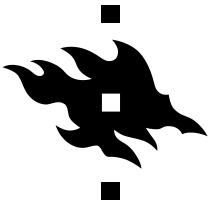

UNIVERSITY OF HELSINKI

Factors Contributing Direct Investments in Forest Plantations

Master's Thesis
for the examination of Master of Science (Agr. & For.)
Forest Economics

Jaana Korhonen

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Tiivistelmä — Referat — Abstract

Direct investments are considered the main source of economic growth and are desirable for countries. Factors driving the geographical distribution of direct investments are unknown. Many forest investments are directed to plantations, which have expanded rapidly during the past two decades. The global forestry scheme is changing; until 1990, developed countries accounted for almost all investments. Since then, developing countries have started to employ them at an accelerating rate. The major changes in a world economy are likely to drive this trend in the future.

To assess factors contributing to investment in forest plantation, we drew from methods used by the Inter-American Development Bank (IADB), which developed a forest attractiveness index (IAIF) to "measure the business climate to sustainable forest business". In this research, several multiple linear regression models were developed to examine the effects of different variables. As well, different macro-economic, institutional, and forest-sector factors were considered the main components that drive forest plantation development. Factors attracting direct investment in forest plantations are different on a global scale, in developed and developing countries. Therefore, some general trends can be identified:

Macro-economic factors are important. Foreign direct investment inflows and area of planted forests are positively correlated, indicating that the investment behavior of forestry investors is not significantly different from other investors'. Other significant factors are GDP and the exchange rate. GDP was positively correlated with the area of planted forests. Weak currency is desirable in OECD countries, and a strong currency is favorable for plantation investments in non-OECD countries.

Institutional factors were not significant, which suggests investments occur despite the country challenges. The human development index was the most significant factor in this category. The human development index had a negative effect on the area of planted forests. The more developed a country, the fewer plantations.

The forest-sector factors were the most important factors that determine plantation investment attractiveness. Production capacity and productivity were globally significant. Productivity was not significant in non-OECD countries, which may have equally beneficial circumstances for tree growth. Macro-economic factors are important especially in these countries.

The results suggest macro-economic and forestry factors are key determinants of investment attractiveness in forestry. Macro-economic factors cannot be affected by investors. Forestry-factors can be affected by country level decision making. Investors can choose between countries, and sometimes affect these factors. These results may be useful to firms considering foreign direct investment and to policy makers in potential destination countries.

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Tiivistelmä — Referat — Abstract

Suuri osa metsäsektorin investoinneista kohdistuu istutusmetsiin, joiden pinta-ala on kasvanut nopeasti erityisesti viimeisen kahden vuosikymmenen aikana. Suorat investoinnit edistävät taloudellista kasvua ja siksi yritysten sekä maiden oletetaan haluavan houkutella investointeja. Globaalin metsäsektorin investointirakenne muuttuu: 1990-luvulta lähtien kehitysmaiden osuus investoinneista on kasvanut. Maailmantalouden muutokset edesauttavat investointeja kehitysmaihin ohjaavaa kehitystä.

Tutkiaksemme mitkä tekijät houkuttelevat suoria investointeja istutusmetsiin, sovelsimme Latinalaisen Amerikan kehityspankin kehittämää metsäinvestointien houkuttelevuutta mittaavaa indeksiä. Kehitimme kolme regressiomallia tutkimaan tekijöiden vaikutusta investointihoukuttelevuuteen. Investointien määrään vaikuttavat tekijät ovat eri globaalissa mittakaavassa, kehitys- ja kehittyneissä maissa. Kehitysmailla tarkoitetaan Taloudellisen yhteistyön ja kehityksen järjestöön kuulumattomia maita (ei-OECD), kun taas järjestöön kuuluvat maat (OECD) luokitellaan kehittyneiksi. Tämän tutkimuksen perusteella voidaan havaita joitain yleisiä trendejä:

Makroekonomiset tekijät ovat tärkeitä. Ulkomaalaisten suorien investointien määrä vaikuttaa positiivisesti istutusmetsäpinta-alaan. Tämä osoittaa, että metsäinvestoijien käyttäytyminen ei poikkea huomattavasti muiden investoijien käyttäytymisestä. Myös bruttokansantuote ja valuuttakurssit ovat tärkeitä tekijöitä. Heikko valuutta OECD-maassa houkuttelee investointeja, kun taas ei-OECD-maissa vahva valuutta.

Institutionaaliset tekijät eivät olleet niin merkityksellisiä, mikä osoittaa, että tietyt maata epävakauttavat institutionaaliset haasteet eivät vaikuta ratkaisevasti investointipäätöksiin. Kaikista tutkimuksessa käytettävistä kyseisen ryhmän tekijöistä inhimillisellä kehityksellä oli suurin vaikutus. Inhimillisen kehityksen indeksi vaikutti negatiivisesti istutusmetsien pinta-alaan. Tämän tutkimuksen perusteella voidaan ehdottaa, että mitä kehittyneempi maa, sitä vähemmän istutusmetsiä.

Metsäsektorilliset tekijät olivat kaikista tärkeimpiä istutusmetsien pinta-alan kehityksessä. Tuotantokapasiteetti ja metsän tuotoskyky olivat merkittäviä tekijöitä globaalilla tasolla. Tuotoskyky ei ollut kuitenkaan merkitsevä tekijä ei-OECD-maissa, mikä johtunee maiden samankaltaisista puunkasvatusolosuhteista. Ei-OECD-maissa makroekonomisten tekijöiden rooli on korostunut.

Tämän tutkimuksen tulosten perusteella makroekonomiset ja metsäsektorilliset tekijät ovat metsäinvestointien houkuttelevuuden pääelementtejä. Makroekonomisiin tekijöihin investoijat eivät pysty vaikuttamaan, kun taas metsäsektorillisiin heillä on mahdollisuus vaikuttaa. Metsäinvestoijat pystyvät valitsemaan eri kohdemaiden välillä, ja näin ollen ohjamaan metsäsektorin kehitystä päätöksenteollaan. Tämän tutkimuksen tulokset voivat auttaa yrityksiä, jotka suunnittelevat suoria investointeja ulkomaalaisiin kohteisiin ja poliittisia päätöksentekijöitä investointien kohdemaissa.

Avainsanat — Nyckelord — Keywords	
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BIOGRAPHY

Jaana was born in Juuka, Finland. She started her academic career at the physics department in University of Joensuu in eastern Finland, but found out fast that she does not want to become a physicist. She enrolled in University of Helsinki, department of Forestry, in 2006 and achieved her Bachelor of Science in Forest Economics in the fall 2009. Right after graduation she left to Vienna, Austria for two semesters and studied at University of Natural Resources and Life Sciences. In 2010, Jaana enrolled in the two year Trans-Atlantic Master's program in Forestry (EU-US Atlantis Programme) collaboration among the University of Helsinki, Swedish University of Agriculture and North Carolina State University. Jaana started her ATLANTIS-studies in Umeå, Sweden during the fall 2011. She continued to Raleigh, NCSU in January 2011, where she stayed for three semesters working under supervision of her committee Chair Dr. Fred Cubbage. From NCSU she will head to Rome, Italy for 3 months and work as an intern at the forestry department of FAO. The people she met and experiences she gained about international forestry during her master's inspired Jaana so much that she decided to continue proceed toward PhD at University of Helsinki starting in the Fall 2012.

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1 Introduction and the background of forest plantation development and forest investments

Overall, there exist incomplete understandings of what are the factors that determine geographical distribution of direct investments in forestry. This study examined what are the most important macro-economic, institutional and forest sector factors attracting investments in forest plantations or planted forests.

The theoretical background and literature review consist of three major parts. The first part describes the forest investment attractiveness index, which forms the theoretical approach of my study. The general theories of investment behavior, with emphasis on foreign direct investment point, are presented in the second part. The effects and influence of individual factors on investments are presented in the third part. The aim was to define the factors what affect the general investment and forestry related investment decisions the most. Individual factors are classified into three broad categories: Macroeconomic, Institutional and Forest Sector. This division is adapted from the forest IAIF attractiveness index (Nascimento 2006; IAIB 2008.) and is also used in my empirical analysis.

1.1 Forest investment attractiveness index (IAIF)

The Inter-American Development bank (IADB) has developed a forest attractiveness index (IAIF) to "measure the business climate to sustainable forest business" (Nascimento 2006; IAIB 2008).The index is a single number that represents the business environment for each nation. The IADB has used this number to rank the South- and Central American countries according to their investment attractiveness. The basic hypothesis behind the index is simple: forest investment profitability makes an investment destination attractive for investors, which leads to higher IAIF-value. The

index is based on three broad factors called to sub-indexes: SUPRA, INTER and INTRA sector (Figure 1). The supra-sector index refers to general macroeconomic factors that affect the business profitability in a country. The inter-sector factors are those non-forestry factors which affect directly or indirectly the profitability of forestry business. The intra-sector factors measure the operational environment and profitability of forestry from the forest-sector point of view itself. Altogether there are 21 indicators measuring the positive and negative effects of different social, economic or institutional phenomena on forest investment profitability within these three categories. Each broader category is weighted differently; the Supra-Sector factors have a weight of "1", the Inter-Sector factors "2" and Intra-Sector "4". The indicators themselves are assumed to have equal weights within each sub-index. (Nascimento 2006; IAIB 2008).

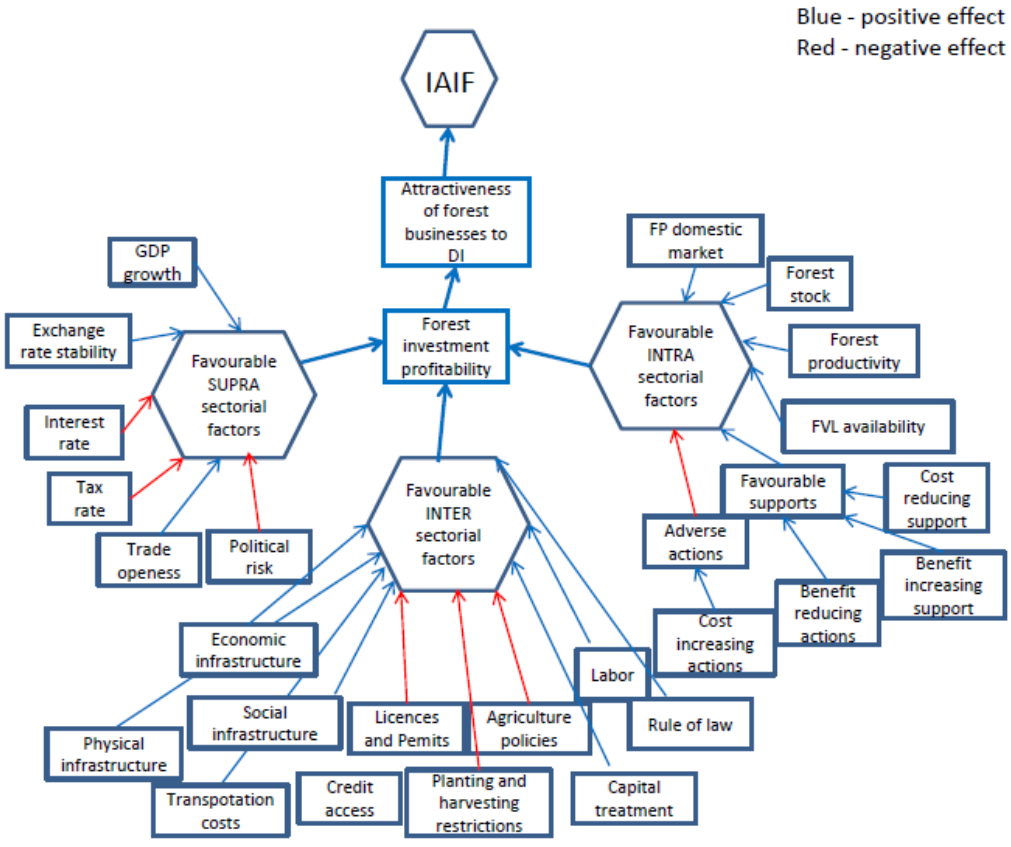

Figure 1. Forest investment attractiveness index

1.2 Theories of investing and forests as an investment destination

1.2.1 Effects of foreign and domestic direct investments

There are several theories concentrating on determinants of foreign and domestic direct investments on industry, country and firm level, but general models explaining the most important determinants of investments are missing. Both direct domestic investments (DDI) and foreign direct investments (FDI) are universally accepted to be a major source of economic growth and strategically important for socio-economic development, and therefore desirable for countries. There is also evidence that direct investments may not be beneficial for the host country and it's been argued that attracting investments is easier than gaining benefits from them (Asiedu 2002, 2006). To avoid exploitation of natural resources it is important to understand the underlying reasons for geographical distribution of investment in forestry.

At the forest industry level, the FDI inflows have tripled since 1990 (UNCTAD). Until 1990, developed countries received almost 90% of the foreign direct investment inflows. This trend has been changing gradually during the past two decades, when developing countries have been gaining progressively larger share of these investments. Currently, less than 70% of all investment inflows are directed to developed countries.

