ANALYSIS OF INDIA'S PLYWOOD MARKET

-Opportunities for foreign and Finnish companies-

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ABSTRACT

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ABSTRACT

India is known as one of the most populous countries in the world. Its economic liberalisation occurred in 1991 allowed India to increase the high rate of GDP and became a fast economy. The steadily growing middle-class has improved the local purchasing power and developed the construction sector for housing and infrastructure. Significant investments in these sectors have increased the demand for wood and wood products. As such, the demand for plywood has grown in the domestic market and has opened an opportunity for foreign investors and manufacturer countries to invest in the Indian domestic market of plywood.

Despite the lack of information about Indian wood market, this research aims to complement previous studies related to Indian wood products based on the use of a descriptive and empirical research methods. The PEST analysis and an econometrical demand model are used to provide an overall overview of the Indian plywood market at local and global level; determine the potential drivers that impact the Indian demand for imports of plywood; and propose the current challenges and opportunities for foreign and Finnish investors to explore the plywood market in India.

As in previous studies related to demand models of wood products, this study confirms that the demand for imports of plywood is positively related to consumer income (GDP per capita) but negatively to price variables (Domestic price of plywood). However, the Indian demand for plywood appears to be income elastic but price inelastic. Additionally, other significant economic activity variables such as population density, economic openness and unemployment were tested to determine the impact of significant cross-price elasticities for products that show to be complements of plywood. Nevertheless, further modelling is recommended for future studies related to wood products in India.

Keywords India, Plywood, Demand, Imports, Time-Series, Modelling, Econometrics, Elasticities.

Pages 52 pages including appendices 71 pages

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1 INTRODUCTION

Nowadays, the trade of wood and wood products around the world is growing rapidly due to different factors such as the diversification of commercialization channels, trade liberalisation and other different drivers that impact the demand and production of these products (Sizer et al. 2005). All these factors enhance competition among wood producing countries by developing their wood-based industries through more efficient processing methods.

In the case of India, the country has recently experienced a rapid economic growth rate due mainly to economic liberalisation policies that have represented a steadily rising gross domestic product in the country (Ablett 2007). Thus, today, India is considered among the countries with the highest population growth rate in the world and the second fastest growing economy, just behind China (Bartosh 2007). In consequence, India became a significant competitor in the global economy.

Regarding wood products, the forestry sector has not experienced the same growth as in the service or manufacturing industries. However, Montiel (2016) highlights that globally, India is among the largest consuming countries of tropical hardwood sawn wood. Thus, despite that more than 150 native tree species are present in India, since the mid-1980s, the country has been a net importer of tropical hardwood logs. Such imports are necessary to satisfy the current demand of wood from local forest-based industries. Nevertheless, the primary sources of wood are obtained from the local agroforestry sector, the private forest plantations and the natural forests.

Per Montiel (2016), the upward trend for imports of wood and wood products is also shown for their consumption. Thus, wood consumption in India is estimated at around 95 million m3 in 2010, where 73 million m3 corresponded to solid wood. Construction sector constitutes about 30 percent of solid wood use, and it is followed by primary-processed wood products such as sawn wood, plywood and panel products (26 percent), packaging (8.8 percent) and furniture (6.3 percent). Other uses represent the remaining 30 percent. However, for plywood, its primary use is in the housing sector. Moreover, the plywood industry in India is structured by large and medium-sized mills as well as for small-scale mills. The local production of plywood is estimated to increase from 17.96 million m3 to 29.20 m3 by 2020. Therefore, there is an opportunity for foreign investors to establish business relationships with India regarding the plywood industry.

Finnish wood-based industries are positioned worldwide as strong wood manufacturers. However, during 2014, forest industry products represented only 20 percent of the value of the total Finnish exports, where 23 percent corresponded to wood products and furniture (Janatuinen 2014). Business relationships with India are dominated by high-technology products (70 percent of the total Finnish exports to India) and about forest products, 99 percent corresponds to newsprint and 1 percent for the remaining, including plywood. Thus, considering India as a promising economy, more opportunities will raise for Finnish wood-based industries.

2 BACKGROUND OF THE STUDY

2.1 PREVIOUS STUDIES

Forests have supported rural populations around the world. In India, this is not an exception due to forest products, such as wood and non-wood, have contributed to increasing the level of incomes among rural populations. In addition to this, the use of wood products has been rising in India due to major projects for urbanisation caused by the constant growth in population and economy.

Today, India is an important consuming country of forest products in the world. For this reason, previous studies have been conducted by students, researchers and local authorities about this matter. In the recent study "Analysis of India as a market area for sawn wood" (Montiel 2016), a collection of annual time-series secondary data was used to create econometric models to determine the potential economic factors that might influence the Indian demand for sawn wood (hardwood and softwood). For this purpose, two models, conventional demand and ad hoc, analysed the relationships between different socioeconomic variables and the demand for sawn wood in India. Such models were based on previous empirical analyses of forest products conducted by Buongiorno (1979) and Hurmekoski et al. (2015), among others. Thus, the study highlights that the demand for imports of sawn wood is related to both variables, income and price, however, it also depends on other factors such as population density, unemployment and economic openness.

Other researchers, such as Yadav and Basera (2013), assess the availability, production and trade of Indian forest products at national, regional and global level. For this purpose, the authors analysed a collection of secondary data and provided a forecast of the Indian forest product industry from 2011 to 2016. This study remarks on the importance of imports of logs to meet the supplies for the domestic production of wood products. Additionally, Pandey and Rangaraju (2008), on behalf of the Indian Plywood Industries Research and Training Institute -IPIRTI-, provide an overview of India's industrial wood balance. Their study describes the Indian wood-based industry divided into three different categories (sawn wood, composite wood panels and pulp wood-based) and proposes different recommendations that involve the government, private sector and local institutions as the main actors to meet the industry demand for wood as raw material.

Finally, there are also previous studies conducted by countries with a serious interest in strengthening business relationships with India about wood-based products. On the one hand, Midgley et al. (2007), on behalf of the Australian government, propose a strategy for developing market opportunities for Australian forest products in India. The study described the use and trade of wood in the Indian forestry sector and based on the perceptions of the Australian Forestry Sector builds different strategies under three different themes. On the other hand, Ganguly and Eastin (2007), present an overview of the Indian market for American wood products. The study provides an in-depth insight into the Indian economy, wood-based industry and trade of wood-based products. Thus, the authors highlight potential opportunities for American wood and wood products and suggest promotional campaigns on the properties and end-use of American woods for their better acceptance by end-users in India.

This research attempts to complement such previous studies on the Indian market of forest products by focusing on the demand for plywood. Thus, a PEST (political, economic, social, technological) analysis is conducted with the aim of gaining a better general understanding of the Indian market. For this purpose, each macro-environmental factor is analysed from a selected background information obtained from previous studies. Moreover, a statistical methodology for wood products market modelling is applied based on previous empirical research. For this purpose, a similar framework is followed to assess the key factors that impact the demand for plywood in the Indian market.

2.2 **OVERVIEW OF THE GLOBAL MARKET OF PLYWOOD**

The calculation of the total global consumption of plywood differs depending on the sources for the statistical database. For instance, there are differences between ITTO Statistical database and FAOSTAT. However, considering that the economic upturn is strengthening globally, the global consumption of plywood is expected to continue growing above current levels, mainly due to furniture manufacturing, packaging sector and residential housing in the construction industry, among other reasons. Additionally, it is important to highlight that the use of plywood provides different advantages over conventional materials such as metal, wood or plastic. Thus, plywood is still preferred in many applications due to its quality, low cost, flexibility and re-usability. Nevertheless, the plywood industry might face a major challenge in the immediate future due to the use of other alternatives that offer similar benefits to plywood. In this case, the oriented strand board (OSB) known as flakeboard, is the closest competitor to plywood but its rate of the substation is still varied depending on which part of the world is used.

The global trends in consumption of plywood, including both hardwood and softwood species, have followed similar patterns since 1990. However, since 2002, the global consumption of softwood plywood started to dominate the plywood industry. Although the production and consumption of plywood have been replaced by more value-added products, such as particleboard and fibreboard, the global consumption of plywood has increased substantially. This change happened right after the global economic downturn an average annual growth rate of 9.1 percent during the period from 2009 to 2014 (from 74.6 to 126.9 million m3, respectively). This change is partly due to a considerable increase in the global consumption of softwood plywood, which in 2012 overtook the global consumption of hardwood plywood with a 68 percent global share. In addition to this, in 2013, the average annual growth rate of the total consumption of softwood was 28.26 percent. Therefore, more and more softwood plywood has substituted hardwood plywood mainly due to less production of tropical hardwood plywood in ITTO producing countries. (See Fig. A based on data extracted from Table 1A in Annex 1).

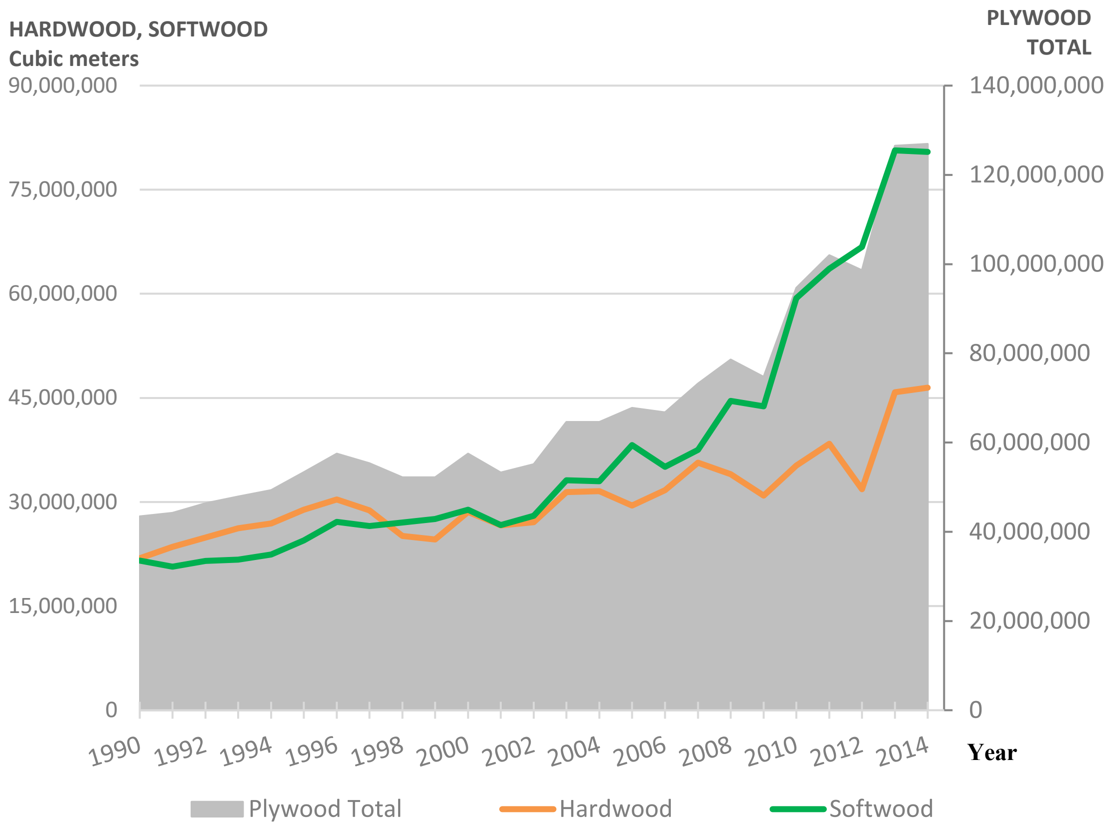

Figure A: Global consumption of plywood (m^3), 1990-2014.
Data: ITTO 2016.

Until 1999's, the global consumption of plywood was led by Asian and North American regions with global shares of 43 and 42 percent, respectively. Thus, for the North American region, the world's largest consumers were the United States and Canada (19.3 and 1.4 million m3, respectively), and for the Asian region were China, Japan and Indonesia (10.4, 8.1 and 1.2 million m3, respectively). However, since 2000 until today, the Asian region has been leading the global consumption of this forest product with global shares moving from 48 to 79 percent in 2015. (FAOSTAT 2016). This change was achieved in part by the substitution in the consumption of tropical plywood with softwood plywood caused in 2011 in response to depressed demand in the leading consuming countries such as China and Indonesia due to plant closures in the North American region, coupled with less production of tropical plywood (APFSOS II 2010). It is important to highlight that in the Asian region, plywood comprises the largest share of all the wood-based panels trade. This proportion is nearly 63.3 percent of the regional wood panel exports and about more than half regarding imports. (APFSOS II 2010). Moreover, since 2002 China became the largest producing country of plywood in the world surpassing the United States (16.1 and 15.3 million m3, respectively). Then, one year later, China became the world's largest consuming country of plywood, also surpassing the United States (26.1 and 18.6 million m3, respectively). Currently, China consumes nearly 65 percent of the total global consumption of plywood and produces about 71 percent of the global production of this wood product (See Tables 3 and 4, respectively, in Annex 1). In addition to this, 31 percent of the global production of tropical plywood (See Table 5 in Annex 1). Raw material supply only limits its output. As such, China's competitive advantage has strongly influenced the rapid growing rate of the consumption of plywood in the Asian region and therefore, in the world. (See Fig. B and C based on data extracted from Tables 2 and 3, respectively, in Annex 1).

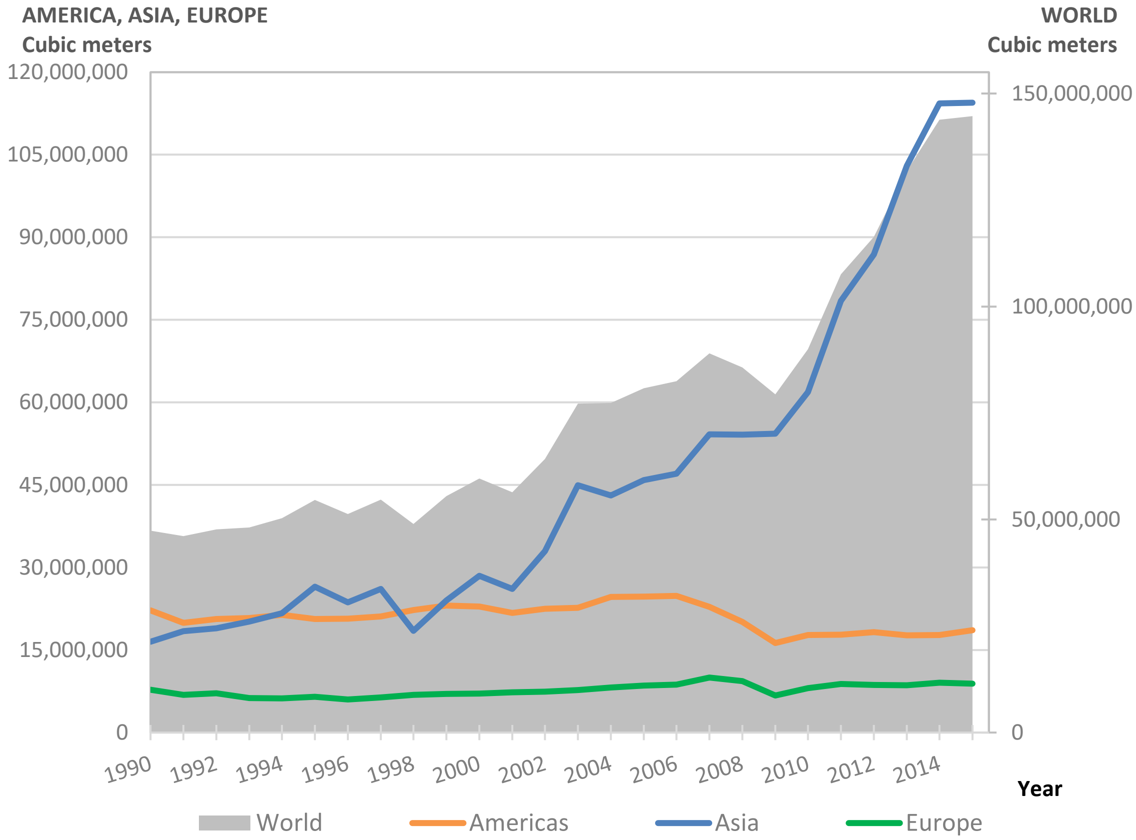

Figure B: Global consumption of plywood by regions (m^3), 1990-2015.
Data: FAOSTAT 2016.

Although global consumption of plywood has been growing considerably, this is not the case for North America and Europe. In these regions, the total consumption of plywood dropped during the global economic downturn and had remained stable but without surpassing previous levels from 2008. On the one hand, in North America, the slowdown in the consumption of plywood started in the United States since 2005 due to the housing downturn. Thus, six plywood mills were closed in the United States and later one in Canada. In addition to this, a decline in imports of plywood from China, in response to an investigation on imposing antidumping duties. However, a high demand for plywood in the residential construction sector contributed to a slight recovery in the consumption of plywood in the North American region by re-opening three plywood mills in the United States (Clark 2011, ITTO 2012). On the other hand, in Europe, the slowdown in the consumption of plywood was mainly caused by a downturn in the construction market. Nevertheless, a substantial increase of 46.5 percent in the Russian use of plywood in 2010 contributed in part to recover the total consumption of plywood in Europe, and since then, the trend has remained stable. Also, the European plywood industry has only partly recovered from the global economic downturn due to a severe competition from high-producing countries of plywood from outside Europe, such as China. (Clark 2011). (See Fig. B based on data extracted from Table 1B in Annex 1).

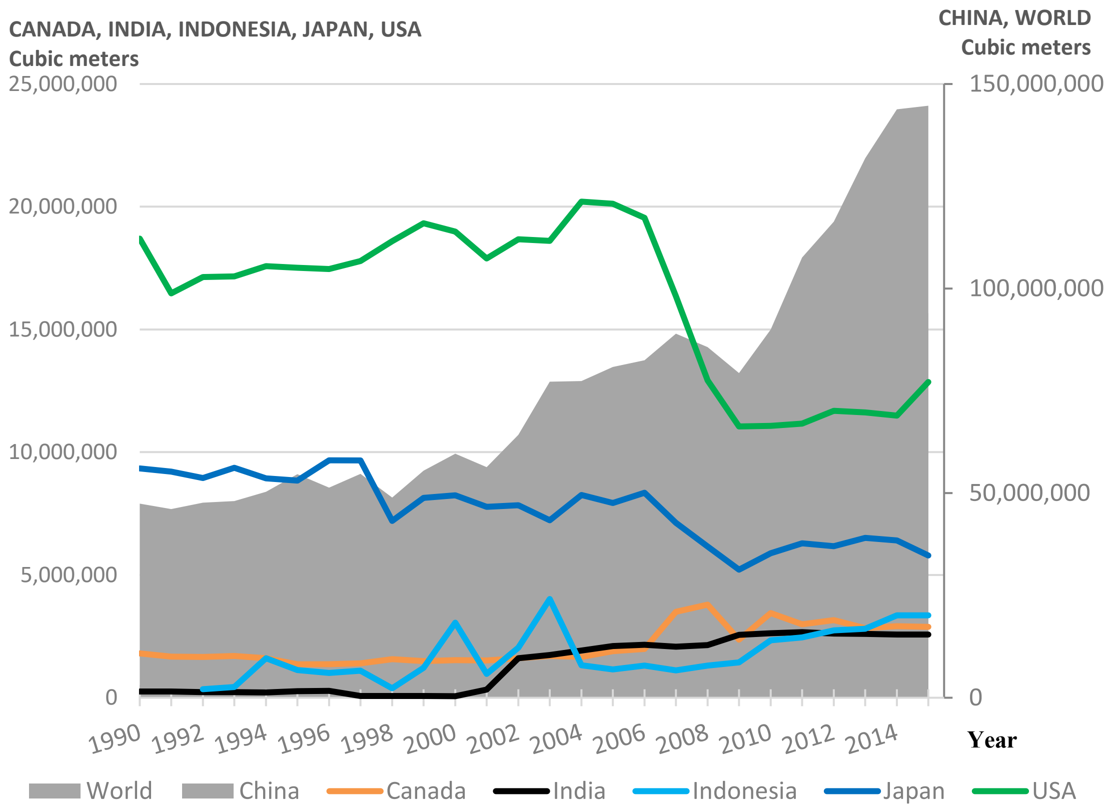

Figure C: Major consuming countries of plywood (m^3), 1990-2015.
Data: FAOSTAT 2016.

2.3 INDIA´S SITUATION IN THE GLOBAL MARKET OF PLYWOOD

Wood-based industries are key sectors that play a vital role in the Indian economy. In addition to this, India is one of the major wood-users not only in the Asia-Pacific region but worldwide. Since 2000, the plywood industry in India has grown in average 4.76 percent annually (from 1.3 to 2.4 million m3). (Patel 2012). Although, India is a net exporter of plywood, the value and volume of exports are relatively insignificant. Nevertheless, the plywood industry holds a great potential for enhancing the exports in international markets. The plywood industry in India is limited by the availability of wood as a raw material. Wood is mainly imported to the country in an unprocessed form as logs. Imports of plywood are not as high as in other nations; they are almost insignificant. The reason is the high import tariff rates (28.85 percent) that protect domestic wood-processing industries. Moreover, plywood is primarily manufactured locally in large quantities due to approximately 90 percent of its production is commercialised among Indian end-users. This wood product is highly used instead of other wood products in the market (e.g. plain wood) due to plywood is inexpensive, flexible, workable and re-usable. Also, plywood's properties such as resistance to cracking, splitting, shrinkage and warping are more appreciated for Indian end-users. (Ganduly and Eastin 2007).

In 2001, the Federation of Indian Plywood and Panel Industry -IPPI- estimated that the domestic production of plywood was around 50 percent of the industry capacity. (Ganduly and Eastin 2007). Thus, today, the plywood industry is considered, among other composite wood products industries, as one of the most promising industries due to its consumption trend has shown a rapid growth in the last 15 years. For instance, in 2000, the total consumption of plywood in India was about 63 thousand m3. Today is calculated on 2.5 million m3, and it places India as the sixth among the major consuming countries of plywood in the world, a bit close to Canada. (See Fig. C based on data extracted from Table 1C in Annex 1).

Regarding the production of plywood, India's current production levels are higher than other traditional top producing countries of wood products worldwide, such as Brazil, Canada and Finland. However, its current production of plywood only represents 2 percent of the total global share. Meanwhile, at the local level, among other engineered wood products such as particleboard and Medium-density fibreboard -MDF-, plywood stands out as the largest category with more than 65 percent of the local market share (Dun and Bradstreet 2015). Today, the production level of plywood seems stable, despite that the plywood industry was recently hit by a collapse in the real estate sector in 2011. In addition to this, local plywood producers have faced intense competition from the invasion of cheap imports from the largest plywood producer in the world, China, and shortages of power labour. Therefore, the share of plywood in India within the total market of wood products is still small. (See Fig. D based on data extracted from Table 1D in Annex 1).

