.0000**
North and Central America	Machinery and transport equipment	15097.91	3.45%	2.51E+09	1	2.51E+09	150.1567	0.0000**
North and Central America	Crude materials, inedible, except fuels	10715.02	2.45%	1.26E+09	1	1.26E+09	75.6305	0.0000**
Europe	Crude materials, inedible, except fuels	10672.05	2.44%	1.25E+09	1	1.25E+09	75.02521	0.0000**
Asia and Oceania	Manufactured goods classified chiefly by material	8768.375	2.01%	8.46E+08	1	8.46E+08	50.64651	0.0000**
South America	Crude materials, inedible, except fuels	4845.711	1.11%	2.58E+08	1	2.58E+08	15.46772	0.0001**
Africa	Crude materials, inedible, except fuels	4104.345	0.94%	1.85E+08	1	1.85E+08	11.09683	0.0005**
North and Central America	Chemicals and related products n.e.s.	3964.507	0.91%	1.73E+08	1	1.73E+08	10.35356	0.0007**
Europe	Beverages and tobacco	3935.256	0.90%	1.7E+08	1	1.7E+08	10.20134	0.0008**
North and Central America	Miscellaneous manufactured articles	3767.495	0.86%	1.56E+08	1	1.56E+08	9.350106	0.0013**
South America	Food and live animals	3043.183	0.70%	1.02E+08	1	1.02E+08	6.100527	0.0077**
Asia and Oceania	Chemicals and related products n.e.s.	2423.091	0.55%	64585080	1	64585080	3.867682	0.0294**
Europe	Animal and vegetable oils, fats and waxes	2233.035	0.51%	54850889	1	54850889	3.284749	0.0427**
Across Continents	Rest of imports	14901.300	3.41%	1.9E+08	30	6359670	0.27084	0.5972

** Significant at 5% level of significance

Estimates of the mean expenditure is in million NOK

Table 3.5: Model Fit of import trade since 2008

Source of Variation	SS	DF	MS	F-Cal	P-value
Model	1.71547E+11	50	3.4309E+9	606.49	0.00000**
Error	1.41427E+9	250	5.6578E+9		
Total	1.72961E+11	300			
R-square	0.9690				
Adjusted R-Square	0.9902				
Mean square error (MSE)	5657059.84				
Dimension of information matrix of estimable function	56				
Characteristics function of information matrix of estimable function	$f(\lambda) = \lambda^6 (6-\lambda)^{50}$				
Rank of information matrix of estimable function	50				
Nullity of information matrix of estimable function	6				
Additional degree of freedom acquired for the MSE	6				

** Significant at 5% level of significance

Table 5.5: Estimates of Estimable Function and their significance of the post 2008 trade pattern of Norway across Continents

Continental variation	Items of Import	Estimates of Estimable Function	Estimates of Share	SS	DF	MS	F-Cal	P-Value
Europe	Machinery and transport equipment	130328.5670	26.45%	1.02E+11	1	1.02E+11	18015.23	0.0000**
Europe	Manufactured goods classified chiefly by material	60208.5377	12.22%	2.18E+10	1	2.18E+10	3844.83	0.0000**
Europe	Miscellaneous manufactured articles	44683.3480	9.07%	1.2E+10	1	1.2E+10	2117.64	0.0000**
Asia and Oceania	Machinery and transport equipment	43904.8692	8.91%	1.16E+10	1	1.16E+10	2044.49	0.0000**
Europe	Chemicals and related products n.e.s.	39107.0263	7.94%	9.18E+09	1	9.18E+09	1622.07	0.0000**
Europe	Mineral fuels, lubricants and related materials	26587.4490	5.40%	4.24E+09	1	4.24E+09	749.75	0.0000**
Asia and Oceania	Miscellaneous manufactured articles	22999.1853	4.67%	3.17E+09	1	3.17E+09	561.03	0.0000**
Europe	Food and live animals	21204.0647	4.30%	2.7E+09	1	2.7E+09	476.87	0.0000**
North and Central America	Machinery and transport equipment	17677.4913	3.59%	1.87E+09	1	1.87E+09	331.44	0.0000**
North and Central America	Crude materials, inedible, except fuels	11170.4427	2.27%	7.49E+08	1	7.49E+08	132.34	0.0000**
Europe	Crude materials, inedible, except fuels	10665.7007	2.16%	6.83E+08	1	6.83E+08	120.65	0.0000**
Asia and Oceania	Manufactured goods classified chiefly by material	10312.8972	2.09%	6.38E+08	1	6.38E+08	112.80	0.0000**
South America	Crude materials, inedible, except fuels	5143.1515	1.04%	1.59E+08	1	1.59E+08	28.06	0.0000**
Africa	Crude materials, inedible, except fuels	5124.5002	1.04%	1.58E+08	1	1.58E+08	27.85	0.0000**
North and Central America	Chemicals and related products n.e.s.	4792.9837	0.97%	1.38E+08	1	1.38E+08	24.37	0.0000**
Europe	Beverages and tobacco	4755.8850	0.97%	1.36E+08	1	1.36E+08	23.99	0.0000**
North and Central America	Miscellaneous manufactured articles	4436.4518	0.90%	1.18E+08	1	1.18E+08	20.88	0.0000**
South America	Food and live animals	4113.8913	0.83%	1.02E+08	1	1.02E+08	17.95	0.0000**
Asia and Oceania	Chemicals and related products n.e.s.	3372.9508	0.68%	6.8E+07	1	68260784	12.07	0.0003**
Europe	Animal and vegetable oils, fats and waxes	2979.5618	0.60%	5.3E+07	1	53266732	9.42	0.0012**
North and Central America	Manufactured goods classified chiefly by material	2376.3535	0.48%	3.4E+07	1	33882336	5.99	0.0083**
Asia and Oceania	Food and live animals	1983.1290	0.40%	2.4E+07	1	23596804	4.17	0.0244**
North and Central America	Mineral fuels, lubricants and related materials	1973.7743	0.40%	2.3E+07	1	23374711	4.13	0.0251**
Africa	Mineral fuels, lubricants and related materials	1917.4340	0.39%	2.2E+07	1	22059319	3.90	0.0289**
Asia and Oceania	Beverages and tobacco	1903.4753	0.39%	2.2E+07	1	21739310	3.84	0.0300**

Table 5.5 continued

North and Central America	Food and live animals	1890.2928	0.38%	2.1E+07	1	21439242	3.79	0.0310**
Across Continents	Rest of imports	7188.0862	1.46%	2.7E+07	24	1131109	0.20	0.5792

** Significant at 5% level of significance

Estimates of the mean expenditure is in million NOK

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Figure 1: Plot of standardized residuals

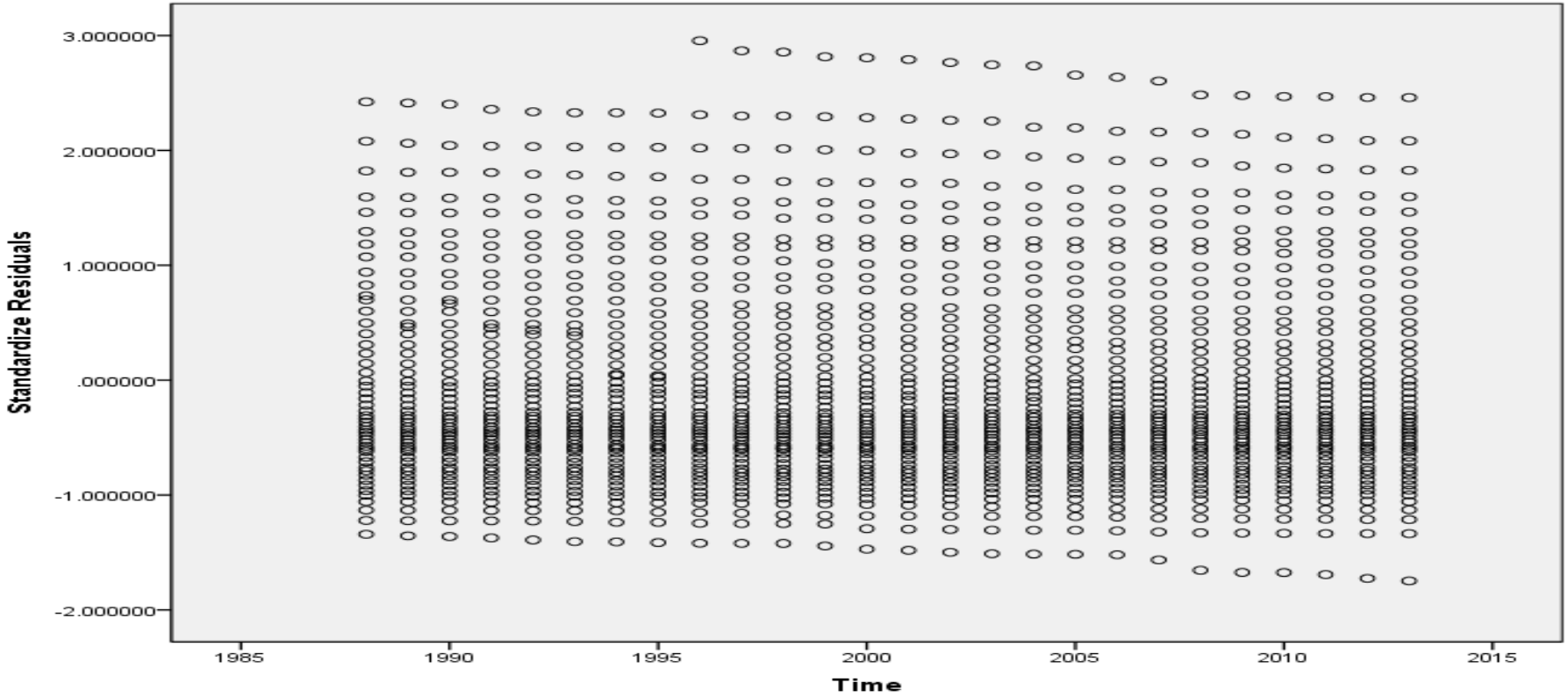
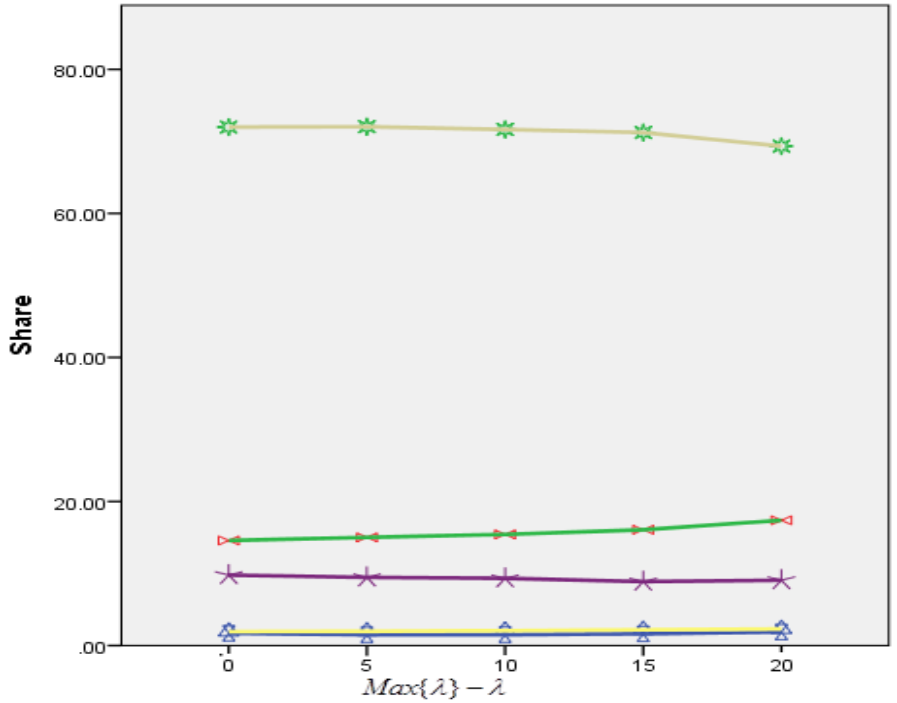


Figure 2.1: Structural changes on expenditure based Continental share (in percent) of imports



Key

: Share of import from Africa

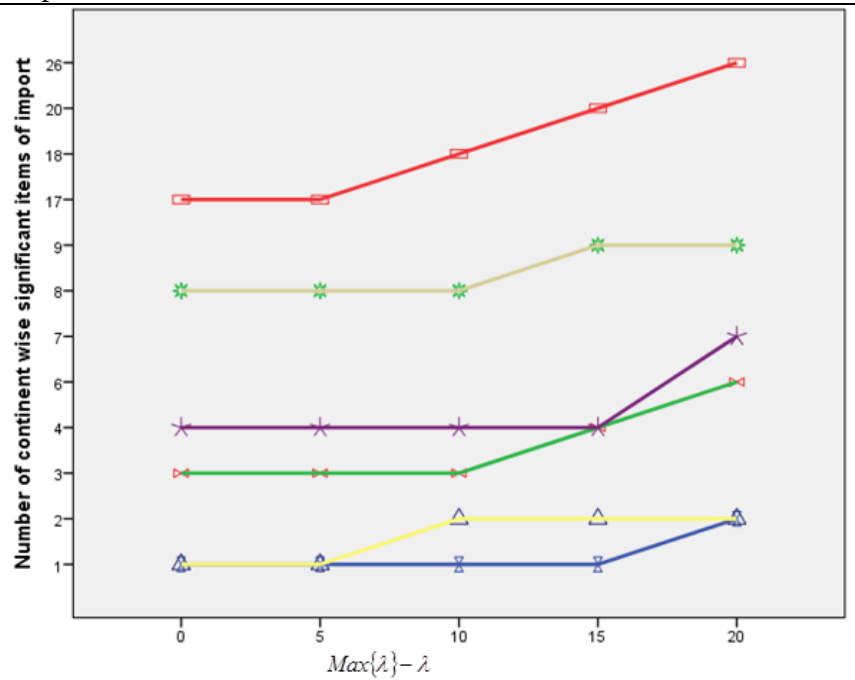
: Share of import from Asia and Oceania

: Share of import from Europe

: Share of import from North and Central America

: Share of import from South America

Figure 2.2: Structural changes on Number of significant items of import



Key

: Number of significant items of import from Africa

: Number of significant items of import from Asia and Oceania

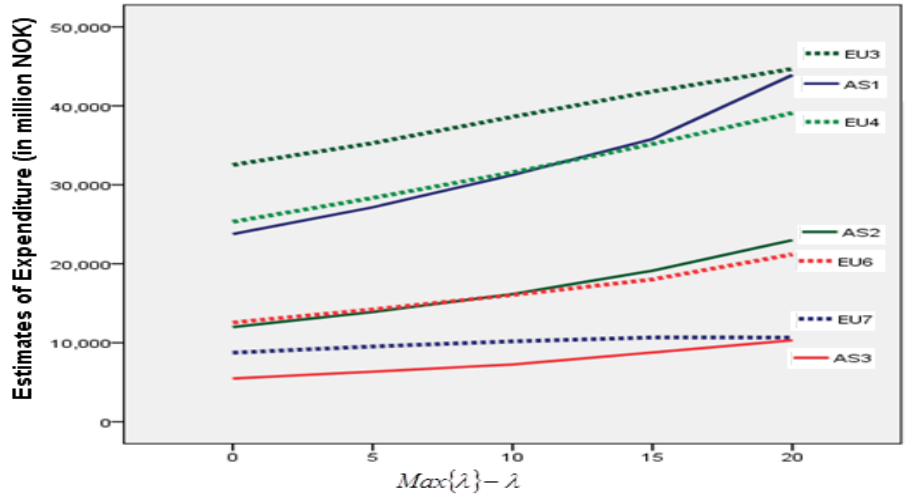
: Number of significant items of import from Europe

: Number of significant items of import from North and Central America

: Number of significant items of import from South America

: Total number of significant items of import across continents

Figure 2.3: Structural changes on the import trade patterns of Norway from the Europe to Asia and Oceania



Key

AS1 :Estimates of expenditure to import of Machinery and transport equipment from the continent of Asia and Oceania

AS2 :Estimates of expenditure to import of Miscellaneous manufactured articles from the continent of Asia and Oceania

AS3 :Estimates of expenditure to import of Manufactured goods classified chiefly by material from the continent of Asia and Oceania

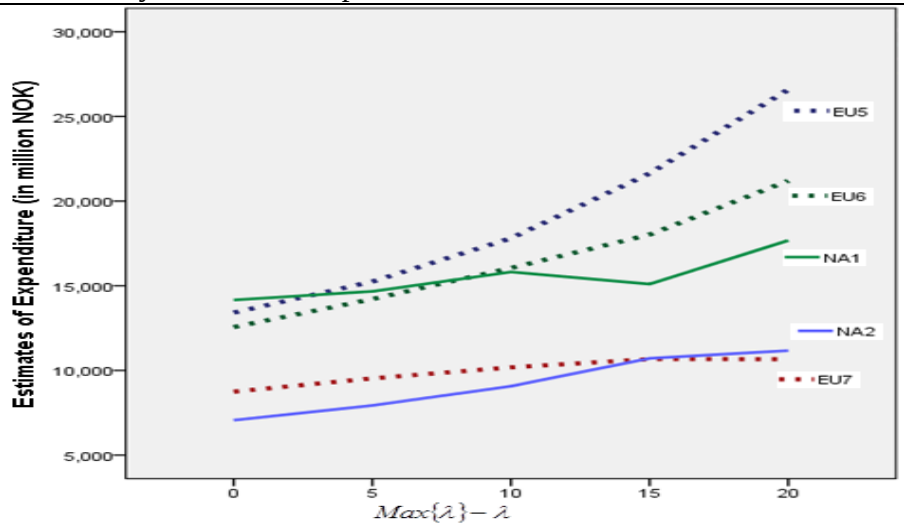
EU3 :Estimates of expenditure to import of Miscellaneous manufactured articles from the continent of Europe

EU4 :Estimates of expenditure to import Chemicals and related products from the continent of Europe

EU6 :Estimates of expenditure to import Food and live animals from the continent of Europe

EU7 :Estimates of expenditure to import Crude materials, inedible, except fuels from the continent of Europe

Figure 2.4: Structural changes on the import trade patterns of Norway from the Europe to North and Central America or vice versa



Key

EU5 :Estimates of expenditure to import of Mineral fuels, lubricants and related materials from the continent of Europe

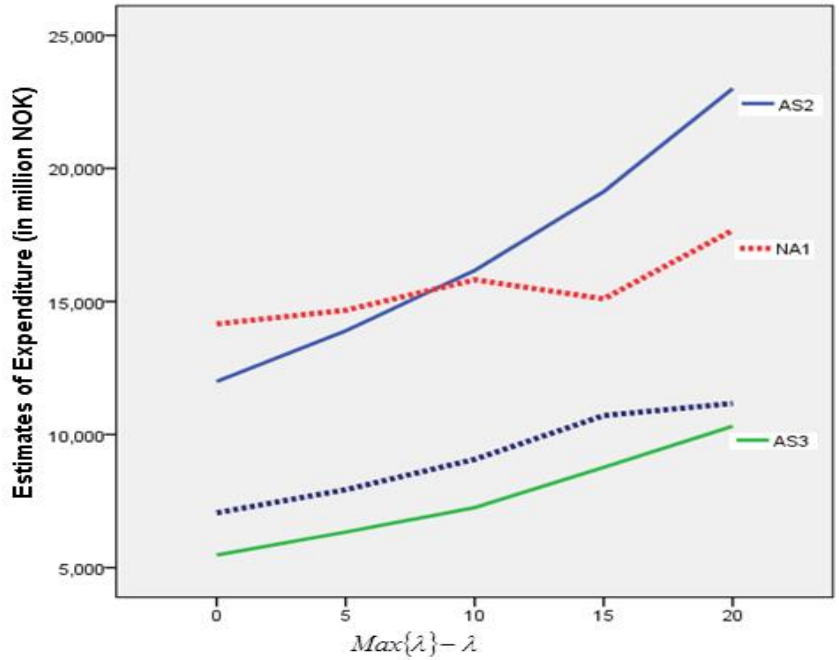
EU6 :Estimates of expenditure to import of Food and live animals from the continent of Europe

EU7 :Estimates of expenditure to import of Crude materials, inedible, except fuels from the continent of Europe

NA1 :Estimates of expenditure to import of Machinery and transport equipment from the continent of North and Central America

NA2 :Estimates of expenditure to import of Crude materials, inedible, except fuels from the continent of North and Central America

Figure 2.5: Structural changes on the import trade patterns of Norway from the North and Central America to Asia and Oceania or vice versa



Key

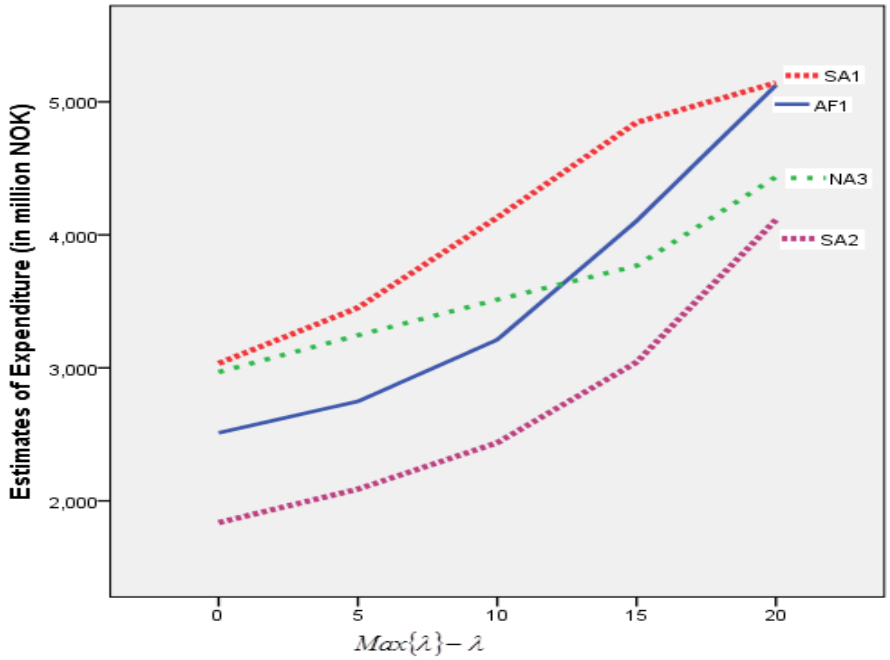
AS2 :Estimates of expenditure to import of Miscellaneous manufactured articles from the continent of Asia and Oceania

AS3 :Estimates of expenditure to import of Manufactured goods classified chiefly by material from the continent of Asia and Oceania

NA1 :Estimates of expenditure to import of Machinery and transport equipment from the continent of North and Central America

NA2 :Estimates of expenditure to import of Crude materials, inedible, except fuels from the continent of North and Central America

Figure 2.6: Structural changes on the import trade patterns of Norway of the continents of the North and Central America, South America and Africa