In the future, it is likely that more timberland investments will be directed to developing economies. The mature economies suffer from rising debt. A weakened economy in the USA has resulted in lower consumption, weak housing markets, and high savings and unemployment rates in the country. These changes have led to lower land prices, lower timber prices, flat or declining development in processing capacity, and a weakening US dollar. Emerging economies, on the other hand, have faced strong economic growth. Historically the growth patterns have been volatile, but the growth somewhat compensates for the volatility. The trend is that the emerging economies are gaining a larger share in the global economy. Also, access to information is getting better. For

example, inflation volatility in Brazil has sharply declined and volatility in GDP growth in China has declined since 1990. Especially so called BRIC-countries (Brazil, Russia, India and China) have strengthened their economies. In 1990 only 7.8% of World's GDP contributions went to BRIC countries, whereas by 2009 the share was 17.3%. (Caulfield 2011.)

The area of plantations increased about at the rate of 4.5 million hectares per year from the early 1990s to early 2002 (Carle et al. 2002). A 1.8 million hectare increment took place in developing countries. This means $3 to $4 million annual investments, without investments in already existing plantations, which lack reliable information (FAO 2006). The increasing trend has been ongoing since 2002, and in 2010 the total area of plated forest exceeded 260 million hectares (FAO 2011).

Forestry has some special characteristics that make forestry related investment decisions different from many other investment decisions and creates special challenges: Forestry is a capital intensive production sector, where the gestation periods of investments are long compared to the 'traditional' investment option such as stocks, bonds, and apartments. The investments in forestry in general require vast areas of land, which results in managing complex relationships with local land owners and governments.

1.2.2 Plantation development in a nutshell

In 2010 the planted forest area was 264 million hectares, which accounts for 7% of total global forest area (FAO 2011). Despite that the plantation area is estimated to produce over 60% of the 1.8 billion cubic meters of global industrial round wood consumed (Carle and Holmgren 2008). The area of world's plantation estate has increased rapidly during the last three decades. In 1980 the global forest plantation area was only 17.8 million hectares (Carle et al. 2002). In 1990 the total area of planted forests was about 170 million hectares (Figure 2). This number doesn't include smaller former Soviet Union countries such as Estonia, nor Ecuador, Nicaragua, Mexico, Sri Lanka, Burundi

and Cape Verde. By 2000 the area of planted forest had increased to 215 million hectares, whereas in 2005 it was 242 million. The per cent increased in the area of planted forest during the last decade was 23% (FAO 2011).

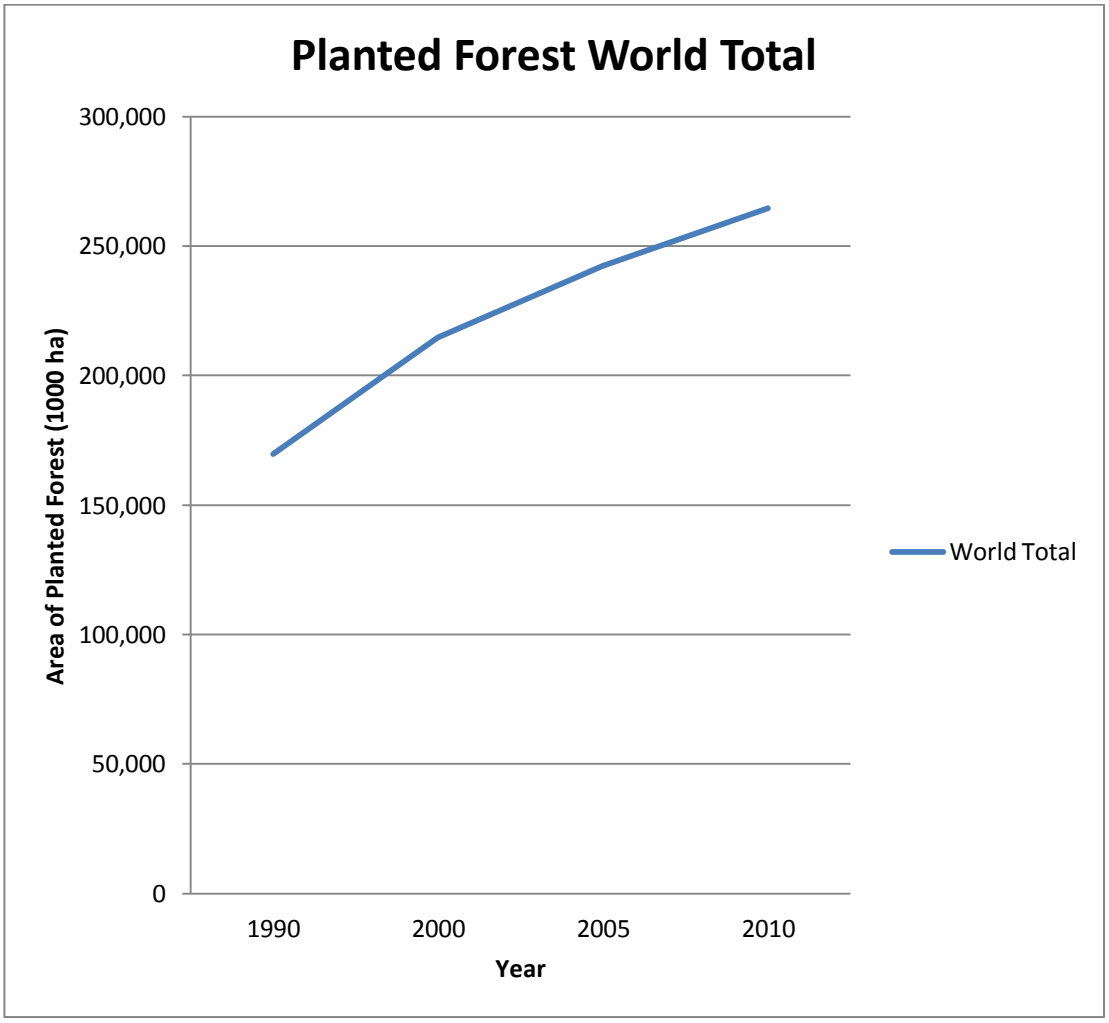

Figure 2. Area of planted forests, world total according to FAO.

1.2.2.1 Fast rotation species growers

Cossalter and Pye-Smith (2002) list Brazil as the most important *Eucalyptus grandis (plus some Eucalyptus ssp. hybrids)* growing-region, while Chile is identified as the most important producer of temperate Eucalyptus species. Globally, *Eucalyptus grandis (plus some Eucalyptus ssp. hybrids)* have an estimated plantation extent of 3.7 million hectares whereas the temperate Eucalyptus species have extents of 1.9 million hectares. China is the most important fast-rotation tropical eucalyptus grower and the second most important grower of tropical acacias. The estimated extent of tropical acacias plantations exceeds 1.4 million hectares. Table 2 gathers the mean annual increments, time to reach maturity, extend of the plantation and main grower countries.

Table 1. Productivities, rotations, areas and main growers of fastwood plantations and main growers. According to Cossalter and Pye-Smith (2002).

Species	**Mean annual increment at an operation scale (m^3/ha / year)**	**Time to reach maturity**	**Estimated extend fast-wood plantations only (1000 ha)**	**Main countries (in decreasing order of importance)**
Eucalyptus grandis and various eucalypt hybrids (1)	15–40	5–15	± 3.700	Brazil, South Africa, Uruguay, India, Congo, Zimbabwe
Other tropical eucalyptus (2)	10–20	5–10	± 1.550	China, India, Thailand, Vietnam, Madagascar, Myanmar
Temperate eucalyptus (3)	5–18	10–15	± 1.900	Chile, Portugal, north-west Spain, Argentina, Uruguay, South Africa

Table 1 Continued

Tropical acacias (4)	15–30	7–10	± 1.400	Indonesia, China, Malaysia, Vietnam, India, Philippines, Thailand

(1) Mainly hybrids involving: *E. grandis, E. urophylla, E. tereticornis, E. camaldulensis, E. pellita*
(2)Mainly E. camaldulensis, *E. tereticornis, E. urophylla, E. robusta, E. pellita, E. deglupta*. India alone reports 8 million hectares of eucalypt plantation(FAO 2001). Our estimate is that the large share of this does not qualify as fast wood due to its modest growth rates.
(3) Essentially *Eucalyptus globulus*, but also several frost-resistant species (mainly E. nitens).
(4) Essentially *Acacia mangium*, but also *A. auriculiformis* and *A. crassicarpa*.

1.2.3 Future projections

According to the literature, there is no reason to expect that area of planted forest would start to decline, on the contrary. Carle and Holmgren (2008) defined three possible scenarios: pessimistic, business as usual (BAU) and higher productivity, for the development of the area of planted forests (plantations and seminatural) until 2030. The pessimistic scenario was based on an assumption that the current increase of planted forest area will slow down. The BAU scenario predicts the change rate will remain the same until the year 2030. The higher productivity scenario assumes increase in annual productivity in the forests where genetic, managerial or technological improvements are expected. A deterministic model was run for 666 management scenarios for 61 countries for the period of 2005–2030. Despite the slower growth of planted forest area the pessimistic model estimates 16% increase in the area. The BAU and higher productivity scenarios predict the increase to be 32% higher to the year 2005 situation. Asia will have the highest absolute increase in areas, but Southern Europe will develop the highest relative increase.

1.2.4 Investment theories from foreign investors point of view

The degree of internationalization of the forest industry firms and company's profits has been proven to have a positive, but U-shaped relationship by for example by Zhang and Toppinen (2011). This means that the largest profits occur in the least and the most

internationalized firms. The underlying factors explaining differences in internationalization processes and results of them are important to understand. The economic and managerial theories of internationalization have been studied and understood more broadly than cultural aspects of internationalization (Zhang et. al 2012). Resource-based models demonstrate at firm level, when economic and social issues are mainly studied at country level.

The earliest theories for foreign investments were from 1930s when Coase (1937) concluded that transaction costs due to market imperfection encourage firms to expand abroad. If the transaction costs exceed the operating costs of production, the firm is expected to enter into the international markets. This theory was based on an assumption of efficient markets, where the lowest price for product is provided by external markets. Dunning (1988) conceptualized "an eclectic paradigm" of international production in 1976. According to this theory the incentives for internationalization, in addition to transaction costs and market imperfection, were corporate ownership advantages, location and internalization advantages (OLI theory). Brand, technology and patent are the ownership advantages that benefit in a competition against local competitors in a host country. Among the locational attributes considered by multinational firms considering foreign direct investments are the economic, political, social, and cultural characteristics of the destination country

The resource-based theories have often approached investments from a resource barrier point of view. If resources, services or knowledge are limited within the firm, then expansion becomes an option (Wernerfelt, 1984; Barney, 1991). The direction of firm's foreign expansion is correlated to the geographical location of the unused production capacity. The Uppsala model (Johanson and Vahlne, 1990) explains how firms gradually expand their activities abroad. The expansion initiates from foreign countries which are culturally and geographically close, moving step-by-step to the more culturally and geographically distant countries.

The industrial organization theory approaches industrialization from a strategic view. The process is seen as a corporate behavior on institutional level that is defined in a firm's strategy. According to Caves (1971) the firm must have an advantage that enables it to achieve a strong competitive position in new markets. He also takes the theory further suggesting that these advantages should be transferable intact to the new market, and stable to be profitable for the firm to increase the scale of its operation in the long run.

There are also theories that emphasis managerial, social and cultural perspective. The agency theory by Eisenhardt (1981) demonstrates how the internationalization can be due to a manager's personal interests rather than the corporation's strategy. Cultural and managerial aspects are often considered a part of corporate strategy. In 1995, Calof and Beamish introduced a model that suggests the attitudes of executives have a strong impact on selecting the internationalization strategy. The importance of customers and networks are also recognized by internationalization theories for example (Cardone-Ripotella et al., 2003).

1.2.5 Domestic investing

Domestic firms do not have to necessarily have superior firm-specific advantages like the multinational firms; domestic investors do not need to overcome trade barriers and extra costs that internationalization causes. According to Greene and Villanueva (1991) the domestic investments are more likely occur in countries with higher per capita income, like Organization of Co-operation and Economic Development (OECD) member countries. Greene and Villanueva (1991) assume that these countries are able to direct income to domestic saving which are later to be used for financing investments.

The developed countries fulfill the underlying assumptions of perfect markets remarkably better than the developing countries. Due to the severe constraints in institutional structures and data availability, the neoclassical investment models have not

been developed successfully for developing countries (Oshikoya, 1994). Rather than developing theories the studies have concentrated on testing hypotheses on explaining the variation in investment behavior in developing countries.

1.3 Studies on individual macro & economic determinants of direct investments

1.3.1 Market size

Chakrabarti (2001) gathered studies on potential determinants of foreign direct investments and did a meta-analysis on the effects and methods of the studies. The effects of the individual factors were classified positive, negative or insignificant. Gross domestic product (GDP) is used as an indicator of a market size and it has been widely accepted to be one of the central determinants of FDI flows. Among all the indicators studied, GDP showed the least controversial results on foreign direct investments, with positive effects on FDI for example, Wheeler and Mody (1992), Schneider and Frey (1985).