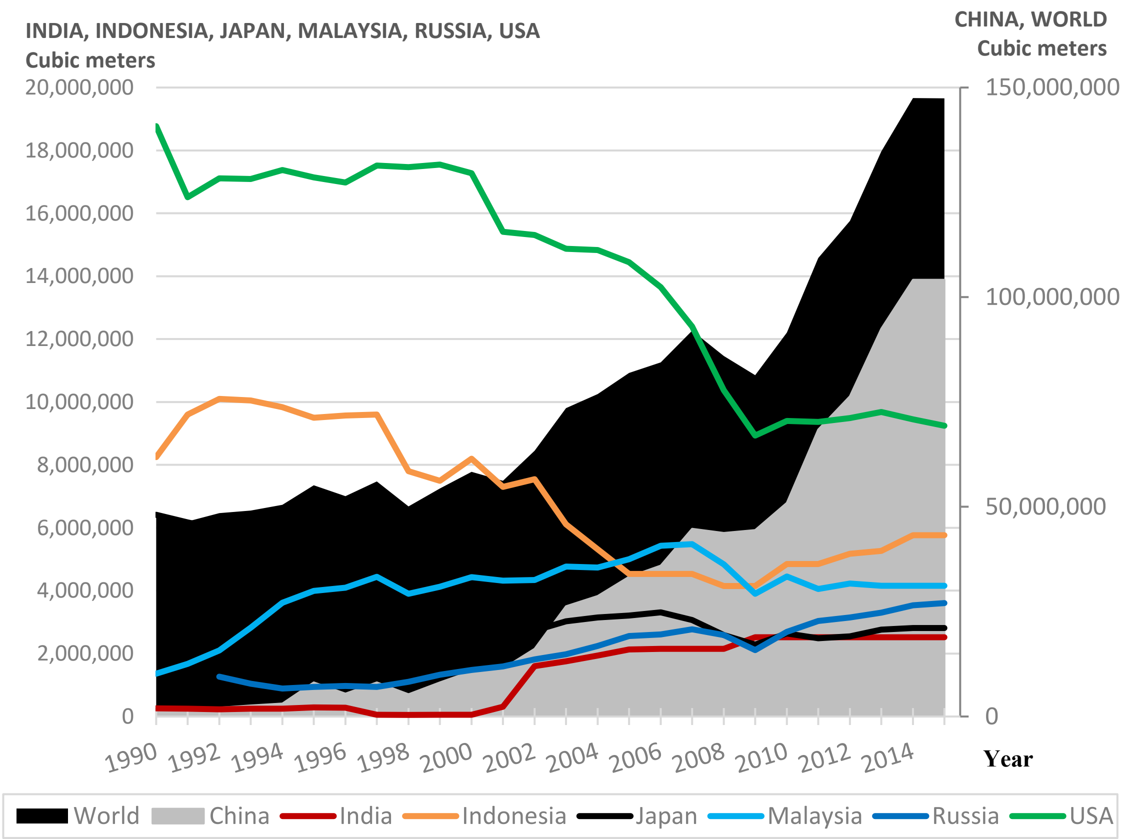

Figure D: Major producing countries of plywood (m^3), 1990-2015.
Data: FAOSTAT 2016.

It is important to highlight that the Indian plywood industry is mainly supplied by local tropical hardwood species from tropical forests of evergreen type and in insignificant amounts by imports of softwood and other hardwood species from neighbouring countries. However, to produce plywood, no other hardwood species are reported to be used for that purpose, and only 1 percent of the total production of plywood in the country corresponds to softwood species. Moreover, after sawn wood, most of the tropical hardwood species available in the country are manufactured into plywood. For this reason, today, India plays a significant role in the global market of tropical hardwood plywood.

Since 2000, India ranks fourth among the major producing countries of tropical hardwood plywood worldwide along with China, Malaysia and Indonesia. During that time, India accounted for about 6 percent (1.3 million m3) of the global share of the production of tropical hardwood plywood in the world. However, in 2014, India doubled its production and accounted for nearly 13 percent (2.4 million m3) of the global share of the manufacture of plywood for these wood species, and together with China, Malaysia, Indonesia and Brazil their global share rose to 87 percent (16.5 million m3). (See Fig. E based on data extracted from Table 1E in Annex 1).

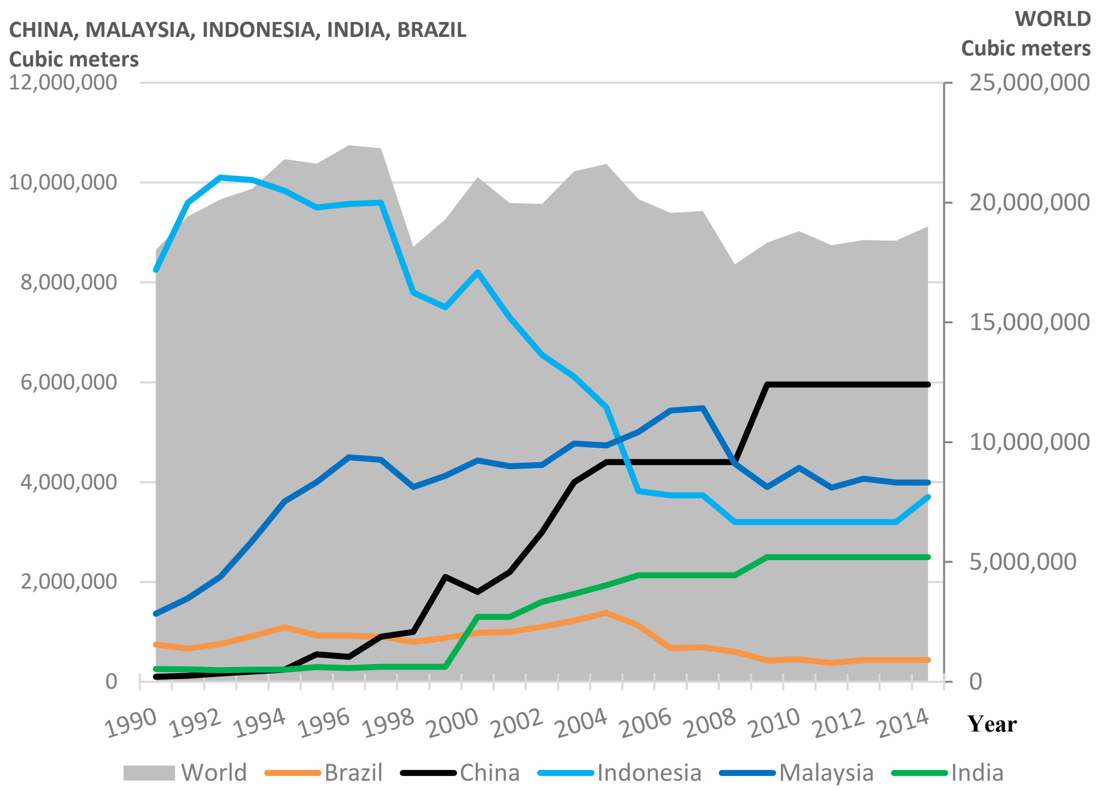

Figure E: Major producing countries of tropical hardwood plywood (m^3), 1990-2014.
Data: ITTO 2016.

Additionally, since 2006, India ranks among the top three major consuming countries of tropical hardwood plywood in the world (behind China and close to Japan) with a global share of 12 percent. Later, in 2014, India increased its share in the global consumption of tropical hardwood plywood to 14 percent (2.4 million m3), and along with China and Japan, their share rose to 62 percent (10.6 million m3). (See Fig. F based on data extracted from Table 1F in Annex 1).

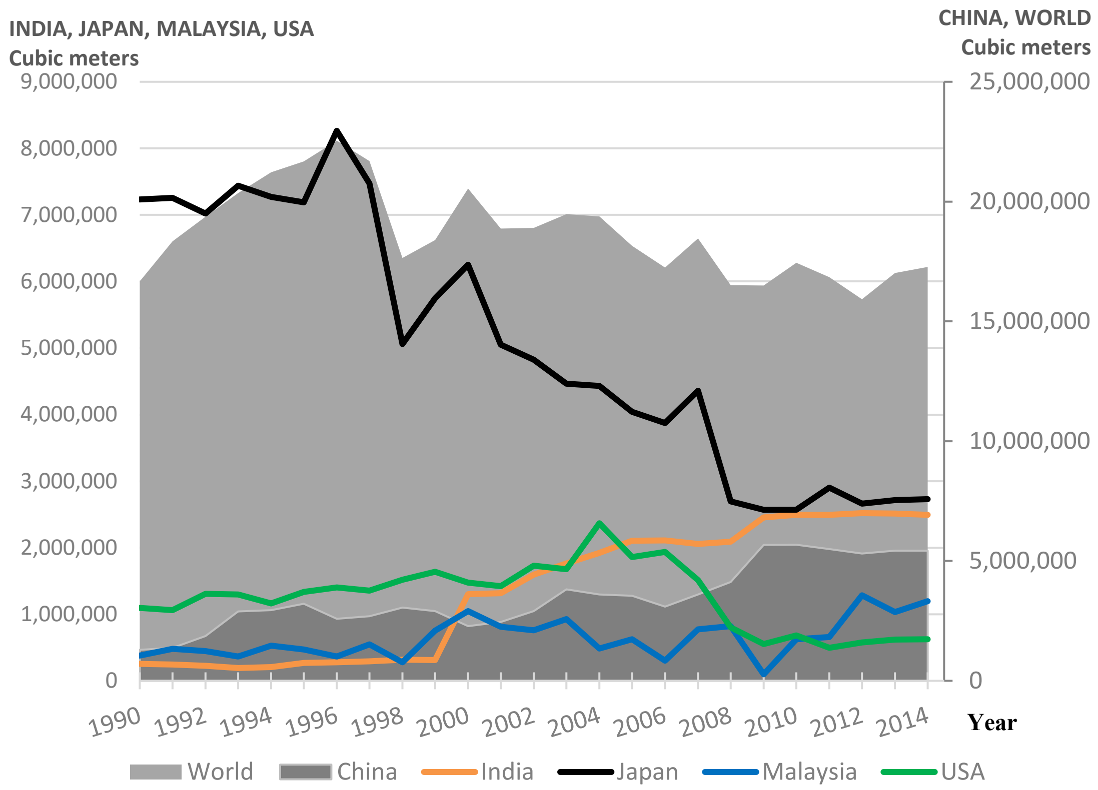

Figure F: Major consuming countries of tropical hardwood plywood (m^3), 1990-2014.
Data: ITTO 2016.

In both cases, production and consumption of plywood in India, the trends have shared quite similar behaviour due to both have shown a steady increase since 2000 and have remained relatively constant over the past five years. One of the reasons is the insignificant amount of plywood imported and exported in India. In consequence, the consumption of tropical hardwood plywood is entirely domestic and finds its highest contribution to the housing sector.

3 MOTIVATION AND PURPOSE OF THE STUDY

3.1 MOTIVATION OF THE STUDY

Since the mid-1980s, India has changed its economy from an agriculture-based into a chiefly services-oriented. The main reason was an economic liberalisation that provided a more macroeconomic stability in the country. As such, today, India is, along with China, one of the largest economies in the world. Its economy has experienced a fast growth rate and the demand for resources to fuel the industry and end-users has grown intensely. Consequently, India has become more international and is now a key target for exporting countries of a wide variety of products, including primary wood-based products.

The increasing per capita income in India has increased the demand for import value-added wood products. Thus, it is expected that due to the boom in the construction sector, mainly for housing needs as urbanisation, the Indian market of wood products will continue growing and expanding in the long-term basis. Furthermore, it is estimated that the local production of primary wood products and the limited availability of wood as raw material, will not meet the domestic demand for wood products. For this reason, more imports of primary wood products will be required by local wood-based industries to meet the significant gap.

Considering the facts mentioned above, it is evident that the Indian wood-based market provides significant potential business opportunities for exporting countries of forest products, including Finnish wood-based industries. Therefore, the primary motivation of this study is to complement previous studies related to the Indian market of wood products. Thus, the study aims to provide a better understanding of the Indian market of forest products through the analysis of different macro-environmental factors by focusing on the key drivers that influence the demand for plywood.

Although there is information available published about India, academic research in the Indian market of wood products is scarce. Additionally, the market is not regulated, and there is a lack of appropriate market information system. Thus, due to data constraints, time-series data is unreliable or missing and therefore, it is not possible to assess with certainty the importance of the forestry sector in the local economy. For this reason, another motivation for this study is trying to fill this gap by contributing with reliable data on plywood consumption in India. For this purpose, a similar methodology, based on previous research to model the Indian market of sawn wood, is used to determine the key drivers that influence the demand for plywood in India.

3.2 **PURPOSE OF THE STUDY**

The study attempts to complement Montiel's (2016) previous research "Analysis of India as a market area for sawn wood" by focusing on the demand for plywood. For this purpose, the scope of the study is to analyse the different macro-environmental factors (political, economic, social, technological) that might affect the plywood industry in India. In addition to this, the study provides empirical estimates of the consumption of plywood in India by modelling annual times-series data between 1990 to 2015, where possible. Plywood is modelled as a total, including both softwood and hardwood species. The secondary data is collected mainly from previous studies, international and official sources. Finally, it is expected that the conclusions drawn in this study will be used as 1) an essential reference about the potential challenges and opportunities for foreign and Finnish wood-based industries seeking to enter the Indian market of plywood; 2) an appropriate source for future studies.

Based on the aim of the study, it is expected to answer the following three research questions:

1) What is the current state of India's plywood market at the local and global level and how is expected to be in the future?

2) What factors explain the plywood demand in India?

3) What are the challenges and opportunities that the Indian plywood market shows for foreign and Finnish wood-based industries?

4 THEORETICAL BACKGROUND OF THE STUDY

4.1 PEST Analysis

PEST analysis is an important tool used to provide an overview of those macro-environmental factors that should be taken into consideration while determining the overall business environment in the long-term. (Cameron, 2008). The basic framework of this analysis includes four different macro-environmental factors:

4.1.1 Political environment

It includes all those factors that are related to the government participation in various areas of the local economy. The political trends and government stability are also important. Some political factors related to trade include tax policy, trade restrictions and trade tariffs. Factors that involve legislation can be employment laws and consumer protection as well as those environmental, competitive and industry regulations. In addition to these factors, governmental leadership and government structures can also be considered.

4.1.2 Economic environment

It involves all those factors that affect company operations and decisions. As such, economic growth trends and rates related to exchange, interest and inflation can also be included. Additionally, the government spending level, as well as the disposable income and consumer purchasing power, are part of this list. Finally, regarding development, foreign trade and foreign investments are also important economic factors.

4.1.3 Social environment

The primary examples of social environment are related to demographics such as age distribution, population growth, family size, gender and race. Social factors can explain the limitations of the Indian society. For this purpose, it is possible to analyse different cultural aspects like housing trends, lifestyle changes or living standards. Furthermore, the social environment can be used to describe the consumer needs based on elements associated with education and leisure activities, like attitudes to work, occupations, and earning capacity. Finally, other factors such as diversity and immigration can also be considered.

4.1.4 Technical environment

Many considerations can be included among the factors related to technology. Thus, it is possible to analyse either the technology has a positive impact on technological incentives, the rate of technological change or manufacturing advances or adverse consequences due to rates of obsolescence or lack of information-technology. However, inventions or research and development (R&D) are some of the factors that can be used to assess ecological and environmental aspects (e.g. recycling) that influence the societies.

5 THEORETICAL FRAMEWORK AND EMPIRICAL MODELLING OF THE STUDY

5.1 Theoretical Framework of the Study

This study aims to determine all those possible factors that can cause an impact on the Indian demand for plywood. The theoretical framework establishes the limitations for variables with significant data that only contribute to explain the analysis of the study. It can also be used to define the empirical stage of the research, which at the end will generate new knowledge. Based on this premise, the main purpose of this research is to integrate different disciplines such as mathematics, economics and statistics, while using econometrics, to generate quantitative estimates. Thus, based on the economic theory, such estimates are expected to be the result of the analysis of all the potential relationships among different factors that can be used to explain a particular econometric model.

In addition to what has mentioned above, the framework in this study is expected to follow a conventional empirical model as a base and be solved in one phase. As such, the empirical model will be used to analyse the econometric model structure developed by Buongiorno in 1979 and then used by Wan et al. (2011) and Kayacan et al. (2013) in recent researches related to wood products. With the utilisation of this conventional model, the study aims to assess the probability to use different dependent and independent variables that, interacting with them, can determine the causes that impact the Indian import demand for plywood.

As a base of the econometric model, Indian imports of plywood will play the role of the dependent variable. Furthermore, the dependent variable of Indian imports of plywood will be associated with consumer income and product price, following the economic theory. Thus, the variable of consumer income will be represented by Gross Domestic Product per Capita. Meanwhile, the variable of product price will be associated with the domestic price of plywood. It is important to mention that the values that will be used for the domestic price of plywood will be obtained from the import price of plywood.

Additionally, considering that this research model demand as Indian imports of plywood, also other random variables considered in previous econometric research, will be tested. For this purpose, McKillop (1967) and Buongiorno (1979) are used the primary reference. However, Hurmekoski et al. (2015), provides a broader list of independent variables and suggest and ad hoc model to complement the analysis. Thus, after estimating different variables, only a few of them were significant. Therefore, in this study, the variables that will be tested econometrically are population density, unemployment, economic openness and domestic prices of Industrial Roundwood and Medium-Density Fibreboard. In the case of the variables related to domestic price, the value of the product will be obtained through the relationship between import unit values and the import unit quantity (See Fig. G).

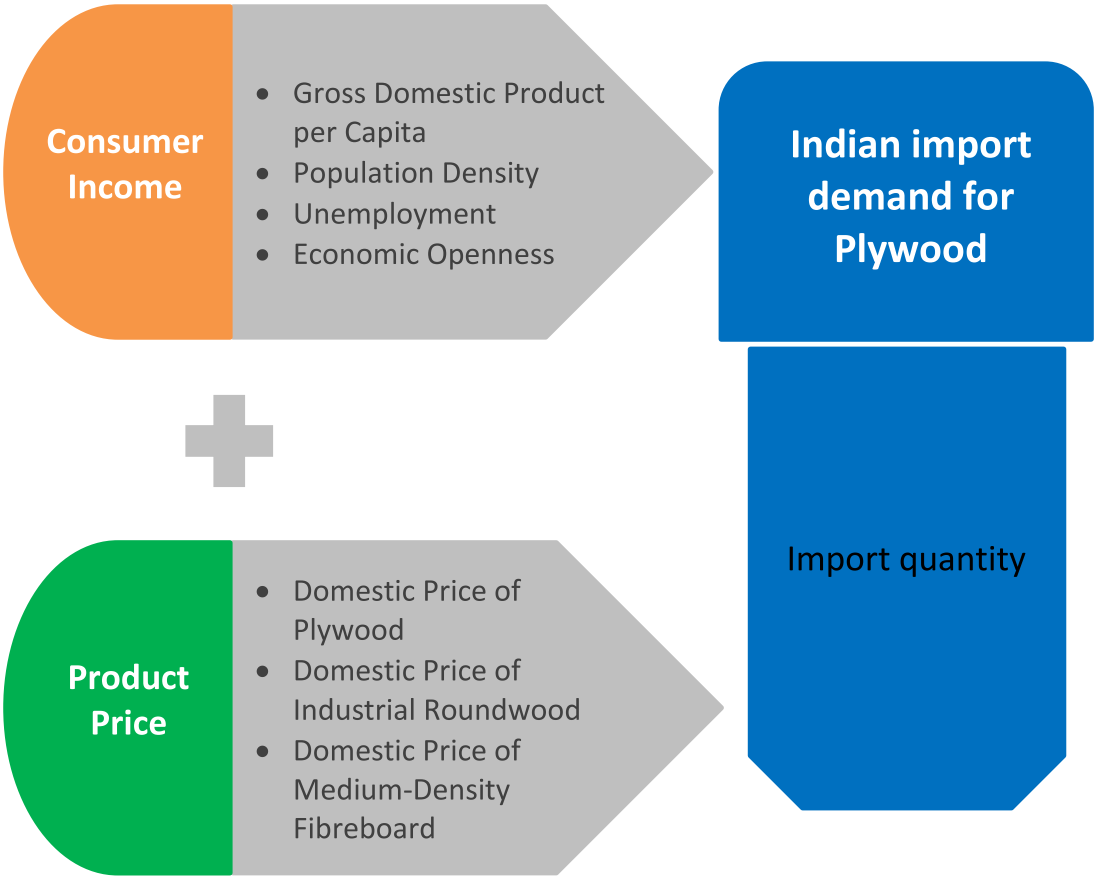

Figure G: Framework of the study

5.2 Empirical Modelling of the Study

The use of an empirical model in this study provides the opportunity to analyse a secondary data gathered from a particular period with the only purpose of improving a market model through the application of econometrics. Thus, statistical models used in econometrics involve different empirical content related to economic theories. However, not always econometrics models have to be tied to a specific economic theory. Statistical models, also include the use of mathematics and statistics to specify the relationships that are expected to hold between different variables about an economic data (Gujarati 2003). Per Koutsoyiannis (1977), many market drivers influence the economic theory. The well-known law of supply and demand can be considered as the central pillar that supports other economic theories and econometric models. Thus, the relationship between supply and demand provides the opportunity to assign resources related to market economy theories. However, there is a difference between both terms. On the one hand, the term supply explains the relationship between the quantity of a particular product and the price when it is distributed in a specific market. On the other hand, the term demand refers to the price that consumers are ready to pay for a particular quantity of goods. In the end, supply and demand are an economic model that determines the price of goods in a particular market. Additionally, both concepts provide valuable information regarding consumer income or purchasing power as well as products availability (O'Connor and Faille 2000).

5.3 **Indian Plywood Demand Model**

Demand models for forest wood products have been tested by different authors based on economy theories. For this study, the demand model is based on Buongiorno et al. (1979) approach for forest wood products that considerers consumption demand. This author also has developed the demand model as a derived demand model (Chou and Buongiorno 1982, Buongiorno 1996, Chas-Amil and Buongiorno 2000, Buongiorno et al. 2003, Hetemäki et al. 2004, Hänninen et al. 2007a, Hurmekoski et al. 2015). Nevertheless, in this study, the demand model does not consider consumption demand but import demand due to a significance level of the data.

The time-series model will analyse the collection of secondary data used in this study. Koutsoyiannis (1977) suggests that this method accounts that data were taken over a period might have an internal structure that should be considered. In addition to this, time-series models contribute to understanding the common elements of Indian imports of plywood. Thus, the demand model will be based on the time-series analysis of yearly data collected from India in the period from 1990 to 2015, where possible. For some variables, the data might not be available. The application of time-series models for the analysis of secondary data also shows some difficulties. In some cases, time-series models not always show stationarity in the data. Additionally, data frequently show a slight variability in the observations when they are expressed over long time periods. Other difficulties refer to high collinearity between explanatory variables. In such cases, it is not possible to measure all over the years of consistent economic growth. The reason is that it might cause uncertainty while estimating structural coefficients accurately. (Buongiorno 1979). In this research, the short period of annual observations (1900 to 2015), is consider already as a source of uncertainty.