Key

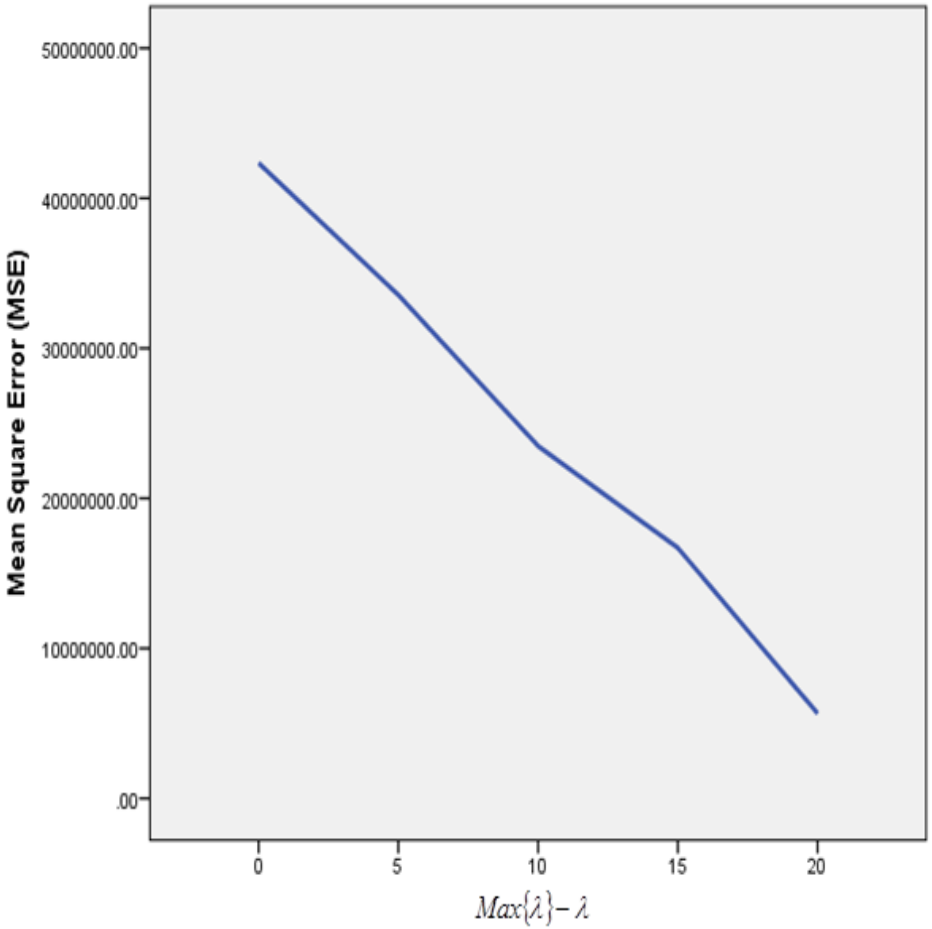
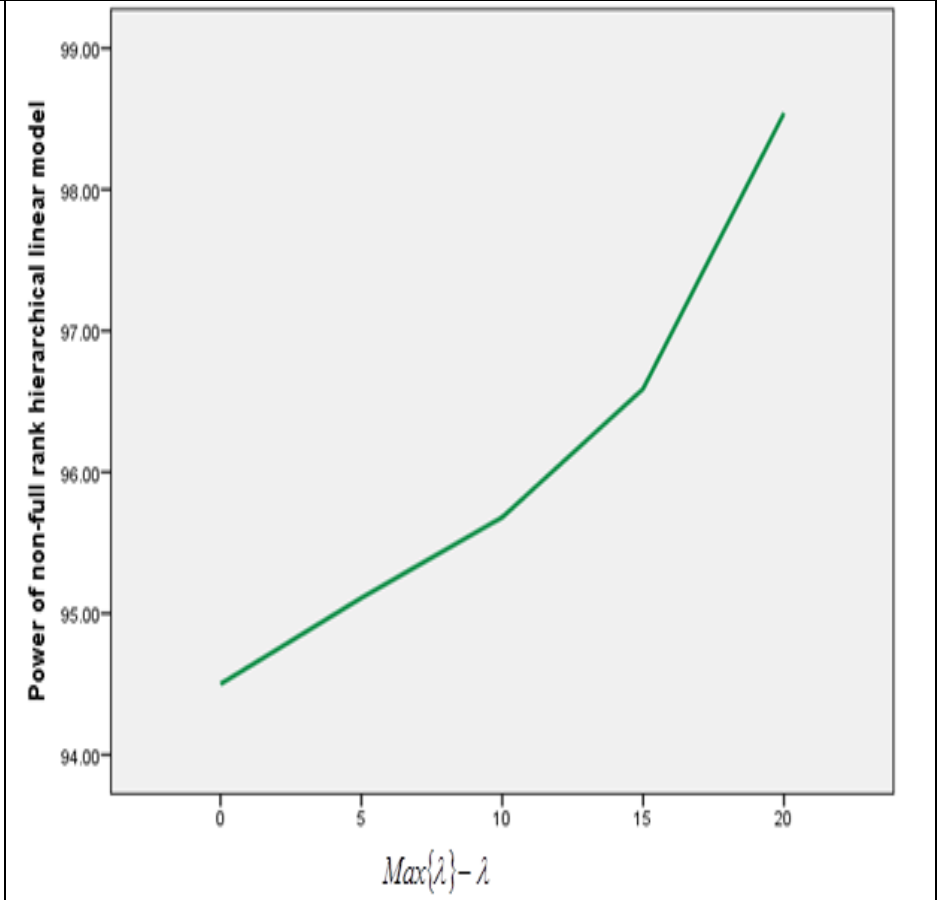
AF1 : Estimates of expenditure to import of Crude materials, inedible, except fuels from the continent of Africa

NA3 :Estimates of expenditure to import of Miscellaneous manufactured articles from the continent of North and Central America

SA1 :Estimates of expenditure to import of Crude materials, inedible, except fuels from the continent of South America

SA2 :Estimates of expenditure to import of Food and live animals from the continent of South America

Figure 3.1: Information about the best fitted non-full rank hierarchical linear model of the trade pattern of Norway

Estimates of population variance from non-full rank hierarchical linear model as a function of Eigen value of information matrix	Power (in percent) of non-full rank hierarchical linear model as a function of Eigen value of information matrix
	

Paper 2

Modelling Intra-Continental and Inter-Continental Variations of Norway's Import Trade over Time: An Application to estimable functions of the two stage non-full rank hierarchal linear econometric model

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Abstract

This paper is a continuation of econometric analysis of the continental variation of the import trade of Norway. The paper derives the best linear unbiased estimator (BLUE) of estimable functions of the two-stage non-full rank hierarchical linear econometric model to analyse the intra-continental and inter-continental variations of the expenditure of the Norwegian imports based on the yearly import data ranging from 1988 to 2014 (26 years). The results confirms that the intra-Europe variation of Norwegian import-item expenditures can be characterized as highly configured, stable and standardized. 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. The three import-items cover more than 60% of the Norwegian import expenditure. Furthermore, the model predicts that Europe is the leading continent for Norwegian import-items. For future Norwegian trade patterns, the European continent is therefore the most influential.

Keywords: *import trade of Norway, intra-continental and inter-continental variations, items of import, generation of estimable functions,*

1. Introduction

Many scholars of international trade put forward that the participation in the international trade (imports and exports) have a positive impact on maximization of welfare of nations (Krugman 1980, Amiti and Davis 2008). Trade can aid to enhance economic development and diminish poverty by improving growth and increasing commercial opportunities and investment (Francisco and Dani 1999, Hans and Ernst 1999). For example, the Gross Domestic product (GDP) per capita of the Least-Developed Countries was in 2000 $325 and more than doubled over an eight years period (2008) to $625. The major contributor of such improvements is an increase in trade and foreign investment (European Commission 2009, OECD 2009).

International trade assists to smooth out transitory from long-term excess demand or excess supply state affairs in domestic markets. Consequently, international trade may in many real world situations, remove price fluctuations and ensuing supply shortages. Economists also put forward an argument that international trade plays a significant role for the increase of the global economy (Helpman 1981). Hence, international trade boosts competitiveness and effectiveness by assisting countries to reduce the cost of inputs, acquire financing through investments, proliferation of the value added of their products and upgrade the global value chain (Gereffi et al. 2005). For example, through the benefits of international trade, Europe has assisted South Asian countries like Sri Lanka, Bangladesh to benefit from quality standards of textiles and other exports. These south Asian countries have shown a strong volume export increase over the last two decades (Kelegama 2010, European Commission 2009).

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 courtiers 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 impact of free trade on the economic performance can be evidenced by India. In 1991 India cuts import duties from an average of 90%. This duty is reduced to 30% in 1997 and this gave Indian producers access to a diversity of intermediate and capital goods. And cause to the imports of intermediate goods increased by 227% compared to imports in 1991 to 1997 (Deborah and Patrick 2013). Furthermore, due to international trade emerging economies like China, Brazil, Russia, India and South Africa are progressively catching up with developed countries (Kwang 2013).

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 is characterized by its advanced level of complexity of the transaction and economic exchange (João *et al.* 2007, 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. According to the arguments forwarded by international economists, 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 the emergence of global supply chains (Arvis *et al.* 2007, Bernard *et al.* 2007, Anderson 1979).

The geography of international trade dominated by a few large economic blocs, mainly in North America, Europe and few Asian countries like Japan, South Korea and Taiwan. For example, economists estimated that the G7 countries account for about half of the global trade, a supremacy which has undergone for over 100 years. Though, the existing global trade pattern is being seriously challenged by emerging economies. A mounting share is being

accounted by the developing countries of Asia, east Europe and South America. 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 trade 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, 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 play 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). Therefore conducting this research one of our major research questions is to measure the impact of global trade-pattern dynamics for Norwegian import trade.

1.2 The Problem and the outcome of the analysis

Many international scholars 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.

This paper is a continuation of the variation of the import trade of Norway across contents and over time. The previous analysis identified that the import trade of Norway showed heterogeneity with respect of import items and the continents of origin. These findings partly confirm that the prediction of the Heckscher-Ohlin theory of international trade explaining the continental variation of the Norwegian import trade items. The theory explains why countries trade goods and services with each other, and emphasizes the difference of resources between countries. The model shows that the comparative advantage is influenced by the interaction between a country's resources (relative abundance of production factors) and theirs production technologies (which influences the relative intensity by which the different production factors are being utilized during the production cycle).

Furthermore, in the previous paper we have identified and quantified potential structural changes on continent wise items of import. The results of the assessment of structural changes again confirm that the Norwegian trade patter is showing dynamics suggesting global trade shifts to new and the new and emerging nations (i.e. China). However, such an analysis of its own is not enough to determine the future trade pattern of any country. Therefore, the paper's main interest is to get rigorous quantitative information about the pattern of Norwegian import trade across continents. Moreover, the paper aims to identify important and influential import items and to perform inter-continental and intra-continental variation analysis based on expenditure over the import items.

Therefore, the main objective of this study is to generate the estimable functions from a two-stage non-full rank hierarchal model and to apply them to make a thorough analysis of the Norwegian import-items across continents. Specifically, the paper tries to give econometric evaluations for:

- Comparing and characterizing the inter-continental variation of the items of import,
- Comparing and characterizing the intra-continental variation of the items of import,
- To estimate the growth rate of the expenditure to import items, and
- To estimate short run and long run impact of the item of import.

In order to meet our objectives and to improve the analysis, we generate important estimable functions from the two-way non-full rank hierarchical linear model. The estimable functions which are important to evaluate for the intra-continental analysis of the Norwegian imports,

are multiple comparison tests for the nested factors. The estimable function that is important for the evaluation of the inter-continental import analysis is a multiple comparison test of the nesting factors, which contain the nested factors.

The estimation results will provide us with the following important policy suggestions:

- Stability and short and long run impact of continent wise items of imports.
- Providing preliminary information for continent wise future trade pattern Norway.
- Providing preliminary information for country wise trade concentration and dynamics of future trade pattern Norway.

2. Literature Review

This paper main emphasis is to analyse the intra-continental and inter-continental variations of the import trade of Norway. Therefore, our literature review involves by identifying factors that lead heterogeneity of import/ export trading partners in the international trade.

There are always a simple question "why nations to become open towards international trade?". This simple question can create a number of subsequent, but complicated questions. The theory of international trade tried to provide the solutions to these questions. The explanations of international trade theories are well-designed and convincing. The vast majority of economists accepted about the desirability and the importance of liberal trade theory. However, the argument about the importance of bilateral trade theory is subtle, compound and often misunderstood (Shiozawa 2007, Feenstra 2003, Matsuyama 2000, Bowen *et al.* 1998). Therefore, first and foremost, it is vital to assess how international trade benefits the trading partners.

2.1 Benefits of International Trade

Economists have shown the benefits of international trade theoretically and practically with empirical evidences (Feenstra 2003, Samuelson 2001, Leontief 1953). These economists argue that 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 is subject to social force as it changes the conditions in which wealth is distributed within a

national economy, particularly due to changes in prices and wages (Bhaduri and Bengal 2012).

International economists argued and classified the benefit of international trade into three major groups (Feenstra 2003): (i) the increase that trade can bring to the total amount of goods and services available to the national population (increased consumption argument), (ii) the diversity of goods and services made available through trade to this population (diversification argument), or (iii) the stability in the supply and prices of goods and services brought about by trade (stability argument). We examine these arguments and classifications in the following sub-sections.

2.1.1 Impact of international trade on increasing the domestic consumption

Participation in the international trade can increase the total amount of goods and services available to the domestic market. The participation of the country's foreign trade can be in intra-industry trade, which is the trading of homogeneous items. One of the fundamental reasons why countries participate in intra-industry trading style is to increase their domestic consumption (Davis 1995).

Intra-industry trade in homogeneous goods among nations can take place under four known possible conditions. First, homogenous and bulky product for which the cost of transportation is high relative to its value can be a root of intra-industry trade when individuals purchase the product from the neighbouring supplier. Second, homogeneous services also can be the foundation of intra-industry trade because of the joint production of the service or abnormal technical conditions. Third, some countries participate in an extensive re-export trade. Fourth, seasonal or other periodic instabilities in output or demand can push nations to participate in the intra-industry trade of homogeneous products (Young 1991, Tharakan 1989, Lancaster 1980).

Industrial organization economist Cournot's model of analysed the strategic interaction among competing firms producing a homogeneous product based on the quantity of goods that they supply in the market. The model gives the solution for the equilibrium quantity that the firms supply in the market. The current model gives important solutions in multi-stage applications. The model analysis showed that positive impact of maximizing the welfare of countries by being participating in the international trade. The model showed that

participation in international trade of homogenous product can benefit (maximize the welfare) of the trading partner (importers and exporters) by stabilizing (lowers at the importer nation and increase at the exporter nation) price and increase the quantity of the product (Federico 2006, Jean 1988).

In the international market analysis one of the important contributions of the Cournot's model is its ability to solve the complex problem of oil exporting countries (OPEC). The model showed that a formation of a cartel by the oil exporter nations can bring higher profits by colluding than from competing against each other (Chapman 2000, Corts 1999, Cremer 1976).

In the following sub-sections we will discuss a about the role of international trade in maximizing diversity (differentiated products) of goods or services and stabilizing prices (economy of scale). The impacts of international trade on these two aspects indirectly cause to increase the domestic consumption of goods or services.

2.1.2 Impact of international trade on diversification of goods and services at domestic market

International trade can cause to the appearance of diversified goods and services in the domestic market of the trading partners. Horizontally differentiated products are stated to be dissimilar in some extent, even though they have equivalent prices. Vertically differentiated products have very different appearances, physical characteristics, and different prices. The occurrence of the varieties of either horizontally or vertically differentiated products in the international trade created an opportunity for nations to have the diversified products in their domestic market (Qhlin 1933, Gray and Martin 1980).

Intra-industry trade in differentiated products improves the overall welfare of a nation to the degree that domestic consumers have a variety of types of the product available from which to choose. Furthermore, superfluous types of the horizontally differentiated product lower the prices, improve the quality of those products (Luciana 2009, Daniel 2001, Helpman 1981).

Intra-industry trade is associated to metamorphoses in income per capita and how the amount of transactions of trade is contingent on differences in income per capita and next of kin country-size. The traditional trade theories (absolute and comparative advantage trade

theory, even the Heikecher-Ohlm trade theory) do not explain the effects of product differentiation, economies of scale, and monopolistic competition in international trade has existed for many years (Besedes and Prusa 2005, Feenstra and Gordon 2000).

International trade allows reveal systematic patterns of vertical specialization. When developed and undeveloped countries export/import goods in the same product category, the richer countries sells goods with higher unit values. There are several economic explanations are associated with why this phenomena occurs. This prehumen suggests that there is a correlation between per capita income and the quality of exports. Also, when a country exports goods in a product type to more than a few destinations, the higher-quality goods are directed unreasonably to the higher-income markets. The pattern of vertical specialization (product differentiation) has imperative repercussions for the distributional consequences of world trade because typically household income distributions (Besedes and Prusa 2005, Feenstra 1994).

2.1.3 Impact of international trade on Stability of market

The stability in the supply and prices of goods and services brought about by trade. Economies of scale can be a route for international trade when a proliferation in the demand for a product leads a firm to produce more production and take benefit of economies of scale and lower unit costs. With trade liberalization, the firm would be able to export the product to foreign countries where the product is demanded and the price of the product is higher than its origin price plus transportation and other transaction costs. So, economies of scale are the fundamental tool to stabilize the prices of the product in the domestic and foreign market.

One more way in which international trade can raise efficiency is through the enhancement of competition. By opening their frontiers to trade, countries force their industries to compete with goods and services produced abroad and hence to struggle to become competitive and pass on cost reductions to consumers in the form of lower prices (Feenstra and Gordon 2000).

In industries which tend to be monopolistic or oligopolistic because of the nature of the production process (e.g. presence of big entry costs, large economies of scale, depending on a specialized input in short supply), this may be particularly important. The car and telecommunication industries are examples of this. Trade may be a good way to bring competition and raise efficiency in these industries. This advantage of trade is not very

relevant in agriculture since, because there are many farms producing very similar commodities, the farm sector is hardly a concentrated industry. However, farmers may benefit from the increased efficiency of input supply industries or good processing industries brought about through trade (Feenstra 1994, Ethier 1984).

Once we review how international trade benefits for the participating nations, we have to assess "why international trade is not uniformly distributed among the nations across the world?". In the following sections we try to summarize the major factors that affect the distribution (equity) of international trade.

2.2 Factors that affect distribution (equity) of international trade

In the recent days, the world has countersigned the emergence, partnership, consolidation and diffusion of a new economic pattern. This resulted from the understanding of improvement of economic thought globalization by many nations across the world. International trade, both in terms of value and tonnage, has been increasing in the global economy. It is essential to looking at the structure of global trade that it is not nations that are trading, but typically companies with the end products consumed in majority of individuals (UN 2008).

The new economic patterns not only increasing bilateral trade, but also reducing stringent macroeconomic policy many nations, increasing privatization and liberalization, removal of barriers to international trade, opening up to foreign direct investments and expansion of global supply chains. The development of information technology played a fundamental role in the accelerating pace of the international trade of the world economy (Antoine 2008). However, such economic can never create equitable trading partnership with the existing nations in the world due several factors. These factors are reviled in the following sections.

2.2.1 The impact of cost regulation on trade

Trade costs are the major sources of pattern of trade and leads to heterogeneity of International Trade. The economic theory of gravity explains the complex bilateral trade patterns among countries. Actual trade is much lower than gravity predicts in a frictionless world, providing evidence of trade costs much larger than those due to policy or transportation. Costs of associated facilitating international trade are one of the most import factors that determine the trade pattern, hence hither costs are beneficiary for the countries of importer and exporter. There are four major cost components in international trade are [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 in behind the trade. These costs include the collecting of information, negotiating and imposing contracts, letters of credit and transactions. Sometimes this cost 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 than the other.

Tariff and non-tariff costs are costs that are associated with duties imposed by governments to realise 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 tare 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 tare costs associated the delays between the time of order for the exporter nation and the time when 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 the others. Furthermore, some nations (companies) are strict on the on-time delivery of goods and the others are not.

2.2.2 The impact of government regulation 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 countries have a different foreign trade policy (Frieden and Lake 1995, Filanlyason and Zakher 1981).

2.2.3 Impact of resource and product differentiation on 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 of 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 intra-continental and inter-continental variations of the import trade of Norway. The output of the econometric analysis will be impute for the policy makers of the country and provide highly refined quantitative information for researchers of related areas.

3. The 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/statistikkbanken) and External Economy (External trade, External trade in goods, 08801). The data is 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 is 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 expenditure to import items.

3.2 The hierarchical linear econometric model

The model of a two-way nested model are has two independent main factors. Suppose the main factor A has "*a*" levels and the nested factor B has "*ab*" levels which are grouped into sets of "*b*" levels each, and "*n*"n (for a complete and balanced case) observations are made at each level of the factor B giving a total of "*abn*"observations. The nested or hierarchical designs of this type are very important in many industrial and genetic investigations. 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 (Douglas 2004, Searle 1971):

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

$i = 1,2,3...a$, is the level of the nesting factor, $j = 1,2,3...b$, is the level of the nested factor, and $k = 1,2,3...n$, 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:

$$\mathrm{Y} = \mathrm{X}\gamma + \varepsilon \qquad (2)$$

where: $X = [L_a \vdots I_a \otimes L \vdots I_{ab} \otimes \ell]$

$$Y=\underset{\text{abn X 1}}{\begin{bmatrix} y_{111} \\ y_{112} \\ \vdots \\ y_{ijk} \\ \vdots \\ y_{abn} \end{bmatrix}}, \quad \ell=\underset{\text{n X 1}}{\begin{bmatrix} 1 \\ 1 \\ \vdots \\ 1 \\ \vdots \\ 1 \end{bmatrix}}, \quad L=\underset{\text{bn X 1}}{\begin{bmatrix} \ell \\ \ell \\ \vdots \\ \ell \\ \vdots \\ \ell \end{bmatrix}}, \quad L_k=\underset{\text{abn X 1}}{\begin{bmatrix} L \\ L \\ \vdots \\ L \\ \vdots \\ L \end{bmatrix}}, \quad \gamma=\underset{\text{(ab+a+1) X 1}}{\begin{bmatrix} \mu \\ \alpha_1 \\ \vdots \\ \alpha_a \\ \beta_{1:1} \\ \vdots \\ \beta_{b:a} \end{bmatrix}}, \quad \varepsilon=\underset{\text{abn X 1}}{\begin{bmatrix} \varepsilon_{111} \\ \varepsilon_{112} \\ \vdots \\ \varepsilon_{ijk} \\ \vdots \\ \varepsilon_{abn} \end{bmatrix}}$$

Model assumptions

The following assumptions six are considered as specific assumptions that we take for our econometric analysis using the two-stage hierarchical linear model (Greene 2012, Douglas 2004, Rao 1973, Searle 1971).

***Assumption 1*:** The model parameters are fixed effects.

This assumptions is telling about $E[\gamma]=\gamma$ so that $Var[\gamma]=0$

***Assumption 2*:** Erogeneity of the $X-Matrix$

$$E[\varepsilon|X]=0$$

This assumption leads to $E[\varepsilon]=0$, since the model parameters are fixed effects, $E[Y]=X\gamma$.

This shows that the expected value of the vector of endogenous variable is deterministic.

***Assumption 3*:** The $X-Matrix$ is non-Full rank

This assumption leads to the $X'X-Matrix$ is not invertible.

***Assumption 4*:** Random error terms are homoscedastic

$$Var(\varepsilon_{ijk})=\sigma^2 \text{ for all } i=1,2,3,....,a,\ j=1,2,3,....,b \text{ and } k=1,2,3,....,n$$

***Assumption 5*:** Random error terms are serially uncorrelated

$$Cov\left(\varepsilon_{ijk},\varepsilon_{i'j'k'}\right)=0 \text{ for all } i\neq i',\ j\neq j' \text{ or } k\neq k'$$

***Assumption 6*:** Random error terms are normally distributed.

$$\varepsilon_{ijk}\sim N\left(0,\sigma^2\right)$$

3.2.1 Model fit of 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 (Douglas 2004):

$$X'X\gamma=X'Y \tag{3}$$

Since the $X'X - Matrix$ is not invertible (see assumption 2), our normal equations have no-unique solution. As the result we can't estimate the all the model parameters. In the normal equations we have a total of "$ab + a + 1$" parameters. However, we have only "ab" degrees of freedom to estimate the model parameters. This confirms that the model is over parameterized. Therefore, we advance our model fit technique by solving the normal equations using the concept called generalised inverse. The generalized inverse of $X'X$ is a matrix that satisfy the following condition (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 predated 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).

$$SSR = \hat{Y}'\hat{Y}$$

$$SSR = \left(X(X'X)^{-}X'Y\right)\left(X(X'X)^{-}X'Y\right)$$

$SSR = Y'X(X'X)^{-}X'X(X'X)^{-}X'Y$, Since $(X'X)^{-}(X'X)(X'X)^{-} = (X'X)^{-}$

Therefore, $SSR = Y'X(X'X)^{-}X'Y$

(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:

$$SST = Y'Y$$

$$SST = Y'[I]Y$$

$$SST = Y'[\left(X(X'X)^{-}X'\right) - \left(I - X(X'X)^{-}X'\right)]Y$$

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

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). Chi-square the distributions of the given as:

$$\chi^2_{cal} = \frac{SSR}{ab} \sim \chi^2_{ab,\alpha} \tag{9}$$

$$\chi^2_{cal} = \frac{SSE}{abn-ab} \sim \chi^2_{abn-ab},\alpha \tag{10}$$

Since the matrix $X(X'X)^{-}X'$ is an idempotent matrix, the result of $\left(X(X'X)^{-}X'\right)\left(I-X(X'X)^{-}X'\right)=0$ (Horn *et al.* 1990, Chiang 1984, Searle 1971). This shows the sum of squares of the model and the sum of square of the error are orthogonal (independent). 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).

$$F_{cal} = \left(\frac{SSR}{SSE}\right)\left(\frac{abn-ab}{ab}\right) \sim F_{ab,abn-ab,\alpha} \tag{11}$$

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

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

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

Here we reject the null-hypothesis if $F_{cal} > F_{ab,anb-ab,\alpha}$.

3.2.2 Generation of Estimable functions from 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 (Fabio 1999, Magnus and Neudecker 1988, Searle 1987, Foodnight 1978).

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.