According to the World Bank (in Asiedu 2006) Angola, Nigeria and South Africa have potential markets and access to resources. According to the World Bank these countries received 65% of the total foreign direct investments (FDI) to sub-Saharan area 2000–2002 (as cited in Asiedu 2006). Also Oshikoya(2004) found a positive relationship between GDP growth rates and private investments in African developing countries. Laaksonen-Craig (2008) concluded similar results and argued that level of GDP together with domestic demand and supply are the key motivators for foreign investors to enter in developing countries.

1.3.2 Impact of origin of the investment on profitability

Chen (2010) demonstrated that the origin of FDIs have an impact on firm's performance in the USA. The labor productivity in FDI receiving firm in USA was 13% better after acquisition by a firm from an industrialized country compared to the firms acquired domestically. However, the labor productivity was better in domestically acquired firms compared to acquisitions by foreign firms from developing countries. The profit increases were observed when acquisition originated from foreign firms, from industrial and developing countries compared to domestic. Also, comparison of employment and sales showed a different result. Acquisition from an industrial country increased both employment and sales compared to domestic acquisition, whereas they decreased if the acquisition originated from developing countries. Helpmann et al. (2004) have created a theoretical model supporting these results. Their model demonstrates that foreign acquirers can increase their revenues by making themselves more competitive by lowering the prices; foreign acquirers have smaller marginal costs, because of larger production levels.

1.3.3 Credit access

In developing countries, investing decisions are strongly affected by the volume of bank credit that is accessible for firms. The well-established firms as well as multinational wealthy corporations base their investment activities on retained earnings and equity financing, but companies from developing countries are dependent on credit. The banking credit is suggested to be positively correlated with private investments, and results were similar between middle- and low-income African countries. Oshikoya(2004) confirmed that credit availability has a strong, positive, and statistically significant impact on private investment rates in Malawi, Tunisia, Cameroon and Kenya. Negative, but insignificant, relationships were observed for Morocco, Tanzania and Zimbabwe.

1.3.4 Exchange rate

The role of exchange rate has been considered to be one of the most critical FDI determinants. The common hypothesis suggests that the weaker the currency, the less likely country will attract FDI. There are numerous studies, e.g., Blonigen and Feenstra (1997), indicating that the exchange rate (foreign currency per domestic) is negatively correlated with FDIs. Such findings are not universal, however: Edwards (1990) observed a positive correlation between exchange rate and FDI.

Regarding private investing, Oshikoya (2004) confirmed that the real exchange rate has a different kind of impact in middle-income and low-income African countries. In the middle-income countries such as Mauritius, Morocco, and Tunisia, the exchange rate was found by this author to be positively correlated with investments, whereas in low-income countries of Malawi, Kenya, and Tanzania, the correlation was insignificant. In middle-income African countries, a the weaker currency correlated positively with investments.

Exchange rate volatility has been also considered as a determinant for investment. The results on the impact of exchange rate volatility are controversial. In forestry volatility seem to be less significant factor compared to the exchange rate itself. Kim et al. (2003) studied the impact of exchange rate volatility on importing quantity variation and concluded that volatility have had only a short term impact, up to 10 months. Sun and Zhang (2003) observed that exchange rate volatility had a negative impact on exports from the USA. Nagubadi and Zhang (2011) found a positive relationship between bilateral FDIs and exchange rate volatility between USA and Canada. Uusivuori and Laaksonen-Craig (2001) confirmed that dollar variability does not affect U.S. forest product exports or FDI into U.S forest industries.

1.4 Studies on individual institutional determinants of direct investments

1.4.1 Openness

The openness and favorable investment policies tend to show a positive relationship with FDIs, but the empirical evidence is controversial. The degree of openness of an economy to external markets is often measured by comparing the sum of exports and imports to GDP. The common hypothesis is that the investments are directed to the tradable sector, and countries' openness is an important variable. For example Kravis and Lipsey (1982) found a positive statistical relationship between openness and foreign direct investments. Nevertheless, empirical evidence is mixed.

Openness can also have a negative relationship with FDIs if firms decide to avoid the trade barriers by going into a country with restricted openness. Instead of investing, the firm can move the whole business into the country. This phenomenon is known as a 'tariff discrimination' hypothesis. If a country has abundant resources or large markets, it can be a potential investment destination in spite of its trade obstacles (e.g., Mundel, 1957). Since the early work by Mundel, studies have indicated positive, negative and insignificant relationships between FDI and openness (Chakrabarti 2001).

Although tariff and some nontariff barriers have been on the decline over the past several decades, there are still measurable barriers to trade and investment in the forest sector. The traditional timber product producers from the developed countries such as Canada, Finland, Sweden, the USA, and Japan are re-locating their production facilities and the value-added processing to the developing countries such as Brazil, China, Indonesia and Russia. Tariffs and other obstacles to trade are driving this trend. Local governments in developing countries sometimes ban roundwood exports to create new jobs and improve the economy (Dauvergne and Lister, 2011).

1.4.2 Labor and Wages

Chakrabarti (2001) concludes in his study that wages have the most controversial results regarding analysis on FDI determinants. The effects of wages have been positive, negative and insignificant among studies. According to Charabarti (2001), cheap labor has been accepted as an attracting factor for multinational companies in general, but the empirical evidence is not unconditionally in support of that hypothesis. For example Goldsbrough (1979) and Scheiner and Frey (1985) argued higher wages to be unattractive for foreign investors.

Mody and Srinivasan (1998) observed that the labor and capital are technical substitutes in production and neither can be used to explain the choice of host country: low labor costs often lead to labor-intensive production which requires less capital. High labor cost may indicate efficient production, which naturally is attractive for investors. There is evidence that a highly educated population attracts foreign direct investments to the country, especially when it comes to investment requiring access to efficient and skilled labor.

Mody and Srinivasan (1998) revealed that the there is a difference between US and Japanese investors' interests. The 'trainability' of the labor force was more important for Japanese investors than to US investors. Labor costs did not explain the differences in selection between different investment destination countries. Although low wage inflation had generally a positive influence on investors and high wage inflation was likely to drive investors away.

1.4.3 Risk

Gonzales et al. (2008) argue perceived and actual financial and political risks are perhaps the most important factors affecting forest related investment. According to these authors, Brazil and Chile have the lowest level of export and direct investment risk in Latin America, and this explains why the investors have been particularly interested

in these countries. However, compared to the developed countries Brazil has high political and commercial risks as well as high risk of expropriation and government action (Table 2). Overall, developed countries have a better risk rating than developing countries in general (ONDD 2011). Still, foreign direct investment flows are increasingly going to developing countries.

For example Finland has the lowest risk rating in all risk classes and the USA has a middle class commercial risk after the financial crises although otherwise the risk ratings are the lowest possible. China, Russia and Brazil have the lowest rating in commercial risk. China and Russia have also a moderate risk of war and government action. OECD countries are considered developed countries, whereas non-OECD countries are considered developing.

Table 2. Political, commercial, war and government-related risk in selected countries in 2010 (ONDD 2010).

						Risk of	
	Political risk	Political risk	Special	Commercial	War	expropriation and	Transfer
OECD	Short term	Long term	transactions	risk	risk	government action	risk
Japan	1	1	1	A	2	1	1
Finland	1	1	1	A	1	1	1
USA	1	1	1	B	1	1	1
Australia	1	1	1	B	1	1	1
NOT OECD							
South Africa	3	3	3	B	2	3	3
China	1	2	1	C	3	4	2
Russian Federation	2	3	2	C	3	4	3
Brazil	2	3	2	C	2	3	3
Costa Rica	2	3	2	B	1	3	3
1 (low risk) - 7 (high risk)			A (low risk) - C (high risk)				

High capital cost and lack of liquidity for forest management projects increase investment risk and are characteristic of Latin American forest investments. Keipi and Haltia (1995) argue that high capital cost and lack of liquidity to be due to two facts: The capital market imperfections and the long time period in terms of income from forest investment. To reduce the capital cost, a co-financing arrangement could be introduced. The investment risk could be lowered by introducing indirect incentives to higher the protection against forest fires or introduce up-to-date technologies and provide market information. Appropriate credit programs could hinder liquidation problems caused by long period of maturity for forest investments.

1.4.4 Corruption

Many illegal activities may be associated with forestry. Corruption is a complex concept which has various forms and therefore is perceived differently in different countries. There are common characteristics that are common to all kind of corruption. These characteristics include: conflict of interest, embezzlement, fraud, bribery, political corruption, nepotism and extortion. There are several surveys that have examined the opinions of investors on factors that constrain FDIs in Africa. Both World Business Environment and World Investment Report surveys rank corruption as the main constraint with 49% of surveyed firms identifying corruption (Asiedu 2006).

1.4.5 Role of governance

Investors tend to prefer countries with a credible government and an efficient, transparent and moderate legal system. Nevertheless, tropical and subtropical developing countries have a comparative advantage in fast wood production with their potential high growth rates, cheap land and labor compared to temperate planting countries. The lack of clear governance and legislation as well as poor infrastructure makes these countries less attractive for investments.

In developed countries the longer-rotation plantation areas have been increasing faster. The advantages of developed countries, mainly located outside of tropics, include relatively stable economies, good governance, and low investment risks as compared to developing countries. The quality of the wood can be improved during the longer rotations of the North. The yield increases received from sawn wood and veneer are larger compared to increases in pulp wood production (Cossalter and Pye-Smith 2002).

Lack of governance may hinder countries from benefiting from investments. Asiedu (2002) notes the investment policies that have been successful in terms of sustainability in one region may not be equally successful in other. According to Asiedu (2006) the lack of governance that has resulted in, for example, inability to control corruption has hindered certain developing countries from capturing the benefits accruing from investments.

1.5 Studies on individual forest sector determinants of direct investments

1.5.1 Subsidies

Keipi and Haltia (1995) argue that the incentives used for promote forest investments should be targeted and cost effective to avoid trade distortions. The aims of the use of subsidies in Latin America by Beattie (1995), McGaughey and Gregersen (1988), Southgate (1995) (as cited in Haltia and Keipi, 1995) are as follows:.

1. Investment destinations with low private profitability could be justified to be made more attractive by subsidies to gain the external benefit for the whole society.
2. The subsidies can reduce farmers' bias against forestry. Forests could become an attractive alternative land use.

3. In terms of risk reduction, subsidies could reduce investors' risk caused by the long time period. The long time scale of forest investments and especially late maturity of investments is a challenge to the cash flow analysis, because planting and operational costs occur in the beginning and throughout the entire rotation. Subsidies could improve the liquidation of forests, and give forest owners alternatives to selling the land getting income before the end of a rotation.
4. Subsidies can be aimed at the establishment of new plantations, to attract new industries, which help in overall economic development.

On the other hand, if plantations are subsidized by taxpayers, the social benefit becomes important. If the taxpayers don't gain larger social benefits than the cost of their subsidies, then they will be disappointed.

In Australia, the commonwealth government introduced managed investment scenes (MIS), which has led to a noticeable increase especially in hardwood plantation area. In 1990, the role of hardwood plantations was very small; by 2005, the hardwood planted area had expanded to over 0.7 M ha. Through the MIS, companies are able to raise funds from individual taxpayers through the issuance of prospectuses. Many taxpayers are attracted to the possibility to claim the investment against their taxable income in the year of investment (Cossalter and Pye-Smith 2002).

1.5.2 Demand and Supply

Global per capita consumption of wood based products has been estimated to increase, along with the growing population. The population will be estimated to increase from current 6.9 billion to 9.4 billion by 2050 (International Programs Center of the US Bureau of the Census 2012). Even if the per capita consumption were to remain the same, the projected population increase itself would lead to significantly higher total consumption of wood products (Cossalter and Pye-Smith 2002). The consumption of

forest products is projected to increase especially in emerging economies in Latin-America and in China.

In areas with preferred biological growth factors and economic factors, such as low labor cost and high rates of return, there will be new or larger production possibilities. Therefore, for example, Latin-America has more potential to attract investments than North America (Gonzales et al. 2008).

A lack of timber availability in USA was considered as the main driver of outward FDIs in the study by Zhang (1997). Laaksonen-Craig (2008) also concluded that the abundant resources and markets are the main factors attracting FDI. The relationship between investments, round wood supply and wages were studied with Granger-causality tests conducted by Laaksonen-Craig (2004). The results indicate that roundwood supply doesn't cause foreign direct investments, but investments increase roundwood supply in developed countries. In developing countries the causal relationship appeared the other way around: Timber supply attracts FDI. She also argues that GDP and foreign direct investments (FDI), or wage level and FDI don't have a bilateral causal relationship in developed countries. However in developing countries bi-directional causality between GDP and FDI exists.

Cubbage et al. (2006) determined timber investment returns to selected plantations and native forests in South America and the Southern United States. There was a variation between the main species eucalyptus and loblolly pine. The internal rate of return for exotic eucalyptus plantations was the most profitable in South America ranging from 13 to 23%, respectively pine plantations had IRRs ranging from 9 to 13%. In the US South the loblolly reached on average 9.5% IRR, whereas native species plantations in the Americas had IRR from 5 to 13%. Subtropical and tropical native forests reached 4% IRR at the best, in unmanaged stands the rate being negative. The observed factors effecting IRR were state subsidies, reservations and included land cost in cash flow

calculations. State subsidy was likely to increase IRR. Dedicating land to protection lowered IRRs the same happened when land cost was taken into the consideration.