In consequence, following Buongiorno's approach (1979), this research considers the classic double-logarithmic formula as demand equation for the general time-series model:

$$\log \mathrm{IMP}t = a + b \log \underset{+}{\mathrm{GDPC}t} + c \log \underset{-}{\mathrm{DPP}t} + ut \qquad \textbf{(Eq. 5.3.A)}$$

Where IMPt is the Indian Import demand of Plywood in year t; GDPCt refers to India's Gross Domestic Product per Capita in year t; while DPP is the Indian Domestic Price of Plywood based on import unit price per quantity in year t; and finally, ut is an error term. Other coefficients such as a, b, c represent the constant term, the income elasticity of demand and the price elasticity of demand, respectively. Per Labys (1973), there is no explicitly in the formulation of this model. Therefore, it can be considered static. It is also important to highlight the symbols positive (+) and negative (-) under each coefficient. These symbols determine the expected signs of each coefficient estimated based on the economy theory. In consequence, Indian imports of plywood are supposed to be influenced positively by an increment in the variable GDPC that represents the

Indian consumer income; meanwhile, it is expected that the imports of plywood in India will decline every time there is a rise in the price of Indian imports of plywood.

There are consumption models establish for forest wood products that based on the concept of derived demand. Klemperer (2003) suggests that forest wood products are regularly associated with particular elements related to economic activity. In this case, price and income. Based on this assumption, the research defines the model of imports of plywood in India as a base for the econometric analysis as follows:

IMP = f(GDPC, DPP) (**Eq. 5.3.B**)

Where GDPC represents the Gross Domestic Product per Capita and DPP refers to the Domestic Price of Plywood based on import unit price per quantity. Per Kangas and Baudin (2003) as well as Hurmekoski et al. (2015), the reason for using a per capita scale for the GDP contributes to homogenise the data considering the size of the market.

In addition to the above mentioned, other authors have tested different probable drivers to assess the plywood demand. This research considers Kangas and Baudin (2003), Klemperer (2003), Virtanen (2005) and Hänninen et al. (2007b) as sources for variables that can be tested to determine the Indian import demand for plywood. However, Hurmekoski et al. (2015), approaches that income and price variables can be replaced or complemented by other equivalent variables that represent economic activity. For this reason, a considerable number of variables determining demand were tested in this research. All of them suggested and tested in previous literature. Consequently, this study considers, for the analysis of the empirical model, only those explanatory variables that show to be significant after being tested. Thus, following Hurmekoski's (2015) ad hoc model, the explanatory variables are defined as:

IMP = f(GDPC, UE, EO, POPD, DPP, DPIR, DPMDF) (**Eq. 5.3.C**)

Where GDPC represents Gross Domestic Product per Capita; UE refers to Unemployment; EO is Economic Openness; POPD is Population Density; DPP is Domestic Price of Plywood based on import unit price per quantity; DPIR is Domestic Price of Industrial Roundwood (raw material) based on import unit price per quantity; and DPMDF is Domestic Price of Medium-Density Fibreboard (substitute) based on import unit price per quantity (Virtanen 2005, Hurmekoski et al. 2015).

6 DATA AND DATA ANALYSIS OF THE STUDY

6.1 Data of the Study

The data of the study assesses the Indian plywood demand and considers plywood including softwood, tropical hardwood and other hardwood. The aim of analysing data related to plywood is to create a primary source for foreign and Finnish wood-based industry producers of plywood to reach the plywood market in India. Under this basis, all the secondary data gathered during this research will use for the description analysis that will support the analysis of the econometric model. Thus, the information has been collected from different official and international sources that include consulting analysis and reports, news and scientific papers. All this information will be useful to build a better understanding of the Indian plywood market.

The yearly time-series data that has been collected for the econometric model are necessary to carry out the empirical analysis and subsequently hypothesis testing. After several tests on different variables that represent an economic activity, Table 1 shows the variables by unit data that will be used in the empirical analysis. In the case of these variables, all of them have been obtained only from official international sources. The reason of this is to bypass incongruity and differences when comparing national with international sources. Another reason is that India does not provide accurate and reliable data concerning most of the variables that showed to be significant. In this way, some of the variables are not available with the statistical databases at the national level due to an inefficient data collection system in India. In consequence, most of the variables were obtained from the World Bank Development Indicator (2013) and the World Bank's Database (2016). Thus, such macroeconomic statistics are Gross Domestic Product (GDP) per capita, population density, unemployment and economic openness. While, in the case of forest wood products statistics, the primary source considered to collect the yearly time-series data, was the Food and Agriculture Organization of the United Nations Statistical Database (FAOSTAT). Based on previous literature, all the data collected is assumed to be the most reliable and the most important, the most accurate data available. The data collected is shown in Annex 2 in Table 2A and 2B.

Table 1: Variables used in the empirical analysis

ID	Variable	Unit	Data Source	H_0	r
IMP	Indian Imports of Plywood	m^3	FAOSTAT, UN		
GDPC	Indian Gross Domestic Product per Capita	USD	World Bank	+	0.91
DPP	Indian Domestic Price of Plywood	USD/m^3	FAOSTAT, UN	-	0.32
UE	Indian Unemployment	% of TLF	World Bank	-	-0.79
EO	Indian Economic Openness	% (trade of GDP)	World Bank	+	0.81
POPD	Indian Population Density	inh/km^2	World Bank	-	0.79
DPIR	Indian Domestic Price of Industrial Roundwood	USD/m^3	FAOSTAT, UN	-	0.63
DPMDF	Indian Domestic Price of Medium-Density Fibreboard	USD/m^3	FAOSTAT, UN	-	0.53

H_0: Hypothesis for the sign of the correlation between IMP and the variable based on consumer theory.
r: Pearson correlation coefficient.

6.2 Data Analysis of the Study

The data collected for this research has been analysed by two methods, descriptive and empirical modelling. In the case of the descriptive method, a PEST analysis is used to define the background information that will support the description of the global and local markets of plywood. Meanwhile, for the assessment of the empirical modelling the use of the statistical software Econometric Views (EViews) will be required. The first step will be to evaluate how an explanatory variable can be impacted when it is related to one or more variables that are changing over the time. For this purpose, the empirical modelling will be based on an empirical regression modelling that will consider only the significant relationships obtained between dependent and independent variables after previous analysis using the statistical model.

The theory says that independent or explanatory variables can assess dependent variables. For regression purposes, all the dependent variables are estimated as random variables. On the contrary, independent or explanatory variables are evaluated as non-random variables. However, for the statistical interpretation of the variables under study, the empirical regression modelling will be considered to test the null hypothesis in the model. Another purpose of the empirical regression modelling will be to evaluate the dependent variable by using new values provided by the independent variables.

Dependent variables also need to identify their distribution. In the case of regression modelling, a function will contribute to defining whether the dependent variable can be associated with an independent variable or not. In addition to this, the random variation in the dependent variable can be assessed. Regarding functions used for regression modelling purposes, a straight-line is the most common feature among them. A straight-line is also acknowledged as linear regression modelling. Larsen (2008) suggests that a collinear relationship between a dependent variable and an independent or explanatory variable can be explained using a linear regression modelling. Hurmekoski et al. (2015) also assessed the relationships between these variables in the same way. In consequence, this research will have based the assessment between both variables on the linear regression modelling as well.

This study aims to define the drivers that can cause an impact on the demand for plywood in India. The previous studies of McKillop (1967), Buongiorno (1979), Wan et al. (2011), Kayacan et al. (2013) and Montiel (2016) are used as a support for this purpose. All this literature has in common the assessment of the demand modelling of different forest products markets, e.g. sawn wood, plywood and wood-based panels. Additionally, each author has used different empirical models by the data studied. The literature also proves that time-series data models can explore the viability of the estimations for income and price elasticities of the demand for forest products. In such cases, time-series data models have been based on yearly or quarterly variations of only significant variables depending on the region evaluated (Buongiorno 1979). In this research, the basic time-series model is considered to determine the elasticities of the demand for Indian imports of plywood -IMP-. This variable includes the total imports of plywood considering then, softwood, tropical hardwood and other hardwood. The period of data evaluated is from 1990 to 2015, where possible, and it is collected yearly. All the data collected corresponds to variables that are associated with the consumer income, price and economic activity.

The subjects and methods used in the different analysis of this study, are summarised in Table 2. For example, the table lists various methods used to explain the descriptive analysis. In this case, different types of charts such as line, bars and customise; a summary; data tables and numbers. All these tools, provide a better understanding when describing the global market of plywood and the participation of India in the plywood market at global level. The descriptive method also contributes to understanding the demand for imports of plywood in India within the empirical model.

Table 2: Subjects and methods of analysis for the study.

<table>
<tr><th>Subject of Analysis</th><th>Method of Analysis</th></tr>
<tr><td>Overview of the global market of plywood
• Global consumption of plywood
• Global consumption of plywood by regions
• Major consuming countries of plywood</td><td rowspan="3">Descriptive Analysis
• Charts
• Summary
• Data tables
• Numbers</td></tr>
<tr><td>India's situation in the global market of plywood
• Major producing countries of plywood
• Major producing countries of tropical hardwood plywood
• Major consuming countries of tropical hardwood plywood</td></tr>
<tr><td>PEST analysis
• Political environment
• Economic environment
• Social environment
• Technical environment</td></tr>
<tr><td>Indian plywood demand modelling</td><td>Empirical Statistical Analysis
• Regression Analysis
• BG serial correlation LM test
• JB Histogram-Normality test
• Heteroscedasticity test
• ADF unit root test
• MacKinnon critical values
• Johansen Cointegration test</td></tr>
<tr><td>Ad hoc models</td><td>Empirical Statistical Analysis
• Regression Analysis
• BG serial correlation LM test
• JB Histogram-Normality test
• Heteroscedasticity test
• ADF unit root test</td></tr>
</table>

Table 2 also list all the different statistical analysis used to define the demand model for imports of plywood in India. Thus, a regression analysis method (OLS) is utilised in both conventional and ad hoc models. Other statistical analyses are listed as the Breusch-Godfrey (BG) serial correlation Lagrange Multiplier (LM) test, Jarque-Bera (JB) Histogram-Normality test, Heteroskedasticity test, Augmented Dickey-Fuller (ADF) unit root test, MacKinnon critical values and Johansen Cointegration test.

6.2.1 The Breusch-Godfrey (BG) serial correlation Lagrange Multiplier (LM) test

This analysis method was developed by Breusch (1978) and Godfrey (1978). It is used to analyse the presence or absence of serial correlation in the variables. This analysis is carried out beyond the first order and is only valid if lagged dependent variables are shown in the regressors. Compared to other methods, such as the standard Durbin-Watson (DW) statistic, the BGLM test is more wide-ranging. The reason is that the BGLM test can be considered for general hypothesis related to serial correlations in the errors, while with DW is not possible. Thus, the BGLM test examines higher orders of serial correlation but avoiding offering inconclusive results.

A serial correlation exists when an ordinary least square regression cannot be an efficient linear estimator. Also, Asteriou and Hall (2007), suggest that serial correlation occurs when the standard errors are incorrect. Moreover, per Mittelhammer et al. (2000), serial correlations are shown when the dependent variable or the residual shows correlation within their values from previous periods. In this case, such difficulties influence statistical inferences owing to standard errors cannot be consistent. In consequence, Godfrey 1991 determines that the null hypothesis of the BGLM test can be explained as there is no serial correlation up to the number of lags estimated.

Godfrey (1988) also define another characteristic of the BGLM test. In this case, the method can regress the residuals on the original regressors and lagged residuals up to the specified lag order. In other words, the Obs*R-squared statistic is the value that defines the BGLM test. Thus, in the regression analysis, the Obs*R-squared statistic is calculated as the number of observations multiplied by R2. Furthermore, in general conditions, the BGLM test is asymptotically disseminated under the null hypothesis as $\chi2$ (p). For this purpose, p is equal to 1 degrees of freedom. Finally, Asteriou and Hall (2007) concludes that the null hypothesis of no serial correlation can only be rejected when the p-value of F-statistic is smaller than the significance level tested.

6.2.2 The Jarque-Bera test

The Jarque-Bera (JB) test is a parametric statistic method that is used when analysing data that can be measurable on ratio scales or intervals. The JB test is highly suggested to apply before the use of other methods that are based on normal distribution. Thus, Bera and Jarque (1982) suggest this test when the aim is to assess whether the errors in the regression model are normally distributed or not. Another use of the JB test, suggest by Jarque and Bera (1987), is to assess a null hypothesis where each variable is expected to be normally distributed. The reason is, per Domański (2010), that the JB test compares how separated are the measures of the sample skewness and the sample kurtosis from the characteristics values in a normal distribution. Consequently, under the JB test, the residuals can be considered normally distributed only if the p-value is greater than the 5 percent level of significance. Hence, a measure of deviation from a normal distribution could be estimated as the absolute value of these parameters.

6.2.3 Heteroskedasticity test

Heteroskedasticity can be defined etymologically as different dispersion or variance. Also, it is defined as an unequal spread. Based on Bohannon's (1988) research, there is an assumption in regression analysis that confirms the presence of heteroskedasticity. This assumption is confirmed when the variance of the errors is not constant across observations. On the contrary, there is homoscedasticity. Robert Engle (1982) was one econometrician that based on his studies on regression analysis established that heteroskedasticity might be a problem in time-series data. Thus, his studies led him to formulate the autoregressive conditional heteroskedasticity (ARCH) modelling method. Econometrics frequently use variance for the spread. As such, a heteroskedasticity test is an important tool within econometrics because it deals with different variances (Asteriou and Hall 2007). For detecting the presence of heteroskedasticity in a regression analysis, the null hypothesis defines that the variance of the error is constant. In this case, the null hypothesis can be only rejected when there is no heteroskedasticity. Therefore, the p-value of F-statistic shows to be smaller than the significance level tested. If any of this happens, the null hypothesis should be accepted.

6.2.4 The Augmented Dickey-Fuller (ADF) unit root test

In time-series analysis is common that variables are non-stationary. When this happens, then in econometrics is known as unit root. For this reason, time-series samples require being tested. Thus, Dickey and Fuller (1979) extensively test unit roots in time-series and their studies led to the Augmented Dickey-Fuller (ADF) test. The application of this method is important because it assesses when the form of the data-generating process presents a unit root. If so, Asteriou and Hall (2007) suggest that this method can also determine the total number of unit roots that are found in the time-series. With this method, it is possible to confirm if a time-series sample is non-stationary. It depends on the presence of unit roots. However, if after the test, there is no confirmation of unit roots, then it can be said that the residuals are stationary and therefore, the variables are cointegrated. (Pupongsak 2010). In consequence, the ADF test is necessary to make a time-series sample stationary.

One advantage of using the ADF test is that this method allows obtaining the first or second difference of the variable when it is non-stationary at the level. Furthermore, the ADF test can be used as a valuable tool when is necessary to exclude autocorrelation. For this purpose, Seddighi (2013) suggest that it is possible to include additional lagged terms of the dependent variable. In addition to this, when the regression analysis is running, the ADF test can be modified per the significance of the variable by adding a constant, a constant and a linear trend, or in the last case, when any of these alternatives are significant, neither of them (Asteriou and Hall 2007). However, it is important to highlight that it is not possible to add only a linear trend. Therefore, in the cases when only the trend is statistically significant but no the constant, then it is compulsory to include a constant and a linear trend.

Fu (2012), highlights another characteristic of the ADF test. Per him, this test allows to include lagged values of the difference of the variable during the regression analysis. However, the ADF test provides a more practical reason for using it. Kwiatkowski et al. (1992) explain that one of them concerns to the specification of the lag length p. Hence, when the p-value is too small, then the residual in the serial correlation of the errors will bias the test. Meanwhile, when the p-value is too large, then the power of the test will suffer.

Within the ADF test, there are also several alternatives that can be used to define the ideal number of included lags. For this purpose, the methods commonly used are the Schwartz Information Criteria (SIC), the Akaike information Criteria (AIC) or the Hannan-Quinn information Criteria (HQC). In this study, SIC is used to estimate the correct lag length. This measure is due to the number of observations is less than 60 (Liew 2004).

Based on Campbell and Perron's (1991) assumption, the presence of unit roots in a time-series sample depends on the existence of deterministic drifts and trend. Thus, only when a time-series sample contains a drift or trend, is possible to test the null hypothesis of a unit root. For this purpose, it is necessary to use a normal distribution. The null hypothesis will be defined as the variable with a unit root. Meanwhile, the alternative hypothesis will be explained as the variable was generated by a stationary process. The assumption to reject the null hypothesis of a unit root against the one-sided alternative occurs when the ADF statistics is smaller than the critical value represented at 5 percent level. Only now, per Asteriou and Hall (2007), the series sample can be considered as stationary.

6.2.5 MacKinnon's critical values

As regards with the assumption of the presence of unit roots, there are other options to reject the null hypothesis of a unit root or cointegration. In this case, unit root refers to one variable, while cointegration does for more than one variables. For this purpose, it is necessary to compare the values obtained from the ADF test against MacKinnon's estimates of critical values. MacKinnon's critical values are related to 1, 5 and 10 percent significance level. Some of the reasons of comparing against MacKinnon's estimates is that the Mackinnon's critical values show accurate asymptotic p-values for any finite sample size (MacKinnon 1996). Additionally, they allow tabulating results for any different sample size (MacKinnon 2010).

6.2.6 Johansen Cointegration test

Based on Granger's (1983) assumption, he defines cointegration as a phenomenon where a particular linear combination of a time-series process is stationary. This econometrician studied the relationship between cointegration and the error correction model. Per him, an empirical cointegration analysis is vital to understand economic data. However, more research was necessary to explain the phenomenon of cointegration.

Years later, another statistician and econometrician, S. Johansen (1988, 1991), contributed with a new methodology to the theory of cointegration. Johansen proposed to test the cointegrating rank or number of cointegrating relationships among the variables. Additionally, to the cointegrating rank, Johansen suggested including other factors within a relationship between variables. These factors are the number of the non-zero eigenvalues of the matrix and the rank of the matrix.

The Johansen test shows different advantages compared to previous theories. One of them refers to data set that can contain more than two time-series. In this case, the Johansen test enables to estimate more than one cointegration relationship. In consequence, the maximum number of cointegrating relationships will be the same number of variables in a model. (Johansen 1988). Nevertheless, it is important to highlight that Johansen assumes that two cointegrating relationships would determine that the variables do not have unit roots.

Johansen also proposed two different likelihood-ratios. One of them is known as the trace test. The other one is the maximum eigenvalue test. Both likelihood-ratios show differences between them. In the case of the maximum eigenvalue method, it evaluates the null hypothesis of r cointegrating vectors in contrast to the alternative hypothesis of cointegrating vectors (r+ 1). Also, the eigenvalues must show two characteristics. It must be positive and real. In other words, when using the largest eigenvalue, the test starts with r = 0 and with an alternative hypothesis. Here the r value is 1. Then, in the cases when the rank of the matrix = 0, then, it will be the largest eigenvalue. In consequence, there is no cointegration, and no more tests are needed. However, when the rank of the matrix is at least 1 and the largest eigenvalue is non-zero, then, it might be possible that more cointegration relationships exist. Additionally, considering that after running Johansen test, the second largest eigenvalue = 0, it is possible to conclude that there is one cointegration relationship between variables and no more tests are needed. However, in the case that the second largest eigenvalue is non-zero and there are more than two variables, then it can be concluded that there is a probability that more cointegration relationships exist. The Johansen test will continue until there are no possibilities to reject the null hypothesis when the eigenvalue = 0. (Johansen and Juselius 1990).

In the case of the trace method, this test evaluates the null hypothesis of r cointegrating vectors against the alternative hypothesis of n cointegrating vectors. Thus, when r = 0, it determines that there is no relationship among the variables analysed, and therefore it is stationary.

In both statistic tests, the maximum eigenvalue test and trade test, the null hypothesis of no cointegration is evaluated against the alternative of cointegration. However, there is only one difference between both tests, which is the alternative hypothesis. (Johansen 1991). Finally, the resulting integrated model is estimated per the normalised cointegrating relationships of the variables.

7 RESULTS OF THE STUDY

7.1 Descriptive Analysis of the Indian Market of Plywood

The descriptive analysis of the Indian market of plywood is described based on the PEST analysis into different environments as follow::

7.1.1 Political Environment

Today, various industries related to the wood product sector have been increasing due to larger population rates and a major purchase power among their inhabitants. This phenomenon occurs mainly in developing countries where the middle-class segment is continuously growing. The Asia-Pacific Region is not an exception of this. Their broad availability of forests has led them to produce and consume wood products in larger volumes than in other regions. As such, the Asia-Pacific Region has become a key manufacturer for different types of wood products around at global level. Among the main goods produced in this region are wooden furniture, wood-based panels, paper and paperboard. India has become an important member of the Asia-Pacific Region because its economy is market-oriented and the country is mostly focused on trade and investments with other nations around the world. Inside the region, India is also participating in the production, consumption and trade of wood products due to the country has been actively building multilateral, bilateral and regional free trade agreements (FTA) with other country members. Besides, the country has established FTA with other nations around the world. Some of these FTA are the South Asia Free Trade Agreement (SAFTA), BIMSTEC, ASEAN, MERCOSUR, GCC and SACU (Midgley et al. 2007).

All these changes within the Indian economy have attracted foreign companies that now have seen India as a potential partner to trade their products. Foreign companies related to wood and wood products are more interested in establishing operations in India and deal with more business relationships. Per the report “Doing Business 2008” published by the World Bank (2007), India is doing business faster because the current market regulation in the country enables tracking time and cost for all the requirements related to start-ups, taxation and closure. Toppinen et al. (2010) highlights that from 2008 to 2010, India and China have been nominated by the United Nations Conference on Trade and Development (UNCTAD) as the world’s most attractive locations for Foreign Direct Investments (FDIs). In the case of India, the return on investment (ROI = 19 percent), is considered as one of the highest in the world. Thus, India manages two different types of foreign investments in India. One is a direct investment by an entity (FDI). The other is a foreign institutional investment (FII). Regarding FDIs, these investments have supported the paper industry. For this reason, the local paper industry in India is growing rapidly and accounts nearby 1.6 percent of the total production of paper and paperboard in the world. This proportion represents an annual turnover of USD 6 billion for both Indian industries (Manoharan 2013).

India has experienced another phenomenon caused by the rise in its population. Their people are migrating to urban areas, and because of this, there is also an increase in the local demand for the urban market. For this reason, there is an accelerated uncontrol use of local resources that has caused a decline in the local stock of wood and then a wood deficit in the country. All these problems were a challenge for the government. So, in 1991, the government put in force the National Forest Policy of 1988 and the Forest Conservation Act. Both regulations aim to protect the forests. The creation of agroforestry programs and forest plantations in non-forest areas started to be promoted in the country with the only purpose of becoming as the primary sources of raw material for all the local wood-based industries. Later, in 1996, the government adopted an economic liberalisation policy for trade. The idea was to supply the domestic demand for wood and face the local deficit of raw material. The policies created, aimed to reduce local tariffs and eliminate most of the quantitative restrictions such as licensing requirements on imports. The new tariff structure favoured the log supply by allowing imports of wood. The small duty of 9.35 percent banned their exports (Pandey and Rangaraju 2008). The main idea of these policies was to protect the local producer of wood against the external supply of processed wood. In this case, a total duty of 36.8 percent for plywood, laminated wood and veneer, among other wood products (see Table 3).

Table 3: India's imports tariffs on logs and wood products.