(i). Estimable Function using the expected value of response variable

This estimable function is helping for 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:

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

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

Since the parameters are fixed (see assumption 1), therefore,

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

Since the expected value of the random error term is zero (see assumption 2), therefore,

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

(12)

Therefore, the linear combination of parameters $\mu + \alpha_i + \beta_{j(i)}$ is estimable hence $E[\varepsilon_{ijk}] = 0$. 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).

$$E\left(\bar{y}_{ij.}\right) = E\left(\sum_{k=1}^{n} y_{ijk} / n\right)$$

$$E\left(\bar{y}_{ij.}\right) = \frac{1}{n} E\left(\sum_{k=1}^{n} y_{ijk}\right)$$

$$E\left(\bar{y}_{ij.}\right) = \frac{1}{n}\left(\sum_{k=1}^{n} E\left(y_{ijk}\right)\right)$$

$$E(\bar{y}_{ij.}) = \frac{1}{n}\left(\sum_{k=1}^{n} E(\mu + \alpha_i + \beta_{j(i)} + \varepsilon_{ijk})\right)$$

$$E(\bar{y}_{ij.}) = \frac{1}{n}\left(\sum_{k=1}^{n} (\mu + \alpha_i + \beta_{j(i)})\right)$$

$$E(\bar{y}_{ij.}) = \frac{1}{n} n(\mu + \alpha_i + \beta_{j(i)})$$

$$\textit{Therefore,} \quad E(\bar{y}_{ij.}) = \mu + \alpha_i + \beta_{j(i)} \tag{13}$$

From equation 10 we observe that 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.

$$Var(\bar{y}_{ij.}) = Var\left(\sum_{k=1}^{n} y_{ijk} / n\right)$$

$$Var(\bar{y}_{ij.}) = \frac{1}{n^2} Var\left(\sum_{k=1}^{n} y_{ijk} / n\right)$$

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

Since the estimable function is a constant (see assumption 1), therefore,

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

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

Since the random error terms are assumed to be independent (see assumption 5), therefore,

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

Since the random error terms are assumed to be homoscedastic (see assumption 4), therefore,

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

$$\textit{Therefore} \quad Var(\bar{y}_{ij.}) = \frac{1}{n^2} n\sigma^2 = \frac{\sigma^2}{n} \tag{14}$$

In order to test the significance of the estimable function which defined in equation 13 we use the F-distribution which expresses as:

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

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

(ii). Estimable function for inter-variability of the endogenous variable

Suppose $E[y_{ijk}] = \mu + \alpha_i + \beta_{j(i)}$ and $E[y_{ij'k}] = \mu + \alpha_i + \beta_{j'(i)}$ for $j \neq j'$ are estimable functions from the two-stage hierarchical linear models. Therefore, the linear combination simply by taking the difference of these two estimable functions that is the function $E[y_{ijk}] - E[y_{ij'k}] = \beta_{j(i)} - \beta_{j'(i)}$ is also 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 $\bar{y}_{ij.} - \bar{y}_{i'j.} = \sum_{k=1}^{n} y_{ijk} / n - \sum_{k=1}^{n} y_{i'jk} / n$. Applying the similar derivation as above, we have 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):

The variance of the BLUE of $\beta_{j(i)} - \beta_{j'(i)}$ is derived as follows:

$$Var\left(\bar{y}_{ij.} - \bar{y}_{i'j.}\right) = Var\left(\sum_{k=1}^{n} y_{ijk} / n - \sum_{k=1}^{n} y_{i'j'} / n\right)$$

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

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

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

Since $(\alpha_i - \alpha_{i'}) - (\beta_{j(i)} - \beta_{j(i')})$ is constant (see assumption 1), therefore,

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

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

Since the random error terms assumed to be independent (see assumption 5) and homoscedastic (see assumption 4), therefore,

$$Var\left(\bar{y}_{ij.}-\bar{y}_{i'j.}\right)=\frac{1}{n^2}\left(\sum_{k=1}^{n}\left(Var\left(\varepsilon_{ijk}\right)+Var\left(\varepsilon_{ij'k}\right)\right)\right)=\frac{1}{n^2}\left(n\sigma^2+n\sigma^2\right)=\frac{2\sigma^2}{n} \quad (16)$$

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

$$F_{cal}=\frac{\left(\sum_{k=1}^{n}y_{ijk}/n-\sum_{k=1}^{n}y_{i'jk}/n\right)^2}{\left(\frac{2}{n}\right)\left(\frac{SSE}{abn-ab}\right)}\sim F_{2,abn-ab,\alpha} \quad (17)$$

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

(iii).Estimable function for intra-variability of the endogenous variable

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 $E[y_{ij'k}]=\mu+\alpha_i+\beta_{j'(i)}$ for $j\neq j'$ are estimable functions from the two-stage hierarchical linear models. Therefore, the linear combination simply by taking the difference of these two estimable functions that is the function $E[y_{ijk}]-E[y_{ij'k}]=\beta_{j(i)}-\beta_{j'(i)}$ is also estimable function. The best linear unbiased estimator (BLUE) of $\beta_{j(i)}-\beta_{j'(i)}$ is $\bar{y}_{ij.}-\bar{y}_{ij'.}=\sum_{k=1}^{n}y_{ijk}/n-\sum_{k=1}^{n}y_{ij'k}/n$. The variance of the BLUE of $\beta_{j(i)}-\beta_{j'(i)}$ is derived as follows (Sheldon 2007, Richard 1991, Searle 1987, 1971):

$$Var\left(\bar{y}_{ij.}-\bar{y}_{ij'.}\right)=Var\left(\sum_{k=1}^{n}y_{ijk}/n-\sum_{k=1}^{n}y_{ij'k}/n\right)$$

$$Var\left(\bar{y}_{ij.}-\bar{y}_{ij'.}\right)=\frac{1}{n^2}Var\left(\sum_{k=1}^{n}y_{ijk}-\sum_{k=1}^{n}y_{ij'k}\right)$$

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

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

Since $\beta_{j(i)} - \beta_{j'(i)}$ is constant (see assumption 1), therefore,

$$Var\left(\bar{y}_{ij.} - \bar{y}_{ij'.}\right) = \frac{1}{n^2} Var\left(\sum_{k=1}^{n}\left(\varepsilon_{ijk} - \varepsilon_{ij'k}\right)\right)$$

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

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

Since the random error terms assumed to be independent (see assumption 5) and homoscedastic (see assumption 4), therefore,

$$Var\left(\bar{y}_{ij.} - \bar{y}_{ij'.}\right) = \frac{1}{n^2}\left(\sum_{k=1}^{n}\left(Var\left(\varepsilon_{ijk}\right) + Var\left(\varepsilon_{ij'k}\right)\right)\right) = \frac{1}{n^2}\left(n\sigma^2 + n\sigma^2\right) = \frac{2\sigma^2}{n} \tag{18}$$

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

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

(19)

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

4. Results and discussions

4.1 Preliminary Assessment

Before we move to perform intra-continental and inter-continental variations of the import trade of Norway based on expenditure on the item of imports, it is necessary to perform a preliminary assessment on the overall continental variations. The assessment will help to analyse the intra-continental and 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). Table 1 reports the results from the estimable functions for the import expenditure (in million NOK) across the worlds' continents.

{*Insert* Table 1 *about here*}

4.1.1 Expenditure to 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 expenditure. 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 confirms that African exports to Norway are the least influential of the Worlds' continents.

4.1.2 Expenditure to 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 expenditure. 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.

4.1.3 Expenditure to 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 expenditure. 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 with10,665.70, 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.

4.1.4 Expenditure to 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 expenditure. 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.

4.1.5 Expenditure to 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 expenditure. 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.

4.2 Item based inter-continental variation of expenditure the Norwegian imports

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 inter-continental variation of expenditure the Norwegian imports is estimated 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-item expenditure across continents (i.e. inter-continental variation), we will test the hypothesis:

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

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

i = 1, 2, 3, 4, 5 and j = 1, 2, 3… 10

Therefore, in the following sub-sections we will investigate and analyse the test results. The test results of our hypothesis are reported in Table 2.

{*Insert* Table 2 *about here*}

4.2.1 Inter-continental variation of expenditure to import 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 contribute with a share of 14.7% (see Table 1) of the overall Norwegian import expenditure. The item is the third most influential item over all 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. The multiple comparison of import expenditure over items and across the three continents is shown in Table 2. 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 expenditure on the items from the continent of Asia and Oceania exceeds the expenditure to import the item 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 of the item miscellaneous manufactured articles are Europe, Asia and Oceania, and North and Central America.

4.2.2 Inter-continental variation of expenditure to import mineral fuels, lubricants and related materials

The estimates of the estimable function of the two stage non-full rank hierarchical model shows that the import of mineral fuels, lubricants and related materials covers the share of 6.28 % (see Table 1) of the overall Norwegian import expenditure. 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 the continents. The multiple comparison of import-item expenditure across the three continents is shown in Table 2. 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 reports that the import expenditure for mineral fuels, lubricants and related materials from the continent of Europe exceeds the expenditure used from the continent of North and Central America, and Africa by 24,613.67 and 24,670.02 million NOK, respectively. Furthermore, the import expenditure used for this 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 import of miscellaneous manufactured articles are Europe, North and Central America and Africa.

4.2.3 Inter-continental variation of Expenditure to import manufactured goods classified chiefly by material

The estimates of the estimable function of 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 expenditure. This makes the item 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 the continents. The multiple comparison of import-item expenditure across the three continents is shown in Table 2. 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 expenditure for manufactured goods classified chiefly by material from the continent of Europe exceeds the import expenditure from the continent of Asia and Oceania, and North and Central America by 49,895.64 and 57,832.18million NOK, respectively. Furthermore, the import expenditure from the continent of Asia and Oceania exceeds the expenditure from the continent of North and Central America by7, 936.54 million NOK. Therefore, we have shown that in descending order, the most influential continent for the import of manufactured goods classified chiefly by material are Europe, Asia and Oceania, and North and Central America.

4.2.4 Inter-continental variation of expenditure to import machinery and transport equipment

The estimates of the estimable function of the two stage non-full rank hierarchical model show that the import of machinery and transport equipment contribute with a share of 39.07% (see Table 1) of the total Norwegian import expenditure. This makes this item the most influential items for Norwegian import. 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 the continents. The multiple comparison of import-item expenditure across the three continents is shown in Table 2. 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

expenditure 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 expenditure from the continent of Asia and Oceania exceeds 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 import of machinery and transport equipment are Europe, Asia and Oceania, and North and Central America.

4.2.5 Inter-continental variation of expenditure to import food and live animals

The estimate of the estimable function of 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 expenditure. 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. The multiple comparison of import-item expenditure across the four continents is shown in Table 2. At the 5% level of significance, we find that the continent of Europe is the most influential continent. The estimation result shows 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.

4.2.6 Inter-continental variation of expenditure to import crude materials, inedible, except fuels

The estimate of the estimable function of 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 expenditure. 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 the continents. The multiple comparison of import-item expenditure across the three continents is given in Table 3.1. At the 5% level of significance, we find that the continent of Europe is the most influential continent. The estimation result shows 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 expenditure from North and Central America exceeds the expenditure 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 equal. 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.

4.3 Import-item based intra-Continental variation of Norwegian Expenditure

In section 4.1 we saw that the two of import items from the continent of Africa, six of import items from the continent of Asia and Oceania, nine of import items from the continent of Europe, seven of import items from the continent of North and Central America and two of import items from the continent of South America are the significant items of the Norwegian imports. This leads us to extend our analysis in order to quantify the expenditure differences between import items from the same continent. The intra-continental variation of Norwegian import expenditures is estimated using the estimable function defined as $E[y_{ijk}] - E[y_{ij'k}] = \beta_{j(i)} - \beta_{j'(i)}$. In order to perform multiple econometric comparison of the import-item expenditures within the same continent (i.e. intra continental variation) we apply the following hypothesises. The general form of econometric hypotheses is set as:

Null hypothesis (H_o): *Expenditure of the importing the* j^{th} *item and the* j'^{th} *item within the* i^{th} *continent has no significant difference on the Norwegian import trade. That is* $\beta_{j(i)} - \beta_{j'(i)} = 0.$

Alternative hypothesis (H_1): *Expenditure of the importing the* j^{th} *item is significantly different from the import of the* j'^{th} *item within the* i^{th} *continent has significant difference on the Norwegian import trade. That is* $\left|\beta_{j(i)} - \beta_{j'(i)}\right| > 0.$

i = 1, 2, 3, 4, 5 and j = 1, 2, 3… 10

4.3.1 Import-item based intra-Africa variation of Norwegian Expenditure

The import items of crude materials, inedible, except fuels and mineral fuels, lubricants and related materials from the continent of Africa are the significant items of the overall expenditure of Norwegian import trade. Therefore, our intra-Africa variation of expenditure

of the Norwegian imports involves only these two items. The test result of the comparison of the import of crude materials, inedible, except fuels and mineral fuels, lubricants and related materials from the continent of Africa is shown in Table 2.1. Table 2.1 shows that at the 5 % level of significance the import expenditure of crude materials, inedible, except fuels is higher than the expenditure to import mineral fuels, lubricants and related materials from the continent by 5,124.50 million NOK. This makes the import of crude materials, inedible, except fuels the most influential item of import from the continent of Africa.

{*Insert* Table 2.1 *about here*}

4.3.2 Import-item based intra-Asia and Oceania variation of Norwegian Expenditure

The import items of food and live animals, beverages and tobacco, chemicals and related products n.e.s., manufactured goods classified chiefly by material, machinery and transport equipment, and miscellaneous manufactured articles from the continent of Asia and Oceania are the significant import-items for Norwegian expenditure. Therefore, our intra- Asia and Oceania variation of import expenditure involves these six items. The test result of the comparisons for the six significant import items from the continent of Asia and Oceania is shown in Table 2.2. At the 5 % level of significance Table 2.2 shows that:

- The import expenditure for machinery and transport equipment from the continent of Asia and Oceania is significantly exceeding the other import items from this continent. The result shows that the import expenditure for machinery and transport equipment is greater than miscellaneous manufactured articles, manufactured goods classified chiefly by material, chemicals and related products n.e.s., food and live animals and beverages and tobacco by 20,905.68, 33,591.97, 40,531.92, 41,921.74, and 42,001.39 million NOK, respectively.
- The import expenditure for miscellaneous manufactured articles is the second most influential import items from the continent of Asia and Oceania. The result shows that the import expenditure for miscellaneous manufactured articles is greater than manufactured goods classified chiefly by material, chemicals and related products n.e.s., food and live animals and beverages and tobacco by 12,686.29, 19,626.24, 21,016.06, 21,095.71, and 6,939.95 million NOK, respectively.
- The expenditure to manufactured goods classified chiefly by material is the third most influential import item from the continent of Asia and Oceania. The result shows that the import expenditure for manufactured goods classified chiefly by material is

greater than chemicals and related products n.e.s. and food and live animals and beverages and tobacco by 6,939.95, 8,329.77 and 8,409.42 million NOK, respectively.

- The expenditure to chemicals and related products n.e.s. and food and live animals and beverages and tobacco are statistically equal.

{*Insert* Table 2.2 *about here*}

4.3.3 Import-item based intra-Europe variation of Norwegian Expenditure

The import items of food and live animals, beverages and tobacco, crude materials, inedible, except fuels, mineral fuels, lubricants and related materials, animal and vegetable oils, fats and waxes, chemicals and related products n.e.s., manufactured goods classified chiefly by material, machinery and transport equipment and miscellaneous manufactured articles from the continent of Europe are the significant items of the Norwegian overall import expenditure. Therefore, the intra-Europe variation of Norwegian import expenditure involves these nine items. The comparison results for these nine significant items of import from the European continent is reported in Table 2.3. . Relatively for the World's continents, the imports from the continent of Europe showed the highest standardized import trade of Norway. The impact from the import items on the import sector is item dependant and at the 5 % level of significance, Table 2.3 shows that:

- The import expenditure for machinery and transport equipment from the continent of Europe is significantly exceeding all other items. The results show that the import expenditure for machinery and transport equipment exceeds 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 by 70,120.03, 85,645.22, 91,221.54, 103,741.12, 109,124.50, 119,662.87, 125,572.68, and 127,349.01 million NOK, respectively.
- The import expenditure for manufactured goods classified chiefly by material is found to be the second most influential import items from the continent of Europe. The results show that the import expenditure for manufactured goods classified chiefly by material exceeds 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 by 15,525.19, 21,101.51, 33,621.09, 39,004.47, 49,542.84, 55,452.65, and 57,228.976 million NOK, respectively.

- The import expenditure for miscellaneous manufactured articles is the third most influential items of import from the continent of Europe. The results show that the import expenditure for miscellaneous manufactured articles exceeds 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 by 5,576.32, 18,095.90, 23,479.28, 34,017.65, 39,927.46, and 41,703.789 million NOK, respectively.
- The import expenditure for chemicals and related products n.e.s. is the fourth most influential items of import from the continent of Europe. The results show that the import expenditure for chemicals and related products n.e.s. exceeds 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 by 12,519.58, 17,902.96, 28,441.33, 34,351.14 and 36,127.47 million NOK, respectively.
- The import expenditure for mineral fuels, lubricants and related materials is the fifth important items of import from the continent of Europe. The results show that the import expenditure for mineral fuels, lubricants and related materials exceeds food and live animals, crude materials, inedible, except fuels, beverages and tobacco and animal and vegetable oils, fats and waxes by 5,383.38, 15,921.75, 21,831.56, and 23,607.89 million NOK, respectively.
- The import expenditure for food and live animals is the sixth important items of import from the continent of Europe. The results show that the import expenditure for food and live animals exceeds crude materials, inedible, except fuels, beverages and tobacco and Animal and vegetable oils, fats and waxes by 10,538.36, 16,448.18, and 18,224.50 million NOK, respectively.
- The import expenditure for crude materials, inedible, except fuels is the seventh important items of import from the continent of Europe. The results show that the import expenditure for crude materials, inedible, except fuels exceeds beverages and tobacco and Animal and vegetable oils, fats and waxes by 5,909.82 and 7,686.14 million NOK, respectively.

- The import expenditure for beverages and tobacco is the eighth important items of import from the continent of Europe. The results show that the import expenditure for beverages and tobacco exceeds animal and vegetable oils, fats and waxes by 1,776.32 million NOK.

{*Insert* Table 2.3 *about here*}

4.3.4 Import-item based intra-North and Central America variation of Norwegian Expenditure

The import items of food and live animals, crude materials, inedible, except fuels, mineral fuels, lubricants and related materials, chemicals and related products n.e.s., manufactured goods classified chiefly by material, machinery and transport equipment and miscellaneous manufactured articles from the continent of North and Central America are the significant items of the overall Norwegian import expenditure. Therefore, our intra- North and Central America variation of Norwegian import expenditure involves these seven items. The test result of the comparison for the seven significant import items from the continent of North and Central America is shown in Table 2.4. At the 5 % level of significance, Table 2.4 reports that:

- The import expenditure for machinery and transport equipment from the continent of North and Central America is significantly exceeding all other import items from the continent. The results show that the expenditure to import machinery and transport equipment exceeds the import of 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 by 6,507.05, 6,507.05, 13,241.04, 15,301.14, 15,703.72 and 15,787.20 million NOK, respectively.
- The import expenditure for crude materials, except fuels, inedible by material is the second most influential import item from the continent of North and Central America. The results show that the import expenditure for crude materials, except fuels exceeds 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 by 6,377.46, 6,733.99, 8,794.09, 9,196.67 and 9,280.15 million NOK, respectively.

- The import expenditure for chemicals and related products n.e.s. and miscellaneous manufactured articles from the continent of North and Central America is statistically equal. This makes these two items the third most influential import item from the continent of North and Central America. Numerically, the import expenditure for chemicals and related products n.e.s. is exceeded by 356.53 million NOK relative to the expenditure for miscellaneous manufactured articles. The multiple comparison results show that expenditure to import chemicals and related products n.e.s. exceeds the expenditure to import manufactured goods classified chiefly by material, mineral fuels, lubricants and related materials, chemicals and related products n.e.s., and food and live animals by 2,416.63, 2,819.21 and 2,902.69 million NOK, respectively. Furthermore, the import expenditure for miscellaneous manufactured articles exceeds the expenditure for manufactured goods classified chiefly by material, mineral fuels, lubricants and related materials and food and live animals by 2,060.10, 2,462.68 and 2,546.16, respectively.

- The import expenditure for manufactured goods classified chiefly by material, mineral fuels, lubricants and related materials and food and live animals from the continent of North and Central America are statistically equal. The result show that these three items are the fourth important import items from the continent. However, the numerical differences show that the import expenditure for manufactured goods classified chiefly by material exceeds the expenditure for mineral fuels, lubricants and related materials and food and live animals by 402.58 and 486.06 million NOK, respectively.

{*Insert* Table 2.5 *about here*}

4.3.5 Import-item based intra-South America variation of Norwegian Expenditure

The import items of crude materials, inedible, except fuels and food and live animals from the continent of South America are the significant items of the overall Norwegian import expenditure. Therefore, our intra-South America variation of Norwegian import expenditure involves only these two items. The test result of the comparison of the import of crude materials, inedible, except fuels and food and live animals from the continent of South America is shown in Table 2.5. Table 2.5 shows that at the 5 % level of significance, the import expenditure for crude materials, inedible, except fuels is higher than the expenditure

for food and live animals by 5,143.15 million NOK. This makes the import of crude materials, inedible, except fuels the most influential item of import from the continent of South America.

Using estimation results of section 4.1, 4.2 and 4.3 and growth rate estimation, we induced a guide that tells overall characteristics of the intra-continental variation of the import trade of Norway in Table 2.6. Table 2.6 show the detailed information about: [1] the rank and characteristics, [2] the expected rank, [3] the estimated intra-continental share, [4] the expected growth rate, [5] the short run and long run contribution of the items of intra-continental variation of the Norwegian import trade.

{*Insert* Table 2.6 *about here*}

5. Conclusions and Recommendations

5.1 Conclusions

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

The inter-continental 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.

The intra-continental variations analysis confirm that only two of the import items (crude materials, inedible, except fuels and mineral fuels, lubricants and related materials) from the continent of Africa, are significantly affecting the Norwegian import trade in the short run. The test result of the comparison suggests that the import of crude materials, inedible, except fuels is the most influential item of import from the continent of Africa.

Six (all except crude materials, inedible, except fuels, mineral fuels, lubricants and related materials, animal and vegetable oils, fats and waxes, commodities and transactions) of the import items from the continent of Asia and Oceania 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 (all except commodities and transactions) of import items from the continent of Europe 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 (all except beverages and tobacco, animal and vegetable oils, fats and waxes and commodities and transactions) from the continent of North and Central America 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 (crude materials, inedible, except fuels and food and live animals) import items from the continent of South America are found significantly affecting 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). These three items cover more than 60% of the Norwegian import expenditure. Furthermore, the model predicts that the European continent is the leading seller of Norwegian import items. Therefore, even considering structural changes for the European continent, it will be the most influential selling 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 rate. Furthermore, Tesfay and Solibakke (2014) identifies a similar characteristics for Norwegian exports to the continent of Europe. These results show firstly the benefits of international trade. Secondly, the practice and the realization of bilateral Norwegian trade with European trading partners, are strong. Thirdly, the significant items of Norwegian imports and exports are different. The results confirm that intra-industry trade is insignificant and inter-industry trade is significant in the external trade. Therefore, the analysis of the two stage non-full rank hierarchical model linear econometric model of 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 implies that the trade stability efforts made by the government (or firms) is low. The causes of trade stability can be the degree of bilateral relationship, exchange rate, transportation cost, etc. Therefore, we recommend for the Norwegian government or concerned bodies to conduct research on [1] the impact of exchange rate and transportation cost, and [2] Country level analysis of the Norwegian external trade. Finally, we recommend the Norwegian government or any other concerned

bodies apply the detailed econometric result from this paper's model for the future planning of imports and balance of payment across continents.