1.5.3 Exports

Uusivuori and Laaksonen-Craig (2001) studied the relationship of forestry exports and FDI in the USA, Sweden and Finland. The results suggest that one-time investment had no effect on long term trend of FDI. They also observed that the U.S. industries seem to follow different type of behavioral pattern when it comes to long term assessment. In USA the exports and FDI are full substitutes whereas in Sweden and Finland an increase in exports cause highly negative impact on FDI, but FDIs has no significant impact on exports.

1.5.4 Financial returns

Financial returns are naturally one of the most important factors driving investments. New technology has increased the productivity of forest plantations. Cossalter and Pye-Smith (2002) point out that the expansion of fast wood plantations has been purely economic: less land is needed for producing same amount wood. Therefore the land purchasing, production and transportation costs stay smaller. Lopez et al. (2010) pointed out that a high site quality and high growth rates make forestry profitable. They concluded that the site quality can be manipulated by intensive forest management. Allen (2001) argues that the productivities could be increased by intensive forest management also, in the world's largest industrial roundwood production area, the Southeastern USA. Lopez et al. (2010) argue that site quality has larger effect on more timber investment returns than do either land prices, or transportation distances, or timberland prices.

1.5.5 Environmental regulations

The strict environmental legislation has been considered to be both desirable and undesirable. The FDI inflows may be deterred by increased costs caused by the

environmental regulation. The Pollution Haven Hypothesis (PHH) states the countries with lenient environmental regulation attract investment from polluting firms. However, the literature lacks a consensus on PHH. For example Cole and Elliott (2005) found strong evidence on PHH. However, many studies have concluded that the environmental regulation do not influence investment decisions of an industry. An insignificant relationship between foreign direct investments and environmental regulation was found for example by McConnell and Schwab (1990) and Friedman et al. (1992) (as cited in Dijkstra et al., 2011).

The studies also conclude that sometimes environmental regulations can have a positive effect on FDIs. The regulation can for example improve the quality of the environment, and a clean environment is often considered as an indicator for better quality of life; ergo, moderate regulations can promote FDIs.
Dijkstra et al. (2011) take a reverse approach to the relationship of FDIs and environmental regulation, and examine the effect of FDIs to regulations. Their hypothesis is that the raising rival's cost is a motive for FDIs. When FDIs lead to stricter environmental policy in a hosting country, the costs of foreign investors increase. The foreign investors retain their relative competiveness within the subject country because the costs of domestic rival firms increase simultaneously as well.

Studies that have examined the relationship of environmental regulation and FDI haven't been able to find evidence of a negative relationship between environmental regulations and FDIs (e.g. Wheeler, 2001).

1.5.6 Land access, property laws

The access to new land is one important factor in terms of firm's strategic decision making. Property rights should be stable when dealing with investments which require a lot of land. The poor availability of land may have directed forest investments away from the countries which are considered to have preferable conditions, such as a high timber growth rate and a stable economy. Uruguay has been a desired destination for

foreign direct investments in South America because of its location and relatively stable political and economic conditions. Brazil has a large advantage because of its size and well developed forest sector. But the country has also a challenging land tenure law.
Because of the lack of land available together with strict regulations the global companies have started to seek opportunities to invest in other countries than in Brazil in southern America. There are programs to improve business environment in less stable South American and Caribbean countries. For example the Inter-American Development Bank (IADB) provided US $9.7 billion for governmental cooperation to address specific market or institutional failures, and therefore support the private sector in Latin America and the Caribbean, during 2004-2009 (Nascimento 2006; IAIB 2008).

Also Asia has experienced rapid growth in plantation are in the last decade. Especially China has been directing a lot of investments in timber plantations to increase the domestic capacity for timber production. Russia is another emerging economy with a large land base where plantations are expanding fast. These two countries together with the USA maintain over half of the world's timber plantations. Traditional timber product producers from developed countries such as Canada, Finland, Sweden, the USA, and Japan are transferring their production facilities to developing countries such Brazil, China, Indonesia and Russia. (Dauvergne and Lister, 2011).

2 Description of objectives, data and methods

The primary objective of my research was to determine the most important macro-economic, institutional and forest sector factors attracting investments in forest plantations on a global scale.

The sub-objective was to study if there are differences between the factors among countries with different social and economic structures. I will base the country division on the Organization for Economic Co-operation and Development (OECD) member country and non-member country classification as of the year 1990.

The results and the theory of my study will be related to the prior research. The aim is examine and discuss the implications for forest investors who are seeking new investment destinations. The influential factors are likely linked to the expected profits, as the theory behind IAIF suggests.

The aim is to create a multiple linear regression model to examine effects of macroeconomic, institutional and forest sector factors on forestry investments. The area of planted forest was set to be a dependent variable, indicating the amount of direct investment in the forest plantations, in this research. First, the possible independent variables were listed using IAIF as a framework (Table 3) and previous done research. Then, a more specific set of measurable indicators (Table 4) for each factor was selected to the further analysis. Anticipated effects of the indicators on plantation area were generated to Table 3 and 4 by using previously conducted studies on foreign direct investments in forestry and in other economic and industrial sectors.

A regression model was developed to explain the panel data on the independent variables and the dependent variable, the planted forest area. A theoretical model for the panel data was formulated as:

$$DIplant_t = f(M_{it}, I_{it}, F_{it}),$$

where

DIplant = the area of planted forests

M = macro-economic factors

I = institutional factors

F = forest sector factors

i = the individual independent variable

t = the time dimension.

Table 3. Full list of potential independent factors and anticipated effects on investment in forest plantations.

	Factors	Anticipated effect
1. Macro & Economic Factors		
General economy	GDP per capita	+
	Growth	+
Capital	Domestic	+
	Foreign	+
	Exchange rate	-
	Stability	-
Taxes	Raters	-
	Complexity	-
	Administration	-
Trade	Quantity	+
	Openness	+
Risk & security	Political Risk	-
	Personal Risk and Safety	-
2. *Institutional Factors*		
Infrastructure	Economic, physical, social	±
	Transportation costs	-
	Establishment costs	-
Business Environment	Legal contracts and rule of law	+
	Corruption	-
	Credit access	+
	Licenses, permits	-
	Opening business	+
	Closing business	-
	Labor availability	+
	Relations	+
Legal environment	Agriculture policies	±
	Land use	±
	Ownership laws	±
3. *Forestry Sector Factors*		
Markets	Domestic	+
	Export	+
Forests and plantations	Inventory	+
	Growth	+
	Removals	±
	Land change	±
	Productivity	+
	Input costs	-
Regulations	Reserves	-
	Harvesting	-?
	Planting	-
	Biodiversity	-
	Rigor	-
	Enforcement	+/?
	Predictability	+
Incentives and Subsidies	Amount	+
	Rate	+
	Availability	+

Table 4. Independent factors, indicators and their anticipated effects on forest plantation investments.

1. Macro & Economic Factors		
		Anticipated effect
General economy	GDP per capita	+
Capital	Foreign direct investment inflows	+
	Exchange rate	-
Taxes	Taxes on international trade	-
Trade	Tariff rate of manufactured products	±
Risk & security	Political risk for export credits more than 1 year	-
	Political risk for export credits less than 1 year	-
2. *Institutional Factors*		
Infrastructure	Unemployment	-
	Human development index	+
	Corruption perception index	-
Business Environment	Domestic credit provided by banking sector	+
	Domestic credit to private sector	+
	OECD membership	±
Ease of doing business	Procedures, days, costs to start business	-
	Procedures, days, costs to register property	-
	Years, Costs to recovery of insolvency	-
3. *Forestry Sector Factors*		
Markets	Roundwood production, exportation, consumption	+
	Woodpulp production, exportation, consumption	+
	Sawnwood production, exportation, consumption	+
	Woodfuel production, exportation, consumption	+
Forests and plantations	Total forest area	+
	Forest Productivity	+
Resource availability for export	Roundwood (net exports / domestic consumption)	+
	Woodpulp (net exports / domestic consumption)	+
	Sawnwood (net exports / domestic consumption)	+
	Woodfuel (net exports / domestic consumption)	+

2.1 Data collection description and initial manipulation

I started the data collection with an extensive list of indicators (Table 4) since answering my research question requires covering a high number of different aspects. I collected initial data on the different variables for countries that appeared in the FAO dataset on planted forests on for years 1990, 2000, 2005 and 2010 (FAO 2011, 2006, 2001, 1995). Over the 6 month time period I sought potential data sources and matched their data with the planted forest data. The data were or aimed to be collected for each country and variable for all the four planted forest inventory years. The procedures for data recording and collecting both vary a great deal over the continents and countries, which caused challenges to make the countries datasets comparable. If there weren't any data available for the exact year, the closest available year was used to represent it. Increased variability and error among independent variables may be caused by choosing adjacent years, possibly resulting in decreased significance of parameter estimates. The final selection of countries and indicators used in the analysis was based on data availability. The final dataset contains 32 indicators of which two are binary and 30 continuous variables. The analysis contains altogether 42 countries from 7 different regions (Table 5).

The data were collected through secondary online sources open for public. The main sources for the data were FAO, The World Bank and The International Monetary Fund. The consistent data series for all of the countries weren't always available in one data source. Therefore, for some variables the data were collected from multiple sources. In case data were not accessible, it was recorded as missing.

Table 5. Countries included in the analysis.

OECD		NON-OECD	
Asia		**Africa**	
	Japan		South Africa
	South Korea		
Europe		**Asia**	
	Belgium		China
	Denmark		India
	Finland		Indonesia
	France		Malaysia
	Germany		Thailand
	Ireland	**Europe**	
	Italy		Russian Federation
	Netherlands	**South America**	
	Norway		Argentina
	Portugal		Bolivia
	Spain		Brazil
	Sweden		Chile
	Switzerland		Colombia
	United Kingdom		Ecuador
North America			Paraguay
	Canada		Peru
	United States		Uruguay
	Mexico		Venezuela
Oceania		**Central America**	
	Australia		Costa Rica
	New Zealand		Guatemala
			Nicaragua
			Panama
			Mexico

2.2 Description of variables and sources

2.2.1 Macro-economic variables

The data on **Gross Domestic Product (GDP) per capita** (Current US$) was obtained from the World Bank databank at http://data.worldbank.org/indicator/NY.GDP.PCAP.CD. GDP per capita is gross domestic product divided by midyear population.

Domestic credit provided by banking sector (% of GDP) data were obtained from World Bank website at databank at http://data.worldbank.org/indicator/NY.GDP.PCAP.CD. The year 2009 represents year 2010, because the data on year 2010 were not available. Some individual values for different years and countries were substituted by the value from a previous or a following year. The most recent data for Portugal was from 2006, which were used for representing the year 2010. According to the World Bank "Domestic credit provided by the banking sector includes all credit to various sectors on a gross basis, with the exception of credit to the central government, which is net. The banking sector includes monetary authorities and deposit money banks, as well as other banking institutions where data are available (including institutions that do not accept transferable deposits but do incur such liabilities as time and savings deposits). Examples of other banking institutions are savings and mortgage loan institutions and building and loan associations".

Domestic credit to private sector (% of GDP) -data were obtained from World Bank website at databank at http://data.worldbank.org/indicator/NY.GDP.PCAP.CD. The year 2009 represents year 2010, because the data on year 2010 were not available. Some individual values for different years and countries were substituted by the value from a previous or a following year. According to World Bank the domestic credit to private sector include financial resources provided to the private sector "such as through loans,

purchases of non-equity securities, trade credits and other accounts receivable, that establishes a claim for repayment". The claims include credits to public enterprises for some countries, which is not pointed out more specifically in the World Bank database.

Political risk for export credits more than 1 year. The risk is classified from 1(the lowest) to 7(the highest). The data on risk indicators were obtained from Belgium Export agency (ONDD) via personal consultation. The year 1994 is the earliest in this data set. The risk in the year 1994 is used for representing the year 1990 risk values. The Belgium export agency bases on country risk classification on systematic analysis using reliable sources such as International Momentary Fund (IMF), World Bank and The Economist Intelligence Unit.

Political risk for export credits up to 1 year. The risk is classified from 1(the lowest) to 7(the highest). The scale was changed from 1 (Lowest)–5 (Highest) to 1–7 in 1997. The 1994–1996 scaling was replaced with the new one to make the data compatible over time. In the adjusted scaling the old highest and lowest values remain the highest and lowest, 1 is 1 on a new scale and 5 changes to 7. The old middle values 2 to 4 were changed to the middle values in adjusted scale (Table 6). The data on risk indicators were obtained from the Belgium Export agency (ONDD) via personal consultation. Again, 1994 is the earliest in this data set. The risk in year 1994 is used for representing the year 1990 risk values.

Table 6. Risk Class 1994–1996 values fit to Risk Class 1997– values.