ITC HS CODE	Basic Customs Duty -BCD	Countervailing Duty -CVD	Special Countervailing Duty -SCVD	Total Duty %	Wood product
44.01	5	0	4	9.4	Logs, Chips
44.07	12.5	0	4	17.3	Sawnwood, >6mm thickness
44.08	12.5	16.3	4	36.8	Veneer Sheets
44.12	12.5	16.3	4	36.8	Plywood, laminated wood

Source: USDA 2014; Montiel 2016.
Note: ITC = India Tariff Code; HS = Harmonized System; Total Duty = BCD + CVD + SCVD + CESS (2% Education + 1% Higher Education).

7.1.2 Economic Environment

The policies running in the Indian market have opened a new opportunity to participate in the global economy. There are more trade opportunities for goods and services. India has modified the traditional agriculture into a self-sufficient sector represented by new industries owing to the economic growth. In the last years, Indian manufacturers have growth and diversified operations, becoming more service-oriented. The Economic Survey published by the Ministry of Finance of India (GoI 2013a), highlights that during the period 2012-2013, the service and manufacturing sectors grew about 6.6 and 1.9 percent, respectively. Without any doubt, the rise in the Indian economy is the result of more industrialisation and the modernization of the local market. These changes also benefited the local population with better education and higher salaries, usually in the service sector. Thus, the growth of the service sector has contributed to increasing the Indian GDP since 2008 (Nayyar 2012). See Fig. H.

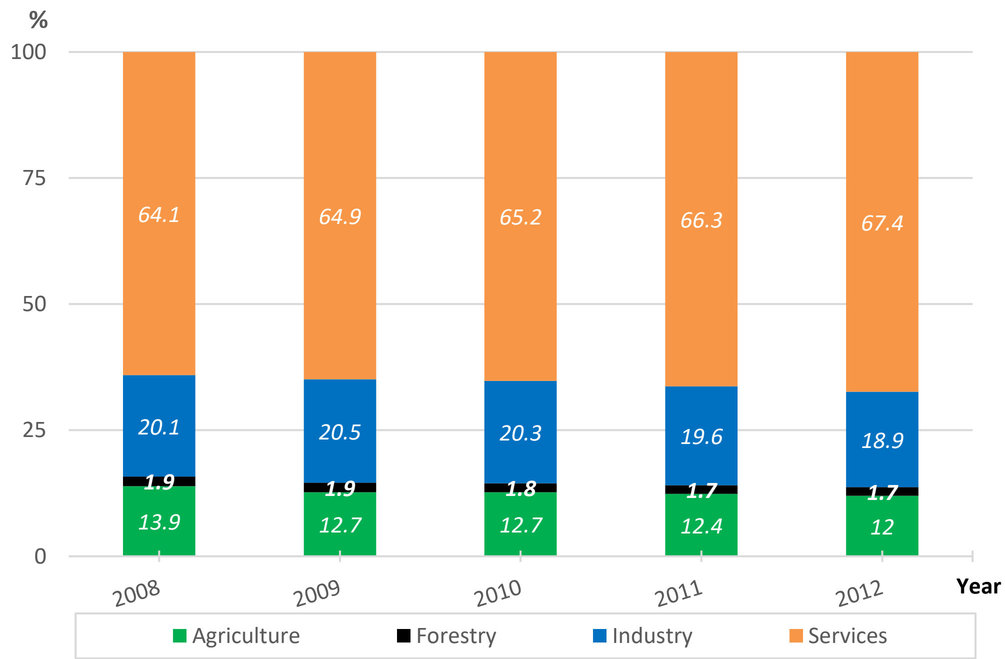

Figure H: Contribution of different sectors to GDP growth (%), 2008-2012.
Source: GoI 2013b; Montiel 2016.

Currently, it is possible to say that the economy in India has been renovated. There is more consumption in the domestic market mainly caused by a growth of the service sector. On the contrary, there is a progressively declining of shares in the agriculture, forestry and industry sectors.

Regarding GDP, its growth from 5 to 10 percent from the year 2002 to 2010 (see Fig. I). A dramatic decline occurred in 2008 was mainly caused by the global financial downturn. Later in 2010, the service sector growth its share in the total Indian GDP by 65 percent, meanwhile the industry stayed with 20 percent and only about 15 percent was associated with agriculture and forestry (see Fig. H). All these changes caused by the growth in the Indian GDP since the year 2000 to 2010 are known as the decade of economic development in India (Bajpai and Sachs 2000). Hubacek et al. (2007) refer to this phenomenon as the flourishing in the Indian economy. After this decade, India faced a decline in its GDP (growth rates of 6.6% in 2011 and 5.1% in 2012). However, the country recovered earlier than other nations in the world. This recent decline in Indian GDP is caused by external and local factors, such as a continues inflation or by the high deficit.

Currently, India's share of the global GDP is about 7.7 percent. The World Bank has forecasted a steady increase in the GDP of about 8 percent in the coming years. However, regarding purchasing power parity (PPP), CIA (2006, cited in Midgley et al., 2007), placed India as the third largest economy in the world with a GDP per capita nearly USD 3,400. Leslie (2015), based on IMF estimations, confirms that by highlighting the Indian personal incomes are rising by 50 percent from 2010 to 2015. The expectations regarding this trends place India as the fifth largest consumer market by 2025 (Ablett et al. 2007).

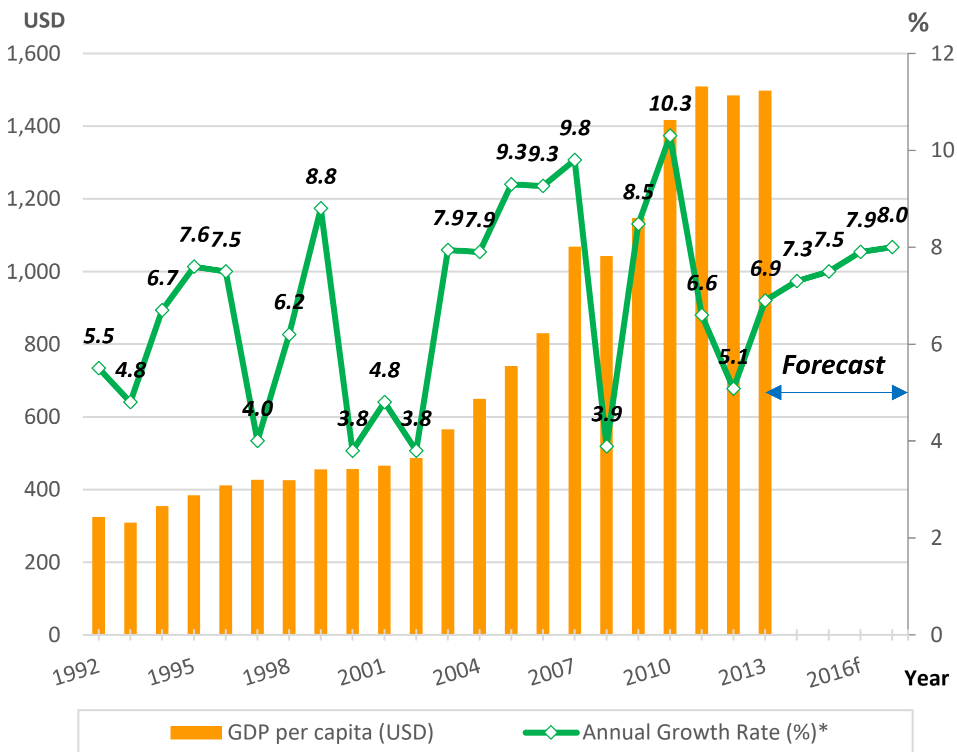

Figure I: India's GDP per capita (USD), annual growth rate (%) and forecast, 1992-2016.
Data: World Bank 2014; Montiel 2016.
Notes: * = aggregates are based on constant 2005 USD; e = estimate; f = forecast.

In 2006, the World Bank considered India as the second-fastest growing economy in the world, and it has been part of the top 10 since 1980 owing to its growth performance. There is no doubt that in coming years, India will play a significant role in the global economy. However, India faces some problems such as the fiscal deficit and government debt. Both cases should be addressed together with the development of its infrastructure.

Today, India still depends on subsistence agriculture and per Midgley et al. (2007) the country needs high technology. Hubacek et al. (2007) suggest that both scenarios have caused different situations. One of them is that part of the population has become wealthier and willing for a better quality of life. This results in more consumption in different segments in the country (e.g. high nutrient food and health care). The other scenario is that poverty is still the largest challenge in the country representing about 26 percent of the total population that is living under the poverty line (1 USD/day). This amount is about one-third of the poor population in the world. Besides, India ranks 65th among the countries where hunger exists. Consequently, India should overcome this challenge by distributing equally at all the levels the benefits obtained from its economic growth.

7.1.3 Social Environment

Regarding land, India is one of the largest countries in the world with about 3.29 million km2. The country is divided into 29 states and seven union territories (IDKN 2014). It is a democratic nation, and it is known as the second most populous country in the world with about 1.21 billion inhabitants, just behind China. Both countries share about one-third of the global population. Demographically, the annual growth rate is nearly 1.3 percent (see Fig. J based on data extracted from Table 1G in Annex 1) and therefore, Hubacek et al. (2007) estimate that India will surpass China's population by 2050 with about 1.6 billion inhabitants.

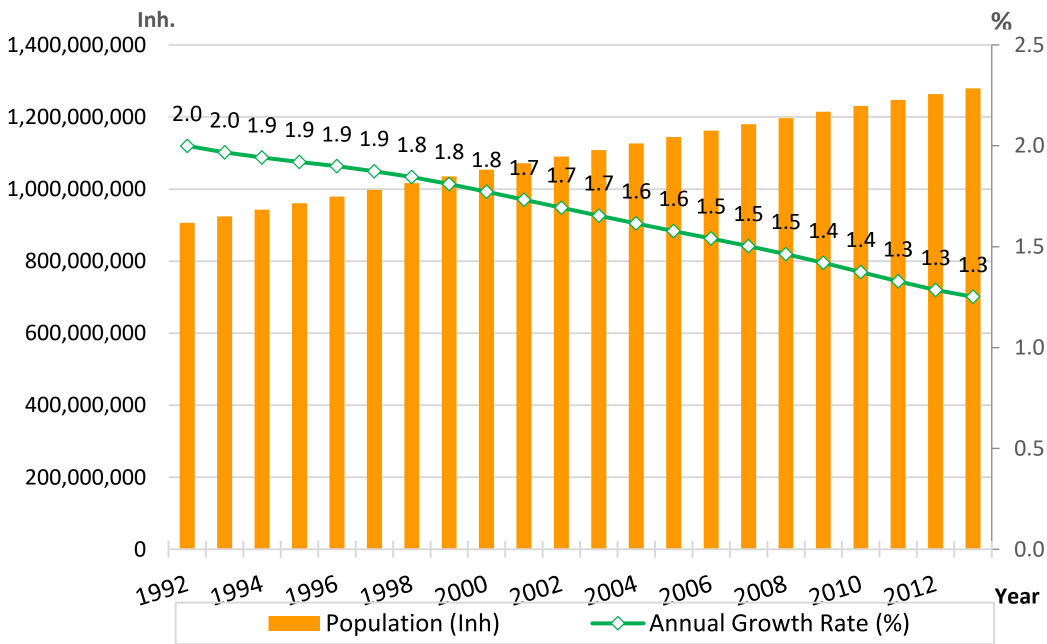

Figure J: India's population (inh.) and its annual growth rate (%), 1992-2013.
Data: World Bank 2014.

Constant migration of Indian inhabitants from rural to urban areas within the country has caused more investments for infrastructure to satisfy the rapid urbanisation. Besides, India's large population causes major consumption of wood products within the construction sector, mainly for housing. However, the differences in the purchasing power within the Indian population has divided the society into several socio-economic statuses. Thus, the housing sector is represented per each socio-economic status. Furthermore, the area of housing has seen a steady growth over the past decade, and it has become the second largest generator of employment in the country. Regarding GDP, the housing sector contributes to nearly 6 percent. The National Housing Bank (2012) has estimated a rise in the total the total housing stock from 186 million units in 2001 to 245 million units in 2011. It is about 25 percent in ten years (see Fig. K). In addition to this, it is important to remark that most of the housing units are situated in rural areas. Nevertheless, in 2012 the National Housing Bank estimated a shortage of housing units of 18.78 million in rural areas and about 43.67 million in the urban sector.

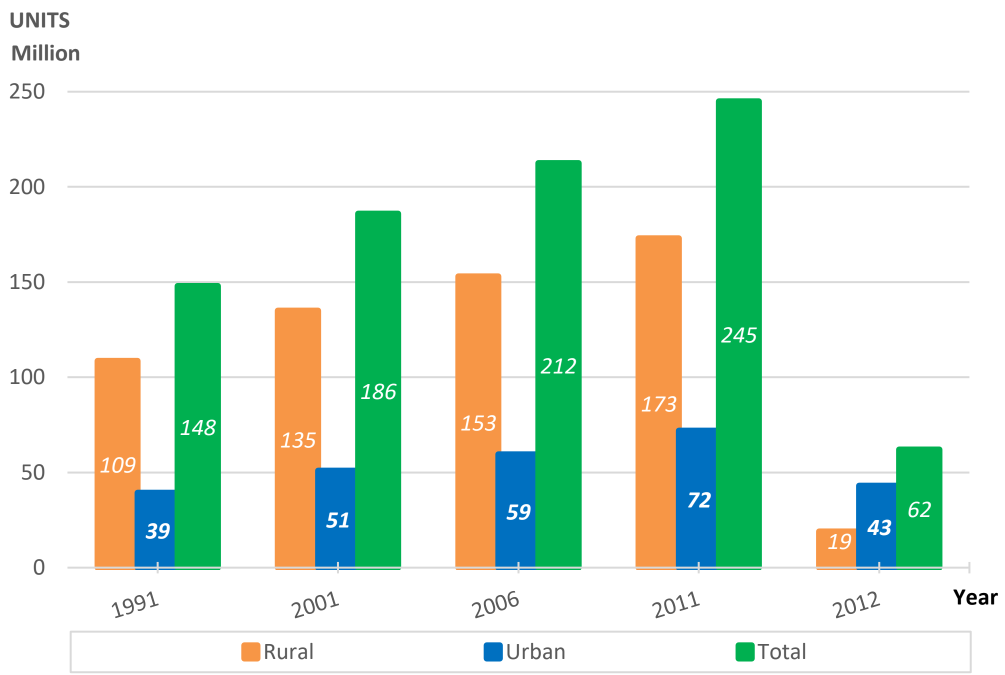

Figure K: Total housing stock in India (rural and urban), million units, 1991-2012.
Source: National Housing Bank 2012; Montiel 2016.

Indians love wood. For this reason, locals prefer to use good-quality wood products for their homes. The constant growing middle-class population in India is also being influenced by western styles of wood decorations (e.g. doors and windows). However, Indians prefer tropical hardwood species due to wood structure and properties such as high resistance to termites and climatic conditions of heat and humidity (Rawat 2004). In the case of softwood species, these are still not considered much in the housing sector. The main reasons of this are the lack of information regarding the use of these species. The only use of softwood in India is for shuttering and formwork. Indians consider good nailing properties and lighter weight in softwood species. In addition to this, its low cost. Indians also find softwood species as low-quality wood. Therefore, they should be regarded as only for short-life use and low-value applications (Leslie 2014).

Nevertheless, Indian end-users are currently changing their habits by accepting softwood species owing to the deficit in the supply of tropical hardwoods.

Regarding construction, Indians use bricks and cement. It might be less use of wood for residential and commercial purposes because of the shortage of raw materials available in the market. The government has been restricting the use of wood for the benefit of substitutes products (e.g. glass, steel or aluminium used for windows frames and doors). The situation change when is about housing. This sector uses wood for flooring and roof structures. Wood is also used for interior finishes (e.g. doors, door frames, windows, window frames, stairs) and interior decoration (e.g. furniture, joinery, interior and exterior walls), although the use is insignificant. (Agarwal 2013, BMTPC 2014). Another difference is seen for commercial construction. Dun and Bradstreet (2015), remark that in this sector, the use of wood fills other purposes (e.g. cabinetry and desks). On the contrary, wood can also be used for infrastructure and industrial constructions (e.g. railway sleepers, warehousing and rolling stock structures). Nevertheless, the use of wood for construction purposes present some disadvantages. Wood represent both high price and cost of maintenance. Besides, wood is vulnerable to fires, insects (e.g. termites) and extreme weather conditions. Thus, the wood value decreases as well as its strength over time. Finally, to use softwoods within the construction sector, it is necessary to develop the market by creating campaigns to demonstrate properties and applications.

7.1.4 Technical Environment

India is one the most populous and hence, largest consuming countries in the world. Owing to the recent economy liberalisation that turned India from a closed and central-planned economy to a more service-oriented market, India is in the process of modernization and industrialisation to maintain its current economic growth path. The country has gradually transformed its economic structure, shifting from the dominant agriculture to industry and service sectors. However, it is evident that rural areas show an uneven development between poverty and regions. Hubacek et al. (2007).

The use of technology in the country has become one the major drivers causing harmful impacts into the Indian environment. The Indian economy is always developing, and technology improvements are considered as the ideal solution to prevent environmental degradation. However, the consumption patterns in India has caused high environmental pollution due mainly to CO2 emissions. According to Hubacek et al. (2007), during the period from 1980 to 2001, the emissions of CO2 in India were more than tripled compared to previous years, increasing from 303 to 992 million metric tonnes by an annual growth of 5.4 percent. Thus, India ranks fifth CO2 emitter in the world. The emissions of CO2 in India are not as high as expected due to the Indian economy depends on more from tertiary industries, such as services, than the secondary or manufacturing sector. Nevertheless, India and China account about two-thirds of Asia’s CO2 emissions. The expansion of industries around the country has damaged the local natural resources regarding quality and availability. Hubacek et al. (2007).

The rise in the diversity of products available in the domestic market is also a pattern in the wood industry sector. The Forest Survey of India (FSI), estimated that in 2011 the total forest area and tree cover in the country was approximately around 782,871 km2. This proportion represents 0.08 ha of the availability per capita of forest land in India (one of the lowest in the world) and about 23.81 percent of the total geographical area. The problem of low availability of forest land has been faced since 1996 by banning indiscriminate clearing and illegal logging of forests. Officially, only authorised forest management plans that follow strictly limited harvesting of wood are allowed of logging. Furthermore, the forest in India are mainly owned by the state and about 10 percent are in private hands (Ganguly and Eastin 2007).

In general, the wood industry in India is known by low-technology manufacturing sectors. Most of these industries operate without regulations for standardising their products and prefer to work with a cheap labour force to reduce the production costs. However, the domestic demand of plywood in India depends on the local production of this product. Although all large and medium scale plywood manufacturing industries (around 62 units) have been closed, the current production structure of plywood depends on nearly 3,500 units in the small-scale sector. These remaining industries depend on forest plantations of tropical hardwood species (around 93 percent), to satisfy the local demand for raw material.

7.2 **Statistical Modelling of Indian Plywood Demand**

7.2.1 Time-Series Properties of Variables

Time-series samples are part of the econometric methods that can be used to analyse economic data. Time-series samples are collections of observations from one or many variables gathered over time (Asteriou and Hall 2007). This method requires the analysis of properties, such as normality and stationarity, to determine a suitable econometric model. In this study, Figures AA to HH in Annex 4 exemplify the performance over time of the logarithmic transformations of the level series and their respective first differences. The same figures include their corresponding correlograms, up to 12 lags. Additionally, Table 4 lists all the statistics information regarding the normality of the data series obtained from Jarque-Bera (JB) test. In the next step, Table 5 provides the results achieved from the ADF unit root test. These results show the possibility to use differenced time-series data or cointegration specifications.

Based on the results listed in Table 4, all time-series data sets from 1990 to 2015, where possible, can be considered as distributed normally. The premise is that all p-values obtained from the JB tests are larger than the 0.05 level of significance. Furthermore, half of the series are positively skewed. These variables are Indian imports of plywood, Indian Gross Domestic Product per capita, Indian domestic price of plywood and Indian economic openness. The other half of the series are negatively skewed. These are Indian unemployment, Indian population density, Indian domestic price of industrial Roundwood and Indian domestic price of medium-density fibreboard. It is important to remark, that all the distributions show an asymmetric tail extending to more positive or negative values. In the case of positive kurtosis, this indicates a relatively peaked distribution in all the series.

Table 4: JB Test for normality of logarithmic transformations of the levels series 1990-2015.

Variable	Normality	*p*-values	Skewness	Kurtosis
LIMP, Indian Imports of Plywood	1.477	0.477	0.210	1.911
LGDPC, Indian Gross Domestic Product per Capita	2.741	0.254	0.323	1.553
LDPP, Indian Domestic Price of Plywood	1.367	0.505	0.110	1.898
UE, Indian Unemployment	2.262	0.323	-0.255	1.648
EO, Indian Economic Openness	2.638	0.267	0.223	1.504
LPOPD, Indian Population Density	1.688	0.429	-0.197	1.816
LDPIR, Indian Domestic Price of Industrial Roundwood	2.323	0.312	-0.529	1.985
LDPMDF, Indian Domestic Price of Medium-Density Fibreboard	0.829	0.661	-0.144	2.045

Note: Jarque-Bera Test refers to normality and the H_0 suggests that the variable is distributed normally.

The results obtained from Table 5, determine that all the time-series data sets from 1990 to 2015, where possible, are non-stationary in levels. In the case of these data series, the lag length *p* considered was estimated by the Schwartz's information criterion (SIC). This method shows that the correct lag length for the 25 observations analysed (included after adjustments), was 5. The only exception was the logarithm of the data series corresponding to Indian Domestic Price of Medium-Density Fibreboard (LDPMDF) owing to the number of 19 observations analysed (included after adjustments). Table 5 also shows that half of the data series have a significant linear time trend. The exceptions after running the ADF are the logarithm of the data series corresponding to Indian Domestic Price of Plywood (LDPP) and Indian Domestic Price of Medium-Density Fibreboard (LDPMDF). Both variables have only a significant intercept. Other exceptions were found in the data series of Indian Unemployment (UE) and the logarithm of the data series of Indian Population Density (LPOPD). In both cases, there is no significant linear time trend nor trend.

The Schwartz's information criterion also shows that almost all the series data become stationary in the first difference and have none intercept nor trend. The exceptions to this, are the first differences of the logarithm of the data series corresponding to Indian Gross Domestic Product per Capita, D(LGDPC), and Indian Population Density, D(LPOPD). The intercept for D(LGDPC) is significant, while for D(LPOPD), both trend and intercept are significant. Finally, Table 5 shows that the only data series that become stationary until the second difference is the logarithm of the data series of Indian Population Density, 2D(LPOPD). In this case, the intercept is significant.

Table 5: ADF Unit Root Tests for the variables in Levels, 1st and 2nd Differences, 1990-2015.