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List of Tables of Paper 2

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

Continental variation	Items of Import	Estimates of Expenditure	Estimates of Share	SS	DF	MS	F-Cal	P-Value
Model	**All Items of Import**	**492801.5003**		**1.72E+11**	**50**	**3.43E+09**	**606.49**	**0.0000****
Africa	Food and live animals	843.8238333	0.17%	4272232	1	4272232	0.76	0.19283
	Beverages and tobacco	44.77383333	0.01%	12028.18	1	12028.18	0.00	0.48162
	Crude materials, inedible, except fuels	5124.500167	1.04%	1.58E+08	1	1.58E+08	27.85	0.0000**
	Mineral fuels, lubricants and related materials	1917.434	0.39%	22059319	1	22059319	3.90	0.0289**
	Animal and vegetable oils, fats and waxes	71.99533333	0.01%	31099.97	1	31099.97	0.01	0.47048
	Chemicals and related products n.e.s.	95.98883333	0.02%	55283.14	1	55283.14	0.01	0.46067
	Manufactured goods classified chiefly by material	444.3055	0.09%	1184444	1	1184444	0.21	0.32384
	Machinery and transport equipment	420.8313333	0.09%	1062594	1	1062594	0.19	0.33255
	Miscellaneous manufactured articles	342.3263333	0.07%	703123.9	1	703123.9	0.12	0.36236
	Commodities and transactions	1.584166667	0.00%	15.0575	1	15.0575	0.00	0.49935
Sub Total Africa	**All items of import from Africa**	**9307.563**	**1.89%**					
Asia and Oceania	Food and live animals	1983.129	0.40%	23596804	1	23596804	4.17	0.0244**
	Beverages and tobacco	1903.475333	0.39%	21739310	1	21739310	3.84	0.0299**
	Crude materials, inedible, except fuels	923.0253333	0.19%	5111855	1	5111855	0.90	0.1714
	Mineral fuels, lubricants and related materials	172.362	0.03%	178252	1	178252	0.03	0.4296
	Animal and vegetable oils, fats and waxes	146.3911667	0.03%	128582.2	1	128582.2	0.02	0.4401
	Chemicals and related products n.e.s.	3372.950833	0.68%	68260784	1	68260784	12.07	0.0003**
	Manufactured goods classified chiefly by material	10312.89717	2.09%	6.38E+08	1	6.38E+08	112.80	0.0000**
	Machinery and transport equipment	43904.86917	8.91%	1.16E+10	1	1.16E+10	2044.5	0.0000**
	Miscellaneous manufactured articles	22999.18533	4.67%	3.17E+09	1	3.17E+09	561.03	0.0000**
	Commodities and transactions	3.9175	0.00%	92.08084	1	92.08084	1.63E-05	0.4984
Sub Total Asia and Oceania	**All items of import from Asia and Oceania**	**85722.20283**	**17.39%**					
Europe	Food and live animals	21204.06467	4.30%	2.7E+09	1	2.7E+09	476.87	0.0000**
	Beverages and tobacco	4755.885	0.97%	1.36E+08	1	1.36E+08	23.99	0.0000**
	Crude materials, inedible, except fuels	10665.70067	2.16%	6.83E+08	1	6.83E+08	120.65	0.0000**
	Mineral fuels, lubricants and related materials	26587.449	5.40%	4.24E+09	1	4.24E+09	749.75	0.0000**
	Animal and vegetable oils, fats and waxes	2979.561833	0.60%	53266732	1	53266732	9.42	0.0013**
	Chemicals and related products n.e.s.	39107.02633	7.94%	9.18E+09	1	9.18E+09	1622.07	0.0000**
	Manufactured goods classified chiefly by material	60208.53767	12.22%	2.18E+10	1	2.18E+10	3844.83	0.0000**
	Machinery and transport equipment	130328.567	26.45%	1.02E+11	1	1.02E+11	18015.23	0.0000**
	Miscellaneous manufactured articles	44683.348	9.07%	1.2E+10	1	1.2E+10	2117.64	0.0000**
	Commodities and transactions	1181.498167	0.24%	8375628	1	8375628	1.48	0.156109
Sub Total Europe	**All Items of import from Europe**	**341701.6383**	**69.34%**					

Table 1 continued

Continental variation	Items of Import	Estimates of Expenditure	Estimates of Share	SS	DF		F-Cal	P-Value
North and Central America	Food and live animals	1890.292833	0.38%	21439242	1	21439242	3.79	0.0310**
	Beverages and tobacco	170.3156667	0.03%	174044.6	1	174044.6	0.03	0.4305
	Crude materials, inedible, except fuels	11170.44267	2.27%	7.49E+08	1	7.49E+08	132.34	0.0000**
	Mineral fuels, lubricants and related materials	1973.774333	0.40%	23374711	1	23374711	4.13	0.0251**
	Animal and vegetable oils, fats and waxes	202.6126667	0.04%	246311.4	1	246311.4	0.04	0.4174
	Chemicals and related products n.e.s.	4792.983667	0.97%	1.38E+08	1	1.38E+08	24.37	0.0000**
	Manufactured goods classified chiefly by material	2376.3535	0.48%	33882336	1	33882336	5.99	0.0083
	Machinery and transport equipment	17677.49133	3.59%	1.87E+09	1	1.87E+09	331.44	0.0000**
	Miscellaneous manufactured articles	4436.451833	0.90%	1.18E+08	1	1.18E+08	20.88	0.0000**
	Commodities and transactions	14.27116667	0.00%	1221.997	1	1221.997	0.00	0.4941
Sub Total North and Central America	**All items of import from North and Central America**	**44704.9897**	**9.07%**					
South America	Food and live animals	4113.891333	0.83%	1.02E+08	1	1.02E+08	17.95	0.0000**
	Beverages and tobacco	124.6893333	0.03%	93284.58	1	93284.58	0.02	0.4489
	Crude materials, inedible, except fuels	5143.1515	1.04%	1.59E+08	1	1.59E+08	28.06	0.0000**
	Mineral fuels, lubricants and related materials	279.3666667	0.06%	468274.4	1	468274.4	0.08	0.3869
	Animal and vegetable oils, fats and waxes	732.9336667	0.15%	3223151	1	3223151	0.57	0.2255
	Chemicals and related products n.e.s.	269.4158333	0.05%	435509.3	1	435509.3	0.08	0.3908
	Manufactured goods classified chiefly by material	443.3231667	0.09%	1179213	1	1179213	0.21	0.3242
	Machinery and transport equipment	168.4641667	0.03%	170281.1	1	170281.1	0.03	0.4312
	Miscellaneous manufactured articles	81.29983333	0.02%	39657.98	1	39657.98	0.01	0.4667
	Commodities and transactions	8.570666667	0.00%	440.738	1	440.738	0.00	0.4965
Sub Total South America	**All items of import from South America**	**11365.10617**	**2.31%**					
Error				**1.41E+09**	**250**	**5.66E+09**		
Total				**1.73E+11**	**300**			

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

Table 2: Inter-continental multiple comparisons of significant items of import of Norway 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

Table 2.1: Intra-Africa multiple comparison of Norwegian items of import

Continent	Comparison of the effect of import items j with j' within the same continents	Difference	SS	DF	MS	F-cal	P-Value
Africa	Crude materials, inedible, except fuels Vs. Mineral fuels, lubricants and related materials	5124.500	1.58E+08	2	78781506	13.926	0.0000**

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

Table 2.2: Intra- Asia and Oceania multiple comparison of Norwegian items of import

Continent	Comparison of the effect of import items j with j' within the same continent	Difference	SS	DF	MS	F-cal	P-Value
Asia and Oceania	Machinery and transport equipment Vs. Miscellaneous manufactured articles	20905.684	2.62E+09	2	1.31E+09	231.7711	0.00000**
	Machinery and transport equipment Vs. Manufactured goods classified chiefly by material	33591.972	6.77E+09	2	3.39E+09	598.4136	0.00000**
	Machinery and transport equipment Vs. Chemicals and related products n.e.s.	40531.918	9.86E+09	2	4.93E+09	871.2139	0.00000**
	Machinery and transport equipment Vs. Food and live animals	41921.740	1.05E+10	2	5.27E+09	931.9854	0.00000**
	Machinery and transport equipment Vs. Beverages and tobacco	42001.394	1.06E+10	2	5.29E+09	935.5304	0.00000**
	Miscellaneous manufactured articles Vs. Manufactured goods classified chiefly by material	12686.288	9.66E+08	2	4.83E+08	85.34923	0.00000**
	Miscellaneous manufactured articles Vs. Chemicals and related products n.e.s.	19626.235	2.31E+09	2	1.16E+09	204.2699	0.00000**
	Miscellaneous manufactured articles Vs. Food and live animals	21016.056	2.65E+09	2	1.33E+09	234.2248	0.00000**
	Miscellaneous manufactured articles Vs. Beverages and tobacco	21095.710	2.67E+09	2	1.34E+09	236.0037	0.00000**
	Manufactured goods classified chiefly by material Vs. Chemicals and related products n.e.s.	6939.946	2.89E+08	2	1.44E+08	25.54128	0.00000**
	Manufactured goods classified chiefly by material Vs. Food and live animals	8329.768	4.16E+08	2	2.08E+08	36.79564	0.00000**
	Manufactured goods classified chiefly by material Vs. Beverages and tobacco	8409.422	4.24E+08	2	2.12E+08	37.50272	0.00000**
	Chemicals and related products n.e.s. Vs. Food and live animals	1389.822	11589628	2	5794814	1.024351	0.35760
	Chemicals and related products n.e.s. Vs. Beverages and tobacco	1469.476	12956149	2	6478075	1.145131	0.31694
	Food and live animals Vs. Beverages and tobacco	79.654	38068.24	2	19034.12	0.003365	0.99661

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

Table 2.3: Intra- Europe multiple comparison of Norwegian items of import

Continent	Comparison of the effect of import items j with j' within the same continents	Difference	SS	DF	MS	F-cal	P-Value
Europe	Machinery and transport equipment Vs. Manufactured goods classified chiefly by material	70120.029	2.95E+10	2	1.48E+10	2607.442	0.00000**
	Machinery and transport equipment Vs. Miscellaneous manufactured articles	85645.219	4.4E+10	2	2.2E+10	3889.885	0.00000**
	Machinery and transport equipment Vs. Chemicals and related products n.e.s.	91221.541	4.99E+10	2	2.5E+10	4412.912	0.00000**
	Machinery and transport equipment Vs. Mineral fuels, lubricants and related materials	103741.118	6.46E+10	2	3.23E+10	5707.321	0.00000**
	Machinery and transport equipment Vs. Food and live animals	109124.502	7.14E+10	2	3.57E+10	6315.024	0.00000**
	Machinery and transport equipment Vs. Crude materials, inedible, except fuels	119662.866	8.59E+10	2	4.3E+10	7593.627	0.00000**
	Machinery and transport equipment Vs. Beverages and tobacco	125572.682	9.46E+10	2	4.73E+10	8362.205	0.00000**
	Machinery and transport equipment Vs. Animal and vegetable oils, fats and waxes	127349.005	9.73E+10	2	4.87E+10	8600.458	0.00000**
	Manufactured goods classified chiefly by material Vs. Miscellaneous manufactured articles	15525.190	1.45E+09	2	7.23E+08	127.8216	0.00000**
	Manufactured goods classified chiefly by material Vs. Chemicals and related products n.e.s.	21101.511	2.67E+09	2	1.34E+09	236.1335	0.00000**
	Manufactured goods classified chiefly by material Vs. Mineral fuels, lubricants and related materials	33621.089	6.78E+09	2	3.39E+09	599.4515	0.00000**
	Manufactured goods classified chiefly by material Vs. Food and live animals	39004.473	9.13E+09	2	4.56E+09	806.7878	0.00000**
	Manufactured goods classified chiefly by material Vs. Crude materials, inedible, except fuels	49542.837	1.47E+10	2	7.36E+09	1301.644	0.00000**
	Manufactured goods classified chiefly by material Vs. Beverages and tobacco	55452.653	1.84E+10	2	9.22E+09	1630.704	0.00000**
	Manufactured goods classified chiefly by material Vs. Animal and vegetable oils, fats and waxes	57228.976	1.97E+10	2	9.83E+09	1736.85	0.00000**
	Miscellaneous manufactured articles Vs. Chemicals and related products n.e.s.	5576.322	1.87E+08	2	93286090	16.49021	0.00000**
	Miscellaneous manufactured articles Vs. Mineral fuels, lubricants and related materials	18095.899	1.96E+09	2	9.82E+08	173.6564	0.00000**
	Miscellaneous manufactured articles Vs. Food and live animals	23479.283	3.31E+09	2	1.65E+09	292.348	0.00000**
	Miscellaneous manufactured articles Vs. Crude materials, inedible, except fuels	34017.647	6.94E+09	2	3.47E+09	613.6758	0.00000**
	Miscellaneous manufactured articles Vs. Beverages and tobacco	39927.463	9.57E+09	2	4.78E+09	845.4227	0.00000**
	Miscellaneous manufactured articles Vs. Animal and vegetable oils, fats and waxes	41703.786	1.04E+10	2	5.22E+09	922.3196	0.00000**
	Chemicals and related products n.e.s. Vs. Mineral fuels, lubricants and related materials	12519.577	9.4E+08	2	4.7E+08	83.12082	0.00000**
	Chemicals and related products n.e.s. Vs. Food and live animals	17902.962	1.92E+09	2	9.62E+08	169.9731	0.00000**
	Chemicals and related products n.e.s. Vs. Crude materials, inedible, except fuels	28441.326	4.85E+09	2	2.43E+09	428.9732	0.00000**
	Chemicals and related products n.e.s. Vs. Beverages and tobacco	34351.141	7.08E+09	2	3.54E+09	625.7672	0.00000**
	Chemicals and related products n.e.s. Vs. Animal and vegetable oils, fats and waxes	36127.465	7.83E+09	2	3.92E+09	692.1583	0.00000**
	Mineral fuels, lubricants and related materials Vs. Food and live animals	5383.384	1.74E+08	2	86942481	15.36885	0.00000**
	Mineral fuels, lubricants and related materials Vs. Crude materials, inedible, except fuels	15921.748	1.52E+09	2	7.61E+08	134.4349	0.00000**
	Mineral fuels, lubricants and related materials Vs. Beverages and tobacco	21831.564	2.86E+09	2	1.43E+09	252.7552	0.00000**
	Mineral fuels, lubricants and related materials Vs. Animal and vegetable oils, fats and waxes	23607.887	3.34E+09	2	1.67E+09	295.5594	0.00000**
	Food and live animals Vs. Crude materials, inedible, except fuels	10538.364	6.66E+08	2	3.33E+08	58.89479	0.00000**
	Food and live animals Vs. Beverages and tobacco	16448.180	1.62E+09	2	8.12E+08	143.4717	0.00000**
	Food and live animals Vs. Animal and vegetable oils, fats and waxes	18224.503	1.99E+09	2	9.96E+08	176.1335	0.00000**
	Crude materials, inedible, except fuels Vs. Beverages and tobacco	5909.816	2.1E+08	2	1.05E+08	18.52159	0.00000**
	Crude materials, inedible, except fuels Vs. Animal and vegetable oils, fats and waxes	7686.139	3.54E+08	2	1.77E+08	31.32903	0.00000**
	Beverages and tobacco Vs. Animal and vegetable oils, fats and waxes	1776.323	18931944	2	9465972	1.673302	0.00000**

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

Table 2.4: Intra- North and Central America multiple comparison of Norwegian items of import

Continent	Comparison of the effect of import items j with j' within the same continent	Difference	SS	DF	MS	F-cal	P-Value
North and Central America	Machinery and transport equipment Vs. Crude materials, inedible, except fuels	6507.049	2.54E+08	2	1.27E+08	22.45425	0.00000**
	Machinery and transport equipment Vs. Chemicals and related products n.e.s.	6507.049	2.54E+08	2	1.27E+08	22.45425	0.00000**
	Machinery and transport equipment Vs. Miscellaneous manufactured articles	13241.040	1.05E+09	2	5.26E+08	92.97681	0.00000**
	Machinery and transport equipment Vs. Manufactured goods classified chiefly by material	15301.138	1.4E+09	2	7.02E+08	124.1589	0.00000**
	Machinery and transport equipment Vs. Mineral fuels, lubricants and related materials	15703.717	1.48E+09	2	7.4E+08	130.7782	0.00000**
	Machinery and transport equipment Vs. Food and live animals	15787.199	1.5E+09	2	7.48E+08	132.1724	0.00000**
	Crude materials, inedible, except fuels Vs. Chemicals and related products n.e.s.	6377.459	2.44E+08	2	1.22E+08	21.56879	0.00000**
	Crude materials, inedible, except fuels Vs. Miscellaneous manufactured articles	6733.991	2.72E+08	2	1.36E+08	24.04781	0.00000**
	Crude materials, inedible, except fuels Vs. Manufactured goods classified chiefly by material	8794.089	4.64E+08	2	2.32E+08	41.01212	0.00000**
	Crude materials, inedible, except fuels Vs. Mineral fuels, lubricants and related materials	9196.668	5.07E+08	2	2.54E+08	44.853	0.00000**
	Crude materials, inedible, except fuels Vs. Food and live animals	9280.150	5.17E+08	2	2.58E+08	45.67099	0.00000**
	Chemicals and related products n.e.s. Vs. Miscellaneous manufactured articles	356.532	762689.7	2	381344.8	0.06741	0.93432
	Chemicals and related products n.e.s. Vs. Manufactured goods classified chiefly by material*	2416.630	35040608	2	17520304	3.097069	0.04579**
	Chemicals and related products n.e.s. Vs. Mineral fuels, lubricants and related materials*	2819.209	47687648	2	23843824	4.214879	0.01532**
	Chemicals and related products n.e.s. Vs. Food and live animals*	2902.691	50553684	2	25276842	4.468194	0.01197**
	Miscellaneous manufactured articles Vs. Manufactured goods classified chiefly by material	2060.098	25464031	2	12732015	2.250642	0.10556
	Miscellaneous manufactured articles Vs. Mineral fuels, lubricants and related materials	2462.678	36388683	2	18194341	3.216219	0.04072**
	Miscellaneous manufactured articles Vs. Food and live animals	2546.159	38897554	2	19448777	3.437966	0.03276**
	Manufactured goods classified chiefly by material Vs. Mineral fuels, lubricants and related materials	402.579	972419.9	2	486210	0.085947	0.91704
	Manufactured goods classified chiefly by material Vs. Food and live animals	486.061	1417530	2	708764.9	0.125289	0.88141
	Mineral fuels, lubricants and related materials Vs. Food and live animals	83.482	41814.97	2	20907.48	0.003696	0.99628

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

Table 2.5: Intra- South America multiple comparison of Norwegian items of import

Continent	Comparison of the effect of import items j with j' within the same continent	Difference	SS	DF	MS	F-cal	P-Value
South America	Crude materials, inedible, except fuels Vs. Food and live animals	5143.152	1.59E+08	2	79356022	14.02779	0.00000**

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

Table 2.6: Overall characteristics of the intra-continental variation of the import trade of Norway

	Africa	**Asia and Oceania**	**Europe**	**North and Central America**	**South America**
Food and live animals					
Rank ,Characteristics	4, Stable	5,Unstable	6,Stable	7,Unstable	2,Stable
Expected Rank	4	4-6	6	5 to 7	2
Intra-Continental Share	9.06%,	2.27%	5.60%	5.18%	30.36%
Expected growth rate	+7.52%	+6.44%	+6.90%	+3.52%	+9.31%
Contribution-Short Run	Insignificant	Significant	Significant	Significant	Significant
Contribution-Long run	Positively Growing with time	Positively growing with time	Positively growing with time	Positively growing with time, show random and high variability	Positively growing with time
Beverages and tobacco					
-Rank ,Characteristics	7, Unstable	6,Unstable	8,Stable	8,Unstable	7,Unstable
-Expected Rank	7 to 8	4-6	8	8 to 9	7 to 8
Intra-Continental Share	0.48%	+2.14%	1.06%	0.44%	1.74%
Expected growth rate	+4.46%	+7.17%	+8.95%	+ 2.88%	Unpredictable
Contribution-Short Run	Insignificant	Significant	Significant	Insignificant	Insignificant
-Contribution-Long run	No-correlation with time, considerable variability	Positively Growing with time	Positively growing with time	Positively growing with time, show random and extreme high variability	Insignificant
Crude materials, inedible, except fuels					
Rank ,Characteristics	1, Stable	7,Stable	7,Stable	2,Stable	1,Stable
Expected Rank	1	1	7	2	1
Intra-Continental Share	55.05%	1.56%	3.90%	23.14%	50.15%
Expected growth rate	7.104%	Unpredictable	+3.75	Unpredictable	+9.56%
Contribution-Short Run	Significant	Insignificant	Significant	Significant	Significant
Contribution-Long run	Positively growing with time, show random and high variability	No-correlation with time, considerable variability	Positively growing with time, show random and high variability	No-correlation with time, low variability	Positively growing with time, show random and high variability
Mineral fuels, lubricants and related materials					
Rank ,Characteristics	2, Stable	8,Unstable	5,Stable	6,Stable	5,Unstable
Expected Rank	2	8 to 9	5	5 to 7	5 to 6
Intra-Continental Share	20.60%	0.301%	5.98%	2.45%	2.27%
Expected growth rate	Unpredictable	Unpredictable	+10.34	Unpredictable	Unpredictable
Contribution-Short Run	Significant	Insignificant	Significant	Insignificant	Insignificant
Contribution-Long run	Positively growing with time, show random and high variability	No-correlation with time, show random and high variability	Positively growing with time, show random and high variability	Positively growing with time, show random and high variability	Positively growing with time, show considerable variability

Table 2.6 continued

Animal and vegetable oils, fats and waxes					
Rank ,Characteristics	8, unstable	9,Unstable	9,Stable	9,Unstable	4,Stable
Expected Rank	7 to 9	8 to 9	9	8 to 9	4
Intra-Continental Share	0.77%	0.17%	0.55%	0.28%	5.15%
Expected growth rate	Unpredictable	Unpredictable	+ 13.85%	Unpredictable	Unpredictable
Contribution-Short Run	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Contribution-Long run	No-correlation with time, considerable variability	No-correlation with time, show random and high variability	Positively growing with time, show considerable variability	Insignificant	Positively growing with time, show random and extreme high variability
Chemicals and related products n.e.s.					
Rank ,Characteristics	9, Unstable	4,Unstable	4,Stable	3,Unstable	6,Unstable
Expected Rank	8 to 9	4-6	4	3 to 4	5 to 6
Expected Intra-Continental, Inter-Continental, total Share	1.03%	2.88%	11.28%	7.85%	2.24%
Expected growth rate	Unpredictable	+13.50%	+5.46%	Unpredictable	11.43%
Contribution-Short Run	Insignificant	Significant	Significant	Significant	Insignificant
Contribution-Long run	Positively Growing with time	Positively Growing with time	Positively growing with time	Positively growing with time, show considerable variability	Positively growing with time
Manufactured goods classified chiefly by material					
Rank ,Characteristics	5, Unstable	3,Stable	2,Stable	5,Unstable	3,Stable
Expected Rank	5 to 6	3	2	5 to 7	3
Expected Intra-Continental, Inter-Continental, total Share	4.77%	12.03%	18.99%	4.48%	5.44%
Expected growth rate	Unpredictable	+9.60%	+4.10	Unpredictable	Unpredictable
Contribution-Short Run	Insignificant	Significant	Significant	Insignificant	Insignificant
Contribution-Long run	Positively growing with time, show random and high variability	Positively Growing with time considerable variability	Positively Growing with time considerable variability	Positively Growing with time considerable variability	Positively growing with time, show random and extreme high variability
Machinery and transport equipment					
Rank ,Characteristics	6, Unstable	1,Stable	1,Stable	1,Stable	8,Unstable
Expected Rank	5 to 6	1	1	1	7 to 8
Intra-Continental Share	4.52%	52.25%	37.94%	46.41%	1.60%
Expected growth rate	Unpredictable	+8.63%	+5.86	5.20%	Unpredictable
Contribution-Short Run	Insignificant	Significant	Significant	Significant	Insignificant
Contribution-Long run	Declining with time, show random and high variability	Positively Growing with time	Positively Growing with time considerable variability	No-correlation with time, random and extreme high variability	Insignificant

Table 2.6 continued

Miscellaneous manufactured articles					
-Rank ,Characteristics	6, Unstable	2,Stable	3,Stable	4,Unstable	9,Stable
-Expected Rank	5 to 6	2	3	3 to 4	1
Intra-Continental Share	3.68%	26.37%	14.49%	9.73%	1%
Expected growth rate	+12.61%	+8.87%	+ 3.57	5.54%	+2.44%
Contribution-Short Run	Insignificant	Significant	Significant	Significant	Insignificant
Contribution-Long run	Positively Growing with time	Positively Growing with time	Positively Growing with time considerable variability	Positively Growing with time	Insignificant
Commodities and transactions					
Rank ,Characteristics	10, Stable	10,Stable	10,Stable	10,Stable	10,Stable
Expected Rank	10	10	10	10	10
Intra-Continental, share	0.02%	0.03	0.22%	0.04%	0.04%
Expected growth rate	Unpredictable	Unpredictable	+21.50%	Unpredictable	Unpredictable
Contribution-Short Run	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant
Contribution-Long run	Insignificant	Insignificant	Insignificant	Insignificant	Insignificant

Unpredictability is either from higher coefficient of variation, over estimation, alternation of signs

Paper 3

Trade concentration and dynamics of the Norwegian Imports: An Application of Random Effect Multivariate Analysis of Variance (MANOVA)

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Abstract

This paper studies the concentration and the dynamics of Norwegian imports. The paper applies the two-way MANOVA model to analyse the concentration and the dynamics of the expenditure and share of Norwegian imports. The result suggests that Norwegian trade shows considerable dynamics across continents and over business cycles. Furthermore, from this result, we analyse the concentration index (HHI) by fitting a seemingly unrelated (SUR) regression model using exogenous variables of revenue collected from export and number of Norwegian export countries. These results suggest that the structure and dynamics of Norwegian imports are different across continents. The Norwegian import from the continent of Africa is increasing in the extensive margin. The Norwegian import from the continent of Asia and Oceania is increasing in the intensive margin. The Norwegian import from to the continent of Europe is increasing in both the extensive and the intensive margin. The Norwegian import from the continent of North and Central America shows stagnation for both the extensive and the intensive margin. The Norwegian import from the continent of South America is increasing in the intensive margin. The overall analysis shows that the Norwegian bilateral trade with European countries benefits Norway.

Key words: Trade Concentration, Trade dynamics, MANOVA models, SUR models and Norway.