Risk Class 1994–1996	Risk Class 1997–	Risk Class 1994–1996	
1	1	**Old Scaling**	**Adjusted scaling**
2	2	**1**	**1**
3	3	**2**	**3**
4	4	**3**	**4**
5	5	**4**	**5**
	6	**5**	**7**
	7		

Foreign direct investments (FDI) are the "net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor" expressed in current U.S dollars ($ 1 000 000). The data were obtained from World Bank databank at website http://data.worldbank.org/indicator/NY.GDP.PCAP.CD. The year 2009 represents year 2010, because the data on year 2010 were not available. Also some individual values from other years were substituted with values from adjacent years. The foreign direct investments according to World Bank is the sum of equity capital, reinvestments of earning, other long-term capital, and shot-term capital as shown in the balance of payments. All the negative values on foreign direct investment inflows were considered as missing values in the analysis.

Tariff rate, applied, simple mean, manufactured products (%) -data were collected from World Bank databank at website http://data.worldbank.org/indicator/NY.GDP.PCAP.CD. The tariff rate is the unweighted average of effectively applied rates for all the products that are target to tariffs (Appendix A). Some individual tariff rate values in my dataset are individual values from two years before or after than the planted forest inventory years.

National currency exchange rates per US$ were found for the selective currencies since 2000 from the webpage of International Momentary Fund (IMF). The central and Latin American data were found from old IMF publications. The US Federal Reserve System was also a good source for many currencies. I also went through individual countries' central banks to find data on the exchange rate from their archives. The Exchange rates are expressed in the current currencies. For example, Venezuela changed its currency bolivar to bolivar fuerte in 2008 due to inflation: 1 bolivar fuerte=1000 bolivares. All the Venezuelan data are adjusted to bolivar fuerte. The data on exchange rates were not usually accessible for the year 1990, especially in Asian and African countries. I decided to use values before 1995 to represent the year 1990 rates, if data were not available for earlier years. If there were not enough data to calculate the year average values the end of July values were selected to represent the exchange rate of the year. The challenge was to make country specific datasets compatible over time. Eleven European countries adapted a common monetary policy in 1999. The euro was used only for accounting purposes, for example for electronic payments, during the first three years. Euro cash was introduced in 2002. I had to convert year 1990 exchange rates to be compatible with the later data for countries. For that I used exchange rate data from the Finnish central bank and data from European central bank. From Finnish central bank annual report (1990) I got exchange rates for former national currencies of Belgium, France, Germany, Ireland, Italy, Netherlands, Portugal and Spain, reported in Finnish markka. National currency per markka ratios were converted to national currency to US $. The national currency per US $ rates I converted to euro per US $ using the fixed euro conversion rates by the European Central bank.

The data sources with their websites listed below.

Source	Website
International Momentary Fund	http://elibrary-data.imf.org/DataReport.aspx?c=1449311&d=33061&e=169393 Accessed multiple times at 2/20/2011 - 6/26/2011
Reserve Bank of Australia	http://www.rba.gov.au/statistics/frequency/exchange-rates.html Accessed at 5/12/2011
Reserve Bank of New Zealand	http://www.rbnz.govt.nz/statistics/exandint/b1/ Accessed at 5/12/2011
US Federal Reserve System	http://www.federalreserve.gov/datadownload/Build.aspx?rel=H10 Accessed multiple times at 2/20/2011 - 6/26/2011
Central Bank of Finland	http://www.suomenpankki.fi/pdf/SP_Vsk_1990.pdf Accessed at 6/30/2011
Bank of Indonesia	http://www.bi.go.id/biweb/Templates/Moneter/Default_Kurs_EN.aspx?NRMODE=Published&NRNODEGUID=%7bEC4BBAA9-A1A8-4A4F-AC22-EDDA954C1B6A%7d&NRORIGINALURL=%2fweb%2fen%2fMoneter%2fKurs%2bBank%2bIndonesia%2fKurs%2bTransaksi%2f&NRCACHEHINT=Guest# Accessed at 7/1/2011
Russian Central Bank	http://www.cbr.ru/eng/currency_base/daily.aspx?C_month=07&C_year=2011&date_req=08.07.2011 Accessed at 7/8/2011
European Central Bank	http://www.ecb.int/euro/intro/html/index.en.html Accessed at 6/30/2011

2.2.2 Institutional variables

The information on **Organization for Economic Co-operation and Development (**OECD**) membership** was obtained from the OECD home webpage at http://www.oecd.org/document/58/0,3746,en_2649_201185_1889402_1_1_1_1,00.html. The membership division is based on the year 1990 membership classification in my study. The mission of OECD is to improve economic and social well-being around the world. OECD's work is based on continuous monitoring of events in member and non-member countries and projections on the economic development using the information. The member countries may agree on for common rules concerning on international co-operation, for example on arrangement of export credits or on the treatments of capital

movements. The discussion may also produce guidelines for environmental practices or corporal governance.

The Human development index (HDI) combines indicators of life expectancy, educational attainment and income into a simple statistics that can be used for comparing different countries' social and economic development. Each country gets a value between 0(undeveloped) to 1 (highly developed). For some countries, data on individual years were not available. The value from the closest possible year was selected to represent the sought after data point. Usually the values were found within two years, but for Russia the earliest data was from the year 1995. The data were obtained from United Nations Development Programme (UNDP) webpage at http://hdr.undp.org/en/statistics/hdi/.

The Corruption Perceptions Index (CPI) score was obtained from Transparency International (TI) webpage at http://www.transparency.org/policy_research/surveys_indices/cpi/2010/results.
According to TI corruption is "abuse of entrusted power for private gain". The CPI score from 1 (highly corrupt) to 10 (very clean) is used for comparing countries. CPI combines different sources of information about corruption. The year 1990 values are substituted with values from later years due to the lack of data availability. For European countries there were data from 1995, when the index was released by TI, but for example for Asian countries the earliest data were found in 1998. The earliest and closest obtained data were selected to present the years.

Unemployment data were found from World Bank databank at website http://data.worldbank.org/indicator/NY.GDP.PCAP.CD. It measures % of the total labor force that are available and looking for a job. What are meant by labor force and unemployment differs from country to country. The year 2009 represents the year 2010, because during the data collection the year 2010 data were not published by World Bank.

Taxes on international trade measured as a percent of revenue include import duties, export duties, profits of export or import monopolies, exchange profits, and exchange taxes. The zero and negative values were considered as missing values in the analysis. There were difficulties to find data on this variable. Data from the year closest to the representative year were used in the analysis. Usually the data were found within 2 years. The data were more readily available for Asian and North American countries and South Africa than for European and Oceania countries.

The World Bank has developed methodologies to measure **"the ease of doing business".** There are indicators on starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting investors, paying taxes, trading across borders, enforcing contracts and resolving insolvency. I collected data on starting a business, registering property and cost of insolvency, which formerly was known as closing business. The indicators are either time- (number of days required to start the business or register property) or cost-based (a percentage of the value of the debtor's estate). The data were available only from 2004. The year 1990 and 2000 values were interpolated expecting a linear relationship and using values for 2005 and 2010. Data were obtained at http://www.doingbusiness.org/rankings.

2.2.3 Forest sector variables

Area of planted forests, the dependent variable of this research in countries with more than 50000 ha in 1990, 2000, 2005 and 2010 was compiled by Food and Agricultural Organization of United Nations (FAO 1995, 2001, 2006, 2011). The data include plantations and semi natural planted forests.

Total forest area data was obtained from Forest Resource Assessment reports in 1990, 2000, 2005 and 2010 provided by FAO. Most of the data were available online on FAO webpage at http://www.fao.org/forestry/fra/fra2010/en/ for the year 2010, http://www.fao.org/forestry/32032/en/ for the year 2005, and

http://www.fao.org/forestry/3984-FRA 056a29b75cabe60ef56d6279799e758d0.pdf for the year 2000. The 1990 values were obtained from FRA-report published in 1995.

I gathered data on **production, exports and consumption of industrial roundwood, woodpulp, sawnwood and woodfuel** from FAO databank at http://faostat.fao.org/site/626/default.aspx#ancor. The values include both nonconiferous and coniferous products. The consumption I calculated by adding imports and subtracting exports from the production. In most of the cases the year 2009 is used for representing the year 2010, because the data on 2010 were not available. The negative percentage values or zero values of production, exportation and consumption of woodpulp (Bolivia 2010, Paraguay 2010), and sawnwood consumption (New Zealand 2010) were considered to be missing values in my analysis. The **relationship between net exports and consumption** was calculated for different wood products to be used later in the analysis to see if countries that export more compared to domestic consumption are desired destinations for DI. If the level of exports exceeds domestic consumption, this can indicate that the country is used as a so-called export platform.

Productivities (m^3/ha/yr) indicate the circumstances for tree growth. The year 1990 productivity rates for Finland, Norway, United States, New Zealand, South Africa, Brazil and Chile were estimated by Sedjo (1983). The rest of the values were obtained via personal consultation of forestry experts. The year 2010 productivities were obtained from four different sources: FAO, from a Cubbage et al. (2011) summary report for plantation investment analysis summary, or the estimated values were obtained from consultation of forestry experts. The missing values for 2000 and 2005 were interpolated if productivity had increased over the time, otherwise those years were assumed to have the same productivity as in year 1990 and 2010.

Table 7. Summary of variables of analysis and sources.

Macro and economic factors	
Variable	**Source**
GDP per capita (current US$)	World Bank
Long term political risk for export credits (1 lowest, 7 highest)	The Belgian Export Credit Agency (ONDD)
Short term political risk for export credits (1 lowest, 7 highest)	The Belgian Export Credit Agency (ONDD)
Exchange Rates (year average)	IMF Reserve Bank of Australia Reserve Bank of New Zealand: US Federal Reserve System Central Bank of Finland European central Bank Bank of Indonesia Central Bank of Russia The Economic Commission for Latin America (ECLA)
Foreign direct investment, net inflows (BoP, current US$) ($1 000 000)	World Bank
Tariff rate, applied, simple mean, manufactured products (%)	World Bank
Domestic credit provided by banking sector (% of GDP)	World Bank
Domestic credit to private sector (% of GDP)	World Bank
Institutional factors	
Variable	**Source**
Human development index (0 undeveloped, 1 highly developed)	United Nations Development Programme
Corruption Perceptions Index CPI score, (1 highly corrupt, 10 very clean)	Transparency international
Unemployment, total (% of total labor force)	World bank
Starting a Business - Time (days), Procedures (number), Cost (% of income per capita)	FAO Ease of doing business
Registering Property - Time (days), Procedures (number), Cost (% of property value)	FAO Ease of doing business
Resolving Insolvency – Cost (% of estate), Time (years), Recovery rate (cents on the dollar)	FAO Ease of doing business
Forest sector factors	
Variable	**Source**
Area of planted forests (1000 ha)	FAO: Forest resource assessment reports 2010, 2005,2000 and 1990

Table 7 Continued

Woodpulp production, imports, exports (1000 tons)	FAO forest stats
Sawnwood production, imports, exports (1000 tons)	FAO forest stats
Woodfuel production, imports, exports (1000 tons)	FAO forest stats
Forest productivity (m^3/ha/yr)	FAO 2006, Cubbage et al. 2011, Sedjo (1983), Korean values personal consultant with Joon Soon Kim, an associate professor, at Kangwon National University, Expert estimation

2.3 Methods

The analysis process started by identifying 32 possible factors affecting investments in forest plantations, and using a set of indicators from the forest investment attractiveness index determined by the Inter-American development bank as a framework. Selected variables were dropped, due to inconsistencies in the available data. Later, a few additional variables were added to the list. Anticipated effects of independent variables on area of planted forests were defined with the help of previously done studies. All of the independent variables were plotted against the dependent variable to examine linearity and to explore whether and which factors might best predict plantation area development. Also, independent variables were plotted against each other to evaluate whether their joint inclusion in the statistical models could create problems associated with multicollinearity. The final models' validity was examined and the outcomes were compared with previous studies. In this way, conclusions were drawn about which factors are the dominant influences on forest plantation investment decisions.

2.3.1 Regression Analysis

The cross-country panel data were modeled applying ordinary least squares method to find the most unbiased estimators in a linear multiple regression model using SAS 9.2

software and SAS enterprise guide in the analysis. Due to the fact that there are no standardized methods to analyze the effects of direct investments, three potential approaches to model selection were selected to find the best fitting option.