Levels					
Variable	**Lag**	**Determination**	***t*-ADF**	**Significance Level**	**Decision**
LIMP, Indian Imports of Plywood	5	Trend and intercept	-2.601	0.279	I(1)
LGDPC, Indian Gross Domestic Product per Capita	5	Trend and intercept	-3.224	0.102	I(1)
LDPP, Indian Domestic Price of Plywood	5	Intercept	-2.380	0.157	I(1)
UE, Indian Unemployment	5	Trend and intercept	-3.634	0.047	I(1)

EO, Indian Economic Openness	5	None	1.042	0.917	I(1)
LPOPD, Indian Population Density	5	Trend and intercept	-2.957	0.165	I(1)
LDPIR, Indian Domestic Price of Industrial Roundwood	5	None	0.193	0.734	I(1)
LDPMDF, Indian Domestic Price of Medium-Density Fibreboard	4	Intercept	-2.459	0.140	I(1)
1st Differences					
Variable	**Lag**	**Determination**	***t*-ADF**	**Significance Level**	**Decision**
D(LIMP), Indian Imports of Plywood	5	None	-4.843	0.000	I(0)
D(LGDPC), Indian Gross Domestic Product per Capita	5	Intercept	-5.356	0.000	I(0)
D(LDPP), Indian Domestic Price of Plywood	5	None	-5.044	0.000	I(0)
D(UE), Indian Unemployment	5	None	-5.889	0.000	I(0)
D(EO), Indian Economic Openness	5	None	-4.050	0.000	I(0)
D(LPOPD), Indian Population Density	5	Trend and intercept	-2.849	0.198	I(1)
D(LDPIR), Indian Domestic Price of Industrial Roundwood	5	None	-6.549	0.000	I(0)
D(LDPMDF), Indian Domestic Price of Medium-Density Fibreboard	4	None	-5.338	0.000	I(0)
2nd Differences					
Variable	**Lag**	**Determination**	***t*-ADF**	**Significance Level**	**Decision**
2D(LPOPD), Indian Population Density	5	Intercept	-4.253	0.003	I(0)

Notes:
Level Critical Values with none determination: 1%= -2,699; 5%= -1,9614; 10%= -1,607
Level Critical Values with intercept determination: 1%= -3,788; 5%= -3,012; 10%= -2,646
Level Critical Values with trend and intercept determination: 1%= -4,468; 5%= -3,645; 10%= -3,261
1st Differences Critical Values with none determination: 1%= -2,686; 5%= -1,959; 10%= -1,607
1st Differences Critical Values with intercept determination: 1%= -3,808; 5%= -3,021; 10%= -2,650
1st Differences Critical Values with trend and intercept determination: 1%=-4,616; 5%=-3,710; 10%=-3,29
2nd Differences Critical Values with none determination: 1%= -2,728; 5%= -1,966; 10%= -1,605
2nd Differences Critical Values with intercept determination: 1%= -3,857; 5%= -3,040; 10%= -2,660
I(1): There is one unit root which means non-stationary series
I(0): There is no unit root which means stationary series

7.2.2 Time-Series Correlograms for the Indian Plywood Demand Model

The use of correlograms is important when is necessary to validate whether the data series are stationary or not. In this study, the correlograms illustrated in Figures AA to HH in Annex 4, determine that the empirical modelling of Indian Plywood demand based on different time-series data sets from 1990 to 2015, where possible, have problems in trend when non-stationarity is not considered. The demand model illustrated in Figures AA to HH in Annex 4, show a linear graph for each of the logarithmic and difference time-series, together with their respective correlograms. However, the correlograms illustrated in Figures AA to CC belong to the explanatory variables that are part of the conventional demand model of Indian plywood. Meanwhile, the correlograms illustrated in Figures DD to HH belong to the explanatory variables that were tested by the ad hoc model.

In the case of the explanatory variables that belong to the conventional demand model of Indian plywood, the correlograms indicate that the time-series data sets for Indian Imports of Plywood (LIMP), Indian Gross Domestic Product per Capita (LGDPC) and Indian Domestic Price of Plywood (LDPP) seem to be non-stationary in their levels, but appear to be stationary in their respective first differences. However, for LIMP, the sudden and deep drop in observations of 2000 and 2005 indicate problems in the estimation during the period from 1990 to 2015. The same situation seems to happen for LDPP during the period from 1997 to 2004. In both cases, there seem to be two separate time periods.

Regarding the ad hoc model, the correlograms that belong to the explanatory variables indicate that the time-series data sets for Indian Unemployment (UE), Indian Economic Openness (EO), Indian Domestic Price of Industrial Roundwood (LDPIR), Indian Domestic Price of Medium-Density Fibreboard (LDPMDF) and Indian Population Density (LPOPD) are non-stationary in their levels, but seem to be stationary in their respective first differences. Furthermore, at least some of these data series indicate problems in their estimations. The time-series data sets of domestic price for both Industrial Roundwood (LDPIR) and Medium-Density Fibreboard (LDPMDF), seem to have two separate periods: in the case of LDPIR, one period ends in 1993 and the other starts in 2000; meanwhile for LDPMDF, one period ends in 2000 and the other starts in 2007. Both data series show a short period that seems to be a gap between two different trends. Nevertheless, in most of the cases, there is a growth trend starting in 2000 and a decline in 2008. The growing then can be the result of the economic reform, while the global recession evidently caused the decline.

More information can be obtained from the correlograms. Thus, two separate time periods seem to happen in variables such as imports of plywood (LIMP), the domestic price of plywood (LDPP), the domestic price of industrial Roundwood (LDPIR) and domestic price of medium-density fibreboard (LDPMDF). In both conventional model and ad hoc model, there is a possibility to estimate two periods of time separately, however, this only could be possible if more reliable data were available. Finally, there are certain problems in the data series collected because the information cannot be reliable due to the shortages in the Indian statistical system.

7.2.3 Results for Indian Plywood Demand Model: Level Model

Per the economic theory, certain economic variables are considered as non-stationaries. Thus, the combinations of these economic variables to become stationaries, keep their relationships in equilibrium. In consequence, there is cointegration among economic variables when there is a stationary equilibrium relationship among them. However, when the economic variables present non-stationarity, then is necessary to define a method to estimate them. In this study, the Engle-Granger error correction method (Engle and Granger 1987) is considered for determining the conventional import demand model in two stages. Nevertheless, the Johansen's cointegration method can be applied if necessary.

In the first stage, the use of ordinary least squares (OLS) provides the long-run coefficients of the static relationship between the economic variables analysed in the Indian plywood demand model. Later, the second stage estimates the short-run for the error correction method (ECM) based on the residuals obtained from the previous long-run regression. Thus, the ECM combines the information collected in the long-run relationship with the short run dynamic factors.

7.2.3.1. Level Model

The level model is used to define the long-run equation in equilibrium. There is a simple linear regression model in the double-logarithmic formula (Eq. 5.3.A). In this model, the logarithm of Indian Imports of Plywood (LIMP) is the dependent variable, and the logarithm of Indian Gross Domestic Product per Capita (LGDPC) together with the logarithm of Indian Import Price of Plywood (LDPS), are the independent or explanatory variables. An ordinary least square method (OLS) is run by the statistic software EViews and the results show that the equation for the demand is static. The time-series data sets include 26 annual observations that correspond to the period from 1990 to 2015, where possible. The results for the level model are shown in Table 3A (Level Model – Indian plywood demand), in Annex 3. Finally, the estimated coefficients obtained from the level model are presented in the following equation together with the t-values (in parentheses) and the respective logarithmic variables:

$$\underset{}{log\ \mathrm{IMP}t} = \underset{(2.361)}{3.833} + \underset{(15.301)}{1.979}\ log\ \mathrm{GDPC}t - \underset{(-3.452)}{1.023}\ log\ \mathrm{DPP}t + ut \qquad (\textbf{Eq. 7.2.3.1.A})$$

The above equation shows that both coefficients, LGDPC and LDPP, possess the expected signs suggested by the consumer theory (Varian 2010). The values in both coefficients, LGDP and LDPP, are 1.979 > 1 and -1.023 (in absolute value) < 1, respectively. These results explain that the Indian plywood demand seems to be income and price elastic in the long-term. However, the *p*-values of *t*-statistics can validate these results. The *p*-values for LGDPC and LDPP (0.000 and 0.002, respectively), indicate that Indian imports of plywood are highly dependent on consumer income (LGDPC) and price effect (LDPP) at 1% of significance level. In consequence, the null hypothesis of a zero coefficient is rejected. Nevertheless, the significance of the above long-run coefficients should not be understood as usual owing to the presence of non-stationary variables

The model also shows the goodness of fit (92%). This characteristic is explained by the variance of the imports of plywood series (adjusted R-squared = 0.91). Also, there is the presence of serial correlation problems based on Durbin-Watson statistic (DW = 1.05). However, the results obtained from all the different tests, the Jarque-Bera Histogram-Normality test, Heteroskedasticity test and Breusch-Godfrey serial correlation LM test for the residual, show that all the *p*-values are greater than 0.05. Consequently, it is possible to accept that there is no problem of non-normality, heteroscedasticity nor serial correlation in the residual series in the model, respectively.

The results of the unit root test are also shown in Table 3A in Annex 3 (Level Model – Indian plywood demand). These results indicate that the residuals series for the model become stationary at the level. The lag length *p* considered was estimated by the Schwartz's information criterion. Based on this method, the correct lag length for the 26 observations was 5; and the residuals series show none intercept nor trend. Moreover, *t*-statistic is higher than the level critical values at 1, 5 and 10 percent (-2.939 > -2,660, -1,955 and -1,609, respectively). Therefore, the null hypothesis can be rejected, the residuals of the model are stationary, and all the variables of the long-run model are cointegrated.

About DW statistic, it is necessary to take additional tests of the stationarity of the residuals from the level model in all the three variables. MacKinnon critical values, designed for cointegration testing, indicate that the null hypothesis is not rejected at the 1%, 5% nor 10% level. The results are shown in Table 3C (MacKinnon critical values for cointegration test), in Annex 3. These results are rather contradictory to the results shown in Table 3A (Level Model – Indian plywood demand), in Annex 3. Consequently, the existence of cointegration remains uncertain. Nevertheless, we proceed to the second stage in modelling.

7.2.3.2. Error Correction Model

Although the long-run Level Model presents uncertainties in the cointegration test, it is necessary to continue modelling the second stage. The error correction model (ECM), combines information of the long-run relationship with short run dynamic factors. This model follows the residuals obtained in the regression equation in equilibrium (Eq. 7.2.3.1.A). In the short-run, the ECM includes the first differences of the variables, known as regressors and regressands, and the lagged Error Correction Term (ECTt-1). The long-run relationship in equilibrium provides the new variable. In this way, the ECM can combine the properties built in the long-run and short-run. It is important to remark, that all the variables in ECM are stationary. For this reason, it is possible to say that there is no spurious regression problem in the model.

Based on the above information, it is possible to formulate the short-run equation for the ECM based on the long-run equation as:

$$\Delta \text{LIMP}t = a + \underset{+}{b}\,\Delta \text{LGDPC}t + \underset{-}{c}\,\Delta \text{LDPP}t + \underset{-}{d}\,\text{ECT}t\text{-}1 + \varepsilon t \qquad \textbf{(Eq. 7.2.3.2.A)}$$

Where *Δ*LIMP is the first difference of Indian Imports of Plywood, *Δ*LGDPC is the first difference of India's GDP per Capita and *Δ*LDPP is the first difference of Indian Domestic Price of Plywood. Moreover, the coefficient *a* is the constant term, coefficient *b* is the income elasticity, coefficient *c* is the price elasticity; *d* is the coefficient of the ECT and ε is the error term. In the case of the coefficient *d*, its value must be negative and statistically significant. In addition to this, coefficient *d* should denote the speed of correction of the response variable to its long-run value. Notice that the signs under the other coefficients explain the signs for both income and price coefficients that are expected for the short-run. For the ECM, the results are presented in Table 3B (Error Correction Model – Indian plywood demand), in Annex 3. Finally, the coefficients and their *t*-values (in parentheses) estimated in this model are shown in the following equation as:

$$\Delta LIMPt = 0.037 + 1.384\, \Delta LGDPCt - 1.113\, \Delta LDPSt - 0.569\, ECT_{t-1} \qquad \textbf{(Eq. 7.2.3.2.B)}$$
$$(0.521) \qquad (1.988) \qquad (-4.291) \qquad (-2.948)$$

The coefficients for the first differences of LGDP and LDPP in the equation above, count with the expected signs in the short-run. Also, the value for the coefficient of the lagged error correction terms, counts with the characteristics expected. These are a negative sign and a statistically significant value. Thus, the value -0.569 denotes that the Indian imports of plywood adjust on 57% in a year. The adjusted R-squared (0.573) obtained in the ECM shows a lower value of goodness than the level model.

In the case of F-statistic, with a *p*-value = 0.0003, is highly significant and indicates that all the regression coefficients are also significant. However, the value of Durbin-Watson statistic (DW = 1.916) denotes autocorrelation problems. For this reason, the null hypothesis of no autocorrelation can be rejected. With respect to the other tests, the *p*-values corresponding to the Jarque-Bera Histogram-Normality test are lower than 0.05, meaning problems with non-normality; the *p*-values corresponding to the Heteroscedasticity test and Breusch-Godfrey serial correlation LM test for the model residuals are greater than 0.05, indicating no problem in the model in terms of heteroscedasticity nor serial correlation in the residual series, respectively.

Table 3B (Error Correction Model – Indian plywood demand), in Annex 3, also presents the results of the unit root test. These results indicate that the residuals series for the model become stationary at the level. In addition to this, the Schwartz's information criterion was used to estimate the correct lag length *p* for the 25 observations considered after adjustments. This method denoted 5 lag length. The ADF test also shows none intercept nor trend in the residuals.

Based on this information and considering that the value of *t*-statistic is higher than the level critical values at 1, 5 and 10 percent (-4.602 > -2,665, -1,955 and -1,609, respectively), the null hypothesis is rejected. This situation explains no unit root in the residuals of the error model. However, seeing the uncertainties in the cointegration test results of the long run model, it is necessary to compare the results with MacKinnon critical values for cointegration in the error correction model for the same three variables. In consequence, the results on Table 3C (MacKinnon critical values for cointegration test), in Annex 3, indicate that the null hypothesis is rejected at 5%, but there are still uncertainties in the results. For this reason, the Johansen cointegration test is also run to re-estimate the conventional model.

The Johansen Cointegration test (Johansen 1995), is theoretically recognised as a more reliable method than the two-step procedure for cointegration analysis proposed by Engle and Granger. The Johansen Cointegration test allows estimating more than one cointegration relationship independently if there are two or more time-series data sets.

For this study, this test is used to model non-stationary time-series data sets only for the conventional demand model for Indian plywood demand. The results obtained in the long-run cointegration coefficients will be compared with the results of the long-run single-equation level model.

The Johansen Cointegration test shows one cointegration relationship among the three variables of the Indian plywood demand model. This result means that there is a long-run relationship among them. The premise of this is based on two rank tests: Trace and Maximum Eigenvalue cointegration rank tests. Both tests, confirm that there is no possibility to reject the null hypothesis of one cointegration vector. The reason is that in both tests, the *p*-value (at most 1) is higher than 5 percent (0.422 and 0.338, respectively). Based on this information, it is possible to formulate the cointegrated Johansen equation for the logarithm of Indian imports of plywood (LIMP). Thus, considering both, long and short term effects, the normalized cointegrating coefficients for income and price (LGDPC and LDPP, respectively) and the standard error (in parentheses) are:

LIMP	LGDPC	LDPS
1.000	-2.061	0.947
	(0.099)	(0.241)

And the equation for the long-run model, where LIMP is explained by other variables is:

$$\text{LIMP} = 2.061\ \text{LGDPC} - 0.947\ \text{LDPS} \qquad \textbf{(Eq. 7.2.3.2.C)}$$

Considering the results in the level model (Eq. 7.2.3.1.A), the coefficients for LGDPC and LDPP were 1.979 and -1.023, respectively. The new values obtained in Eq. 7.2.3.2.C, denote the difference between the cointegration coefficients, meaning that coefficients LGPC and LDPP in the Johansen equation are larger and smaller, respectively, than the coefficients estimated by ordinary least squares (OLS). Consequently, further modelling is left for future research on this topic.

7.2.4 Results for Ad hoc Model

The results of the Ad hoc models (long-run elasticities of Indian imports of plywood) are in Table 3E and 3F, in Annex 3. For this purpose, the selection of ad hoc models depended whether the sign of the coefficients estimated followed the economic theory or not. Table, 3E have listed the long-run models for the Indian demand for plywood explained by income (LGDPC) and other variables describing economic activity. These economic activity variables are unemployment (UE), economic openness (EO) and population density (LPOPD). Additionally, price explanatory variables were added to another model for testing and create alternative models.

Depending on the ad hoc model, it is important to analyse the magnitudes of the estimated elasticities and the variations of the coefficients. However, regarding income elasticity, values of GDPC varies between 1.57 and 2.06. The highest coefficient was determined by the Johansen test. For unemployment (UE), the value seems to be significant but negative (-2.71), meaning that there is a substantial impact on imports demand for plywood caused by unemployment. On the contrary, the value of economic openness (EO = 0.07), explains a small but positive effect on the demand for imports of plywood. Among all the variables, the coefficient of population density (POPD) seems to be the largest and varies from 7.94 to 8.89, depending on the model. It can be explained as a 1 percent increase in population density induces around 9 percent growth in imports of plywood.

There are also results for the price elasticity of the Indian imports demand for plywood. For this purpose, the variable domestic price of plywood (DPP), is considered. The results vary from -0.95 to -1.02. These results are different than the ones obtained for the income elasticity. In the case of the price elasticity, the larger value was obtained from OLS-estimation (Eq. 7.2.3.1.A). This value indicates can be explained as a 1 percent increase in price reduces imports of plywood by only 1 percent. Therefore, there is no much difference between the estimates neither the need for further modelling of this variable.

In addition to DPP, other price relations were considered (cross-price). Thus, the price of plywood was related to the price of medium-density fibreboard (DPP/DPMDF) and with the price of industrial Roundwood (DPP/DPIR). Different models were used for both cross-price elasticities (see Table 3F). The results from these cross-price elasticities explain that such products complement plywood owing to their negative sign. The cross-price elasticities for MDF are quite large and vary from -3.18 to -4.03, meaning that plywood and MDF are quite close good complements. The same situation occurs with industrial Roundwood. For this variable, the cross-price elasticity value (-4.96) show a high, complementary relationship with plywood.

In is important to highlight, that the explanatory variables of domestic price of medium-density fibreboard (DPMDF) and domestic price of industrial Roundwood (DPIR) were tested in the ad hoc models. However, both variables show no statistical significance nor the sign suggested by the consumer theory (Varian 2010). On the contrary, the coefficients of the variables GDPC, UE, EO and POPD, seem to be highly significant (based on p-values of t-statistics). Nevertheless, regarding elasticity, POPD, UE and GDPC, show to be elastic (in absolute value, in this order). The same situation is indicated for these variables when are analysed with different price relations (DPP/DPMDF and DPP/DPIR).

Regarding goodness of fit, almost all the models show values above 80 percent of the variance of IMP (R-squared > 0.80). The only exceptions are UE, EO and UE related with DPP and DPIR. The R-squared values are 0.55, 0.77 and 0.64, respectively. However, it can be said that most of the models fit very well the time-series data sets.

Regarding autocorrelation, in all the models analysed, the Durbin-Watson (DW) statistic test indicates positive high serial correlation (values < 2). The reason of this could be misspecification, omitted variables or simple systematic errors in the measurements. Based on this, the statistical significance of the coefficients analyses cannot be interpreted owing to serial correlation exist. In addition to this, the estimates are inefficient, and the OLS estimators are considered unbiased. In the case of the Breusch-Godfrey Serial Correlation LM Test, the results show no serial correlation in only half of the variables estimated in the ad hoc model. The reason is that only half of the p-values are greater than 0.05. The other half of the variables, UE, EO and POPD, count with p-values of 0.0062, 0.02 and 0.01, respectively.

Finally, the p-values corresponding to the Heteroskedasticity test and JB test are higher than 0.05, meaning that the ad hoc model does not suffer from heteroscedasticity nor non-normality in the residuals. Moreover, the results of the ADF test for unit root in the ad hoc model, show that most of the t-statistics are larger than the corresponding critical values at 1%, 5% and 10% level. The exceptions are UE and EO, which happened in the first difference.

7.3 **Summary of the Study and Discussion of the Results**

India is one of the largest countries in the world and the third in Asia. Its total area is approximately 3.29 million km2, e.g. about ten times Finland. Regarding population, India is the second largest country in the world with about 1.21 billion inhabitants. The country also shows a significant diversity regarding culture and languages.

Economically, India is one of the greatest economies in the world, and it is acknowledging as the second fastest growing economy globally. Its economy grows fast because of the high growth GDP rate and macroeconomic stability. Following this trend, in the next fifteen years could be considered as the third largest economy. Today, India’s economy is service-oriented. Before the economy was supported mainly by agriculture. All these changes in the Indian economy are the result of economic liberalisation policies adopted by the Indian government since 1991. Such policies aim to better trade. As such, the government supports gradual reductions in domestic tariffs and eliminates quantitative trade restrictions. Thus, the country has increased the volumes of imports and exports.

The rise in the Indian economy also increased the incomes and spent power of its population. Today, more and more consumers have increased their ownership of homes mainly in the urban sector. Thus, there is more demand for wood products to satisfy the demand in the urban market. Local resources of wood are used without control causing deficit of this resource as raw material. Because of this, India depends on imports of wood to supply its internal markets. However, India became a potential player in the global economy, although there is an apparent shortage of raw materials that challenges the Indian wood-base industry.

Regarding wood products, there are more foreign exporting countries interested in invest in the country. Some of these countries are Australia, Canada, the United States and New Zealand. (Dun and Bradstreet 2015). These countries have set up projects to explore the Indian market demand for wood products. They are interested in defining potential alternatives for future investments but overall business relationships. Considering the lack of information for wood products in India, this study aims to provide a better understanding of the drivers that influence the demand for plywood in India. The results of this research are expected to be valuable for industry stakeholders searching for new channels of commercialization.

India’s wood products market has been explored by different producing countries around the world as well as by local governmental institutions. Previous studies have addressed the development of local wood-based industries. Meanwhile, other studies are focused on building strategies to enter the wood products market. Yadav and Basera

(2013) explored the wood industry balance in India by describing the production and trade of forest products in the country. Additionally, the authors provided a better overview of India's role in the economy at different levels, global, national and regional. In the case of large manufacturing countries (e.g. Canada and the United States), their focus is on business strategies to open the Indian wood products market. Thus, Rattan (1999), in the research conducted by British Columbia concludes that there is no knowledge of Canadian softwood for wood products in India, but there is a high demand for trading finished wood products. Other authors, such as Agarwal and Shang (2004), opened a discussion about the potential of high-quality Canadian softwood in India. The authors based their assumptions on the high prices for high-quality hardwood and wood supply in India. The United States has also invested in research about India. In the case of Ganguly and Eastin (2007), the authors revealed the decline in the consumption of tropical hardwood (e.g. teak). For this purpose, they confirmed the high price of tropical hardwood imported to India under low quality. Moreover, the authors described a rise in the use of wood for high-end furniture purposes. Although previous studies are exploring Indian wood products market, the information is still unreliable and scarce. For this reason, this research addresses specifically the Indian market of plywood and intends to provide an overall description of the factors that affect the Indian demand for this product based on an econometrical analysis.