1. Introduction

By applying the two stage non-full rank hierarchical linear econometric model, we have evaluated the variation of the Norwegian import trade across both continents and time. The model helps us to analyse potential structural breaks and is able to identify the influential items and continents of origin. The estimation results from the model show that the import expenditure is heterogeneity over both the destination continent and the import item. The analysis confirms that the Norwegian import trade is sustainable in the short and the long run after controlling for the effect of import items from any continent of origin. The econometric analysis also suggests that potential structural breaks exist in different items of Norwegian import. Furthermore, the results show that the continent of Europe is the most influential continent with an estimated import share of 69.3 %. The continent of Asia and Oceania, North and Central America, South America and Africa covers import shares of 17.4%, 9.1%, 2.3% and 1.9%, respectively. The most influential item across continents is the item *machinery and transport equipment* covering a share of 39.06 % of the total imports. The next top three influential items of Norwegian imports are *manufactured goods* classified chiefly by material, *miscellaneous manufactured articles*, and c*hemicals and related products* covering import shares of 14.97 %, 14.72% and 9.67 %, respectively. The rest of import items cover a share of 21.58% (see the first thesis paper).

In order to obtain detailed quantitative information for both the intra-continental and the inter-continental variations of Norwegian import trade, we have employed the best linear unbiased estimator (BLUE) of estimable functions of the two-stage non-full rank hierarchical linear econometric model. The estimation results show that even after assuming structural breaks, the continent Europe will be the most influential importer to Norway in future trade patterns. The most important output from the econometric analysis is its ability to identify the stability and predictability of these trade patterns. In fact, the model identifies unique characteristics of the Norwegian imports from the continent of Europe. Moreover, the model suggests stability and predictability of growth rate for all import items. Tesfay and Solibakke (2014) identified similar characteristics for Norwegian exports to the continent of Europe. The results show first the benefit of international trade and second the practice and realization of bilateral trade are strong (see the second thesis paper).

The paper's intention is to measure the intensive and extensive margins of the Norwegian imports. In order to quantify the intensive and the extensive margin, we need to evaluate the structure of Norwegian trade concentration and trade dynamics. Broadly speaking international trade concentration is a function of the number of trading partners and the impute outputs of the trading partners. That is, trade concentration is a function of the volume and value of the exchange of goods between trading partners, bilateral trade agreements and other commercial relationships, the investment in trade facilities, the reduction of trade barriers including tariffs, import quotas, export restraints and other trade barriers (Marianne and Michael 2005, Debaere 2003, Bacchetta and Eric 2000, Feenstra 2000). The volume and value of exchange of goods are dependent on several factors. Trade theory tried to give a rational explanation of the factors that affect the exchange of goods flow. The first and the most important factor is the endogenous differences between trading partners' economic growth. Economic growth is therefore the major factor playing a significant role in the volume and value of exchange of goods between trading partners (Feenstra, 2000). However, international economists have figured out that although economic growth and resource dependency between trading partners play a significant role in the magnitude of trade transaction, there are other complicated factors affecting the volume and value of trading partners' exchange of goods. The economies of scale argument is an important focus for the volume and value of exchange of goods. As the unit cost of production for a given good is decreasing, the possibility for large transport distances is increasing. Therefore, the wider the markets are apart, transport costs induce a cost advantage in both countries. Another theory is based on monopolistic competition, whereby the wider markets due to trade increase product variety as buyers seek the special characteristics of foreign brands. That is, differentiated products trade flows both ways within product categories (Besedes and Prusa 2005, Glick and Andrew 2002, Feenstra and Gordon 2000, Feenstra 1994, Niehans 1987).

Free trade policies in international markets imply governments that do not restrict or reduce free trade using for example import quotas, taxes and non-tariff barriers on imports or exports (Bhagwati 2002). The doctrine and theory of free trade plays the overwhelming important role of demand and supply to establish market prices in order to bring resource endowments of nations to the centre stage as the determining factor for mutually gainful trade (Pugel 2007). With this device, free trade theory moved away from the technology-based interpretations of the Ricardian comparative cost doctrine to an endowment based explanation for nations having similar access to technology. One of the important hypotheses

of this study is about the impact of European Union aspect on the extensive and intensive margins of Norwegian imports.

1.1 The Problem

The main motivation of this paper is the idea raised by Felbermayer and Kohler (2006). According to their paper after the post II-war, the increase of world trade took place through both the larger quantities traded between countries (the country's intensive margin) and an increase in the number of country pairs that engage in trade (the country's extensive margin). Growth in trade is therefore driven by changes in both the extensive and intensive margin. According to Felbermayer and Kohler (2006) differences at the extensive margin, generally contributed more to explaining trade patterns while distance and other non-tariff barriers affected the extensive margin. This paper's overall hypothesis is the testing of the intensive and extensive margins for Norwegian import trade across the world continents and countries within continents. In order to support our analysis we use both the expenditure in Norwegian kroner and the item share (item expenditure over total expenditure) as our endogenous variables. Preliminarily, we evaluate the spatial distribution and the time evolution of the expenditure and the share applying a two-way factorial multivariate analysis (MANOVA) using the factors of origin over continents and business cycles.

The main reason that we apply MANOVA models instead of a series of one-at-a-time ANOVAs are: [1] to reduce the experiment-wise level of Type I (rejecting the null hypothesis when it is in fact true) error. That is, if we use four tests each at 5% level of significance, each experiment wise probability of making a Type I error in the test, is 20%. The so-called overall test or compilation test "protects" against this inflated error probability only when the null hypothesis is true. If we apply the MANOVA test with a bunch of ANOVAs on the individual endogenous variables without adjusting the error rates for the individual tests, there's no "protection". [2] There can always be a situation that none of the individual ANOVAs produces a significant effect on the endogenous variables. However, in combination they might have significant impacts on the endogenous variables. The situation suggests that the variables are more meaningful taken together than considered separately. MANOVA takes into account the inter-correlations among the endogenous variables (Huberty and Olejnik 2006, Anderson 2003, Rees 2000, Tabachnick and Fidell 1996).

In international economics, the Herfindahl–Hirschman Index (HHI) is used to evaluate the concentration of the markets (Hirschman 1964). Similarly, this analysis applies the HHI

index to measure the import trade of Norway by summing the squared share of each country or continents (see the definition of HHI in section 3). After analysing the spatial distribution and the time evolution of the expenditure and the share of Norwegian imports using the MANOVA model, we apply seemingly unrelated regression (SUR) models to analyse the structure of the HHI for the Norwegian imports. Therefore, this paper is aimed at addressing the following specific problems.

- To estimate the spatial (continental and country) effect and time (business cycle effect) of the expenditure and the share of Norwegian import trade.
- To identify the most important countries (within each continent) for Norwegian imports. Moreover, we predict the ranking of countries for future trade pattern of Norwegian imports.
- To analyse the structure of the HHI of the Norwegian imports in each origin continent.

1.2 Outcomes of the study

In this study, we will apply different econometric models to assess the concentration and dynamics of Norwegian import trade. The econometric analysis can provide the following important policy implications:

- Identifying the most important nations for Norwegian imports and predict their future impacts.
- Indenting the characteristics of the HHI of Norway's import trade within each continent.
- Providing solid econometric framework about how to analyse the balance of payment of Norway's external trade.

2. Literature Review

The major task of the international trade theory is to give details about "how trade is related to the basic economic problems of, efficiency in motivation, efficiency in distribution and efficiency in the allocation of scarce resources nationally and internationally. This shows that the modern theory of international trade should give the solutions of the following fundamental questions. First, the international trade theory tried to give the solution about the goods and services are traded internationally. Furthermore, the trade theory also consists of the mechanism of the fundamental laws that govern the international flow of trade. From this

aspect we understand that trade concentration caused by the realization and practices of nations regarding the contributions of international trade to the proper utilisation of resources world-wide. Second, the international trade theory is responsible to analyse the prices of goods and services exchanged at the international trade. In this aspect we see that trade concentration is related to the efficient pricing of goods and services exchanged by trading partners. This includes the role of governments on the international trade. Third, the theory of international trade has to address the gains from participation in international trade. In other words the international trade theory tried to address the effect of international trade in equitable distribution world-wide. Many international economists have shown theoretically and empirically that international trade is an important element of the economic development of nations (Henry 2011, Flanders 2008, Smith 2007, Henry 1998, Anne and Tuncer 1982, Luc Soete 1981).

This paper main emphasis is to analyse the continent and country based trade concentration dynamics of the import trade of Norway. Therefore, our literature review involves the theories of bilateral trade. Then we will also assess trade theories helps to explain patterns of trade at the industry level, taking account of industry and country differences in knowledge and technology.

International trade theory has a long history. Generally the evolution of the trade theory reflects the ways how nations maximize the gains of being participating in the international trade. For the duration of the period from the sixteenth to the eighteenth century Spain, Britain, France, and the Netherlands were the most developed countries. The governments of these nations have been a high level of intervention in the economy and concerned with the ways of sustaining their own power and wealth. The economic philosophy and practice in that era to achieve these goals called mercantilism. Mercantilists reasoned that "the best way for a nation to meet faster economic growth was to export more than it imported". The trade transaction (revenue and expenditure) would be a real inflow of gold. Due to the fact that the amount of gold was limited in the short run, not all nations could have such inflows instantaneously. Therefore, the gains from trade of one nation were enjoyed at the expense of the other nations. That was the reason that mercantilist encouraged export promotion and import restrictions (Smith 2008, Vaggi and Groenewegen 2003).

Entrepreneurs and economists naturally compare the monetary cost of the same good in different locations to draw inferences about the direction of trade. Adam Smith, who encouraged free trade based on absolute advantages of nation's against the mercantilists' philosophy. He showed that the benefits of international specialisation and division of labour would be shared by all nations who may advantage, simultaneously from free trade (Blinder 2008, Pugel 2007, Bhagwati 2002).

According to Adam Smith, when nations specialise in industries where they have absolute factor advantages, advances from trade come to every nation and not at the expense of others and there is no need for government intervention that only depreciates allocation of resources and productivity. The absolute cost advantage appears to suggest that "a nation imports goods that are cheaper in a foreign country and export goods that are more expensive abroad". The reasoning is deceptive for the reason that it makes sense in many circumstances. This trade promotes economic efficiency by providing a wider and extensive variety of goods at lower costs, particularly because of specialization and economies of scale. Therefore, this theory played a fundamental role to encourage nations in expanding their intensive and extensive margins of participating in the international trade (Marrewijk 2007, Trefler 1995).

The absolute cost advantages trade theory views' feebleness was overwhelmed by David Ricardo, who introduced the theory of comparative advantages to demonstrate that reciprocally advantageous trade could take place even when one nation was absolutely more efficient in the production of all goods and services. According to the comparative cost advantages trade theory, nations specialise in industries where they have a lower opportunity cost and trade based on these comparative advantages all the countries gains from international trade. The main distinguishing feature of the comparative advantage of trade theory was the international rigidity of factors of production. Factors were considered as perfectly and effortlessly movable within countries and absolutely immovable among countries, while goods were effortlessly movable inside and among countries at zero transport cost. Ricardo reasonably annotated over the problem of the interdependence of industries, treating them as integrated, manufacturing one output and using one principal input (labor). The latter being mobile internally, the unit cost of each good was constant, be contingent solitary on the amount of labor necessary to produce it. This shows that Ricardo clarified comparative advantage as due to differences in labor productivity. Therefore, the theories of comparative advantage much solidifies and improve the absolute advantage of

international trade by including important parameter to improve the nation's benefit from international trade. The comparative advantage gives much emphasis on labour productivity it did not consider and analysed the effect of resource endowments on productivity. The model also ignored and international specialisation and the influence of trade on the distribution of income (Boudreaux 2008, Krugman and Obstfeld 1988, Dixit and Norman1980)**.**

In 1930's Heckscher-Ohlin developed a model of factor endowment to study these subjects that were overlooked by the Ricardian model. The Heckscher-Ohlin model emphasized that international trade is based on metamorphoses in factor endowments of nations. Due to the different endowments of factors of production of nations have comparative advantages in different industries and their comparative price levels fluctuate. The Heckscher-Ohlin analysis of the factor proportions model predicted that a country would have a comparative advantage in the good which made relatively intensive use of its relatively abundant factor. This is the reason why each nation will export the goods intensive in its relatively abundant and cheap factor and import the goods intensive in its relatively scarce and expensive factor (Bernstein and Weinstein 2002, Trefler and Zhu 2000, Feenstra 1994).

The recent philosophy and practice of international trade demanded much concrete solution. After the World War II, Heckscher-Ohin theory was challenged by the advancement of international trade that it could not explain. Substantial flows of intra-industry trade based on product differentiation, exports of goods intensive in nations relatively scarce and expensive factors (the so called Leontief paradox), trade based on technological gaps, trade based on economies of scale and product cycles looked-for a new explanation (Krugman 2000, Helpman 1999, Duchin 1990).

Raymond Vernon developed a model of international product life cycle to give details about trade based on technological gaps. The model put together clarifications of international trade and investment flows that were succeeding in trade. Far ahead this model was extended to explain internationalization of industries in the international industry life cycle model. The latest trade theory, combining old and new trade theory, suggest that inter-industry trade is driven by technology gaps and Heckscher-Ohlin differences in factor proportions, while intra industry trade is based on increasing returns to scale and monopolistic competition (Lancaster 1980, Dixit and Norman 1986, Krugman 1980, Helpman 1981 and Helpman and Krugman

1985). Much of intra-industry trade occurs in knowledge intensive products between highly developed countries, often in industries dominated by multinational companies, due to the fixed costs of R&D (Helpman 1984 and Markusen 1984).

Trade increases or decreases either on the intensive margin or the extensive margin. At the country level, the extensive margin refers to the number of country pairs trading bilaterally with each other, versus the intensive margin, which is the amount of trade taking place within an existing trade partnership. The Melitz model (Melitz 2003) is a dynamic industry model of a firm's decision to produce for the domestic market and their decision to export to foreign markets (creating trade at the extensive margin). In each country, the domestic market consists of firms differentiated by the varieties they produce and their productivity. Fixed production costs lead to the exit of inefficient firms whose productivities are lower than a threshold level, as they do not expect to earn positive profit in the future. There are then additional costs associated with exporting. However, the decision to export occurs after the firm observe their productivity in the domestic market. A firm enters exports markets if, and only if, the net profits generated from its exports in a given country are sufficient to cover the fixed exporting costs.

Helpman, Melitz and Rubinstein (2008) provide an updated probit model of the extensive margin of trade. A country will export to a given market if the most productive exporting firm has a ratio of variable export profits to fixed costs larger than one. Novy (2007) also model the calculation of trade costs from information on bilateral and internal trade flows.

The monopolistic competition model of Helpman and Krugman (1985) explain how fast-growing countries could experience rapid growth without declining terms of trade. If they developed new varieties of products to be exported (increasing the extensive margin), rather than increasing the volume of goods already exported (the intensive margin), the price of existing products would not be lowered.

Any trade barriers that may exist between bilateral trading partners limit international trade. As well as policy barriers, such as tariffs, these include natural barriers, such as transport costs, which tend to increase with distance and decrease with the sophistication of physical infrastructure, and can be as high as 40% of production costs. In Tinbergen's gravity model, bilateral trade flows depend on the market size of the country pair in question relative to the

rest of the world, and the distance between them relative to the distance to all other potential trading partners (Anderson 1979 and McCallum 1995). Eaton and Kortum (2001) calculate that "zero gravity", i.e. no geographical barriers to trade, would imply a more than fivefold increase in world trade.

The presence of sizeable transport costs, combining with increasing returns, also creates the home-market effect (Corden 1970). Where there are possibilities of realising economies of scale, firms tend to concentrate production in one location, and transport costs are minimized if this location is within the larger market. Therefore, while some parts of production may be geographically fragmented, those operations where economies of scale are important, such as R&D, will tend to be geographically concentrated, often in the home market. Consequently, countries tend to export goods for which they have a large domestic market.

There has been an increasing focus on informal trade barriers as an explanation of why trade flows are not higher. These include weak enforcement of international contracts (Anderson and Marcouilier 2000) and inadequate information about international trading opportunities (Portes and Rey 2002). Grafton, Kompas and Owen (2007) present OLS and instrumental variable results that support the hypothesis that social barriers to communication, as measured by linguistic diversity, reduce total factor productivity.

Rauch (2001) models how business and social networks can affect trade. On the one hand, domestic networks can act as informal barriers themselves, with network members colluding to increase market power by restricting foreign competition. Immigration is expected to encourage trade within the country of origin, both through transnational network effect and through immigrant's taste for goods from their country of origin. Estimation results from gravity models suggest that migration flows can have a significant effect on trade flows, particularly intra-industry trade. Some studies of immigration find larger import elasticity compared to export elasticity, although a few find the opposite. Gould (1994), for example, estimates that 10% increase in immigrants to the USA will increase US exports to the country of origin by 4.7% and us imports from the country of origin by 8.3%.

Houthakker and Magee (1969) documents large differences in the income elasticity's of trade flow across countries. Hence, as growth rates start to slow in newly industrialized countries such as China, we would expect to see a simultaneous increase in the relative income

elasticity of import demand. Finally, exchange rate effects on trade are not straight forward, and can be weak. Theory suggests that depreciation is more likely to increase trade at the extensive margin than the intensive margin. Higher import intensity in production reduces the potential competitiveness effect of depreciation.

3. The 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/statistikkbanken) and External Economy (External trade, External trade in goods, 08801). The data are organised yearly ranging from 1988 to the end of 2014 (27 years). The expenditure 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 business cycles, the origin continents and countries. The endogenous variable is the expenditure to import items.

The **endogenous** variables considered in this study are:

(i). Norwegian expenditure to import items.

(ii). Share of exporters (continents or countries) of Norway which is defined as:

$$Share_{it} = \frac{Expandature_{it}}{\sum_{i=1}^{a} Expandature_{it}} X100 \quad (1)$$

where: $i = 1,2,3,...,a$ is the index representing origin continents or countries, $t = 1,2,3,...,T$ is the index representing time.

(iii). Herfindahl–Hirschman Index (HHI) is a measure of trade concentration. The HHI is defined as:

$$HHI_t = \sum_{i=1}^{a} Share_{it}^2 \quad (2)$$

The value of the Herfindahl–Hirschman Index (HHI) ranges from 0 (highly diversified) to 10,000 (highly concentrated). The factors considered in this study are:

[1]. Spatial Effects (Origin continents or countries) and

[2]. Dynamic Effects (Business Cycles).

The exogenous variables of the study are:

[1]. Number of exporter countries to Norway

[2]. Norway's revenue from the export of goods.

3.2 The methodology

3.2.1 Two-way Factorial Multivariate Analysis of Variance (two-way MANOVA)

The model of multivariate analysis of variance (MANOVA) is a generalization of a univariate analysis of variance (ANOVA) that intended to measure the significance of mean differences of the endogenous variables. Multivariate analysis of variance (MANOVA) is a way to test the effect of one or more factors on a set of two or more endogenous dependent variables. In MANOVA we have considered more than one endogenous variable and the model uses the variance-covariance between the endogenous variables in testing the statistical significance of the main differences (Warne 2014, Gelman 2005, Stevens 2002).

In this paper, we will apply specifically the two-way multivariate analysis of variance (MANOVA). The two-way multivariate analysis of variance (MANOVA) is a linear model that contains two-main factors, say factor A and Factor B. The model is formulated to measure the effects of the two main factors and their interaction effect of the main factors on the endogenous variables. The linear model of the two-way multivariate analysis of variance (MANOVA) containing two-endogenous variable is given as (George 2008, Gelman and Hill 2006, Stevens 2002):

$$\begin{bmatrix} y_{ijk1} \\ y_{ijk2} \end{bmatrix} = \begin{bmatrix} \mu_1 + \alpha_{i1} + \tau_{j1} + (\alpha\tau)_{ij1} \\ \mu_2 + \alpha_{i2} + \tau_{j2} + (\alpha\tau)_{ij2} \end{bmatrix} + \begin{bmatrix} \upsilon_{ijt1} \\ \upsilon_{ijt2} \end{bmatrix} \tag{3}$$

where: $i = 1,2,3...a$, is the level of the one factor, $j = 1,2,3...b$, is the level of another factor, and $k = 1,2,3...n$, the number of replications.

- y_{ijk2} and y_{ijk2} are endogenous variables which are observed at the k^{th} cell from the j^{th} factor B and the i^{th} factor A.
- μ_1 and μ_2 is the grand means of the endogenous variables y_{ijk2} and y_{ijk2}, respectively.
- α_{i1} and α_{i2} are the i^{th} effect of factor A on the endogenous variables y_{ijk2} and y_{ijk2}, respectively.
- τ_{j1} and τ_{j2} are the j^{th} effect of factor B on the endogenous variables y_{ijk2} and y_{ijk2}, respectively.
- $(\alpha\tau)_{ij1}$ and $(\alpha\tau)_{ij2}$ the interaction effect of factors A and factor B on the endogenous variables y_{ijk2} and y_{ijk2}, respectively.

- $\begin{bmatrix} v_{ijl1} \\ v_{ij2} \end{bmatrix} \sim N(0, \Sigma)$.

Model Assumptions of MANOVA (George 2008, Gelman and Hill 2006, Stevens 2002, Andrews and Herzberg 1985) are:

Assumption 1: Continuity of endogenous variables

The two or more endogenous variables should be continues random variables. This means the random variables must be measured at the interval or ratio level.

Assumption 2: Factors should be nominal categorical variable

The factors of the model should consist of two or more nominal categorical variable. If one of the independent variable is continuously variable, then the model becomes a multivariate analysis of covariance (MANCOVA).

Assumption 3: Multivariate normality

All of the endogenous variables must be distributed normally. Furthermore, any linear combination and subsets of the endogenous variables must be distributed normally.

Assumption 4: Homogeneity of the covariance matrices

The MANOVA model needed the constant variance assumption of each endogenous variable. Furthermore, in the MANOVA model this assumption extended to have homogeneous "covariance matrices" of the endogenous variables. The homogeneity assumption is tested using the Box's M test (Arnold 1981). The null hypothesis stated that the covariance matrices of the endogenous variables are significantly similar across levels of the factors. If the Box's M test is significant, it means you have violated an assumption of MANOVA.

Assumption 5: Independence of observations

Serial correlations in each the endogenous variable is assumed to be insignificant.

The MANOVA hypothesis is based on the product of the model covariance matrix. Suppose Σ_{Model} is the covariance matrix of the model and Σ_{residual} is the covariance matrix of the residual. Using these covariance matrices we define another matrix A as follows (Rencher and Christensen 2012, Duxbury 2005, Morrison 1998):

$$A = (\Sigma_{\text{Model}}) X (\Sigma_{residual}^{-1}) \tag{4}$$

where: $\Sigma_{\text{residual}}^{-1}$ is the inverse of the covariance matrix of the residual

The null hypothesis of the multivariate analysis of variance (MANOVA) involve about equality of the covariance matrix of the model (Σ_{Model}) and the covariance matrix of the

residual $(\Sigma_{\text{residual}})$. This means the MANOVA null hypothesis are involved in showing the whether A-matrix is statistically equal to the identity matrix or not. In other words the MANOVA statistic should be a measure of magnitude of the singular value decomposition of the A matrix. However, there is no unique choice owing to the multi-dimensional nature of the alternative hypothesis.

The different multivariate test criteria statistics are derived from the eigenvalues of the A-Matrix. Now let us denote λ_p be the eigenvalues of the A-Matrix, then we have the following multivariate test criteria (Rencher and Christensen 2012, Duxbury 2005, Morrison 1998).

a. Hotelling's Trace (Λ_{LH})

$$\Lambda_{LH} = \sum_{1\cdots p}(\lambda_p) = trace(A) \tag{5}$$

b. Wilk's Lambda $(\Lambda_{Wilk"s})$

$$\Lambda_{Wilk"s} = \prod\left(\frac{1}{1+\lambda_p}\right) = \frac{\|\Sigma_{res}\|}{\|\Sigma_{residual} + \Sigma_{model}\|} \tag{6}$$

c. Pillai's Trace $(\Lambda_{Pillai's})$

$$\Lambda_{Pillai's} = \sum_{1\cdots p}\left(\frac{1}{1+\lambda_p}\right) = Trace\left((I+A)^{-1}\right) \tag{7}$$

d. Roy's Largest Root (Λ_{Roy})

$$\Lambda_{Roy} = Maximum_p(\lambda_p) = \|A\|_{\infty} \tag{8}$$

For the estimation, the effects of the model parameters can be fixed or random. If all the model parameters are fixed, then we call it type I model. If all the model parameters are random we call it type II model. If some of the model parameters are fixed effects and the others are random effects, then we call it type III model. The estimation of the type I model parameters is the ordinary least square (OLS) estimation method. The estimation of the type II model parameters is the general least square (GLS) estimation method. However, due to several known and unknown reasons the estimates can be biased. Therefore, in order to estimate the bias of the estimated model parameters we will apply model we will employ

bootstrapping resampling estimation method (Fahrmeir *et al.* 2009, Davidson and Mackinnon 1993). In this particular case we apply the Bias-Estimation Bootstrap technique. The estimation method gives information about bias of the estimates due to resampling in addition to the estimates of OLS or GLS (Davison and Hinkley 1997). Another important task is the identification of the nature of the model parameters. In theory the model parameters can be treated either fixed or random effects. However, in practice it is difficult to distinguish which model effects are fixed and which are random. In this particular study, we try to estimate the continental effect and the business cycle effect on the Norwegian expenditure to import goods. In reality the expenditure is dependent on the exchange rate (which is an extreme volatile factor in the international market), the price of the import item (which is also dynamic for several known and unknown reasons), transportation cost (which is also volatile factor in international market). Furthermore, other several factors directly or indirectly affect the explanatory to import goods. This shows if we apply type I (fixed effect) model then we can't control the variability of the expenditure. Therefore, we apply type II (random effect) model to make our estimation more robust.