1. Model 1 is a marginal effect model. The dependent variable was a logarithm base 10 transformed but the predictor variables are not transformed.
   $\text{Log (DIplant}_t) = f(M_{it}, I_{it}, F_{it})$,
   $\text{Log (DIplant)} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots\ldots. \beta_p X_p$

2. Model 2 is a Log-Log model. The dependent variable and the predictor variables are transformed with base 10 logarithm to measure the elasticities.
   $\text{Log (DIplant}_t) = f(\text{Log } M_{it}, \text{Log } I_{it}, \text{Log } F_{it})$,
   $\text{Log (DIplant)} = \beta_0 + \beta_1 \log (X_1) + \beta_2 \log(X_2) + \beta_3 \log(X_3) \ldots\ldots. \beta_p \log(X_p)$

3. Model 3 is a difference model. The dependent variable is transformed with a 10 base logarithm. The predictor variables are as in the Model 1. The changes of marginal effects from 1990 to 2000, 2000 to 2005 and 2005 to 2010 are analyzed.
   $\Delta\text{Log (DIplant}_t) = f(\Delta M_{it}, \Delta I_{it}, \Delta F_{it})$
   $\Delta\text{Log (DIplant)} = \beta_0 + \beta_1 \Delta X_1 + \beta_2 \Delta X_2 + \beta_3 \Delta X_3 \ldots\ldots. \beta_p \Delta X_p$

2.4 Data screening

2.4.1 Variable selection

To make sure the analysis contains sufficient amount of observations, the data availability for each variable was studied carefully. The number of observation per each indicator was observed and the factors with low number of observations were omitted. The scatterplots between independent variables and Pearson correlation coefficient

tables were used together with identification of likely important variables to select the most relevant ones for the further analysis. The correlation between area of planted forest and independent variables was plotted and linearity of relationship observed to find out what variables would be logical to correlate. The relationship between dependent variable and independent variables was examined, as was the relationship between independent variables. The logical interaction effect of different variables were identified and tested for the Model 1.

2.4.2 Identification of outliers in the data

Unusual and influential data analysis was done to identify problematic data series. The aim was to detect individual observations and series that contain substantially different observations which can lead to a large effect in the regression analysis. Based on this analysis few country-specific series with unusual observations were eliminated from the data set. The unusual and influential data analysis consists of three different parts: Residual analysis, leverage analysis, and Analysis of Cook's distance.

2.4.3 Residual analysis

Outliers with large residuals were studied using SAS software. An observation that has an unusual dependent variable value given its values on the independent predictor values is an outlier. The observations with absolute residual value greater than two were detected and pointed out to be analyzed better.

2.4.4 Leverage analysis

An observation is said to have a high leverage if it has an extreme value on a predictor variable. (2k+2)/n where k is the number of predictors and n the number of observations was used as a cut-off point on values that may have an effect on the estimate of regression coefficients. The observations with high leverages were identified for later examination and possible elimination.

2.4.5 Squared-residual against leverages

The most influential points have both high leverage and residual. Plotting squared residual against leverages was used to observe joint-effects of the both types of observation abnormalities.

2.4.6 Cook's distance

The observation is influential if its removal changes the estimate of the coefficient significantly. The overall influences of individual observations were detected by defining the Cook's distance. The higher the value, the more influential the observation is. The lowest value is zero. The cut-off value of Cook's distance is 4/n where n is the number of observations.

2.5 Model selection

The final model selection was done in SAS enterprise guide using R-square method. The model fit statistics are based on Akaike's information criteria (AIC) and Mallows' Cp criteria, which are model selection criteria for linear models. The Enterprise Guide defines all the possible models with different combinations of variables, and suggests the best fitting model based on the defined criterion. The formulas and the theory of the AIC and Mallow's Cp criteria are presented below. Both of these two criteria handle multicollinearity by excluding highly collinear factors from the model. Both criteria make adjustment to number of variables to select the best model; they also penalize for the increased number of parameters.

2.5.1 The Mallows' Cp statistics

$Cp = SS_{res}/MS_{res} - N + 2p$,

Where

SS_{res} –residual sum of squares for the model with p-1 variables,

MS_{res} –residual mean squares when using all available variables,

N –number of observations

p –number of variables used for the model plus one.

The best fitting model according to Mallows' Cp statistics is the one whose Cp statistics is equal or close to the number of parameters, $Cp \leq p$.

2.5.2 The Akaike Information Criterion (AIC)

$AIC = -2L_p + 2p$

Where

L_p –the maximized log-likehood

p –number of variables used for the model plus one.

The lowest value indicates the best fitting model.

2.5.3 Removing 'scale effects' of variables

The regression coefficient became very small for the Model 1 in the models when they were run for the first time. So called scale-effect was eliminated by dividing the variables.

The scaling of certain variables in Model 1.

Variable	Scale adjustment function
GDP	/ 10000
Banking credit	/ 100
Political risk	/ 10
FDI	/ 10000
Corruption	/ 10
Unemployment	/ 100
Tariff	/ 100
Roundwood production	/ 1000
Days to start	/ 10
Days to register	/ 10
Cost of insolvency	/ 100
Productivity	/ 100

2.6 Observing the validity of analysis and assumptions of regression analysis

2.6.1 Multicollinearity

In the presence of multicollinearity increases the estimators of regression coefficients become unstable and the standard error get badly inflated. Therefore, the multicollinearity is to be examined in the first place by calculating a variance inflation factor (VIF), even though it is not included in the general assumptions of regression analysis. The cut-off value of VIF is 10 and the predictor with value of more that are assigned for further investigation. If the predictor with >10 VIF is highly correlated with other predictor, the relationship between these two predictors was investigated more carefully. If removing highly correlated predictors reduced VIF values in this study, the

choice of remaining predictor was based on the deliberation of predictor of higher interest.

2.6.2 The Variance Inflation Factors

VIF= 1 / (1-R-squared)

2.6.3 Normality of residuals

One of the assumptions of regression is that the residuals are normally distributed. The normality was tested by using Shapiro-Wilk test, which null hypothesis is that the population is normally distributed. Large p-values indicate normally distributed data. Also the studentized residuals were plotted against normal quartile ranges to make visual conclusion on normality. The severe outliers that can threaten the normality assumption are either 3 inter-quartile-ranges below the first quartile or 3 inter-quartile-ranges above the third quartile.

2.6.4 Heteroscedasticity

The homogeneity of the variances of the residuals is one important characteristic of robust regression analysis. The well-fitted model does not show any pattern when residuals are plotted against predicted values. The heteroscedasticity is detected by applying a White's test and also graphically by plotting residuals against predicted values. The sum of the residuals should equal to zero and they shouldn't show any trends. The null hypothesis is that the variance of residuals is homogenous.

3 Results

3.1 Overview of results

The description of the dependent variable, the area of planted forests, includes the value distribution examination and the descriptive statistics. The second part contains model-specific variable analysis and subset specific data screening followed by a robustness analysis. The initial variable selection and data screening were done separately for global, OECD and non-OECD country datasets. The set of variables seemed to fit all of the model-specific datasets. Data screening and poor series detection resulted in the elimination of certain countries from specific datasets. Italy and Panama were the countries that seemed to have most serious outliers.

The relationship between dependent and independent variables was initially difficult to analyze because of the nature of the data. The variability of the values was large. The scatter plot showed linearity between dependent and independent variables, and was estimated to be sufficient to this analysis. The scatter plot between the area of planted forests and independent variables for Models 1 and 2 can be found in Appendices B through G. Therefore, the validity of regression analysis was emphasized and the fit of the final models was examined carefully in this analysis. The initial selection of different independent variables included in the model was based on the visual examination and Pearson correlation coefficients. The correlation coefficients are summarized in Appendix H. The pairwise examination and plots of independent variables with Pearson correlation helped to exclude independent variables that measured the same phenomenon and are most correlated, such as short-term and long-term political risk or banking credit and private credit (Appendix I). The aim was to choose a variable with higher correlation with plantation area. The Pearson correlation coefficient significance is highly dependable on a sample size and used only as a guideline in variable selection.

Due to the challenges of the data, I decided to give an explanatory role for the regression prediction model. This let us concentrate on the overall effects, direction, and significance of different factors rather than on the actual values parameter estimated. This limitation should be considered if the models were used for predicting the plantation development in the future.

The analysis showed that the marginal effect Model 1 fit the data best and only the marginal effects of the interactions were studied. The interaction of several different variables, FDI and Ease of Doing Business Indicators, HDI and GDP, productivity and long-term political risk, FDI and corruption, were studied but the results were not encouraging enough to leave these logical interactions in the model. Multicollinearity was a significant issue that needed to be recognized between explanatory variables.

There were so many variables in analysis that it is reasonable to place emphasis on examining the main effects of the variables on planted area development. However, interaction effects between roundwood production and several factors worked in this model, and they are discussed later in the analysis. The interaction terms did not show significance, and the primary emphasis was placed on the main effects. Also the nature of the significant interaction effect was not studied more closely. The broad approach to the study topic may not be the most useful for examining the interactions.

3.2 Interpretation of the estimation results

Model 1: The dependent variable is log-transformed, and the independent variables are in their original metric. The general interpretation of the model is that the dependent variable changes by 100*(parameter estimate) percent for one unit increase in the dependent variable if all the other variables in the model are held constant, hence this Model 1 can also be called a marginal effect model.

Model 2: When the dependent and independent variables are log-transformed, the parameter relationship is referred to as an elasticity in econometrics. Elasticity is the percent change in the planted area when the independent variable increases by one percent. Elasticity is a good way to analyze the effects in the model because it is independent of units and simplifies the model interpretation.

Model 3: Similar to Model 1, but the observations are changes in variables from year to year. This model was tested because the change from one period to the next period could potentially have better predictive properties and possible reduce problems of collinearity. Model 3 also posits that the dependent and one or more dependent variables are nonstationary, requiring first-differencing to allow for valid inference.

3.3 Description of dependent variable

The total area of planted forest increased in countries included in the analysis from 130 million hectares in 1990 to 216 million hectares in 2010 (Table 8). The increase in area is evident although there were some missing observations from 1990 and 2000.

Table 8. Area of planted forests in study countries.

Year	Planted area total (1000 ha)	Missing values
1990	127577	Ecuador, Indonesia, Mexico, Nicaragua, Portugal, South-Korea, Venezuela
2000	166804	Nicaragua, Venezuela
2005	193051	
2010	216132	

3.4 The descriptive statistics for planted area

There were 159 recorded values for the area of planted forest, meaning that altogether nine values were missing. The area of planted forest includes protective and productive plantation forests as well as semi-natural planted forests. The mean value of the planted area was 4 424 900 hectares and standard deviation 1 287 000 hectares. The minimum value 13 000 hectares was observed in Panama in 1990. The maximum value of 77.2 million hectares was documented in China in 2010. In 2005 China had more than 30 million hectares productive plantation forests, about 3 million hectares of protective plantation forests and about 40 million hectares semi-natural planted forests (FAO 2006). The area of planted forest varied greatly between studied countries.

Originally the plot of planted area showed the distribution to be strongly skewed. To improve the analysis and fulfill the assumption of normality of the dependent variable in regression analysis, the area of planted forest was transformed with a logarithm base 10. This transformation resulted in close to normal distribution of dependent variable values (Figure 3).

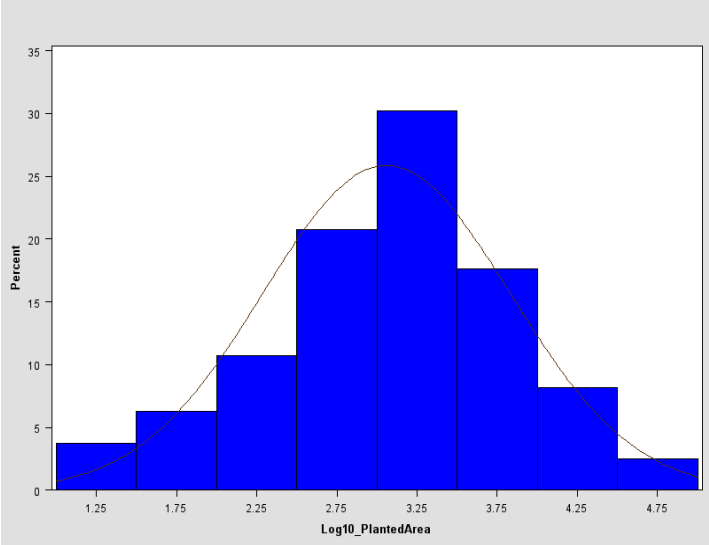

Figure 3. Distribution of planted area.

3.5 Model 1: Regression results in global data set

3.5.1 Data availability –global data

There are 168 observations for the global data set. To secure a sufficient amount of observations for the analysis, those variables with a low number of observations were omitted. Taxes had significantly smaller number of observation (91) than other variables and were left out of the analysis.

3.5.2 Selection between the independent variables

Macro and economic factors

As can be assumed, the long-term and short-term political risk showed high correlation (Appendix I). The time span in forestry exceeds 1 year, which is the cut-off point for long- and short-term risks. The long-term political risk was chosen from the two. The domestic credit to the private sector and domestic credit provided by banking sector variables are both indicators of capital usage and were highly correlated. The domestic credit to the private sector was omitted, and the source-based approach to the financial and capital management was selected. The correlation matrixes for macro-economic independent variables are presented in Appendix J.

Institutional factors

The full data set of independent indicators included time based, number of procedures and cost based variables for each of the 'ease of doing business' indicators: starting business, registering property and resolving insolvency. I decided to use time-based indicator for starting business and registering property, and cost-based indicator for resolving the insolvency indicator. The decision was based mainly on the deliberation of the most suitable way to measure the development of plantation are. There were not great differences in correlations with the other independent variables among the three alternative ways to measure the same phenomenon. The correlation matrix for institutional variables is presented in Appendix K.