For the description of the Indian plywood market, it was necessary to analyse different background information and to create a database that can contribute to explain the current situation of the plywood market at the global level as well as the Indian position in the global market of plywood. In the case of the econometrical analysis, this was based on an empirical modelling that helps to visualise the changes in one or more variables when impacting the Indian plywood demand. One of the limitations while collecting secondary data was the inefficiency and lack of systems for gathering information in India. Then, it was common to find variations in the information received. For these reasons, the most reliable and accurate sources were found from official international sources (e.g. the World Bank Development Indicator Database (WB-DID), the Food and Agriculture Organization of the United Nations Statistical Database (FAOSTAT), the International Tropical Timber Organization (ITTO) and the Directorate General of Commercial Intelligence and Statistics (DGCIS), among others). The data collected is annual and corresponds to the period between 1990 to 2015, where possible. For this purpose, FAOSTAT and WB-DID were highly used. In cases of the gap of information, then ITTO and DGCIS were used.

All the information gathered as a secondary data for the descriptive, and econometrical analysis was used to response the research questions of the study. Two questions are aimed to achieve the understanding of the current situation of India's plywood market as well as the factors affecting the demand for imports of plywood. The last question tries to address the market opportunities and challenges for foreign and Finnish wood-based industries when entering the Indian market of plywood.

7.3.1 What is the current state of India's plywood market at local and global level and how is expected to be in the future?

In general, India plays a significant role as manufacturer and consumer of wood products in the world. Most of the wood produced in the country is used in the construction sector, mainly for housing, and in wood-based industries to provide primary wood products, including plywood. Thus, since 2000, the plywood industry has growth 4.76 percent annually from 1.3 to 2.4 million m3. However, the share of plywood within the total market of wood products in India is still small.

India is known as a net importer of wood, mainly tropical hardwood logs. The reason of this is the scarce availability of wood resources in the country due to policy regulations implemented by the Indian government. As such, the plywood industry is limited to the availability of wood as a raw material. Thus, the plywood industry depends mainly on the supply of tropical hardwood species from evergreen forests and insignificant amounts of imports of softwood and other hardwood species. However, the country imports other wood products, such as sawn wood and plywood, but in negligible volumes. Although the local production of plywood is almost consumed in the country, India is considered a net exporter of plywood but the value and volume exported are as insignificant as the imports.

The plywood industry is the process of transforming from an unorganised market into an organised. The local production of plywood depends on about 3,500 units in the small-scale sector. In addition to this, it is well known the use of low-technology in the manufacturing sector, as well as, the use of cheap labour to reduce the production costs. Although the manufacture of plywood is about only 50 percent of the total industry capacity, the plywood industry is considered as the most promising among other composite wood products industries. Thus, the production of plywood represents 65 percent of the total output of engineered wood in the country. Regarding wood species, the production of wood is based on tropical hardwood and only 1 percent corresponds to softwoods species. Today the production of plywood seems stable despite that in 2011 this industry was hit by a collapse in the real estate sector, a shortage in the labour force and by the invasion of cheap imports from China. Nevertheless, India is still among the major producing countries of plywood in the world, mainly of tropical hardwood plywood, and together with China, Malaysia, Indonesia and Brazil accounts a global share of 87 percent.

The use of plywood is preferred instead of other wood products because plywood is inexpensive, flexible, workable and reusable. In addition to this, plywood provides excellent resistant properties to cracking, splitting and warping. These features are highly appreciated for Indian end-users. That is how about 90 percent of the local production of plywood is commercialised in the domestic market. In the last 15 years, the consumption trend of plywood has growth rapidly moving from 63 thousand m3 to 2.5 million m3. For this reason, India is among the six major consuming countries of plywood in the world and the top three major consuming countries of tropical hardwood plywood.

The plywood industry in India has a bright future. The production of plywood is steadily growing since the last 20 years. The continuously growing population and purchasing power of the Indian middle-class can ensure significant investments related to infrastructure and low-cost housing. The growing interest in buying brand plywood amongst middle class implies significant investments to improve the quality of the plywood, its durability and eco-friendliness. However, it is necessary to establish more cost-efficient production processes for plywood due to tightening competition in the domestic market due to potential substitute products such as Medium-Density Fibreboard (MDF).

7.3.2 What factors explain the plywood demand in India?

To answer this question, it was necessary to run an econometrical model based on the Indian demand for plywood. An econometric time-series model based on only significant variables was considered to estimate the elasticities of the demand for Indian plywood. The time-series data sets corresponded to annual data over the period between 1990 to 2015, where possible. The empirical analysis was divided into two models: the conventional demand model and an ad hoc model. Both models intended to explain the Indian demand for imports of plywood based on income, price and economic activity variables. The data was non-stationarity and therefore, it was necessary to test the Engle and Granger (1987) method to solve this purpose. The results show several uncertainties related to cointegration. In this problem, different cointegration tests were considered such as MacKinnon critical values for cointegration and Johansen method (1995).

It is important to highlight that only long-term elasticities were considered to answer this research question. However, the results for short-term elasticities were also calculated. These results, obtained in the conventional demand model, were all smaller than long-term elasticities. This information is important to highlight because it confirms the results of previous studies related to wood products consumption e.g. Hurmekoski et al. (2015), Montiel (2016) and Wan et al. (2011). Meanwhile, in the case of long-term elasticities, in both models, conventional and ad hoc, the results show that all of them are statistically significant. Moreover, although the significance of the coefficients varies from one variable to another, the results cannot be explained directly due to uncertainties in the cointegration testing.

In the conventional demand model, the results for the long-term elasticities confirm that imports of plywood in India are related to income and price. Based on Johansen cointegration test (Eq. 7.2.3.2.C), the coefficients in the Indian demand for import of plywood seems to be elastic in income but inelastic in price. As such, considering a rise in Indian consumer income (i.e., Indian GDP per Capita), there is a strong growth of imports of plywood in India because of an increase in the application of plywood for housing within the construction sector. Plywood seems to be a luxury product intended for interior decoration and furniture. Meanwhile, regarding the price of plywood, the elasticity value in the coefficient cannot confirm the price-sensitiveness within the Indian market. In other words, Indian consumers might not adjust their consuming habits during price changes over time due to the Indian plywood market is still not too competitive. This characteristic in the market does not allow end-users to replace plywood with other products nor alternatives. Substitute products such as cheaper medium-density fibreboard or alternatives such as imports of softwood plywood instead of traditional hardwood plywood or imports of plywood with more favourable tariffs from other countries. This result is contradictory with Montiel's (2016) analysis of the Indian sawn wood market. Finally, if in the future, the plywood market becomes more competitive, prices might change, and therefore, the price effect might cause a higher impact on the demand for imports of plywood in India.

In the case of the ad-hoc model, the long-term elasticities obtained in the results of the Indian demand for imports of plywood correspond to income, price and economic activity variables. All the long-term elasticities for both, income and economic activity variables, are statistically highly significant and elastic (coefficient value is greater than one). These elasticities determine that a rise in Indian GDP per capita or the population density would impact positively an increase in the quantity demanded of imports of plywood in India. The reason might be due to an apparent rise in the consumption of plywood for housing in the construction sector. In the case of unemployment (UE), an increase in the rate of this variable might cause a high impact in demand for plywood due to the level of imports of this product in the country might diminish. The exception is economic openness (EO), which shows to be inelastic. Thus, owing to a rise in trade openness, there is a minor impact on the total demand for imports of plywood.

Regarding price, the long-term elasticities seem to be highly significant and elastic when the domestic price of plywood is related to the domestic price of medium-density fibreboard (DPP/DPMDF). This cross-price elasticity is modelled with economic activity and income variables (POPD and EO, and GDPC, respectively), with the highest value in this order. Meanwhile, the long-term price elasticity for the domestic price of plywood when is related to the domestic price of industrial Roundwood (DPP/DPIR), shows the highest elasticity value among all the cross-price elasticities and seems to be elastic, however, it is only significant. Additionally, owing to significant values, this cross-price elasticity is modelled only with the economic activity variable, unemployment (UE). Nevertheless, all cross-price elasticities show negative sign and therefore, it can be considered that such products complement plywood.

In addition to what has been mentioned above, all the income and economic activity variables used to model the cross-price elasticities, show to be highly significant and with the correct sign based on the economic theory. However, the elasticity shows to be higher and elastic with POPD, UE and GDPC, in this order, meanwhile, EO is inelastic.

In general, the results of the ad hoc model seem to show a steady drop in the demand for imports of plywood during a rise in the domestic price of plywood when it is related to other complement products (DPMDF or DPIR). Therefore, the relationships between plywood with DPMDF and DPIR are sensitive to price as consumers have more time to adjust to a price change. The strongest impact occurs when unemployment is combined with the cross-price elasticity DPP/DPIR. In both cases, the impact on price sensitivity might be caused by the small variety of substitute products that can be used instead of plywood for joinery, furniture or interior decorations in the housing sector. Nevertheless, owing to the rise in the Indian population density, there is a high demand in the real estate business represented by more residential constructions. Thus, in the case of the cross-price elasticity DPP/DPMDF, the greatest negative impact on the demand for imports of plywood is caused when is combined with a rise in the population density. On the contrary, the smallest negative price effect occurs when there is an increase in the domestic price of medium-density fibreboard with respect to the domestic price of plywood during an increase of the consumer income (GDPC).

7.3.3 What are the challenges and opportunities that the Indian plywood market shows for foreign and Finnish wood-based industries?

Based on the description and econometrical analysis in this study, there are at least six challenges that foreign and Finnish industries, as well as investors, should consider when facing the Indian plywood market. The first barrier is the perception of Indian end-users with respect to the use of plywood. In India, tropical hardwoods are known as the type of wood with the best properties for working. Thus, tropical hardwoods are considered stronger and more resistant to fire and termites than softwoods. Owing to the appearance of tropical hardwoods, these species are very appreciated in the construction sector.

Second, there is a lack of information regarding the use of softwoods in India. For this reason, suppliers of these products should strengthen their relationships with India and be aware of promoting softwood's attributes and potential applications through campaigns and commercial trials around the country with the only purpose of increasing the availability of softwood products.

In addition to the lack of information in India, another challenge for foreign investors is the shortage of systems to collect statistical data concerning to production and trade of plywood in India. There are governmental entities gathering information about wood and wood products in general. However, the information is unreliable, scarce and even contradictory when is compared to official international sources. This situation makes difficult to analyse the offers and demands on the market that are necessary to build commercial strategies due to poor market intelligence sources.

Fourth, India's bureaucracy is the worst in Asia. This phenomenon together with corruption has been responsible for many complaints from local people in business and foreign investors. Thus, the perceptions about India's bureaucrats is negative as well as the impact caused to business decisions. This situation makes compulsory for foreign suppliers to understand the local culture and search for reliable assistance regarding taxation, payments and transparency among firms operating in India.

Fifth, the exchange rate of the Indian rupee depends on the local market conditions. However, the Indian government intervenes when the exchange rate is out of control. Thus, currency fluctuations impact the circumstances demand on the market of plywood when the government decides to increase or reduce the money supply. In fact, a depreciating rupee makes exports cheaper but import expensive. This a difficult challenge for those countries with overvalued currencies, trying to export plywood to India. In consequence, it is important to examine the local exchange rate and track the rupee to avoid currency risks.

Sixth, India's poor infrastructure and complex distribution channels. Infrastructure is considered as the biggest barrier for companies trying to establish sustainable distribution channels to supply wood and wood products, including plywood, in the country. In addition to this, local wood industry, including plywood, is underdeveloped and fragmented. On average, Indian distribution channels of wood and wood products, including plywood, involve importers, distributors, wholesalers and retailers. This structure impacts foreign suppliers economically due to each of these members count with rigid margins for payments. Moreover, suppliers can be replaced by other competitors due to the high number of intermediations within the distribution channel.

Regarding opportunities, in this study, there are identified at least six different opportunities for foreign and Finnish industries trying to enter the Indian plywood market. Owing to India is expected to become the fifth largest consumer country in the world by 2025, population and economy will continue growing. Thus, a different sector within the wood industry together with the construction business, including housing, furniture and packaging, might turn into key targets for foreign exporters and investors to build business relationships.

Second, India is improving its way to do business in the country. Although in the index published by the Wold Bank, India ranks at the 130th position, India is pushing to become among the top 50 nations by the end of 2018. Based on this fact, it would be easier to negotiate Free Trade Agreements (FTAs) with foreign and Finnish industries interested in the commercialization of plywood. In this way, through foreign direct investments (FDI), is possible to avoid trade barriers and other issues for the benefit of the commercialization of goods and services.

Third, product adaptation based on end user's will. Wood products in India lack industry standards. End-users are responsible for defining grading, dimensions and species for the wood product required. The opportunity is then, only for those exporters willing to adapt their production chain to satisfy India’s end-users desires. However, it is also possible for those potential investors and exporters to recommend and inform end-users about suitable products for their applications.

Fourth, raw materials supply to India. Owing to the shortage in raw material availability, the country relies on imports of wood and wood products. The opportunity is open to those foreign investors and wood industries with evident wood availability to export, secure and low-cost logistics but willing to commercialise at a competitive price. Based on the fact that India is considered as a price-sensitive market.

Fifth, commercialization of softwood plywood as a new alternative. Although India lacks information regarding the use of softwood species, there is a potential opportunity for those foreign and Finnish wood industries willing to explore the Indian market of plywood. The demand for imports of plywood has grown in the last ten years due mainly to the purchasing power of the middle class has also increased over time along with the real estate market. Additionally, the low import price of plywood and other wood products caused by the gradual reduction of their import tariffs. Finally, there is a small but potential interested in the use of softwood in particular applications to replace the traditional use of tropical hardwood in furniture and interior decorations within the housing sector. Softwoods can be easier to work than hardwoods if there is previous knowledge about its correct use. Therefore, owing to the high prices for importing even low-quality tropical hardwoods from some African and South American countries, softwood seems to be a good alternative for those exporting countries of plywood with competitive price.

Sixth, engineered wood products supply. Plywood is known as the original engineered wood product. The rise in the demand for these value-added wood products for high-end applications (joinery, furniture and interior decorations) in housing and commercial constructions, is an opportunity to satisfy the demanding middle and upper classes in India more and more influenced by the western-style. In consequence, the opportunity is for those pioneers willing to establish businesses in India before other competitors do it.

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9 ANNEXES

9.1 Annex 1

Table 1A: Global consumption of plywood (m^3), 1990-2014.

Year	Consumption			Global Share		AAGR	Average in 6 years
	Hardwood	Softwood	Plywood Total	Hardwood	Softwood		
2014	46,473,684	80,447,974	126,921,658	37%	63%	0.35%	9.14%
2013	45,811,379	80,671,398	126,482,777	36%	64%	28.26%	10.31%
2012	31,845,630	66,768,549	98,614,180	32%	68%	-3.30%	7.21%
2011	38,378,964	63,602,250	101,981,214	38%	62%	7.76%	7.52%
2010	35,276,984	59,356,573	94,633,557	37%	63%	26.70%	7.04%
2009	30,922,193	43,771,515	74,693,708	41%	59%	-4.94%	2.58%
2008	34,019,990	44,552,460	78,572,449	43%	57%	7.36%	6.27%
2007	35,667,475	37,520,295	73,187,769	49%	51%	9.66%	5.62%
2006	31,685,367	35,055,040	66,740,408	47%	53%	-1.45%	2.79%
2005	29,504,249	38,218,204	67,722,453	44%	56%	4.89%	4.72%
2004	31,562,822	33,003,945	64,566,768	49%	51%	-0.02%	3.91%
2003	31,433,130	33,145,559	64,578,689	49%	51%	17.18%	2.96%
2002	27,096,303	28,015,133	55,111,436	49%	51%	3.44%	-0.53%
2001	26,619,347	26,657,682	53,277,030	50%	50%	-7.30%	0.19%
2000	28,587,606	28,883,469	57,471,075	50%	50%	10.16%	2.77%
1999	24,610,557	27,561,634	52,172,191	47%	53%	0.02%	1.58%
1998	25,123,631	27,038,586	52,162,217	48%	52%	-5.73%	2.12%
1997	28,795,806	26,534,077	55,329,883	52%	48%	-3.75%	3.87%
1996	30,368,032	27,117,019	57,485,051	53%	47%	7.71%	4.80%
1995	28,904,415	24,465,769	53,370,185	54%	46%	8.18%	
1994	26,887,340	22,445,887	49,333,227	55%	45%	3.02%	
1993	26,193,215	21,694,853	47,888,068	55%	45%	3.27%	
1992	24,879,933	21,491,002	46,370,935	54%	46%	4.81%	
1991	23,561,461	20,683,342	44,244,802	53%	47%	1.84%	
1990	21,893,173	21,552,812	43,445,984	50%	50%		

Data: ITTO 2016.

Table 1B: Global consumption of plywood by regions (m^3), 1990-2015.

Year	Consumption						Global Share	
	Africa	Americas	Asia	Europe	Oceania	World	Americas	Asia
2015	1,838,301	18,580,631	114,463,261	8,892,601	916,560	144,691,355	13%	79%
2014	1,831,332	17,734,630	114,332,106	9,050,777	875,646	143,824,492	12%	79%
2013	1,759,454	17,697,692	103,007,654	8,595,990	800,319	131,861,109	13%	78%
2012	1,771,045	18,270,889	86,873,561	8,648,136	821,757	116,385,388	16%	75%
2011	1,714,846	17,802,013	78,431,543	8,840,553	781,264	107,570,219	17%	73%
2010	1,609,441	17,699,552	61,899,819	8,064,712	713,147	89,986,671	20%	69%
2009	1,559,455	16,270,349	54,307,963	6,717,976	522,186	79,377,929	20%	68%
2008	1,431,790	20,091,121	54,107,773	9,342,904	723,256	85,696,844	23%	63%
2007	1,194,010	22,854,703	54,190,564	9,997,726	747,945	88,984,948	26%	61%
2006	1,087,281	24,838,269	47,050,969	8,726,941	769,170	82,472,630	30%	57%
2005	983,920	24,716,219	45,900,504	8,518,382	692,706	80,811,731	31%	57%
2004	805,164	24,635,420	43,097,929	8,197,441	642,911	77,378,865	32%	56%
2003	1,190,850	22,687,861	44,950,280	7,736,512	662,253	77,227,756	29%	58%
2002	836,229	22,470,382	32,960,179	7,419,973	550,516	64,237,279	35%	51%
2001	831,477	21,715,629	26,090,890	7,319,261	438,961	56,396,218	39%	46%
2000	698,111	22,881,652	28,474,013	7,103,883	478,545	59,636,204	38%	48%
1999	916,032	23,103,914	24,037,262	7,018,328	419,511	55,495,047	42%	43%
1998	1,004,235	22,262,209	18,471,048	6,843,322	376,538	48,957,352	45%	38%
1997	759,674	21,089,669	26,086,412	6,412,812	351,419	54,699,986	39%	48%
1996	671,308	20,711,059	23,631,363	6,010,464	289,633	51,313,827	40%	46%
1995	712,431	20,630,683	26,503,792	6,502,987	280,242	54,630,135	38%	49%
1994	773,373	21,414,655	21,659,729	6,214,059	277,907	50,339,723	43%	43%
1993	598,295	20,811,618	20,153,981	6,286,568	254,795	48,105,257	43%	42%
1992	666,063	20,655,664	18,960,996	7,149,022	244,228	47,675,973	43%	40%
1991	700,566	19,915,105	18,430,201	6,870,569	217,191	46,133,632	43%	40%
1990	627,406	22,219,048	16,507,072	7,781,569	276,191	47,411,286	47%	35%

Data: FAOSTAT 2016.

Table 1C: Major consuming countries of plywood (m^3), 1990-2015.

Year	Consumption							Global Share
	Canada	China	India	Indonesia	Japan	USA	World	China
2015	2,884,050	93,969,303	2,573,801	3,352,959	5,798,700	12,854,635	144,691,355	65%
2014	2,914,147	93,896,325	2,577,205	3,352,959	6,402,871	11,495,977	143,824,492	65%
2013	2,834,936	83,521,512	2,604,092	2,812,836	6,507,810	11,621,368	131,861,109	63%
2012	3,158,000	67,416,286	2,616,217	2,737,847	6,179,180	11,692,500	116,385,388	58%
2011	2,988,129	60,159,503	2,671,908	2,463,491	6,286,012	11,159,654	107,570,219	56%
2010	3,454,000	44,704,842	2,633,305	2,340,875	5,890,762	11,076,633	89,986,671	50%
2009	2,365,000	39,992,483	2,557,817	1,446,846	5,217,000	11,051,330	79,377,929	50%
2008	3,791,000	37,834,068	2,144,226	1,303,759	6,159,000	12,928,938	85,696,844	44%
2007	3,502,000	37,489,206	2,085,393	1,120,161	7,124,000	16,355,686	88,984,948	42%
2006	1,986,977	29,408,504	2,151,061	1,305,116	8,348,000	19,552,289	82,472,630	36%
2005	1,894,000	29,530,138	2,109,272	1,155,099	7,934,000	20,127,395	80,811,731	37%
2004	1,667,013	26,499,232	1,927,346	1,318,419	8,262,000	20,208,537	77,378,865	34%
2003	1,698,000	26,135,481	1,740,203	4,020,814	7,230,000	18,606,839	77,227,756	34%
2002	1,609,000	16,027,217	1,605,000	2,035,008	7,841,000	18,674,874	64,237,279	25%
2001	1,516,000	11,931,850	331,000	967,500	7,779,000	17,895,873	56,396,218	21%
2000	1,532,879	12,170,546	63,400	3,052,000	8,244,000	18,983,033	59,636,204	20%
1999	1,494,480	10,420,641	70,400	1,218,300	8,140,000	19,333,000	55,495,047	19%
1998	1,567,700	7,226,939	71,600	380,600	7,197,000	18,599,000	48,957,352	15%
1997	1,395,000	10,101,988	74,300	1,100,000	9,669,000	17,789,000	54,699,986	18%
1996	1,366,000	8,040,700	278,700	1,014,200	9,670,900	17,457,000	51,313,827	16%
1995	1,366,500	11,272,800	270,300	1,125,800	8,849,300	17,514,000	54,630,135	21%
1994	1,611,500	6,258,993	217,187	1,616,000	8,935,300	17,581,000	50,339,723	12%
1993	1,696,634	5,308,482	234,403	434,967	9,362,000	17,161,000	48,105,257	11%
1992	1,667,848	4,978,984	222,810	347,375	8,943,500	17,139,658	47,675,973	10%
1991	1,678,900	3,703,600	249,500	NA	9,207,400	16,471,800	46,133,632	8%
1990	1,810,400	3,092,000	256,768	NA	9,339,400	18,701,308	47,411,286	7%

Data: FAOSTAT 2016.

Note: NA = Not available.

Table1D: Major producing countries of plywood (m^3), 1990-2015.