The partial eta squared $\left(\eta_p^2\right)$ is an estimate of the amount of the "effect size" attributable to between-group differences (differences in levels of the factors or independent variables). The partial eta squared is computed as follows (Pierce, Block and Aguinis 2004):

$$\eta_p^2 = \frac{SS_{between}}{SS_{total} + SS_{error}} \tag{9}$$

where: $SS_{between}$ is the sum of squares due to the group, SS_{total} the total sum of squares, and SS_{error} is the error sum of squares.

Like a measure correlation coefficient the value of the partial eta squared has a scale which ranges 0 to 1 (where 0 is the least value and 1 is the strongest). The value of partial Eta-squared reflects the percentage of the variance of the endogenous variable explained by the factors in the sample data.

3.2.2 Smilingly unrelated regression (SUR) model

Seemingly unrelated regression (SUR) models are the generalizations of a linear regression model that contains of more than one independent regression equations. The SUR model for

the endogenous vector of $\{y_{1t}, y_{2t}, y_{3t}, ..., y_{at}\}$ and the exogenous vectors of $\{x_{11t}, x_{21t}, x_{31t}, ..., x_{a1t}\}$ and $\{x_{12t}, x_{22t}, x_{32t}, ..., x_{a2t}\}$ is given as (Davidson and MacKinnon 1993):

$$\begin{cases} y_{1t} = \beta_{10} + \beta_{11}x_{i1t} + \beta_{12}x_{12t} + \varepsilon_{1t} \\ y_{2t} = \beta_{20} + \beta_{21}x_{i1t} + \beta_{22}x_{12t} + \varepsilon_{2t} \\ \quad \vdots \\ y_{at} = \beta_{a0} + \beta_{a1}x_{a1t} + \beta_{a2}x_{a2t} + \varepsilon_{at} \end{cases} \tag{10}$$

where: $i = 1,2,3,....,a,\ t = 1,2,3,...,T,$ β_{io} is the constant of the i^{th} regression model, β_{i1} and β_{i2} are the common coefficients of X_{i1} and X_{i2}, and for the $\varepsilon_{it} \sim iidN\left(0, \sigma_i^2\right)$ are the random error terms.

With the above specification we can simply express the SUR model in equation 7 as:

$$y_{it} = \beta_{i0} + \beta_{i21}x_{i1t} + \beta_{i2}x_{i2t} + \varepsilon_{it} \tag{11}$$

For the estimation, under the complete Gauss Markov assumption the ordinal least squares (OLS) estimator is the best linear unbiased estimator (BLUE) of the model parameters for the regression models (Greene 2012).

Controlling autocorrelation from SUR model

Autocorrelation problem leads to inefficient parameter estimate. In order to control autocorrelation problem we can apply the Cochrane-Orcutt recursive autoregression estimation on each the independent regression equations. The the Cochrane-Orcutt recursive autoregression estimation is applied as follows (Cochrane and Orcutt 1949).

First we specify a reasonable the model to avoid such problem as:

$$y_{it} = \beta_{i0} + \beta_{11}x_{i1t} + \beta_{i2}x_{i2t} + \varepsilon_{it} \tag{12}$$

where: $\varepsilon_{it} = \rho_i\varepsilon_{it-1} + v_{it},\ |\rho_i| < 1$ is the coefficient of autocorrelation and $v_{it} \sim iidN\left(0, \sigma_{iv}^2\right)$

Let's apply the Cochrane-Orcutt transformation to eliminate the autocorrelation from the model.

$$y_{it} = \beta_{i0} + \beta_{i1}x_{i1t} + \beta_{i2}x_{i2t} + \varepsilon_{it} \tag{13}$$

$$\rho_i y_{it-1} = \rho_i \beta_{i0} + \rho_i \beta_{i1} x_{i1t-1} + \beta_{i2} x_{i2t-1} + \rho_i \varepsilon_{it-1} \quad (14)$$

Subtract equation 14 from 13 we have:

$$y_{it} - \rho_i y_{it-1} = (\beta_{i0} - \rho_i \beta_{i0}) + (\beta_{11} x_{i1t} - \rho_i \beta_{i1} x_{i1t-1}) + (\beta_{i2} x_{i2t} - \rho_i \beta_{i2} x_{i2t-1}) + (\varepsilon_{it} - \rho_i \varepsilon_{it-1}) \quad (15)$$

$$y_{it}^* = \beta_{i0}^* + \beta_{i1} x_{i1t}^* + \beta_{i2} x_{i2t}^* + v_{it} \quad (16)$$

where: $y_{it}^* = y_{it} - \rho_i y_{it-1}$, $\beta_{i0}^* = (\beta_{i0} - \rho_i \beta_{i0})$, $x_{i1t}^* = (x_{i1t} - \rho_i x_{i1t-1})$ and $x_{i2t}^* = (x_{i2t} - \rho x_{i2t-1})$

Since $v_{it} \sim iidN(0, \sigma_{iv}^2)$, regression equation 10 has controlled the autocorrelation of the series. So, we can apply the Ordinary Least Square Estimator (OLS) recursively on regression equation 16.

4. Results and Discussions

4.1 Multivariate analysis of variance (MANOVA) of Norwegian imports

In order to evaluate the spatial and the time evolution of the expenditure of the Norwegian imports, we will apply the random effect two-way factorial with interactive multivariate analysis of variance (MANOVA). The endogenous variables considered in this analysis are the expenditure (in Norwegian kroner) to import items from the origin continent and the share (item expenditure over total expenditure) for the continent. The factors considered in the MANOVA model are spatial (continental) effects and the dynamic (business cycle) effects. The levels of the spatial effects are: 1 [Africa], 2 [Asia and Oceania], 3 [Europe], 4 [North and Central America] and 5 [South America]. The levels of the dynamic effects are: [1988-1992] business cycle from 1988-1992, [1993-1997] business cycle from 1993-1997, [1998-2002] business cycle from 1998-2002, [2003-2007] business cycle from 2003-2007 and [2008-2014] business cycle from 2008-2014.

The Box's test for equality of the covariance matrices prevails that the Box's *M* value of 585.44, and has an associated *F*-statistic of 6.604, at the degrees of freedom of the numerator and denominator are 72 and 9513.57 implying a *p*-value of 0.0000 (See Table 1). The test result confirms the rejection of equality of the covariance matrices of the expenditure and the share across the levels of continents and over business cycles. This result also suggests that

the covariance matrices are significantly different across levels of the continents. The business cycles may indicate an increased possibility of Type I error. Therefore, instead of using individual ANOVA models to the endogenous variables expenditure and share we prefer to apply the MANOVA models reducing the possibility of Type I errors.

{*Insert* Table 1 *about here*}

The maximum number of time series observations considered in the analysis over the business cycles is seven, which is too small to detect autocorrelation. Therefore, we do not check for autocorrelation. However, considering both expenditure and share as endogenous variables in our multivariate analysis, we must consider the possibility that the variances are different. Accordingly, the Bartlett's test of Heteroscedasticity shows that the likelihood ratio is approximately zero and has an associated chi-square value of 1798.7 with 2 degrees of freedom bringing us a p-value of 0.0000 (See Table 1). The result confirms that the variability of the endogenous variables expenditure and share are different. Therefore, in order to have efficient estimates of the model parameters we will apply the generalized least square (GLS) estimator for the model parameters.

The multivariate tests of the expenditure and the share of the Norwegian imports over the factors of origin continents and business cycles is given in Table 2. According to the estimation results, Table 2 suggests that all the different multivariate test criteria statistics (Pillai's Trace, Wilks' Lambda, Hotelling's Trace and Roy's Largest Root) that the intercept, the continental effects, the business cycle effects, and the interaction effects of continents and business cycles are all significant (p-value< 0.0000) for either the expenditure or the share of Norwegian imports.

{*Insert* Table 2 *about here*}

The Wilks' lambda value of for the intercept is 0.003, and has an associated F-statistic of 20193.09 (p-value< 0.0000). This result suggest the model tells us 99.7 percent of the variation of the mean expenditure and the mean share of Norwegian imports across continents. The estimated value of the partial eta squared for the intercept is 0.997 which is strong enough to estimate the amount of the effect size. Moreover, the power of the model to detect the effect is almost 100 percent. The test results of Table 3 confirm that the intercept of both the expenditure and the share of the Norwegian imports are statistically significant. Therefore, these estimation results confirm that the Norwegian import trade is sustainable in both short and long run controlling for the effect of any origin continent over the business

cycles. The estimation result suggests that the mean expenditure of Norwegian imports is 320196.33 (with bias -892.83 and standard error of 25716.56) million NOK.

The Wilks' lambda value of for the continental effect is 0.001, and has an associated *F*-statistic of 662.78 (*p*-value<0.0000). This means the model tells us 99.9 percent of the variation of the continental effect on expenditure or the share of Norwegian imports controlling the mean and the effects of the business cycles. The estimated value of the partial eta squared for the intercept is 0.962 which is strong enough to estimate the amount of the effect size. Furthermore, the power of the model to detect the effect is almost 100 percent. The test results of Table 3 confirm that the continental effect of both the expenditure and the share of the Norwegian imports are statistically significant. Therefore, this finding confirms that the expenditure or the share of the import trade of Norway showed consistent spatial heterogeneity over the business cycles.

The Wilks' lambda value of for the business cycle effect is 0.191, and has an associated *F*-statistic of 208 (*p*-value <0.0000). This means the model tells us 79.1 percent of the variations of the business cycle effect on the expenditure and the share of Norwegian imports controlling the mean and the continental effects. The estimated value of the partial eta squared for the intercept is 0.563 which is moderately enough to estimate the amount of the effect size. Furthermore, the power of the model to detect the effect is almost 100 percent. The test results of Table 3 confirm that the business cycle effect on the expenditure of the Norwegian imports is significant while the business cycle effect on the share of the Norwegian imports is statistically insignificant. Therefore, this finding confirms that the expenditure of the import trade of Norway showed considerable dynamics over the business cycles. However, the continental share is consistent over the business cycles. This means the continental ranking of the Norwegian imports remains the same also for the future trade pattern.

The Wilks' lambda value of for the interaction effect of continents and business cycles effect is 0.041, and has an associated *F*-statistic of 25.73 (*p*-value 0.0000). This means the model tells us 94.9 percent of the variation of the interaction effect of continents and business cycles on the expenditure and the share of Norwegian imports controlling the mean and the main effects. The estimated value of the partial eta squared for the interaction effect is 0.798 which is moderately enough to estimate the amount of the effect size. Furthermore, the power of the model to detect the effect is almost 100 percent. The test results of Table 3 confirm that the

interaction effect of continents and business cycles on both the expenditure and the share of the Norwegian imports are statistically significant. Therefore, this finding confirms that the expenditure and the share of the import trade of Norway showed considerable volatility across continents or over the business cycles.

In the following sub- sections we will present the estimates of the Norwegian expenditure and across continents and over the business cycles. The estimation results will help us to quantify the spatial effects and the dynamics for the future trade pattern of Norway. The estimation result also moves up to identifying the Norwegian import countries from each continent.

{*Insert* Table 3 *about here*}

4.1.1 Norwegian expenditure and continental share of imports from Africa

The estimation result in Table 4 gives the Norwegian expenditure and share of imports from the continent of Africa. According to Table 4 we observe that the estimate of the Norwegian expenditure to import goods from the continent of Africa was 5714.40 (with bias -10.04 and standard error of 1073.27), 3085.00 (with bias +31.35 and standard error of 717.06), 3171.40 (with bias -2.45 and standard error of 363.59), 4544.80 (with bias -3.74 and standard error of 684.27) and 9376.29 (with bias +55.38 and standard error 734.83) million NOK over the business cycles of [1988-1992], [1993-1987], [1998-2002], [2003-2007] and [2008-2014], respectively. This made the continent to cover the import share of 3.52%, 1.42%, 1.11%. 1.20% and 1.87% over the business cycles, respectively. Therefore, both in the expenditure and the share the Norwegian import from the continent of Africa showed considerable dynamics. Generally, the expenditure is growing over the business cycles especially from 1993 while and the continental share is below 2% in the recent trade patterns. According to the estimation results of Table 5.1 we observe that from 1988 to 2014, Botswana, Liberia, South Africa, Morocco and Equatorial Guinea accounts 74.83% of Norwegian imports (see the detailed estimation results in Table 5.1). The results of Figure 1.1 and Figure 1.2 suggest that the share of Norwegian import from the continent of Africa and the share of Liberia is decreasing with time while the share of the other African countries is increasing with time. The estimation result is a primary indicator that the extensive margin of the Norwegian imports is growing in the continent of Africa.

{*Insert* Table 4 *about here*}

{*Insert* Table 5.1 *about here*}

{*Insert* Figure 1.1 *about here*}

{*Insert* Figure 1.2 *about here*}

4.1.2 Norwegian expenditure and continental share of imports from Asia and Oceania

The estimation result in Table 4 gives the Norwegian expenditure and share of imports from the continent of Asia and Oceania. According to Table 4 the estimate of the Norwegian import expenditure from the continent of Asia and Oceania was 16958.00 (with bias +19.53 and standard error of 1018.06), 26064.40 (with bias -12.49 and standard error of 1601.20), 37276.40 (with bias +35.57 and standard error of 1859.84), 50783.60 (with bias +126.97 and standard error of 4519.45), and 86548.27 (with bias 189.019 and standard error 4181.37) million NOK over the business cycles of [1988-1992], [1993-1987], [1998-2002], [2003-2007] and [2008-2014], respectively. The continent covers an import share of 10.45%, 12.46%, 13.05%, 13.74% and 17.25 over the five business cycles, respectively. Therefore, both in the expenditure and in the share the Norwegian import from the continent of Asia and Oceania shows considerable dynamics. Both the expenditure for import goods and the share of the continent are sharply increasing over the business cycles. In the future trade patterns the share of Asia and Oceania seem to exceed 17%. According to the estimation results of Table 5.2 we observe that for cycle [1988-2014], China, Japan, South Korea, Taiwan, Singapore, Thailand, India, Hong Kong and Malaysia accounts for more than 90.00% of the expenditure of the Norwegian imports (see the detailed estimation results in Table 5.2). According to the results of Figure 2.1, we observe that the import expenditure from China is growing fast over time. However, the import expenditure from Japan is relatively stable. According to the results of Figure 2.2, we see that the China share is increasing while the share of other countries, especially Japan, is declining over time. The estimation result is a primary indicator that the intensive margin of the Norwegian imports is growing in the continent of Asia and Oceania.

{*Insert* Table 5.2 *about here*}

{*Insert* Figure 2.1 *about here*}

{*Insert* Figure 2.2 *about here*}

4.1.3 Norwegian expenditure and continental share of imports from Europe

The estimation result in Table 4 gives the Norwegian expenditure and share of the continent of Europe. According to Table 4 we see that the estimate of the Norwegian import expenditure from the continent of Europe was 116460.00 (with bias +54.97 and standard error of 2035.286), 157041.60 (with bias +92.35 and standard error of 11836.16), 208714.40

(with bias -147.84 and standard error of 2960.13), 275074.00 (with bias +285.94b and standard error of 22338.11), and 347773.57 (with bias -30.94 and standard error 10136.69) million NOK over the business cycles of [1988-1992], [1993-1987], [1998-2002], [2003-2007] and [2008-2014], respectively. This makes the continent to cover the import share of 71.79%, 74.36%, 73.32%, 74.58% and 69.46% over the five business cycles, respectively. Therefore, both in the expenditure and the share of Norwegian import from the continent of Europe shows considerable dynamics. The expenditure to import goods from the continent is sharply increasing over the business cycles. However, the share of Norwegian imports from Europe is slightly decreasing over time. In the future trade patterns, the share of Europe seem not to exceed 70%. According to the estimation results of Table 5.3, we observe that from business cycle one [1988-2014], Sweden, Germany, United Kingdom, Denmark, Netherlands, France, Italy, Finland, Belgium, Russia and Spain accounts for more than 85% of Norwegian imports (see the detailed estimation results in Table 5.3). According to Figure 3.1, the import expenditure from all European countries is growing with time. Especially the Norwegian import expenditure from other European countries is growing fast over time. The result shows that the extensive margin of the Norwegian import from the continent of Europe is increasing with time. According to the results of Figure 3.2, we also see that the share of other European countries is increasing while the share of especially Sweden and Germany seems to decline with time. The estimation result is a primary indicator that the extensive margin or the intensive of the Norwegian imports is growing in the continent of Europe.

{*Insert* Table 5.3 *about here*}

{*Insert* Figure 3.1 *about here*}

{*Insert* Figure 3.2 *about here*}

4.1.4 Norwegian expenditure and continental share of imports from North and Central America

The estimation result in Table 4 gives the Norwegian expenditure and share of the continent of North and Central America. According to Table 4 we see that the estimate of the Norwegian import expenditure from the continent of North and Central America was 20535.80 (with bias -53.49 standard error of 1544.60), 21663.60 (with bias +7.04 standard error of 963.90), 31046.20 (with bias -23.57 standard error of 2249.70), 31746.60 (with bias -84.97 standard error of 3925.19) and 45745.57 (with bias -105.09 standard error of 2180.04) million NOK over the business cycles of [1988-1992], [1993-1987], [1998-2002], [2003-2007] and [2008-2014], respectively. This made the continent to cover the

import share of 12.62%, 10.33%, 10.86%, and 8.50% and over the five business cycles, respectively. Therefore, both in the expenditure and the share of Norwegian import from the continent of North and Central America show considerable dynamics. The import expenditure from the continent is increasing over the business cycles. However, the import share of North and Central America countries to Norway is slightly decreasing with time. In the future trade patterns the share of North and Central America seems not be exceed 10%. According to the estimation results of Table 5.4 and the business cycles 1988 to 2014, the three countries United States of America, Canada and Panama accounts for more than 90.00% of the Norwegian imports from North and Central America (see the detailed estimation results in Table 5.4). According to the results of Figure 4.1 and Figure 4.2 we observe that the expenditure and the Norwegian import share from the United States of America and Canada are increasing with time but the trend show high variability. This result indicates that the Norwegian import from the continent of North and Central America is concentrated to the United States of America and Canada.

{*Insert* Table 5.4 *about here*}

{*Insert* Figure 4.1 *about here*}

{*Insert* Figure 4.2 *about here*}

4.1.5 Norwegian expenditure and continental share of imports from South America

The estimation result in Table 4 gives the Norwegian expenditure and share of the continent of South America. According to Table 4 we observe that the estimate of the Norwegian expenditure to import goods from the continent of South America was 2646.60 (with bias-16.26 and standard error of 227.56), 3049.60 (with bias +2.11 and standard error of 340.79), 4729.60 (with bias -3.42 and standard error of 211.06), 7386.60 (with bias+14.55 and standard error of 828.94) and 11533.14 (with bias +27.82 and standard error of 458.55) million NOK over the business cycles of [1988-1992], [1993-1987], [1998-2002], [2003-2007] and [2008-2014], respectively. This made the continent to cover the import share of 1.63%, 1.43%, 1.66%, 1.98% and 2.30% over the five business cycles, respectively. Therefore, both in the expenditure and the share of Norwegian import from the continent of South America show considerable dynamics. The import expenditure and the share from the continent are increasing over the business cycles. In the future trade patterns the share of South America seem be exceed 2%. According to the estimation results of Table 5.4 we see that from 1988 to 2014, to countries Brazil, Suriname, Peru, Chile, Colombia and Argentina accounts more than 90.00% of Norwegian imports from the South American continent (see

the detailed estimation results in Table 5.4). According to the results of Figure 5.1 and Figure 5.2, we see that the import expenditure and the share from Brazil are highly increasing with time. This indicated that the Norwegian import from the continent of South America will be concentrated to Brazil.

{*Insert* Table 5.5 *about here*}

{*Insert* Figure 5.1 *about here*}

{*Insert* Figure 5.2 *about here*}

4.1.6 Overall dynamics of Norwegian imports

According to Figure 6.1 across all the continents the expenditure of Norwegian import trade is increasing with time. Moreover, the result of Figure 6.2 shows that the share of Norwegian expenditure across continents is relatively stable. Therefore, this analysis confirms that Europe is the leading trade partner for Norwegian imports and for the future trade pattern. Furthermore, the ranking of the future Norwegian trade pattern from the remaining continents is in descending order Asia and Oceania, North and Central America, South America and Africa.

{*Insert* Figure 6.1 *about here*}

{*Insert* Figure 6.2 *about here*}

4.2 Analysis of the structure of the Norwegian import trade concentration

4.2.1 Estimates of Herfindahl–Hirschman Index (HHI) of Norwegian imports

The preliminary assessment of the Herfindahl–Hirschman Index (HHI) of each continent for Norwegian imports is reported in Table 6. According to Table 6, the results the HHI for Norwegian imports across continents can be summarized as follows. The HHI of the continents of Africa, Asia and Oceania, Europe, North and Central America, and South America are 2525.42 (with bias +1.07 and standard error of 248.71), 2317.95 (with bias -1.93 and standard error of 79.53), 1114.19 (with bias +0.25 and standard error of 15.07), 4834.15 (with bias -6.00 standard error of 122.15) and 2705.13 (with bias -4.40 standard error of 153.49), respectively. The estimates of coefficient variation of the HHI index of the continents of Africa, Asia and Oceania, Europe, North and Central America, and South America are 0.51, 0.18, 0.07, 0.13 and 0.30, respectively. The result confirm that the intra-continental Norwegian import trade is highly concentrated to few countries in the continent of North America and least concentrated to some small countries in Europe. The mean

continental HHI index for Norwegian imports is 5605.28 (with bias +1.22 and standard error of 57.02). The estimate of coefficient variation of the continental HHI index is 0.053.

{*Insert* Table 6 *about here*}

The trend of the HHI for Norwegian imports is given in Figure 7. From Figure 7 we can observe that the trend of HHI for the continent of Africa is decreasing with time with extreme high variability. This is another indicator that the Norwegian import trade is divided between many countries in the African continent. The trend of HHI of the Asian and Oceanian continent is increasing with time with small variability. This is another important indicator that the Norwegian import trade is progressively concentrated to China. The trend of HHI for the continent of Europe is slightly decreasing with time with extremely small variability. The trend of HHI for the continent of North and Central America is constant over time with high variability. This is another indicator that the United States of America and Canada dominate the Norwegian import trade. The trend of HHI for the continent of South America is sharply increasing with time and with small variability. This is another important indicator that the Norwegian import trade is progressively concentrated to Brazil.

{*Insert* Figure 7 *about here*}

4.2.2 Fitting SUR model of the HHI of Norwegian imports

Here we try to fit a seemingly unrelated regression (SUR) model of the HHI for the Norwegian imports using *exogenous variables* for the number of Norwegian export countries and Norway's revenue from export.

The matrix scatter plot of the variables of the continent of Africa is given in Figure 8.1. According to the Figure 8.1, the revenue collected from the export of goods and the numbers of Norwegian export countries from the continent of Africa are increasing with time. The HHI is decreasing with the numbers of Norwegian exporter countries and the revenue collected from the continent of Africa. In order to test the significance impact of the exogenous variables on the HHI for the Norwegian imports from the continent of Africa, we fit a regression model that is summarized in Table 7. According to Table 7 the model fit show an F-value of 5.19 (p-value=0.03) which is a good fit at 5% level of significance. The estimates of the SUR model show that the number of Norwegian export countries from the continent of Africa is significant to the HHI. As the number of Norwegian export countries increases by one unit in Africa the HHI index of Norwegian import decreased by 158.11.

However, the estimation result suggests that the revenue collected from export of goods to the continent of Africa is insignificant for the HHI. The result confirms that the Norwegian import is increasing in its extensive margin in the continent of Africa. The overall analysis shows that the bilateral trade relationship between Norway and African countries has generally benefited the African countries.

{*Insert* Figure 8.1 *about here*}

{*Insert* Table 7 *about here*}

The matrix scatter plot for the continent of Asia and Oceania is shown in Figure 8.2. According to the Figure 8.2, the revenue collected from the export of goods and the numbers of Norwegian export countries from the continent of Asia and Oceania are increasing with time. The HHI is increasing with the numbers of Norwegian export countries and the revenue collected from the continent of Asia and Oceania. In order to test the significance impact of the exogenous variables on the HHI for the Norwegian imports from Asia and Oceania, we fit a regression model that is summarized in Table 7. According to Table 7 the model fit shows an F-value of 8.05 (p-value=0.01) which is a good fit at the 5% level of significance. The estimates of the SUR model show that the revenue collected from Norwegian export for the continent of Asia and Oceania is significant to the HHI. As the revenue collected from Norwegian export in billion NOK for Asia and Oceania, the HHI index of Norwegian import increased by 9.68. Nevertheless, the estimation result suggested that the number of Norwegian export countries is insignificant to the HHI. This confirms that the Norwegian import is increasing its intensive margin in the continent of Asia and Oceania, especially to China. The overall analysis shows that the bilateral trade relationship between Norway and Asia and Oceania countries has generally benefited the Asian and Oceania countries, especially China.