Forestry factors

Production, export and consumption of roundwood, woodpulp, sawnwood, and woodfuel were correlated. The roundwood and woodpulp had the most available data, and these products are potentially the most interesting in a global forestry scheme. As a result of the multicollinearity issues, it was decided to concentrate on roundwood production. The roundwood and woodpulp 'export-platform' indicators were selected from the (net exports / domestic consumption) variables for further analysis. Appendix L shows the correlation between selected forest sector factors.

3.5.3 Detecting outliers in global data series

The data screening revealed that there are outliers and unusual data points. Panama had large residuals that violated the normality assumption of the regression analysis (Appendix M). The squared residuals were plotted against leverages, which revealed that Panama has unusual observation values (Appendix M). However, according to the influence analysis and Cook's distance, Panama did not have a huge effect on the predictions. There were concerns of data quality and the influence data a small country presented that we did not want to impact the results. The regression was run with Panama. It did not have an effect on variable significance, but the normality of the data suffered. To increase the overall prediction, Panama was omitted from the data set after deliberation and confirming there were no data entry errors.

3.5.4 Model fit statistics

There were 108 out of 164 observation used in the global analysis. The F-value was 12.98 and associated p-value <0.0001. The R-square was 0.749 and adjusted R-square respectively 0.691. The mean square error was 0.118.

The regression analysis showed that there are several factors (marked ***) significant at the 5% level. These factors are banking credit, roundwood production, forest

productivity, roundwood and woodpulp net exports/domestic consumption. All affected area of planted forests positively. Roundwood production and productivity had a significant negative interaction effect.

At the 10% (**) significance level there were long-term political risks, foreign direct investments, and human development index (Table 9). Gross domestic product had a positive effect at the 15% (*) level.

Table 9. Model 1, Global data.

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	3.77	0.68	5.57	<.0001***	0
Gross domestic product	1	0.08	0.05	1.63	0.106*	5.40
Banking credit	1	0.270	0.08	3.60	0.001***	2.18
Long term political risk	1	-0.86	0.44	-1.97	0.052**	4.96
Exchange rate	1	-0.00003	0.00003	-1.28	0.203	1.53
Foreign direct investments	1	0.02	0.01	1.87	0.065**	1.98
Tariff	1	0.88	0.78	1.23	0.223	4.76
HDI	1	-1.62	0.86	-1.88	0.064**	9.09
Corruption	1	-0.21	0.28	-0.73	0.468	4.55
Unemployment	1	-1.20	0.89	-1.35	0.181	1.20
Days start business	1	0.01	0.01	0.70	0.487	1.82
Days to register property	1	-0.01	0.01	-1.32	0.191	1.12
Cost of Insolvency	1	0.71	0.53	1.36	0.179	1.93
Roundwood (RW) production	1	0.18	0.03	6.41	<.0001***	7.72
Forest productivity	1	1.98	0.84	2.37	0.020***	4.16
RW net export / consumption	1	0.02	0.01	4.07	0.0001***	1.47
WP net export / consumption	1	0.002	0.0003	5.66	<.0001***	1.39
RW production x productivity	1	-0.36	0.14	-2.57	0.012***	6.05
RW production x FDI	1	0.001	0.003	0.16	0.873	2.62
RW production x tariff	1	-0.15	0.15	-1.00	0.323	6.04
RW production x political risk	1	0.01	0.08	0.15	0.878	7.77

*** indicates significance at 5% level, ** at 10% level and * at 15% level.

Multicollinearity

The multicollinearity was not problematic, as measured by the variance Inflation factor (VIF), which should be ≤10. The human development index had the highest VIF value 9.09. Therefore, all the variables were kept in the model.

General model fit

The model fit adequately in the data (Figure 4). It appears there is an outlier, but it is an observation from one country with vast forests.

Normality of residuals

The value of Shapiro-Wilk statistics was 0.09865 and associated p-value 0.14. We fail to reject the null hypothesis at the 5% significance level, and conclude that the residuals are normally distributed. The visual examination supports the results (Figure 5).

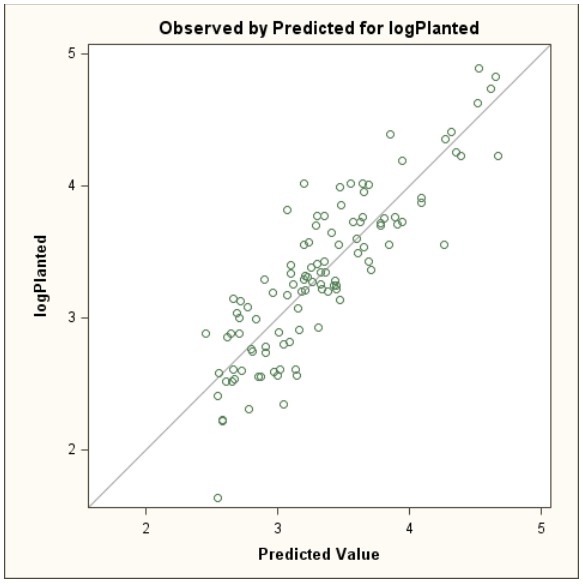

Figure 4. Observed by predicted values for area of plantations, global data set.

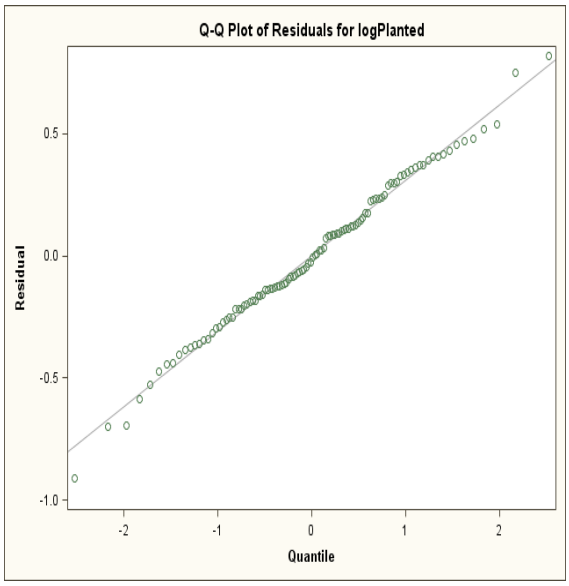

Figure 5. Normality of residuals, global data set.

Test for heteroscedasticity: White Test

The Chi-Square statistics for White's test is 103.85 and associated p-value 0.65. Therefore, we fail to reject the null hypothesis and claim that the residuals are homoscedastic at the 5% confidence level. Visual examination also gives support for homoscedasticity (Figure 6).

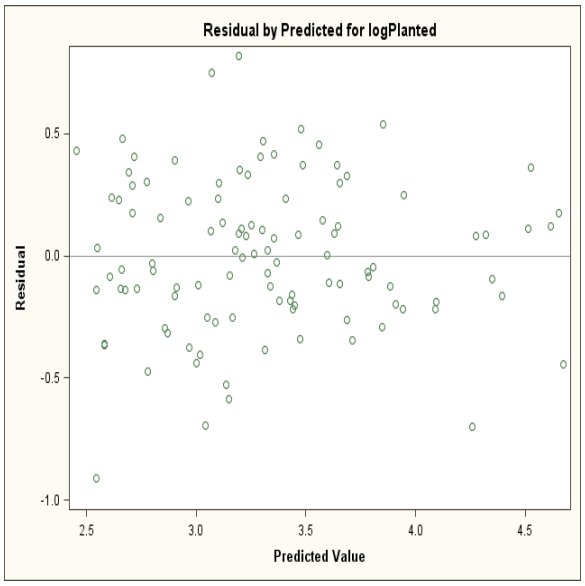

Figure 6. Residuals, global data set.

3.5.5 The summary statistics for global data

The summary statistics of the independent variables in a global data set is presented in Table 8. This table includes the number of observations (N), means, standard deviations (Std Dev), minimums and maximums. The variation in all the factors is large which indicates that the countries differ greatly from each other in economic and cultural matters (Table 10).

Table 10. Summary statistics, Global data set.

Variable	N	Mean	Std Deviation	Minimum	Maximum
Gross domestic product	164	16970	16950	244	84880
Banking credit	164	96	63	13	313
Long term political risk	164	2.7	2	1	7
Human development index	164	0.8	0.1	0.4	0.9
Exchange rate	160	374.99	1489.11	0.03	10298.65
Foreign direct investments	151	20673	42907	1	321274
Tariff	156	7.8	8.8	0.3	82.0
Corruption	147	5.9	2.6	1.7	10.0
Unemployment	161	7.1	4.3	1.2	26.0
Days start business	164	58	69	-15	424
Days to register property	164	51	60	-5	438
Cost of Insolvency	164	11.0	8.7	-20.0	38.0
Roundwood production	155	20704	31207	54	164000
Roundwood exportation	146	1715	5400	0	48020
Roundwood consumption	155	21196	30922	56	153889
Woodpulp production	127	2511	3409	2	13861
Woodpulp exportation	112	764	1232	0	8592
Woodpulp consumption	149	2328	3410	0	19782
RW net export / consumption	159	1	6	-18	53
WP net export / consumption	149	18	109	-13	774

*Negative values in day to start business, days to register property and cost of insolvency due to the interpolation

3.6 Model 1: Regression results for OECD countries

3.6.1 Data screening results

Italy had large residual values and it also had an observation that appeared to be significant in Cook's distance analysis on influential data (Appendix N). Italy's residuals and influence was close to USA and Canada's which may not be true taking country's size into consideration. The potential data entry errors were checked. Based on the analysis, this observation was considered an outlier, and data series for Italy was omitted from further analysis.

3.6.2 Model fit statistics

The same set of variables used for the global data set was used for the OECD countries. There were 58 observation used in the analysis. The F-statistics value in Model 1 for OECD countries was 2.90 and associated p-value 0.003. Therefore, we assume the model is significantly different from the base model. The R-square statistic was 0.798 and adjusted R-square 0.705. The mean square error was 0.083.

At the 5% significance level gross domestic product, exchange rate, foreign direct investment, tariffs, forest productivity, roundwood and woodpulp (net export / consumption) variables were positively correlated with the area of planted forest (Table 11). Human development index, unemployment and roundwood production showed a significant positive correlation at the 10% significance level. At the 15% level tariff was negatively correlated with the area of planted forests.

Table 11. Model 1, OECD data set.

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	4.40	1.69	2.60	0.01***	0
Gross domestic product	1	0.12	0.05	2.22	0.03***	3.07
Banking credit	1	-0.07	0.11	-0.58	0.57	3.04
Long term political risk	1	0.85	3.76	0.23	0.82	1.67
Exchange rate	1	0.01	0.002	4.89	<.0001***	2.96
Foreign direct investments	1	0.03	0.009	3.65	0.0008***	2.14
Tariff	1	-6.15	3.99	-1.54	0.13*	3.89
HDI	1	-3.19	1.77	-1.80	0.08**	4.07
Corruption	1	0.45	0.65	0.69	0.49	4.11
Unemployment	1	3.59	1.97	1.82	0.08**	2.78
Days to start business	1	0.002	0.01	0.13	0.90	2.87
Days to register property	1	-0.01	0.01	-1.13	0.27	2.10
Cost of insolvency	1	1.10	1.17	0.94	0.35	2.39
Forest productivity	1	2.61	0.97	2.69	0.01***	2.04
Roundwood production	1	0.0009	0.001	1.75	0.09**	8.30
RW net export / consumption	1	0.03	0.006	5.52	<.0001***	2.01
WP net export / consumption	1	0.002	0.0003	6.78	<.0001***	2.31
RW production x Tariff	1	0.02	0.02	1.33	0.19	9.91
RW production x FDIs	1	3.90E-7	0.00004	0.01	0.99	2.15

Multicollinearity

Multicollinearity became an issue when all the variables and interactions were included in the model. The interaction between roundwood production and political risk was identified as a linear combination of each other, and roundwood production and productivity showed high VIF value. These interactions were insignificant in this model and therefore excluded. After excluding these two effects the multicollinearity was not an issue.

General model fit

The model fit is moderately good at taking the fact of data variability into an account (Figure 7)

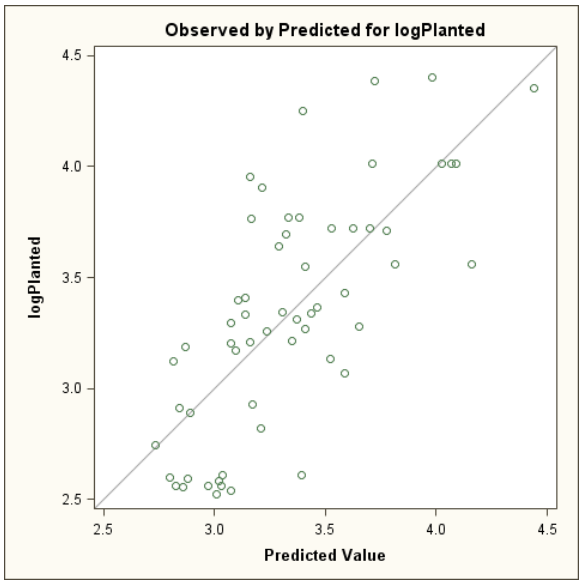

Figure 7. Observed by predicted values, OECD data set.