Year	Production								Global Share
	China	India	Indonesia	Japan	Malaysia	Russia	USA	World	China
2015	104,146,000	2,521,000	5,768,000	2,813,000	4,154,000	3,606,674	9,244,635	147,456,103	71%
2014	104,146,000	2,521,000	5,768,000	2,813,000	4,154,000	3,540,000	9,451,725	147,486,920	71%
2013	92,507,000	2,521,000	5,268,000	2,761,000	4,154,000	3,303,000	9,680,210	134,726,516	69%
2012	76,332,000	2,521,000	5,178,000	2,549,000	4,232,000	3,150,000	9,493,000	118,182,443	65%
2011	68,430,000	2,521,000	4,850,000	2,486,000	4,052,000	3,040,000	9,365,070	109,328,821	63%
2010	50,915,000	2,521,000	4,850,000	2,645,000	4,450,000	2,689,000	9,396,930	91,557,690	56%
2009	44,465,000	2,521,000	4,150,000	2,287,000	3,901,000	2,107,000	8,934,075	81,378,190	55%
2008	43,772,000	2,154,000	4,150,000	2,586,000	4,837,000	2,592,000	10,375,740	85,975,454	51%
2007	44,798,000	2,154,000	4,534,000	3,073,000	5,481,000	2,777,000	12,401,505	92,037,604	49%
2006	36,013,000	2,154,000	4,534,000	3,314,000	5,433,000	2,614,000	13,651,125	84,454,519	43%
2005	33,318,000	2,130,000	4,534,000	3,212,000	5,006,000	2,556,000	14,449,395	81,966,435	41%
2004	28,739,000	1,936,000	5,317,000	3,149,000	4,734,000	2,246,000	14,833,485	76,912,205	37%
2003	26,310,000	1,760,000	6,111,000	3,024,000	4,771,000	1,978,000	14,869,770	73,509,044	36%
2002	16,127,000	1,600,000	7,550,000	2,735,000	4,341,000	1,821,000	15,306,960	63,380,696	25%
2001	11,422,000	315,000	7,300,000	2,771,000	4,318,000	1,590,000	15,416,700	56,238,010	20%
2000	10,764,000	59,000	8,200,000	3,218,000	4,434,000	1,484,000	17,271,000	58,377,653	18%
1999	8,132,000	55,000	7,500,000	3,261,000	4,123,000	1,324,000	17,551,000	54,372,694	15%
1998	5,315,000	51,000	7,800,000	3,267,000	3,904,000	1,102,000	17,468,000	50,086,350	11%
1997	8,127,000	61,000	9,600,000	4,257,000	4,447,000	943,000	17,517,000	56,066,737	14%
1996	5,433,000	277,000	9,575,000	4,311,000	4,100,000	972,000	16,975,000	52,579,614	10%
1995	8,104,000	293,000	9,500,000	4,421,000	3,996,000	939,000	17,140,000	55,134,986	15%
1994	3,124,000	245,000	9,836,000	4,865,000	3,613,000	890,000	17,380,000	50,516,122	6%
1993	2,639,000	245,000	10,050,000	5,263,000	2,821,000	1,042,000	17,093,000	49,119,150	5%
1992	2,079,000	231,000	10,100,000	5,954,000	2,100,000	1,268,000	17,109,008	48,473,408	4%
1991	1,568,000	250,000	9,600,000	6,174,000	1,670,000	NA	16,508,000	46,494,600	3%
1990	1,273,000	258,000	8,250,000	6,415,000	1,363,000	NA	18,771,008	48,156,808	3%

Data: FAOSTAT 2016.

Note: NA = Not available.

Table 1E: Major producing countries of tropical hardwood plywood (m^3), 1990-2014.

Year	Production						Global share		
	Brazil	China	India	Indonesia	Malaysia	World	China	India	Top 5
2014	436,000	5,955,000	2,497,000	3,700,000	3,989,000	19,001,707	31%	13%	87%
2013	436,000	5,955,000	2,497,000	3,200,000	3,989,000	18,406,742	32%	14%	87%
2012	436,000	5,955,000	2,497,000	3,200,000	4,067,000	18,430,967	32%	14%	88%
2011	375,000	5,955,000	2,497,000	3,200,000	3,887,000	18,223,317	33%	14%	87%
2010	450,655	5,955,000	2,497,000	3,200,000	4,285,000	18,808,357	32%	13%	87%
2009	429,195	5,955,000	2,497,000	3,200,000	3,901,000	18,326,414	32%	14%	87%
2008	599,421	4,400,000	2,130,000	3,200,000	4,370,000	17,420,200	25%	12%	84%
2007	690,000	4,400,000	2,130,000	3,734,000	5,481,000	19,642,486	22%	11%	84%
2006	669,000	4,400,000	2,130,000	3,734,000	5,433,000	19,562,752	22%	11%	84%
2005	1,125,000	4,400,000	2,130,000	3,820,000	5,006,000	20,147,199	22%	11%	82%
2004	1,380,000	4,400,000	1,936,000	5,500,000	4,734,000	21,605,237	20%	9%	83%
2003	1,220,000	4,000,000	1,760,000	6,111,000	4,771,000	21,310,592	19%	8%	84%
2002	1,100,000	3,000,000	1,600,000	6,550,000	4,341,000	19,947,013	15%	8%	83%
2001	1,000,000	2,200,000	1,300,000	7,300,000	4,318,000	19,980,975	11%	7%	81%
2000	980,000	1,800,000	1,300,000	8,199,646	4,434,400	21,062,206	9%	6%	79%
1999	880,000	2,100,000	300,000	7,500,000	4,122,900	19,298,881	11%	2%	77%
1998	800,000	1,000,000	300,000	7,800,000	3,904,000	18,160,043	6%	2%	76%
1997	900,000	900,000	300,000	9,600,000	4,447,000	22,261,500	4%	1%	73%
1996	920,000	500,000	277,000	9,575,000	4,500,000	22,394,500	2%	1%	70%
1995	930,000	550,000	293,000	9,500,000	3,996,000	21,629,500	3%	1%	71%
1994	1,086,000	244,000	245,000	9,836,000	3,613,000	21,807,700	1%	1%	69%
1993	915,000	206,000	245,000	10,050,000	2,821,000	20,579,350	1%	1%	69%
1992	754,000	162,690	231,000	10,100,000	2,100,000	20,135,790	1%	1%	66%
1991	667,000	122,740	250,000	9,600,000	1,670,000	19,425,240	1%	1%	63%
1990	741,000	99,620	258,000	8,250,000	1,363,000	18,022,970	1%	1%	59%

Data: ITTO 2016.

Table 1F: Major consuming countries of tropical hardwood plywood (m^3), 1990-2014.

YEAR	Consumption						Global share		
	China	India	Japan	Malaysia	USA	World	China	India	Top 3
2014	5,430,835	2,494,800	2,731,330	1,197,000	624,500	17,274,726	31%	14%	62%
2013	5,436,248	2,511,800	2,714,449	1,030,954	620,481	17,017,460	32%	15%	63%
2012	5,309,179	2,518,813	2,661,527	1,284,767	576,972	15,926,667	33%	16%	66%
2011	5,492,401	2,492,943	2,901,847	655,551	495,787	16,846,842	33%	15%	65%
2010	5,678,772	2,495,691	2,572,335	625,658	683,217	17,449,297	33%	14%	62%
2009	5,674,477	2,454,641	2,569,206	97,409	552,143	16,497,997	34%	15%	65%
2008	4,125,833	2,091,080	2,697,259	819,030	801,029	16,511,722	25%	13%	54%
2007	3,598,774	2,054,752	4,358,303	771,477	1,514,365	18,455,429	19%	11%	54%
2006	3,089,706	2,107,453	3,873,176	304,402	1,938,627	17,243,095	18%	12%	53%
2005	3,544,790	2,104,989	4,041,689	626,358	1,857,663	18,156,506	20%	12%	53%
2004	3,607,628	1,923,282	4,430,826	483,739	2,366,735	19,379,249	19%	10%	51%
2003	3,810,368	1,761,175	4,463,733	928,084	1,676,629	19,481,010	20%	9%	52%
2002	2,908,892	1,596,833	4,826,914	760,277	1,727,723	18,898,511	15%	8%	49%
2001	2,461,462	1,318,413	5,049,934	809,789	1,421,364	18,879,199	13%	7%	47%
2000	2,286,360	1,301,322	6,250,341	1,047,132	1,475,428	20,545,390	11%	6%	48%
1999	2,907,633	313,316	5,747,701	755,847	1,640,553	18,399,939	16%	2%	49%
1998	3,058,961	317,686	5,058,519	277,203	1,517,038	17,651,494	17%	2%	48%
1997	2,689,042	291,777	7,473,898	545,368	1,352,374	21,689,238	12%	1%	48%
1996	2,582,317	275,826	8,264,100	363,790	1,404,858	22,543,619	11%	1%	49%
1995	3,215,559	266,466	7,190,694	468,731	1,335,327	21,671,793	15%	1%	49%
1994	2,951,355	204,569	7,269,588	526,232	1,164,371	21,228,701	14%	1%	49%
1993	2,901,305	192,233	7,437,879	362,482	1,298,666	20,358,154	14%	1%	52%
1992	1,873,982	225,060	7,019,994	444,038	1,308,733	19,366,251	10%	1%	47%
1991	1,368,556	242,684	7,258,458	479,303	1,062,406	18,344,159	7%	1%	48%
1990	1,293,103	254,261	7,230,215	378,610	1,093,990	16,667,885	8%	2%	53%

Data: ITTO 2016.

Table 1G: India's population (inh.) and its annual growth rate (%), 1992-2013.

Year	Population (inh.)	Annual Growth Rate (%)
2013	1,279,498,874	1.3
2012	1,263,589,639	1.3
2011	1,247,446,011	1.3
2010	1,230,984,504	1.4
2009	1,214,182,182	1.4
2008	1,197,070,109	1.5
2007	1,179,685,631	1.5
2006	1,162,088,305	1.5
2005	1,144,326,293	1.6
2004	1,126,419,321	1.6
2003	1,108,369,577	1.7
2002	1,090,189,358	1.7
2001	1,071,888,190	1.7
2000	1,053,481,072	1.8
1999	1,034,976,626	1.8
1998	1,016,402,907	1.8
1997	997,817,250	1.9
1996	979,290,432	1.9
1995	960,874,982	1.9
1994	942,604,211	1.9
1993	924,475,633	2.0
1992	906,461,358	2.0

Data: World Bank 2014.

9.2 Annex 2

Table 2A: Explanatory variables database. India's imports of plywood, GDP per capita, domestic price of plywood and unemployment, 1990-2015.

YEAR	Imports of Plywood	GDP per capita	Domestic price of Plywood	Unemployment
	IMP	GDPC	DPP	UE
	m3	USD	USD/m3	% of TLF
2015	113,756.000	1,581.589	685.458	3.600
2014	121,315.000	1,576.818	632.700	3.600
2013	115,673.000	1,456.202	661.226	3.600
2012	128,348.000	1,444.267	630.458	3.600
2011	200,091.000	1,455.667	533.427	3.500
2010	169,864.000	1,387.880	453.168	3.500
2009	82,693.000	1,124.519	647.056	3.900
2008	60,448.000	1,022.578	852.783	4.100
2007	49,617.000	1,050.025	609.912	3.700
2006	38,154.000	816.734	407.795	4.300
2005	11,990.000	729.001	625.688	4.400
2004	20,256.000	640.601	430.490	3.900
2003	24,203.000	557.897	388.877	3.900
2002	24,000.000	480.621	370.833	4.300
2001	24,000.000	460.826	370.833	4.000
2000	12,000.000	452.414	391.500	4.300
1999	25,000.000	451.089	330.880	4.400
1998	26,200.000	421.822	352.137	4.100
1997	23,400.000	424.087	433.291	4.200
1996	16,500.000	408.242	415.576	4.000
1995	10,300.000	381.528	487.864	4.000
1994	10,128.000	353.293	641.390	3.700
1993	5,214.000	307.411	513.042	4.300
1992	5,037.000	323.525	669.843	4.200
1991	8,300.000	309.328	448.193	4.300
1990	8,157.000	375.152	549.099	4.300

Data: Imports of plywood, Domestic price of plywood: FAOSTAT 2014; GDP per capita, Unemployment: World Bank 2016.
Note: *Data of plywood includes softwood and hardwood.

Table 2: Explanatory variables database. India's economic openness, population density, domestic price of industrial Roundwood and domestic price of medium-density fibreboard, 1990-2015.

YEAR	Economic Openness	Population density	Domestic Price of Industrial Roundwood	Domestic Price of Medium-Density Fibreboard
	EO % (trade of GDP)	POPD inh/km2	DPIR USD/m3	DPMDF USD/kg
2015	44.000	440.958	265.005	327.103
2014	48.800	435.657	288.771	327.103
2013	53.625	430.346	306.702	303.660
2012	55.753	424.995	298.303	311.396
2011	55.626	419.565	284.333	317.045
2010	48.308	414.028	250.341	603.648
2009	45.477	408.377	228.851	361.309
2008	52.269	402.622	297.413	506.671
2007	44.876	396.774	261.455	140.515
2006	45.298	390.856	246.275	143.681
2005	41.305	384.882	232.038	141.913
2004	36.857	378.859	221.435	136.058
2003	30.065	372.788	196.128	247.015
2002	29.000	366.673	186.639	246.441
2001	25.545	360.518	166.552	144.281
2000	26.437	354.327	175.670	109.544
1999	24.388	348.103	94.636	246.875
1998	23.291	341.856	105.808	243.889
1997	22.230	335.605	123.747	342.500
1996	21.552	329.374	120.937	455.000
1995	22.473	323.180	137.111	NA
1994	19.732	317.035	133.845	NA
1993	19.313	310.937	112.199	NA
1992	18.115	304.878	287.282	NA
1991	16.695	298.842	216.337	NA
1990	15.239	292.817	177.798	NA

Data: Economic openness, Population density: World Bank 2016; Domestic price of industrial Roundwood and Domestic price of medium-density fibreboard: FAOSTAT 2016.
Note: * Data of domestic price of plywood includes softwood and hardwood; NA: Not Available.

9.3 Annex 3

Table 3A: Level Model – Indian plywood demand

Dependent Variable: LIMP
Method: Least Squares
Date: 12/13/16 Time: 16:33
Sample: 1990 2015
Included observations: 26

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.833526	1.623576	2.361163	0.0271
LGDPC	1.978654	0.129312	15.30144	0.0000
LDPP	-1.023393	0.296451	-3.452144	0.0022

R-squared	0.916745	Mean dependent var	10.28184
Adjusted R-squared	0.909505	S.D. dependent var	1.103575
S.E. of regression	0.331982	Akaike info criterion	0.740693
Sum squared resid	2.534873	Schwarz criterion	0.885858
Log likelihood	-6.629011	Hannan-Quinn criter.	0.782495
F-statistic	126.6291	Durbin-Watson stat	1.053689
Prob(F-statistic)	0.000000		

Histogram-Normality Test	**Kurtosis**	**Skewness**	**Jarque-Bera**	**Probability**
	3.675	-0.826	3.449	0.178
Heteroscedasticity Test: ARCH	**F-statistic**	**Obs*R-squared**	**Prob. F(1,23)**	**Prob. Chi-squared (1)**
	1.517	1.547	0.230	0.214
Breusch-Godfrey Serial Correlation LM Test	**F-statistic**	**Obs*R-squared**	**Prob. F(2,21)**	**Prob. Chi-squared (2)**
	3.123	5.959	0.065	0.051
ADF Unit Root Tests on Resid (based on SIC)	**Lag**	**Determination**	***t*-ADF**	**Decision: I(0) or I(1)**
	5	None	-2.939	I(0)

Notes:
ARCH stands for Autoregressive Conditional Heteroscedasticity
SIC stands for Schwarz info criterion
Level Critical Values with none determination: 1%= -2,660; 5%= -1,955; 10%= -1,609
I(1): There is one unit root which means non-stationary series
I(0): There is no unit root which means stationary series

Table 3B: Error Correction Model - Indian plywood demand.

Dependent Variable: DLIMP
Method: Least Squares
Date: 12/13/16 Time: 18:58
Sample (adjusted): 1991 2015
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.037554	0.071980	0.521721	0.6073
DLGDPC	1.383770	0.695998	1.988180	0.0600
DLDPP	-1.112972	0.259370	-4.291059	0.0003
RESIDDEMANDMODEL(-1)	-0.569469	0.193197	-2.947609	0.0077

R-squared	0.573025	Mean dependent var	0.105407
Adjusted R-squared	0.512029	S.D. dependent var	0.428408
S.E. of regression	0.299264	Akaike info criterion	0.570667
Sum squared resid	1.880742	Schwarz criterion	0.765688
Log likelihood	-3.133342	Hannan-Quinn criter.	0.624758
F-statistic	9.394411	Durbin-Watson stat	1.916380
Prob(F-statistic)	0.000389		

Histogram-Normality Test	**Kurtosis**	**Skewness**	**Jarque-Bera**	**Probability**
	2.930	-0.099	0.046	0.977
Heteroscedasticity Test: ARCH	**F-statistic**	**Obs*R-squared**	**Prob. F(1,22)**	**Prob. Chi-squared (1)**
	0.066	0.072	0.799	0.788
Breusch-Godfrey Serial Correlation LM Test	**F-statistic**	**Obs*R-squared**	**Prob. F(2,19)**	**Prob. Chi-squared (2)**
	0.119	0.309	0.889	0.857
ADF Unit Root Tests on Resid (based on SIC)	**Lag**	**Determination**	**t-ADF**	**Decision: I(0) or I(1)**
	5	None	-4.602	I(0)

Notes:
ARCH stands for Autoregressive Conditional Heteroscedasticity
SIC stands for Schwarz info criterion
Level Critical Values with none determination: 1%= -2,665; 5%= -1,955; 10%= -1,609
I(1): There is one unit root which means non-stationary series
I(0): There is no unit root which means stationary series

Table 3C: MacKinnon critical values for cointegration test

Level Model			
Significance Level	**MacKinnon critical value equation**	**Critical Value**	**t-ADF**
1%	$\beta\infty + \beta 1 / T + \beta 2 / T^2 + \beta 3 / T^3$	-4.89535	-2.939
5%		-4.08447	
10%		-3.69669	
Error Correction Model			
Significance Level	**MacKinnon critical value equation**	**Critical Value**	**t-ADF**
1%	$\beta\infty + \beta 1 / T + \beta 2 / T^2 + \beta 3 / T^3$	-4.92123	-4.602
5%		-4.09875	
10%		-3.70670	

Notes:
MacKinnon Critical values for No Trend Case:
at 1%: $\beta\infty$= -4.29374; $\beta 1$= -14.4354; $\beta 2$= -33.195; $\beta 3$= 47.433
at 5%: $\beta\infty$= -3.74066; $\beta 1$= -8.5631; $\beta 2$= - 10.852; $\beta 3$= + 27.982
at 10%: $\beta\infty$= -3.45218; $\beta 1$= -6.2143; $\beta 2$= -3.718
T: number of observations (26 for level model and 25 for error correction model).

Table 3D: Johansen Cointegration Test - Indian sawnwood demand.
Date: 12/15/16 Time: 12:18
Sample (adjusted): 1992 2015
Included observations: 24 after adjustments
Trend assumption: Linear deterministic trend
Series: LIMP LGDPC LDPP
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.648700	33.52408	29.79707	0.0178
At most 1	0.295624	8.417353	15.49471	0.4219
At most 2	0.000281	0.006735	3.841466	0.9340

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.648700	25.10672	21.13162	0.0130
At most 1	0.295624	8.410618	14.26460	0.3385
At most 2	0.000281	0.006735	3.841466	0.9340

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LIMP	LGDPC	LDPP
3.780359	-7.792382	3.581734
-0.283042	2.019134	-5.613679
0.345174	0.992252	1.217512

Unrestricted Adjustment Coefficients (alpha):

D(LIMP)	-0.153242	-0.197519	-0.001391
D(LGDPC)	-0.030840	-0.009631	0.000806
D(LDPP)	-0.067752	0.108788	-0.000667

1 Cointegrating Equation(s): Log likelihood 40.18440

Normalized cointegrating coefficients (standard error in parentheses)

LIMP	LGDPC	LDPP
1.000000	-2.061281	0.947459
	(0.09948)	(0.24107)

Adjustment coefficients (standard error in parentheses)

D(LIMP)	-0.579309
	(0.33766)
D(LGDPC)	-0.116587

	(0.04861)	
D(LDPP)	-0.256126	
	(0.18214)	

2 Cointegrating Equation(s):		Log likelihood	44.38971

Normalized cointegrating coefficients (standard error in parentheses)

LIMP	LGDPC	LDPP
1.000000	0.000000	-6.727231
		(2.37212)
0.000000	1.000000	-3.723263
		(1.14284)

Adjustment coefficients (standard error in parentheses)

D(LIMP)	-0.523403	0.795302
	(0.29179)	(0.61960)
D(LGDPC)	-0.113861	0.220873
	(0.04802)	(0.10197)
D(LDPP)	-0.286918	0.747606
	(0.15623)	(0.33175)

Table 3E: Results for the Ad hoc Model- Long-term elasticities of Indian imports of plywood (GDPC, UE, EO, POPD).

ID	GDPC	UE	EO	POPD
C	-1.16	21.11	7.87	-36.61
GDPC	1.76***			
UE		-2.71***		
EO			0.07***	
POPD				7.94***
R-squared	0.87	0.55	0.77	0.82
DW	1.06	0.89	0.91	0.83
JB H-Nt	0.48	0.48	0.39	0.34
Ht	0.93	0.41	0.7	0.5
BG LMt	0.07	0.0062	0.02	0.01
ADFt	-3.01, I(0)	-7.37, I(1)	-5.14, I(1)	-2.67, I(0)

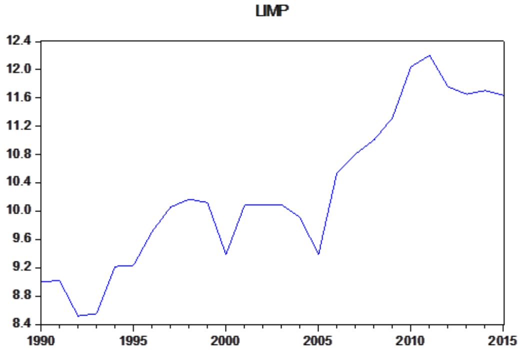
Notes:
***,** and * represent statistical significance of coefficients at the significance levels 1%, 5% and 10%, respectively.
C=constant, GDPC=GDP/capita (USD), UE=unemployment (% of TLF), EO=economic openness (% trade of GDP), POPD=Population density (inh/km^2).
DW=Durbin-Watson stat, JB H-Nt=Jarque-Bera Histogram-Normality Test, Ht=Heteroscedasticity Test (ARCH, Autoregressive Conditional Heteroscedasticity, BG LMt=Breusch-Godfrey Serial Correlation LM Test, ADFt=ADF Unit Root Tests on Resid.
I(0): There is no unit root which means stationary series.
I(1): There is one unit root which means nonstationary series. Then, time-series become stationary at the first difference.