{*Insert* Figure 8.2 *about here*}

The matrix scatter plot for the continent of Europe is shown in Figure 8.3. According to the Figure 8.3, the revenue collected from Norwegian export of goods and the numbers of Norwegian export countries to the continent of Europe are increasing with time. The HHI is decreasing with the numbers of Norwegian export countries and the revenue collected from the European continent. In order to test the significance impact of the exogenous variables on the HHI for the Norwegian imports from the European continent, we fit a regression model that summarized in Table 7. According to Table 7 the model fit shows an F-value of 104.42

(with a *p*-value=0.00), which is a good fit at the 5% level of significance. The estimates of the SUR model shows that the revenue collected from Norwegian export of goods and the numbers of Norwegian export countries to the continent of Europe are significant to the HHI. As the revenue collected from Norwegian export to the continent of Europe in billion NOK, the HHI index of Norwegian import decreases by 0.24. Furthermore, as the number of Norwegian export countries is increases by one unit, the HHI is reduced by 6.18. This confirms that the Norwegian import is increasing both its intensive and extensive margin for the European continent. The overall analysis shows that the bilateral trade relationship of Norway with European countries has generally benefited Norway.

{*Insert* Figure 8.3 *about here*}

The matrix scatter plot for the continent of North and Central America is shown in Figure 8.4. According to the Figure 8.4 the revenue collected from Norwegian export of goods to the continent of North and Central America is increasing with time. However, the number of Norwegian export countries to the continent is neither increasing nor decreasing but varies with time. The HHI is neither increasing nor decreasing with the numbers of Norwegian export countries. The Norwegian revenues from the continent are stable. In order to test the significance impact of the exogenous variables on the HHI for Norwegian imports to the continent of North and Central America, we fit a regression model that is summarized in Table 7. According to Table 7 the model fit shows an *F*-value of 0.089 (with associated *p*-value=0.915) which is not a good fit. The estimates of the SUR model shows that neither the revenue collected from Norwegian export of goods nor the numbers of Norwegian export countries to the continent of North and Central America are HHI significant. Therefore, in order to get precise information about the bilateral trade relationship between Norway and North and Central America, extended analysis has to be performed, especially the impact of exchange rates.

{*Insert* Figure 8.4 *about here*}

The matrix scatter plot for the continent of South America is shown in Figure 8.5. According to the Figure 8.5, the revenue collected from the Norwegian export of goods to the continent of South America is increasing with time. However, the number of Norwegian export countries to the continent is neither increasing nor decreasing but varies with time. The HHI is increasing with the revenue collected from the Norwegian export of goods to the continent of South America. The HHI is not correlated with the number of Norwegian export countries to the continent. In order to test the significance, impact of the exogenous variables on the

HHI of the Norwegian imports from the continent of South America, we fit a regression model that is summarized in Table 7. According to Table 7 the model fit shows an *F*-value of 56.18 (with associated *p*-value of 0) which is a good fit at the 5% level of significance. The estimates of the SUR model shows that the revenue collected from Norwegian export of goods to the continent of South America is significant to the HHI. As the revenue collected from Norwegian export of goods to the continent of South America increased in billion NOK, the HHI index of Norwegian import increased by 346.43. This confirms that the Norwegian import is increasing its intensive margin in the continent of South America, especially Brazil. The overall analysis shows that the bilateral trade relationship of Norway with South American countries has generally benefited the South American (especially Brazil) countries.

{*Insert* Figure 8.5 *about here*}

5. Conclusions and Recommendations

5.1 Conclusions

In this study, we apply the random effect multivariate analysis of variance (MANOVA) to evaluate the spatial (continents and countries) and the time evolution of the expenditure of Norwegian imports. Furthermore, we apply the seemingly unrelated regression (SUR) model to analyse the structure of the Herfindahl–Hirschman Index (HHI) for Norwegian imports. The analysis of the HHI will help us to determine the Norwegian extensive and the intensive margins. The model results suggest the following conclusions.

The fit of the MANOVA estimation results confirms that the Norwegian import trade is sustainable in both short and long run controlling for the effect of origin continent and business cycles. The result suggests that the yearly mean expenditure of Norwegian imports is 320196.33 million NOK. Both the expenditure and the share of Norwegian imports across the continents show considerable dynamics. From 1988 to 2014 the most influential exporter countries to Norway from the continent of (in descending order): [1] Africa were Botswana, Liberia, South Africa, Morocco and Equatorial Guinea countries; [2] Asia and Oceania were China, Japan, South Korea, Taiwan, Singapore, Thailand, India, Hong Kong and Malaysia; [3]. Europe were Sweden, Germany, United Kingdom, Denmark, Netherlands, France, Italy, Finland, Belgium, Russia and Spain; [4] North and Central America were the United States of

America, Canada and Panama; and [5] South America were , Brazil, Suriname, Peru, Chile, Colombia and Argentina.

The overall MANOVA suggest that across all the continents the Norwegian import expenditure is increasing with time. However, the share of Norwegian expenditure across continents is relatively stable. Therefore, the analysis confirms that European exporters will be the leading partners for Norwegian imports in future trade patterns. Furthermore, the ranking of the remaining continents in descending order will be Asia and Oceania, North and Central America, South America and Africa.

The estimates of the Herfindahl–Hirschman Index (HHI) of the Norwegian imports from the continents of Africa, Asia and Oceania, Europe, North and Central America, and South America are 2525.42, 2317.95, 1114.19, 4834.15 and 2705.13, respectively. The trend of HHI of the continent of: [1] Africa is decreasing with time with extreme high variability, [2 Asia and Oceania is increasing with time with small variability, [3]. Europe is very slightly decreasing with time with extremely negligent variability, [4] North and Central America is constant time with high variability, and [5] South America is sharply increasing with time with small variability.

The fit of the seemingly the seemingly unrelated regression (SUR) model of the HHI of the Norwegian imports using exogenous variables of the number of Norwegian export countries and revenue from Norwegian exports show that the determinant of the variable has different feature across continents. The Norwegian import from the continent of Africa is increasing in extensive margin. The Norwegian import from to the continent of Asia and Oceania is increasing in intensive margin. The Norwegian import from to the continent of Europe is increasing in both the extensive and the intensive margin. The Norwegian import from the continent of North and Central America is stable in the extensive and the intensive margin. The Norwegian import from to the continent of South America is increasing in intensive margin. The overall analysis shows that the Norwegian bilateral trade with European countries is beneficial for Norway.

5.2 Recommendations and Policy Implications

Our econometric analysis identified that the Norwegian import HHI from the continent of North and Central America is highly volatile. Furthermore, neither the number of Norwegian

export countries nor the revenue from Norwegian export to the continents have significant impact on the HHI. Consequently, we cannot evaluate the benefits for Norway from the Norwegian bilateral trade with North and Central American countries, especially the Unites States of America and Canada. In this aspect, there are several important hypotheses, such as the impact of exchange rate, elasticity of particular items of imports, the impact of structural changes to the continent of Asia and Oceania etc. must be tested. Furthermore, we recommend that the Norwegian government find the necessary means foe the standardization of the bilateral trade with North and Central American countries.

The Norwegian imports from Asia and Oceania, and South America is progressively intensified for the countries of China and Brazil, respectively. In this aspect, we recommend that Norwegian exporters intensify their export efforts for China and Brazil.

We recommend that similar analyses have to be performed in order to analyse the future external trade pattern of Norway. We also suggest that in order to have a more detailed analysis, a country based Norwegian import analysis must be performed. Furthermore, the result of this study confirms that the structure of the Norwegian imports from the five continents is different. This is a crucial impute for researchers that want to analyse such variability.

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Table 1: Test results of Box's Test of Equality of Covariance Matrices and Bartlett's Test of Heteroscedasticity

Box's Test of Equality of Covariance Matrices[a]	Box's M	F	df1	df2	Significance	Bartlett's Test of Sphericity[a]	Likelihood Ratio	Approx. Chi-Square	df	Significance
	585.444	6.604	72	9513.573	0.0000		0	1798.655	2	0.0000
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.						Tests the null hypothesis that the residual covariance matrix is proportional to an identity matrix.				
a. Design: Intercept + Continents + Business Cycle + Continents*Business Cycle										

Table 2: Multivariate tests of the Expenditure and the Share of the Norwegian imports over the factors of origin Continents and Business Cycles

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[d]
Intercept	Pillai's Trace	0.997	20193.093[b]	2	104	0.0000	0.997	40386.186	1.000
	Wilks' Lambda	0.003	20193.093[b]	2	104	0.0000	0.997	40386.186	1.000
	Hotelling's Trace	388.329	20193.093[b]	2	104	0.0000	0.997	40386.186	1.000
	Roy's Largest Root	388.329	20193.093[b]	2	104	0.0000	0.997	40386.186	1.000
Continents	Pillai's Trace	1.011	26.842	8	210	0.0000	0.506	214.735	1.000
	Wilks' Lambda	0.001	662.784[b]	8	208	0.0000	0.962	5302.272	1.000
	Hotelling's Trace	691.986	8909.316	8	206	0.0000	0.997	71274.526	1.000
	Roy's Largest Root	691.973	18164.290[c]	4	105	0.0000	0.999	72657.159	1.000
Business Cycle	Pillai's Trace	0.809	17.836	8	210	0.0000	0.405	142.688	1.000
	Wilks' Lambda	0.191	33.515[b]	8	208	0.0000	0.563	268.117	1.000
	Hotelling's Trace	4.24	54.585	8	206	0.0000	0.679	436.681	1.000
	Roy's Largest Root	4.24	111.290[c]	4	105	0.0000	0.809	445.16	1.000
Continents * Business Cycle	Pillai's Trace	1.551	22.677	32	210	0.0000	0.776	725.651	1.000
	Wilks' Lambda	0.041	25.730[b]	32	208	0.0000	0.798	823.372	1.000
	Hotelling's Trace	9.037	29.087	32	206	0.0000	0.819	930.78	1.000
	Roy's Largest Root	6.94	45.545[c]	16	105	0.0000	0.874	728.719	1.000

a. Design: Intercept + Continents + Business Cycle+ Continents * Business Cycle
b. Exact statistic
c. The statistic is an upper bound on F that yields a lower bound on the significance level.
d. Computed using alpha = .05

Table 3: Tests of Between-Subjects Effects of the Norwegian import trade across Continents and over the Business Cycles

Source		Type II Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Corrected Model	Expenditure	1080429839769.033[a]	24	45017909990.4	264.77	0.000	0.984	6354.520	1.000
	Share	93020.649[b]	24	3875.9	2935.35	0.000	0.999	70448.288	1.000
Intercept	Expenditure	502780570654.928	1	502780570654.9	2957.09	0.000	0.966	2957.091	1.000
	Share	52000.000	1	52000.0	39381.70	0.000	0.997	39381.697	1.000
Continents	Expenditure	885033515132.516	4	221258378783.1	1301.33	0.000	0.980	5205.301	1.000
	Share	92720.451	4	23180.1	17555.23	0.000	0.999	70220.936	1.000
Business Cycle	Expenditure	75120063808.302	4	18780015952.1	110.45	0.000	0.808	441.817	1.000
	Share	0.000	4	0.000	0.00	1.000	0.000	0.000	0.050
Continents * Business Cycle	Expenditure	120276260828.215	16	7517266301.8	44.21	0.000	0.871	707.402	1.000
	Share	300.198	16	18.8	14.21	0.000	0.684	227.352	1.000
Error	Expenditure	17852668295.769	105	170025412.3					
	Share	138.643	105	1.3					
Total	Expenditure	1601063078719.730	130						
	Share	145159.292	130						
Corrected Total	Expenditure	1098282508064.800	129						
	Share	93159.292	129						

a. R Squared = .984 (Adjusted R Squared = .980)
b. R Squared = .999 (Adjusted R Squared = .998)
c. Computed using alpha = 0.05

Table 4: Estimates of the Continental effects over Business Cycles of the Norwegian import trade

Continents	Endogenous Variables	Business Cycle	Estimates	Bootstrap[a]				
				Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval	
							Lower	Upper
Africa	Expenditure	[1988-1992]	5714.40	-10.036[b]	1073.268[b]	0.001[b]	3465.333[b]	7957.996[b]
		[1993-1987]	3085.00	31.351[b]	717.057[b]	0.002[b]	2112.000[b]	4858.248[b]
		[1998-2002]	3171.40	-2.446[b]	363.589[b]	0.001[b]	2475.000[b]	4021.500[b]
		[2003-2007]	4544.80	-3.741[b]	684.266[b]	0.001[b]	3249.000[b]	5956.000[b]
		[2008-2014]	9376.29	55.379[b]	734.828[b]	0.001[b]	8246.206[b]	11191.674[b]
	Share	[1988-1992]	3.52	-.004[b]	.647[b]	0.010[b]	2.193[b]	4.795[b]
		[1993-1987]	1.42	.008[b]	.234[b]	0.002[b]	1.088[b]	1.995[b]
		[1998-2002]	1.11	.000[b]	.119[b]	0.001[b]	.911[b]	1.379[b]
		[2003-2007]	1.20	-.001[b]	.083[b]	0.001[b]	1.040[b]	1.363[b]
		[2008-2014]	1.87	.006[b]	.115[b]	0.001[b]	1.728[b]	2.148[b]
Asia and Oceania	Expenditure	[1988-1992]	16958.00	19.529[b]	1018.064[b]	0.001[b]	15224.000[b]	19287.000[b]
		[1993-1987]	26064.40	-12.494[b]	1601.203[b]	0.001[b]	23049.000[b]	29426.500[b]
		[1998-2002]	37276.40	35.567[b]	1859.840[b]	0.001[b]	33754.989[b]	41181.000[b]
		[2003-2007]	50783.60	126.971[b]	4519.450[b]	0.001[b]	41054.000[b]	59910.000[b]
		[2008-2014]	86548.27	189.019[b]	4181.367[b]	0.001[b]	78325.333[b]	94956.687[b]
	Share	[1988-1992]	10.45	.023[b]	.600[b]	0.001[b]	9.347[b]	11.887[b]
		[1993-1987]	12.46	-.016[b]	.704[b]	0.001[b]	11.131[b]	13.990[b]
		[1998-2002]	13.05	.007[b]	.421[b]	0.001[b]	12.296[b]	14.015[b]
		[2003-2007]	13.74	-.006[b]	.207[b]	0.001[b]	13.307[b]	14.224[b]
		[2008-2014]	17.25	.019[b]	.561[b]	0.001[b]	16.056[b]	18.204[b]
Europe	Expenditure	[1988-1992]	116460.00	54.967[b]	2035.286[b]	0.001[b]	111673.203[b]	120188.400[b]
		[1993-1987]	157041.60	92.354[b]	11836.158[b]	0.001[b]	131464.396[b]	179803.000[b]
		[1998-2002]	208714.40	-147.837[b]	2960.126[b]	0.001[b]	202429.935[b]	214175.561[b]
		[2003-2007]	275074.00	285.938[b]	22338.111[b]	0.001[b]	231317.333[b]	325141.183[b]
		[2008-2014]	347773.57	-30.937[b]	10136.689[b]	0.001[b]	327763.272[b]	368582.000[b]
	Share	[1988-1992]	71.79	.040[b]	.999[b]	0.001[b]	69.609[b]	73.510[b]
		[1993-1987]	74.36	-.018[b]	.813[b]	0.001[b]	72.504[b]	75.804[b]
		[1998-2002]	73.32	.000[b]	.971[b]	0.001[b]	71.062[b]	74.803[b]
		[2003-2007]	74.58	-.004[b]	.418[b]	0.001[b]	73.729[b]	75.578[b]
		[2008-2014]	69.46	-.016[b]	.545[b]	0.001[b]	68.434[b]	70.549[b]
North and Central America	Expenditure	[1988-1992]	20535.80	-53.489b	1544.596b	0.001[b]	17563.500b	23924.736b
		[1993-1987]	21663.60	7.043b	963.897b	0.001[b]	19658.125b	23722.500b
		[1998-2002]	31046.20	-23.573b	2249.697b	0.001[b]	26691.333b	35266.865b
		[2003-2007]	31746.60	-84.970b	3925.189b	0.001[b]	24452.000b	39927.667b
		[2008-2014]	45745.57	-105.086b	2180.037b	0.001[b]	41156.667b	49941.582b
	Share	[1988-1992]	12.62	-.034b	.807b	0.001[b]	11.223b	14.277b
		[1993-1987]	10.33	-0.000b	.210b	0.001[b]	9.891b	10.771b
		[1998-2002]	10.86	-.014b	.595b	0.001[b]	9.562b	11.911b
		[2003-2007]	8.50	-.009b	.306b	0.001[b]	7.964b	9.170b
		[2008-2014]	9.12	-.006b	.281b	0.001[b]	8.563b	9.668b

Table 4 continued

South America	Expenditure	[1988-1992]	2646.60	-16.263[b]	227.560[b]	.001[b]	2192.000[b]	3096.039[b]
		[1993-1987]	3049.60	2.113[b]	340.788[b]	.001[b]	2425.288[b]	3837.000[b]
		[1998-2002]	4729.60	-3.415[b]	211.063[b]	.001[b]	4293.809[b]	5187.000[b]
		[2003-2007]	7386.60	14.545[b]	828.935[b]	.001[b]	5745.659[b]	9179.291[b]
		[2008-2013]	11533.14	27.824[b]	458.550[b]	.001[b]	10666.209[b]	12418.453[b]
	Share	[1988-1992]	1.63	-.008[b]	.126[b]	.001[b]	1.390[b]	1.878[b]
		[1993-1987]	1.43	.001[b]	.077[b]	.001[b]	1.284[b]	1.596[b]
		[1998-2002]	1.66	-.001[b]	.057[b]	.001[b]	1.542[b]	1.764[b]
		[2003-2007]	1.98	.001[b]	.055[b]	.001[b]	1.855[b]	2.073[b]
		[2008-2013]	2.30	.003[b]	.053[b]	.001[b]	2.222[b]	2.420[b]

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples,
b. Based on 985 samples

Table 5.1: Top African Exporters of Norway from 1988 to 2014

Dependent Variable		Estimate	Bootstrap[a]						
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval		Historical Rank	Expected Rank
						Lower	Upper		
Expenditure	[Exporters=Botswana]	1319.852	1.064	162.116	.001	1011.915	1669.421	2**	3*
	[Exporters=Liberia]	1149.667	-5.991	337.562	.002	550.882	1900.277	3**	6*
	[Exporters=South Africa]	927.481	1.156	165.519	.001	641.008	1284.552	4*	2**
	[Exporters=Morocco]	378.148	2.131	42.154	.001	302.389	468.055	5*	4**
	[Exporters=Equatorial Guinea]	290.704	3.034	137.157	.040	80.936	628.302	6*	5**
	[Exporters=Others]	1423.481	-6.514	249.701	.001	993.682	1966.202	1	1
Share	[Exporters=Botswana]	25.394	.004	2.134	.001	21.391	29.872		
	[Exporters=Liberia]	22.579	-.058	4.946	.001	13.563	32.611		
	[Exporters=South Africa]	16.214	-.019	1.602	.001	13.118	19.322		
	[Exporters=Morocco]	7.436	-.001	.463	.001	6.511	8.354		
	[Exporters=Equatorial Guinea]	3.208	.031	1.210	.017	1.179	5.883		
	[Exporters=Others]	25.169	-.082	1.917	.001	21.576	29.093		

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples
*Changes in ranking

Table 5.2: Asian and Oceania exporters of Norway from 1988 to 2014

Dependent Variable		B	Bootstrap[a]						
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval		Historical Rank	Expected Rank
						Lower	Upper		
Expenditure	[Exporters=China]	17553.037	36.160	3369.973	0.001	11061.113	24352.026	1	1
	[Exporters=Japan]	10570.889	-19.649	401.757	0.001	9802.834	11338.435	2	2
	[Exporters=South Korea]	4667.556	-5.700	742.815	0.001	3291.765	6235.368	3	3
	[Exporters=Taiwan]	2692.444	5.661	211.866	0.001	2297.325	3122.790	5	5
	[Exporters=Singapore]	1675.222	-4.272	190.788	0.001	1323.393	2043.533	6**	7*
	[Exporters=Thailand]	1298.852	-8.113	191.245	0.001	935.755	1667.658	7*	6**
	[Exporters=India]	1280.593	4.819	175.741	0.001	952.406	1649.218	8	8
	[Exporters=Hong Kong]	1271.000	3.572	52.895	0.001	1177.101	1382.475	9**	10*
	[Exporters=Malaysia]	1110.148	3.008	123.992	0.001	878.932	1369.595	10*	9**
	[Exporters=Others]	4593.222	5.687	462.680	0.001	3713.666	5558.108	4	4
Share	[Exporters=China]	28.924	.070	3.292	0.001	22.416	35.394		
	[Exporters=Japan]	29.563	.055	2.598	0.001	24.539	34.838		
	[Exporters=South Korea]	9.303	.004	.611	0.001	8.185	10.631		
	[Exporters=Taiwan]	6.320	.001	.268	0.001	5.797	6.880		
	[Exporters=Singapore]	4.310	.002	.573	0.001	3.291	5.546		
	[Exporters=Hong Kong]	4.048	.037	.598	0.001	2.998	5.356		
	[Exporters=India]	2.565	.000	.095	0.001	2.382	2.758		
	[Exporters=Thailand]	2.546	-.003	.111	0.001	2.315	2.749		
	[Exporters=Malaysia]	2.309	-.002	.111	0.001	2.099	2.531		
	[Exporters=Others]	10.114	-.003	.261	0.001	9.586	10.624		

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples
b. *Changes in ranking

Table 5.3: European exporters of Norway from 1988 to 2014

Dependent Variable		Estimate	Bootstrap[a]					Historical Rank	Expected Rank
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval			
						Lower	Upper		
Expenditure (in million NOK)	[Exporters=Sweden]	46467.89	-19.004	3112.23	0.001	40390.87	52677.16	1**	2*
	[Exporters= Germany]	41469.81	73.715	3093.43	0.001	35469.14	47584.43	2**	3*
	[Exporters= United Kingdom]	23329.59	2.778	1280.63	0.001	20730.89	25840.01	4	4
	[Exporters= Denmark]	21752.96	39.927	1520.96	0.001	18639.40	24735.06	5	5
	[Exporters= Netherlands]	13099.81	-22.805	981.45	0.001	11231.66	15011.81	6	6
	[Exporters= France]	12219.15	15.203	818.84	0.001	10610.40	13902.80	7	7
	[Exporters= Italy]	10493.56	-14.077	711.14	0.001	9004.43	11927.17	8	8
	[Exporters= Finland]	10019.37	-28.969	683.53	0.001	8658.67	11398.60	9	9
	[Exporters= Belgium]	6716.37	2.408	485.12	0.001	5748.38	7649.26	10**	11*
	[Exporters= Russia]	6030.59	8.991	757.44	0.001	4673.65	7593.52	11**	12*
	[Exporters= Spain]	5604.30	22.435	564.52	0.001	4505.97	6708.38	12*	10**
	[Exporters=Others]	33199.00	113.342	4094.78	0.001	25793.94	41734.05	2*	1**
Share (in percent)	[Exporters=Sweden]	20.49	0.003	0.225	0.001	20.07	20.95		
	[Exporters= Germany]	18.12	-0.009	0.131	0.001	17.85	18.36		
	[Exporters= United Kingdom]	10.68	-0.009	0.355	0.001	9.95	11.40		
	[Exporters= Denmark]	9.58	-0.003	0.097	0.001	9.39	9.76		
	[Exporters= Netherlands]	5.72	-0.005	0.089	0.001	5.54	5.90		
	[Exporters= France]	5.37	-0.001	0.100	0.001	5.18	5.57		
	[Exporters= Italy]	4.62	-0.004	0.079	0.001	4.46	4.77		
	[Exporters= Finland]	4.44	0.003	0.088	0.001	4.27	4.62		
	[Exporters= Belgium]	2.99	0.000	0.063	0.001	2.87	3.11		
	[Exporters= Russia]	2.32	-0.001	0.107	0.001	2.11	2.52		
	[Exporters= Spain]	2.31	-0.001	0.231	0.001	1.84	2.74		
	[Exporters=Others]	13.36	0.012	0.663	0.001	12.17	14.78		