Table 3F: Results for the Ad hoc Model- Long-run elasticities of Indian imports of plywood (GDPC DPP/DPMDF, EO DPP/DPMDF, POPD DPP/DPMDF, UE DPP/DPIR)

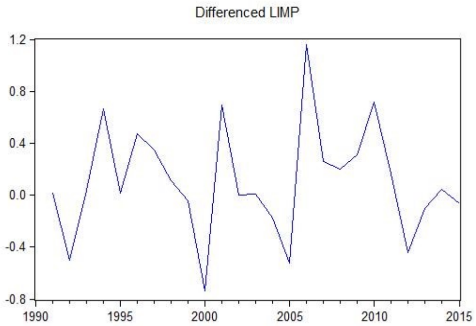
ID	GDPC DPP/DPMDF	EO DPP/DPMDF	POPD DPP/DPMDF	UE DPP/DPIR
C	3.77	12.72	-37.75	25.65
GDPC	1.57***			
UE				-2.38***
EO		0.06***		
POPD			8.89***	
DPP/DPMDF	-3.18***	-4.01***	-4.03***	
DPP/DPIR				-4.96*
R-squared	0.92	0.83	0.88	0.64
DW	1.73	1.66	1.55	1.1
JB H-Nt	0.73	0.67	0.93	0.81
Ht	0.2	0.66	0.28	0.64
BG LMt	0.76	0.96	0.55	0.03
ADFt	-4.21, I(0)	-3.80, I(0)	-3.39, I(0)	-4.67, I(0)

Notes:
***,** and * represent statistical significance of coefficients at the significance levels 1%, 5% and 10%, respectively.
C=constant, GDPC=GDP/capita (USD), DPP=domestic price of plywood (USD/m^3), UE=unemployment (% of TLF), EO=economic openness (% trade of GDP), POPD=Population density (inh/km^2), DPMDF=domestic price of medium-density fibreboard (USD/m^3), DPIR=domestic price of industrial Roundwood (USD/m^3).
DW=Durbin-Watson stat, JB H-Nt=Jarque-Bera Histogram-Normality Test, Ht=Heteroscedasticity Test (ARCH, Autoregressive Conditional Heteroscedasticity, BG LMt=Breusch-Godfrey Serial Correlation LM Test, ADFt=ADF Unit Root Tests on Resid.
I(0): There is no unit root which means stationary series.
I(1): There is one unit root which means nonstationary series. Then, time-series become stationary at the first difference.

9.4 **Annex 4**

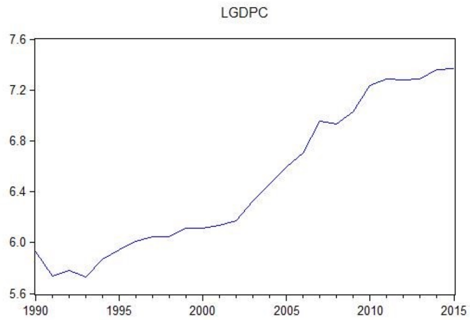


Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.866	0.866	21.840	0.000
		2	0.731	-0.07...	38.070	0.000
		3	0.587	-0.11...	48.988	0.000
		4	0.434	-0.12...	55.213	0.000
		5	0.285	-0.08...	58.027	0.000
		6	0.114	-0.20...	58.504	0.000
		7	0.060	0.348	58.641	0.000
		8	0.023	0.006	58.663	0.000
		9	-0.01...	-0.10...	58.673	0.000
		1...	-0.04...	-0.07...	58.765	0.000
		1...	-0.05...	0.021	58.929	0.000
		1...	-0.04...	-0.04...	59.043	0.000

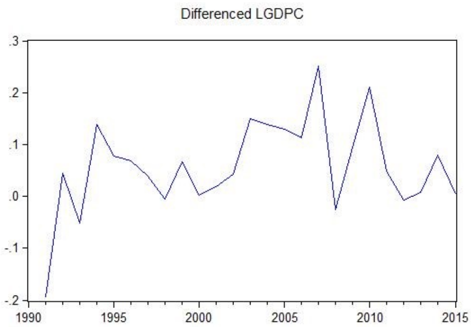


Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.07...	-0.07...	0.1692	0.681
		2	-0.14...	-0.15...	0.7734	0.679
		3	-0.04...	-0.06...	0.8255	0.843
		4	-0.05...	-0.09...	0.9392	0.919
		5	0.126	0.099	1.4763	0.916
		6	-0.49...	-0.52...	10.240	0.115
		7	0.033	-0.01...	10.280	0.173
		8	0.075	-0.14...	10.504	0.231
		9	-0.03...	-0.10...	10.546	0.308
		1...	0.007	-0.20...	10.548	0.394
		1...	-0.15...	-0.16...	11.647	0.391
		1...	0.281	-0.10...	15.756	0.203

LIMP and the 1st Difference D(LIMP) with the respective Correlograms.

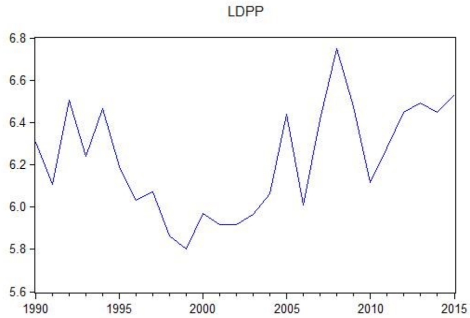


Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.920	0.920	24.635	0.000
		2	0.814	-0.20...	44.757	0.000
		3	0.706	-0.05...	60.537	0.000
		4	0.582	-0.16...	71.762	0.000
		5	0.454	-0.08...	78.913	0.000
		6	0.328	-0.07...	82.819	0.000
		7	0.220	0.044	84.677	0.000
		8	0.114	-0.11...	85.205	0.000
		9	-0.00...	-0.16...	85.205	0.000
		1...	-0.09...	0.051	85.612	0.000
		1...	-0.18...	-0.11...	87.213	0.000
		1...	-0.26...	-0.04...	90.761	0.000

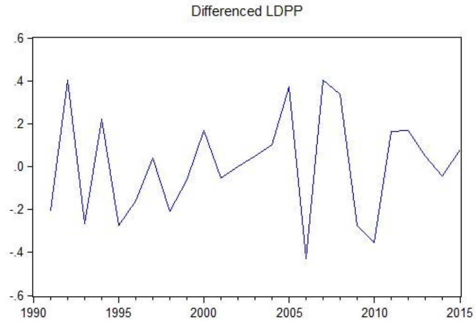


Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.068	0.068	0.1291	0.719
		2	0.149	0.145	0.7784	0.678
		3	0.053	0.035	0.8644	0.834
		4	0.072	0.047	1.0328	0.905
		5	-0.10...	-0.12...	1.4004	0.924
		6	-0.09...	-0.10...	1.7173	0.944
		7	0.104	0.149	2.1236	0.953
		8	-0.09...	-0.07...	2.4469	0.964
		9	-0.04...	-0.04...	2.5150	0.980
		1...	-0.01...	0.001	2.5269	0.990
		1...	0.026	0.007	2.5598	0.995
		1...	-0.17...	-0.15...	4.2094	0.979

LGDPC and the 1st Difference D(LGDPC) with the respective Correlograms.

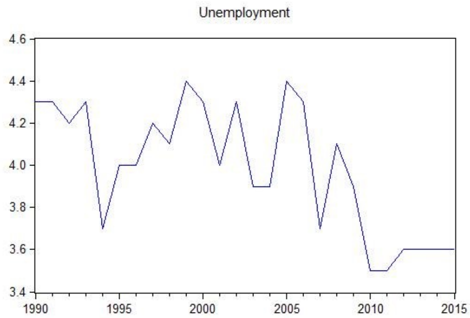


Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.543	0.543	8.5853	0.003
		2	0.398	0.146	13.393	0.001
		3	0.337	0.106	16.985	0.001
		4	0.235	-0.01...	18.817	0.001
		5	0.058	-0.17...	18.934	0.002
		6	-0.05...	-0.13...	19.060	0.004
		7	-0.08...	-0.02...	19.360	0.007
		8	-0.17...	-0.09...	20.623	0.008
		9	-0.38...	-0.29...	26.853	0.001
		1...	-0.30...	0.043	31.210	0.001
		1...	-0.27...	0.005	34.806	0.000
		1...	-0.31...	-0.08...	39.899	0.000

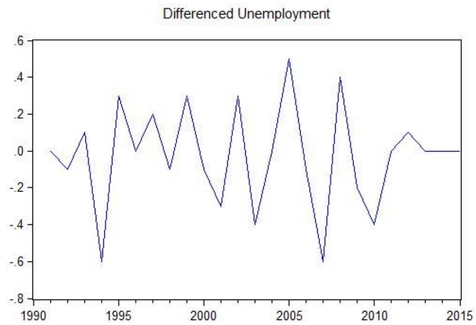


Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.33...	-0.33...	3.2328	0.072
		2	-0.13...	-0.28...	3.7509	0.153
		3	0.073	-0.09...	3.9142	0.271
		4	0.113	0.088	4.3266	0.364
		5	-0.01...	0.096	4.3373	0.502
		6	-0.17...	-0.12...	5.4205	0.491
		7	-0.00...	-0.15...	5.4205	0.609
		8	0.220	0.110	7.3494	0.499
		9	-0.23...	-0.13...	9.6596	0.379
		1...	-0.06...	-0.14...	9.8687	0.452
		1...	0.177	0.053	11.371	0.413
		1...	-0.18...	-0.22...	13.045	0.366

LDPP and the 1st Difference D(LDPP) with the respective Correlograms.

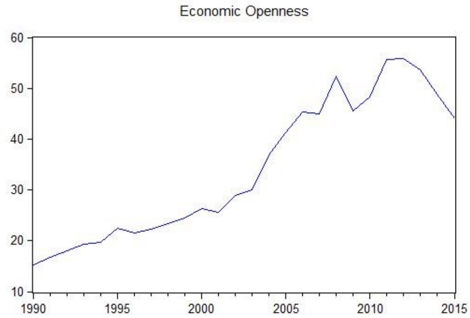


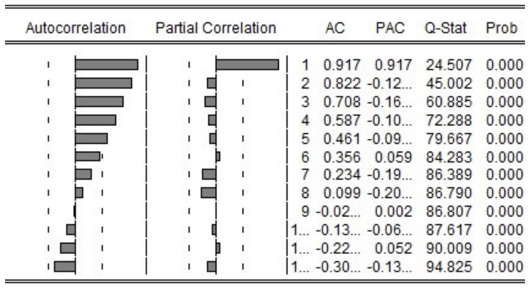
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.524	0.524	7.9815	0.005
		2	0.368	0.129	12.087	0.002
		3	0.399	0.230	17.131	0.001
		4	0.161	-0.20...	17.991	0.001
		5	-0.01...	-0.17...	17.996	0.003
		6	0.103	0.160	18.379	0.005
		7	0.086	0.090	18.660	0.009
		8	-0.02...	-0.06...	18.693	0.017
		9	0.016	-0.05...	18.704	0.028
		1...	-0.12...	-0.26...	19.384	0.036
		1...	-0.20...	-0.01...	21.317	0.030
		1...	-0.17...	0.031	22.876	0.029



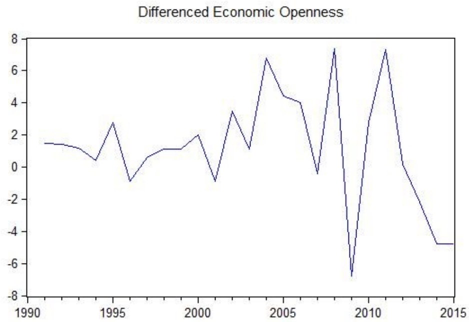
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.39...	-0.39...	4.3638	0.037
		2	-0.21...	-0.44...	5.7423	0.057
		3	0.294	-0.00...	8.3990	0.038
		4	-0.00...	0.097	8.3997	0.078
		5	-0.40...	-0.35...	13.881	0.016
		6	0.234	-0.20...	15.833	0.015
		7	0.120	-0.04...	16.373	0.022
		8	-0.26...	-0.11...	19.117	0.014
		9	0.285	0.254	22.543	0.007
		1...	-0.03...	-0.03...	22.611	0.012
		1...	-0.18...	-0.11...	24.209	0.012
		1...	-0.05...	-0.33...	24.350	0.018

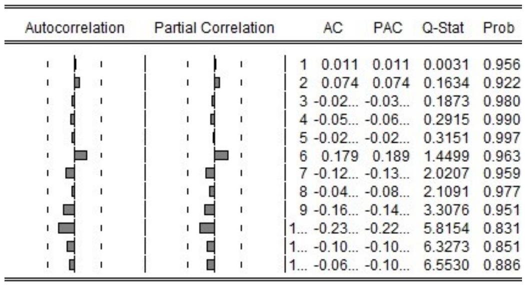
UE and the 1st Difference D(UE) with the respective Correlograms.





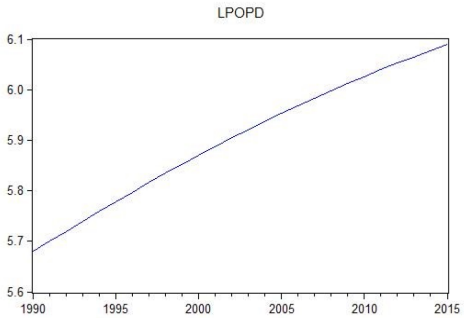
	Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
1			0.917	0.917	24.507	0.000
2			0.822	-0.12...	45.002	0.000
3			0.708	-0.16...	60.885	0.000
4			0.587	-0.10...	72.288	0.000
5			0.461	-0.09...	79.667	0.000
6			0.356	0.059	84.283	0.000
7			0.234	-0.19...	86.389	0.000
8			0.099	-0.20...	86.790	0.000
9			-0.02...	0.002	86.807	0.000
1...			-0.13...	-0.06...	87.617	0.000
1...			-0.22...	0.052	90.009	0.000
1...			-0.30...	-0.13...	94.825	0.000

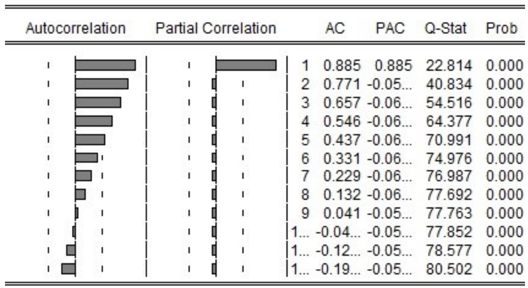




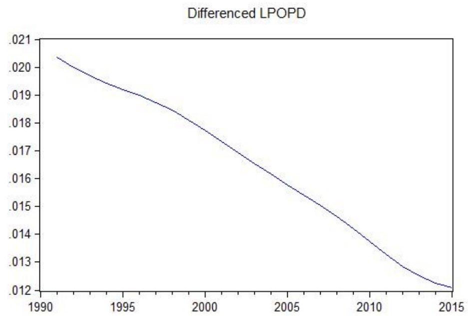
	Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
1			0.011	0.011	0.0031	0.956
2			0.074	0.074	0.1634	0.922
3			-0.02...	-0.03...	0.1873	0.980
4			-0.05...	-0.06...	0.2915	0.990
5			-0.02...	-0.02...	0.3151	0.997
6			0.179	0.189	1.4499	0.963
7			-0.12...	-0.13...	2.0207	0.959
8			-0.04...	-0.08...	2.1091	0.977
9			-0.16...	-0.14...	3.3076	0.951
1...			-0.23...	-0.22...	5.8154	0.831
1...			-0.10...	-0.10...	6.3273	0.851
1...			-0.06...	-0.10...	6.5530	0.886

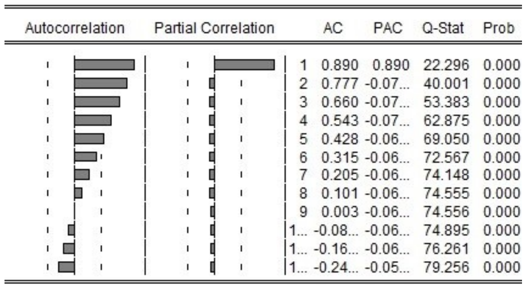
EO and the 1st Difference D(EO) with the respective Correlograms.





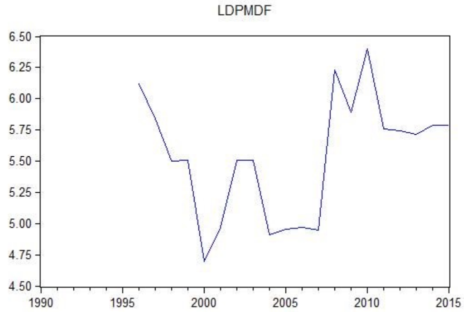
	Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
1			0.885	0.885	22.814	0.000
2			0.771	-0.05...	40.834	0.000
3			0.657	-0.06...	54.516	0.000
4			0.546	-0.06...	64.377	0.000
5			0.437	-0.06...	70.991	0.000
6			0.331	-0.06...	74.976	0.000
7			0.229	-0.06...	76.987	0.000
8			0.132	-0.06...	77.692	0.000
9			0.041	-0.05...	77.763	0.000
1...			-0.04...	-0.05...	77.852	0.000
1...			-0.12...	-0.05...	78.577	0.000
1...			-0.19...	-0.05...	80.502	0.000

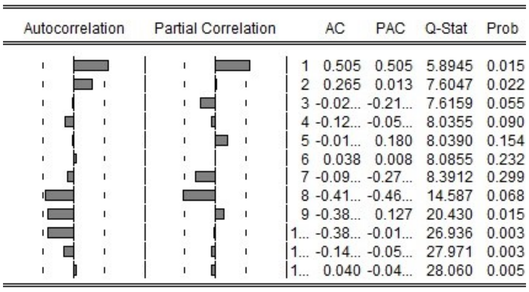




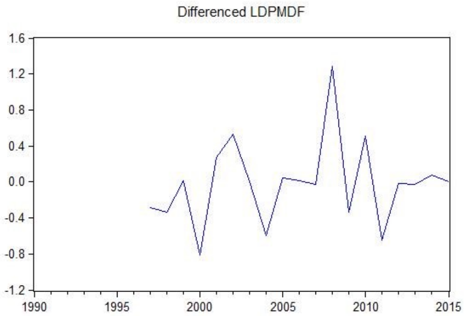
	Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
1			0.890	0.890	22.296	0.000
2			0.777	-0.07...	40.001	0.000
3			0.660	-0.07...	53.383	0.000
4			0.543	-0.07...	62.875	0.000
5			0.428	-0.06...	69.050	0.000
6			0.315	-0.06...	72.567	0.000
7			0.205	-0.06...	74.148	0.000
8			0.101	-0.06...	74.555	0.000
9			0.003	-0.06...	74.556	0.000
1...			-0.08...	-0.06...	74.895	0.000
1...			-0.16...	-0.06...	76.261	0.000
1...			-0.24...	-0.05...	79.256	0.000

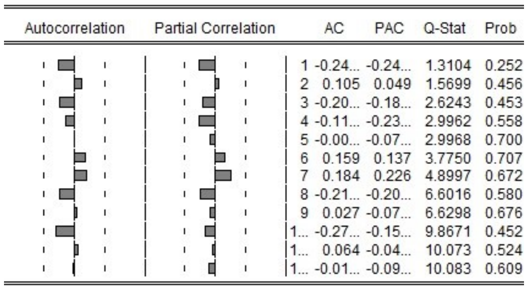
LPOPD and the 1st Difference D(LPOPD) with the respective Correlograms.





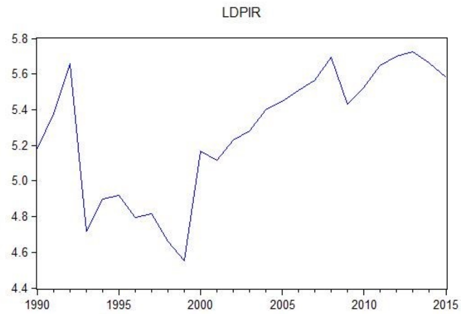
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.505	0.505	5.8945	0.015
		2	0.265	0.013	7.6047	0.022
		3	-0.02...	-0.21...	7.6159	0.055
		4	-0.12...	-0.05...	8.0355	0.090
		5	-0.01...	0.180	8.0390	0.154
		6	0.038	0.008	8.0855	0.232
		7	-0.09...	-0.27...	8.3912	0.299
		8	-0.41...	-0.46...	14.587	0.068
		9	-0.38...	0.127	20.430	0.015
		1...	-0.38...	-0.01...	26.936	0.003
		1...	-0.14...	-0.05...	27.971	0.003
		1...	0.040	-0.04...	28.060	0.005

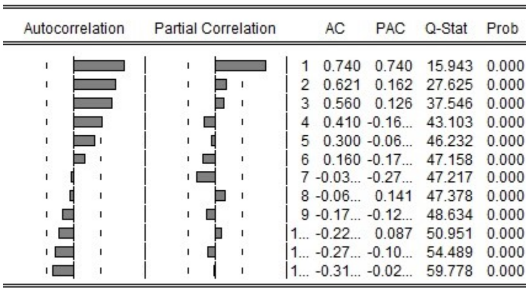




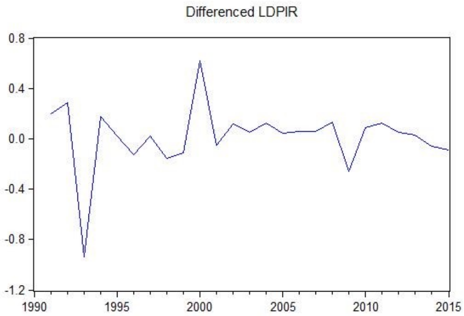
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.24...	-0.24...	1.3104	0.252
		2	0.105	0.049	1.5699	0.456
		3	-0.20...	-0.18...	2.6243	0.453
		4	-0.11...	-0.23...	2.9962	0.558
		5	-0.00...	-0.07...	2.9968	0.700
		6	0.159	0.137	3.7750	0.707
		7	0.184	0.226	4.8997	0.672
		8	-0.21...	-0.20...	6.6016	0.580
		9	0.027	-0.07...	6.6298	0.676
		1...	-0.27...	-0.15...	9.8671	0.452
		1...	0.064	-0.04...	10.073	0.524
		1...	-0.01...	-0.09...	10.083	0.609

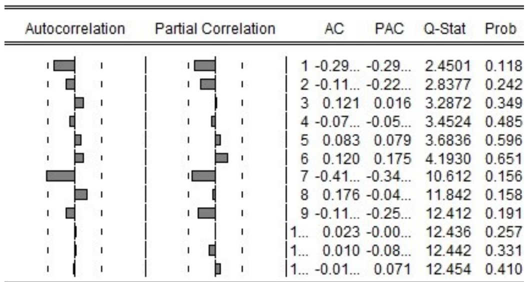
LDPMDF and the 1st Difference D(LDPMDF) with the respective Correlograms.





Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.740	0.740	15.943	0.000
		2	0.621	0.162	27.625	0.000
		3	0.560	0.126	37.546	0.000
		4	0.410	-0.16...	43.103	0.000
		5	0.300	-0.06...	46.232	0.000
		6	0.160	-0.17...	47.158	0.000
		7	-0.03...	-0.27...	47.217	0.000
		8	-0.06...	0.141	47.378	0.000
		9	-0.17...	-0.12...	48.634	0.000
		1...	-0.22...	0.087	50.951	0.000
		1...	-0.27...	-0.10...	54.489	0.000
		1...	-0.31...	-0.02...	59.778	0.000





Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.29...	-0.29...	2.4501	0.118
		2	-0.11...	-0.22...	2.8377	0.242
		3	0.121	0.016	3.2872	0.349
		4	-0.07...	-0.05...	3.4524	0.485
		5	0.083	0.079	3.6836	0.596
		6	0.120	0.175	4.1930	0.651
		7	-0.41...	-0.34...	10.612	0.156
		8	0.176	-0.04...	11.842	0.158
		9	-0.11...	-0.25...	12.412	0.191
		1...	0.023	-0.00...	12.436	0.257
		1...	0.010	-0.08...	12.442	0.331
		1...	-0.01...	0.071	12.454	0.410

LDPIR and the 1st Difference D(LDPIR) with the respective Correlograms.