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples
b. *Changes in ranking

Table 5.4: Top North American Exporters of Norway from 1988 to 2014

Dependent Variable		Estimate	Bootstrap[a]						
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval		Historical Rand	Expected Rank
						Lower	Upper		
Expenditure	[Exporters=United States]	19722.111	33.533	1230.121	0.001	17435.293	22192.347	1	1
	[Exporters=Canada]	8268.815	-34.457	1050.9810	0.001	6307.675	10279.167	2	2
	[Exporters=Panama]	737.593	5.368	227.505	0.004	361.549	1245.575	4	4
	[Exporters=Others]	2574.444	-15.988	284.652	0.001	2083.916	3176.303	3	3
Share	[Exporters=United States]	64.008	.017	1.403	0.001	61.330	66.747		
	[Exporters=Canada]	24.370	-.016	1.593	0.001	21.564	27.562		
	[Exporters=Panama]	3.109	.040	1.027	0.002	1.393	5.393		
	[Exporters=Others]	8.513	-.016	.676	0.001	7.212	9.909		

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples
b. *Changes in ranking

Table 5.5: Top South American North American Exporters of Norway from 1988 to 2014

Dependent Variable		Estimate	Bootstrap[a]						
			Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval		Historical Rank	Expected Rank
						Lower	Upper		
Expenditure	[Exporters=Brazil]	3163.185	23.536	511.243	0.001	2195.224	4275.934	1	1
	[Exporters=Suriname]	873.741	-3.279	97.298	0.001	691.527	1065.622	2**	7*
	[Exporters=Peru]	695.778	.450	131.856	0.001	442.922	960.167	3*	2**
	[Exporters=Chile]	464.778	-.496	47.920	0.001	371.283	558.604	4*	3**
	[Exporters=Colombia]	371.815	.155	27.561	0.001	321.792	434.571	6*	4**
	[Exporters=Argentina]	291.667	-.499	13.747	0.001	264.110	319.248	7*	6**
	[Exporters=Others]	427.704	-.548	33.325	0.001	361.385	492.401	5	5
Share	[Exporters=Brazil]	42.927	.117	2.635	0.001	37.855	48.541		
	[Exporters=Suriname]	19.245	-.048	2.208	0.001	14.551	23.750		
	[Exporters=Peru]	8.593	-.020	1.012	0.001	6.525	10.546		
	[Exporters=Chile]	7.844	.013	.452	0.001	6.982	8.731		
	[Exporters=Colombia]	7.124	-.002	.506	0.001	6.162	8.205		
	[Exporters=Argentina]	6.374	.005	.672	0.001	5.112	7.797		
	[Exporters=Others]	7.893	-.006	.558	0.001	6.822	9.017		

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples
b. *Changes in ranking

Table 6: Preliminary estimates of Herfindahl–Hirschman Index (HHI) of Norwegian imports

Dependent variable HHI		Statistic	Bootstrap[a]				
			Bias	Std. Error	95% Confidence Interval		Coefficient Variation
					Lower	Upper	
Africa	Mean	2525.4165	1.0702	248.7133	2078.5450	3014.8761	
	Std. Deviation	1272.75071	-42.17343	229.74905	730.19769	1650.09183	0.508643015
Asia and Oceania	Mean	2317.9511	-1.9327	79.5257	2161.8176	2480.7943	
	Std. Deviation	403.61322	-10.15444	49.40057	293.66412	482.16252	0.175737263
Europe	Mean	1114.1861	.2452	15.0689	1083.2045	1144.2283	
	Std. Deviation	78.91988	-2.04873	7.59165	61.73355	91.44888	0.071487721
North and Central America	Mean	4834.1527	-5.9999	122.1455	4585.8860	5055.4875	
	Std. Deviation	629.22278	-19.06771	103.38356	419.69684	818.71889	0.131367161
South America	Mean	2705.1349	-4.4006	153.4856	2405.7502	3002.6910	
	Std. Deviation	790.87512	-23.88265	111.16837	523.92151	964.64189	0.295067736
Continental	Mean	5605.2824	1.2205	57.0196	5500.0081	5721.0200	0.053187364
	Std. Deviation	295.39505	-7.46994	33.27985	216.64399	349.77519	

a. Unless otherwise noted, bootstrap results are based on 1000 bootstrap samples

Table 7: Fit of seemingly unrelated regression (SUR) model of the structure of continental import trade concentration of Norway

Model SUR Model Fit										
Continents	SV	SS	DF	MS	F-cal	Sig.	R	R Square	Adj -R Square	Std. Error
Africa	Regression	7216195	1	7216195.0	5.189004	0.03154	0.414589	0.1719	0.139	1179.27
	Residual	34766765	25	1390670.6						
	Total	41982960	26							
Asia and Oceania	Regression	1181687	1	1181687.3	8.046886	0.00891	0.493456	0.2435	0.213	383.21
	Residual	3671257	25	146850.3						
	Total	4852944	26							
Europe	Regression	173751.7	2	86875.9	104.4239	0.00000	0.947063	0.8969	0.888	28.84
	Residual	19966.9	24	832.0						
	Total	193718.6	26							
North and Central America	Regression	72279.33	2	36139.7	0.088776	0.91535	0.085695	0.0073	0.075	638.04
	Residual	9770155	24	407089.8						
	Total	9842434	26							
South and Central America	Regression	17313940	2	8656970.0	56.17724	0.0000	0.907738	0.8240	0.809	392.56
	Residual	3698425	24	154101.0						
	Total	21012365	26							

Table 7 continued

Parameter Estimates						
Continents		Coefficients	Std. Error	Standardized Coefficients	t	Sig.
Africa	Constant	7243.93	2125.26		3.408	0.0022**
	Number of Countries	-158.11	69.41	-0.4146	-2.278	0.0315**
	Revenue from export	-98.35	115.89	-0.2151	-0.849	0.4045
Asia and Oceania	Constant	2041.18	137.63		14.831	0.0000**
	Number of Countries	23.36	36.11	0.2399	0.647	0.5239
	Revenue from export	9.68	3.41	0.4935	2.837	0.0089**
Europe	Constant	1465.17	72.46		20.220	0.0000**
	Number of Countries	-6.18	2.04	-0.3330	-3.034	0.0060**
	Revenue from export	-0.24	0.04	-0.6590	-5.999	0.0000**
North and Central America	Constant	6664.25	1406.86		4.737	0.0001**
	Number of Countries	-47.74	69.54	-0.1378	-0.687	0.4995
	Revenue from export	-15.27	9.70	-0.3160	-1.575	0.1296
South and Central America	Constant	1652.89	139.51		11.848	0.0000**
	Number of Countries	150.80	98.84	0.1310	1.526	0.1402
	Revenue from export	346.43	33.89	0.8983	10.221	0.0000**

Cochrane-Orcutt autoregression estimation is used

SV=Source of variation, SS=Sum of squares, MS=Mean square,

** Significant at the 5% level of significance

List of Figures of Paper 3

Figure 1.1: Dynamics of Expenditure of African exporters to Norway

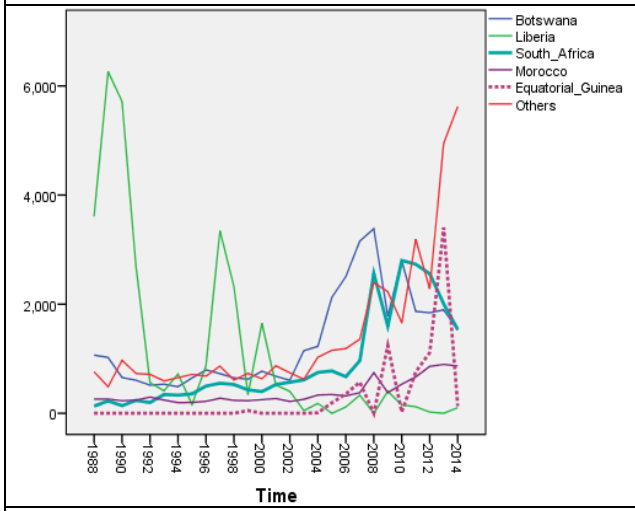


Figure 2.1: Dynamics of Expenditure of Asian and Oceania exporters to Norway

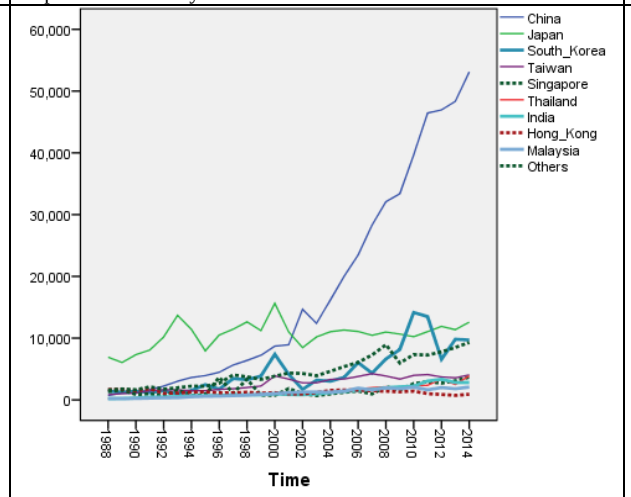


Figure 3.1: Dynamics of Expenditure of European exporters to Norway

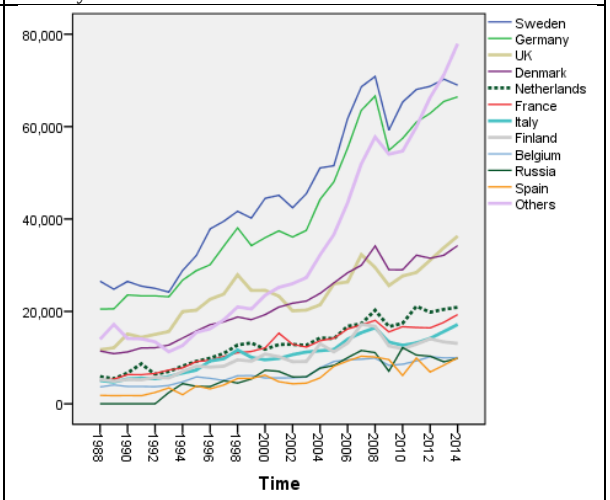


Figure 1.2: Dynamics of share of African exporters to Norway

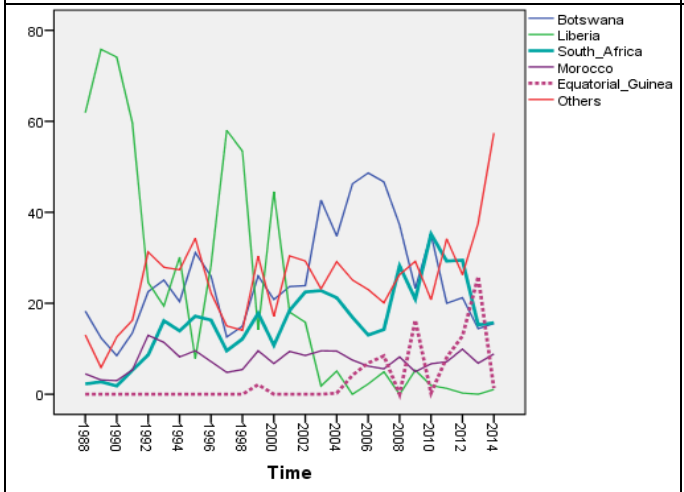
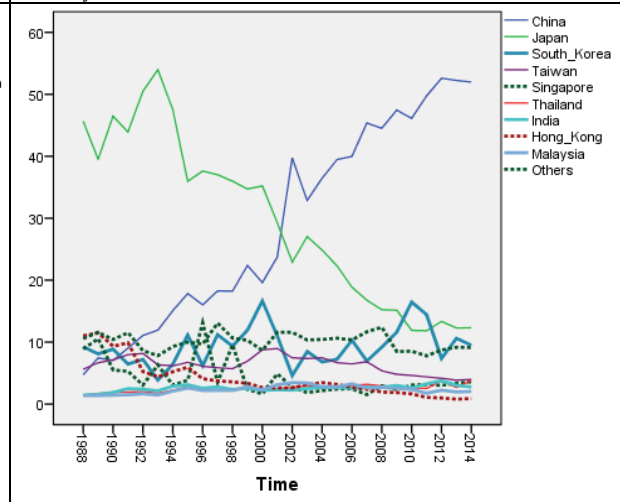


Figure 2.2: Dynamics of Share of Asian and Oceania exporters to Norway



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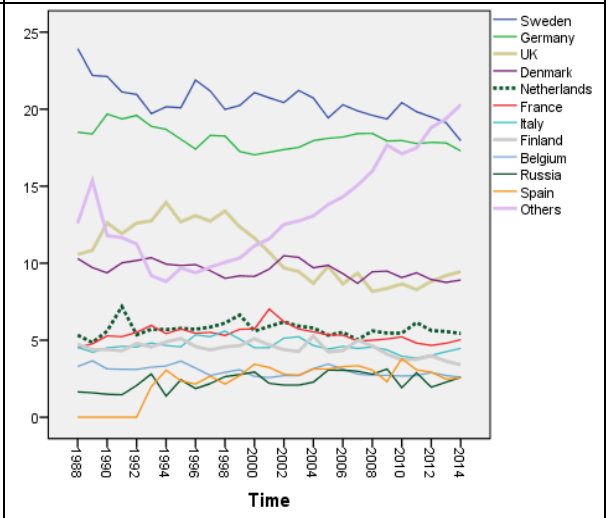

Figure 4.1: Dynamics of Expenditure of North and Central American to Norway

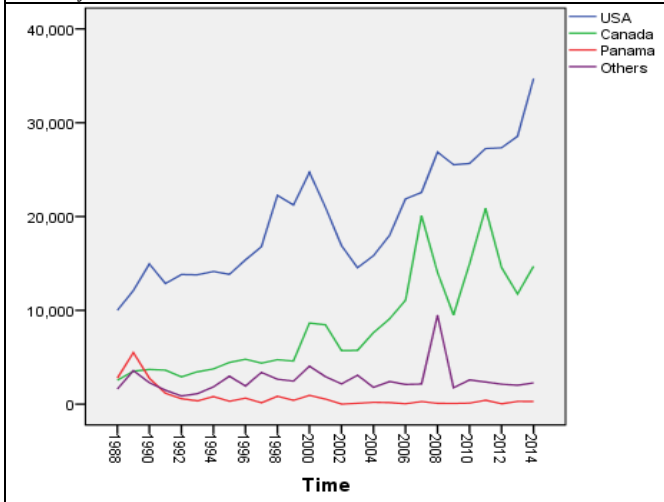

Figure 5.1: Dynamics of Expenditure of South American exporters to Norway

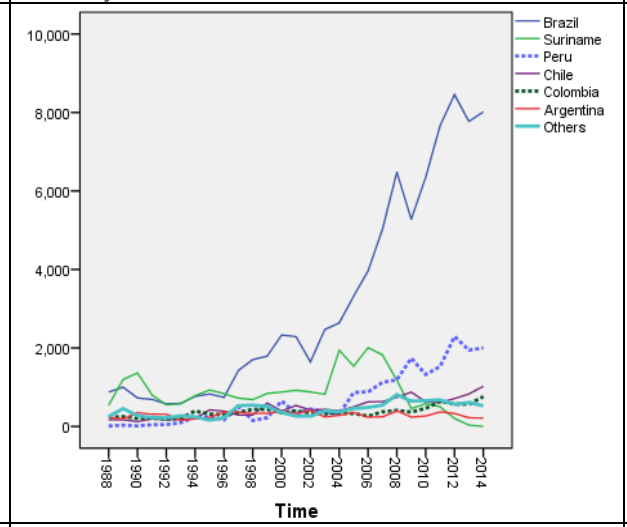

Figure 6.1: Dynamics of Expenditure of across continents of Norway

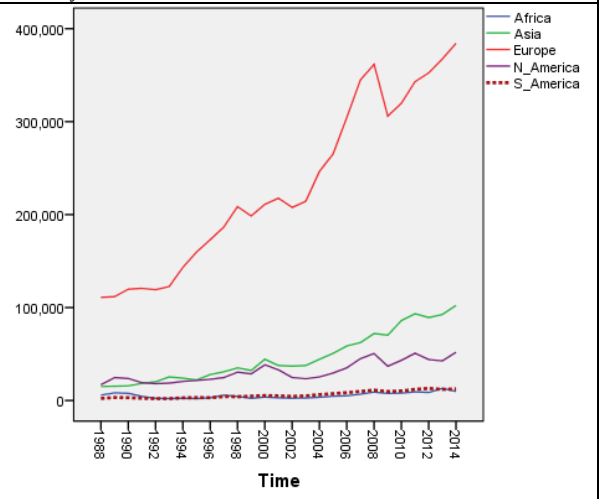

Figure 4.2: Dynamics of Share of North and Central American exporters to Norway

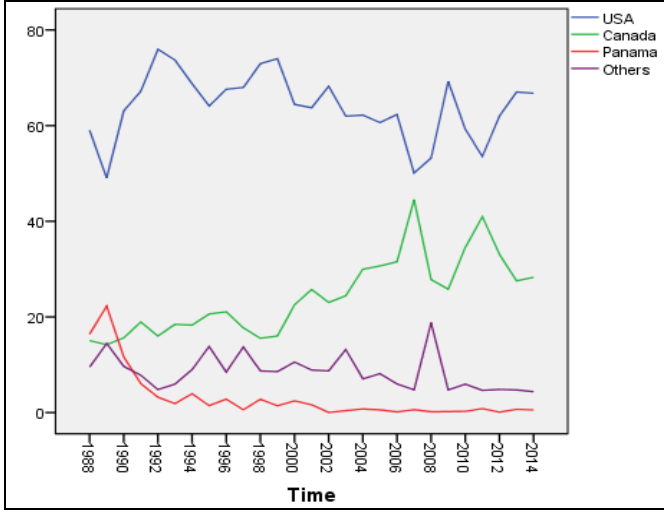

Figure 5.2: Dynamics of Share of South American exporters to Norway

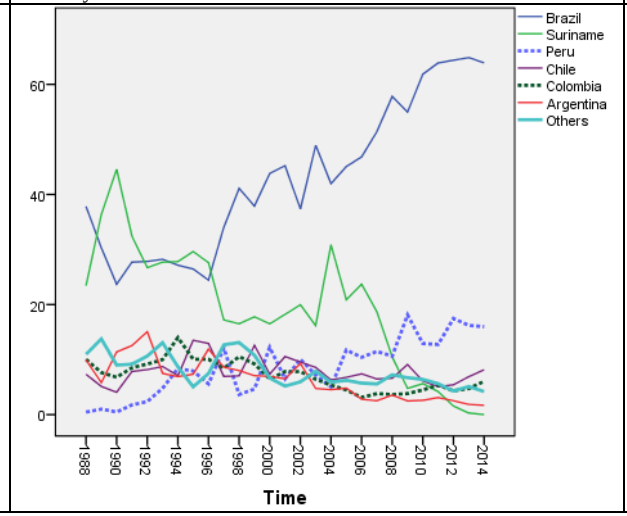

Figure 6.2: Dynamics of Share of across continents of Norway

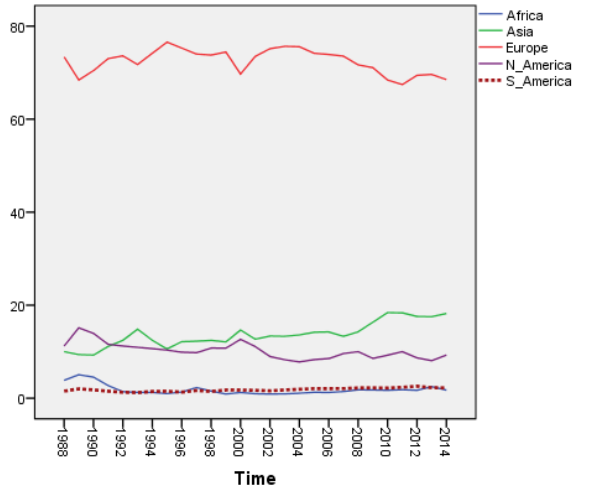

Figure 7: Continental trend of HHI

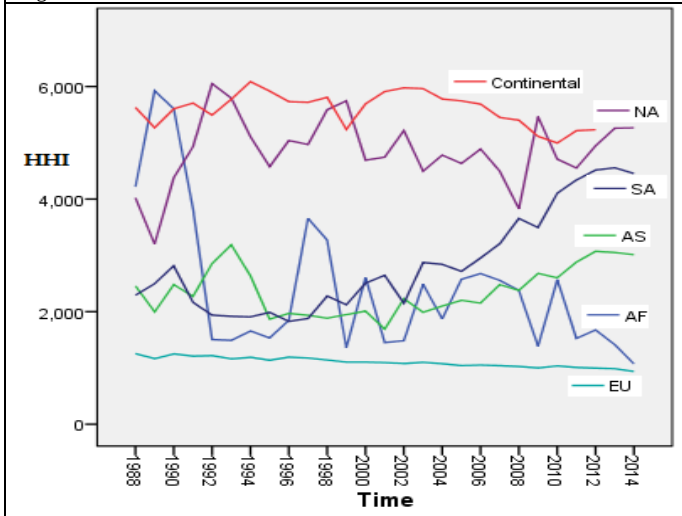

Figure 8.1: Matrix Scatter plot for import from Africa

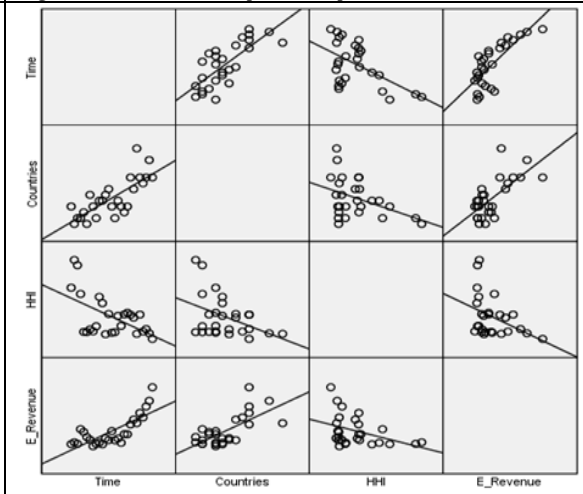

Figure 8.2: Matrix Scatter plot for import from Asia and Oceania

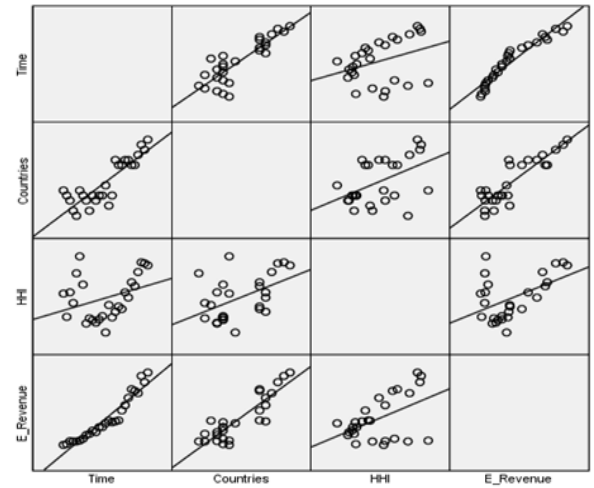

Figure 8.3: Matrix Scatter plot for import from Europe

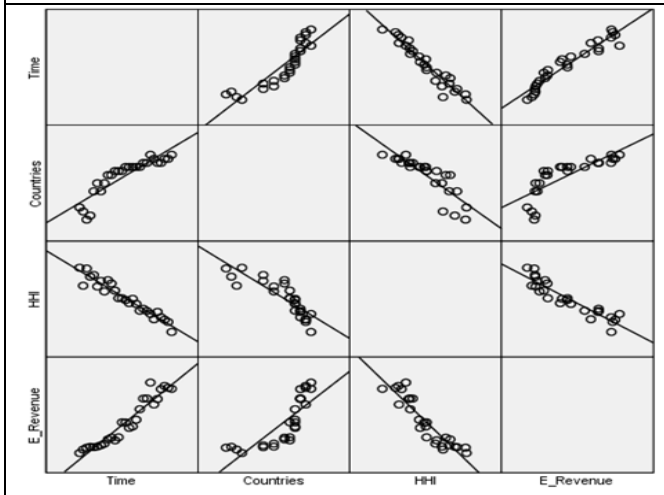

Figure 8.4: Matrix Scatter plot for import from North and Central America

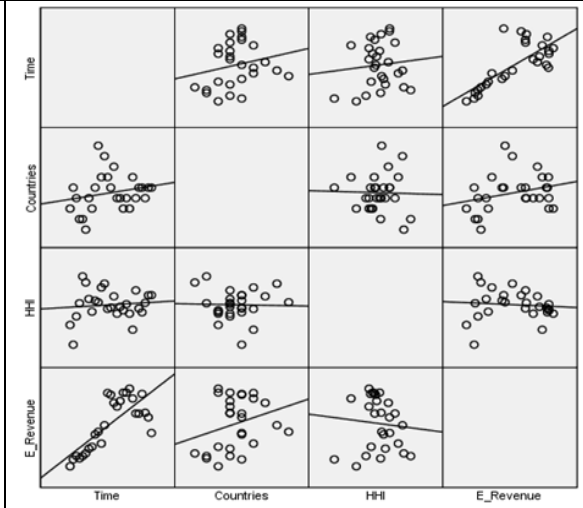

Figure 8.5: Matrix Scatter plot for import from South America