Normality of residuals

The value Shapiro-Wilk statistics was 0.973 and associated p-value 0.12. We fail to reject the null hypothesis on normality and conclude that the residuals are normally distributed at the 5% level. The visual examination also shows that the distribution is

relatively close to the normal (Figure 8). There seem to be some values that look like outliers, but this is due to the great variability in the data.

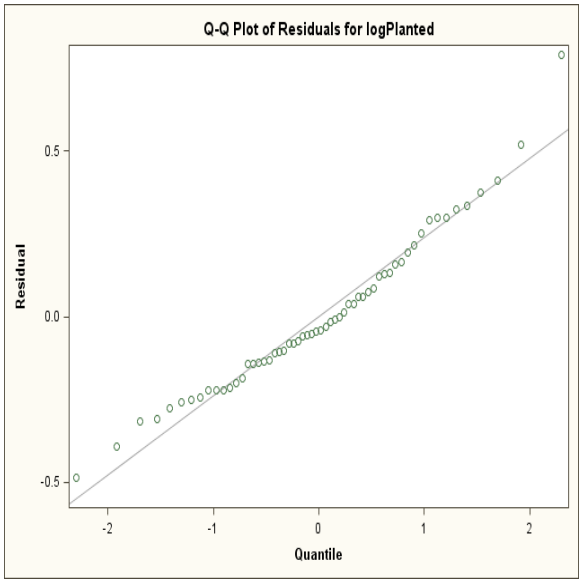

Figure 8. Normality of residuals, OECD data set.

Test for heteroscedasticity: White Test

The Chi-Square statistics of White's test is 56.42 and p-value is 0.64. We fail to reject the null hypothesis and conclude the residuals are homoscedastic. The visual examination does not show alarming heteroscedasticity problems and the assumption of homoscedasticity is accepted (Figure 9). There are no visible trends in the residuals.

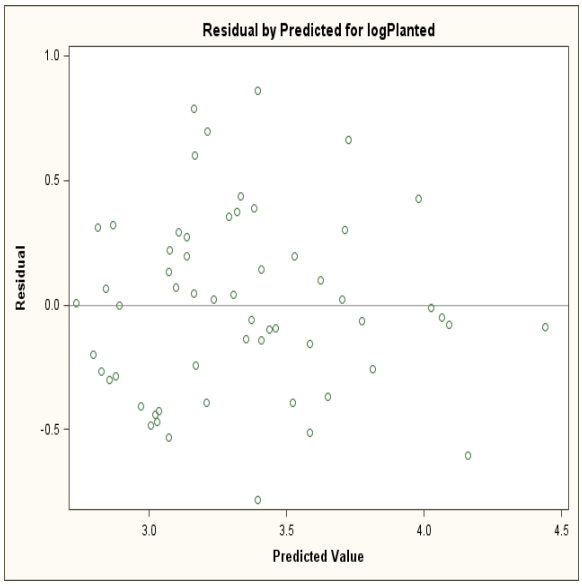

Figure 9. Residuals, OECD data set.

3.6.3 Summary statistics for independent variables in OECD countries

The high variation between observations is in this model lower than in the global data set. The exchange rate has a large range. The corruption has relatively high mean. However, the values of indent variables vary a great deal. Table 12 summarizes the descriptive statistics for independent variables in OECD data set.

Table 12. Summary statistics for Model 1, OECD data set.

Variable	N	Mean	Std Dev	Minimum	Maximum
GDP	80	31058	13877	6153	84880
Banking credit	80	135	57	49	313
Long-term political risk	80	1	0	1	2
Exchange Rate	79	49.06	211.83	0.55	1155.73
Foreign direct investments	72	35288	56968	60	321274
Tariff	75	3.3	2.3	0.3	12
HDI	80	0.86	0.05	0.71	0.94
Corruption	79	7.78	1.58	2.99	10.00
Unemployment	80	6.6	3.1	1.8	18.0
Days to start business	80	33	55	-3	315
Days to register property	80	45	76	-5	438
Cost of insolvency	80	6.0	5.1	-20.0	22.0
Roundwood production	75	16597	20080	105	92300
Forest productivity	80	7	6	3	25
RW net export / consumption	75	0.96	8.19	-17.80	52.79
WP net export / consumption	75	35.90	152.05	-13.22	773.70

3.7 Model 1: Regression results for Non-OECD countries

3.7.1 Data screening results

Cook's test revealed that Panama influenced the data significantly in non-OECD data set. The residuals and plot of leverages by r-square is shown in Appendix O. The reasons for omitting Panama from the data set are the same as in the global data set.

3.7.2 Model fit statistics

The same set of variables as for the global data set and for OECD was used also for the Non-OECD countries, because the data examination did not find other problems. Altogether there were 46 observation used in the analysis. The F-statistics value was 10.81 and associated p-value <.0001. The R-square statistic was 0.868 and adjusted R-square 0.788. The mean square error was 0.111.

At the 5% significance, foreign direct investment and roundwood production were significant and correlated positively, whereas the human development index was significant and correlated negatively. Exchange rate was negatively correlated and woodpulp (net exports/consumption) positively correlated at the 15% significance level (Table 13).

Table 13. Model 1, non-OECD data set.

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	5.38	1.15	4.68	<.0001***	0
Gross domestic product	1	0.20	0.43	0.45	0.66	5.03
Banking credit	1	0.13	0.23	0.59	0.56	4.450
Long term political risk	1	-0.01	0.66	-0.02	0.98	3.74
Exchange Rate	1	-0.0001	0.00003	-1.56	0.13*	1.99
Foreign direct investments	1	0.10	0.04	2.45	0.02***	2.03
Tariff	1	0.03	0.75	0.04	0.97	3.85
HDI	1	-3.825	1.73	-2.21	0.04***	9.22
Corruption	1	-0.13	0.69	-0.19	0.86	3.92
Unemployment	1	-2.55	1.82	-1.41	0.17	3.45
Days to start business	1	-0.02	0.02	-1.38	0.18	3.89
Days to register property	1	0.02	0.02	0.93	0.36	2.11
Cost of insolvency	1	0.36	0.81	0.44	0.66	2.44

Table 13 Continued						
Roundwood production	1	0.001	0.0003	3.94	0.001***	8.32
Forest productivity	1	1.21	1.63	0.74	0.46	4.79
RW net export / consumption	1	-0.20	0.27	-0.75	0.46	3.13
WP net export / consumption	1	0.09	0.06	1.53	0.14*	4.32
RW production x productivity	1	-0.002	0.002	-1.32	0.20	9.46

Multicollinearity: VIF

The results were examined with all the selected interaction effects. The interaction of roundwood production with productivity was found statistically significant. The other interactions led to serious multicollinearity problems and were excluded from the analysis to control the standard errors.

General model fit

The general model fit was good, as the visual examination confirms (Figure 10).

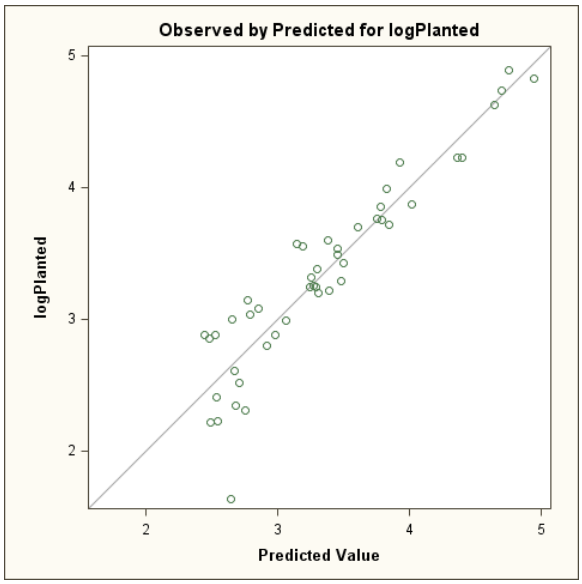

Figure 10. Observed by predicted values, non-OECD data set.

Test for normality: Shapiro-Wilk

The value of Shapiro-Wilk statistics was 0.979 and associated p-value 0.23. We can assume that the residuals are normally distributed. The visual examination shows some volatility, but considering the characteristics of data, nothing is alarming (Figure 11).

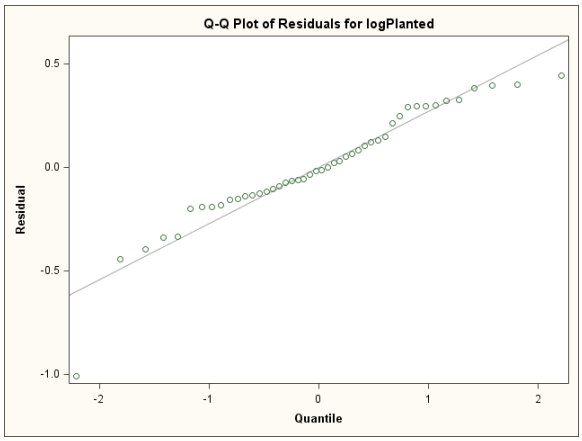

Figure 11. Normality of residual, non-OECD data set.

Test for heteroscedasticity: White Test

The value of Chi-Square statistics was 45.04 and p-value 0.51. The test supports the assumption of homoscedasticity. Residual are randomly distributed, and no trends can be observed (Figure 12).

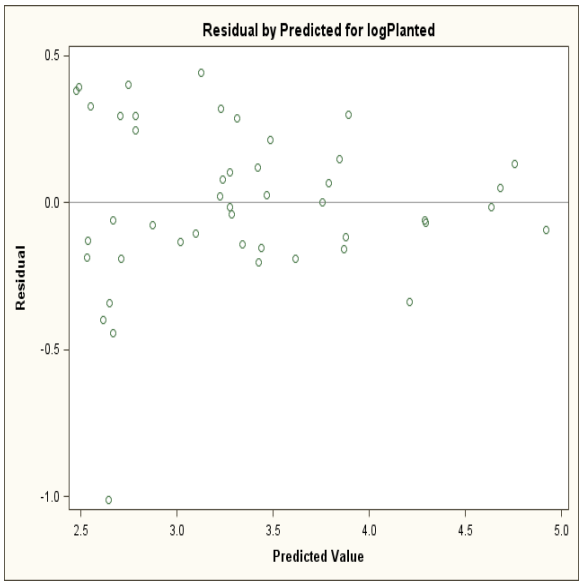

Figure 12. Residuals, non-OECD dataset.

3.7.3 Summary statistics for independent variables in Non-OECD countries

The variability of data was great also between the non-OECD countries. The data set contains countries that differ greatly from each other in their sizes, economies and cultures. The data set contains countries with the highest possible long term political risk (Table 14). There are countries where the business environment is extremely difficult according to the "ease of doing business" indicators. According to the indicators it can take for more than a year to start the business. Table 14 summarizes the number of observations (N), means, standard deviations, minimums and maximums of the independent variables.

Table 14. Summary statistics for the central factors in non-OECD countries.

Variable	N	Mean	Std Dev	Minimum	Maximum
GDP	84	3553	2722	244	13451
Banking credit	84	59	42	13	183
Long-term political risk	84	4	2	2	7
Exchange Rate	81	692.87	2038.68	0.03	10298.65
Foreign direct investments	79	7352	14471	1	79127
Tariff	81	12.0	10.3	2.7	82.0
HDI	84	0.6	0.1	0.4	0.8
Corruption	68	3.61	1.44	1.70	7.94
Unemployment	81	7.5	5.2	1.2	26.0
Days to start business	84	83	72	-15	424
Days to register property	84	57	39	2	195
Cost of insolvency	84	15.7	8.9	0.0	38.0
Roundwood production	80	24555	38598	54	164000
Forest productivity	84	16	7	3	31
RW net export / consumption	80	0.09	0.32	-0.39	1.90
WP net export / consumption	70	0.02	1.45	-1.60	8.17

3.8 Regression results for Model 2

The Model 2 gives directly values which can be interpreted as elasticities of individual variables. The values smaller than one in absolute value indicate an inelastic effect on area of planted forests, while values larger than one in absolute value indicate an elastic relationship.

3.8.1 Data screening

The data examination was done separately for the dataset, where all the variables were transformed by 10-based logarithm. There were no serious outliers after the data were transformed into logarithm in a global data set. Italy appeared as an outlier and it was excluded from the OECD dataset (Appendix P). Non-OECD data were quite good after the transformation. None of the countries were excluded.

Net exports divided by domestic consumption variables were excluded, because the series of data contained negative values. Log-transformation is possible only for positive values. Roundwood and woodpulp production selected to substitute those variables.

The Model 2 did not produce very consistent results for global, OECD and non-OECD datasets. The model does not generally fit as adequately into the data as the Model 1. Therefore, the results of the predicted model 2 are mainly presented for comparison for the Model 1.

3.8.2 Model 2: Regression results in global data set

The r-square value for the global set of data was 0.522 and adjusted R-square 0.436. The mean square error was 0.210. In the Model 2 human development index and GDP had very high variance inflation factor values. This resulted in excluding HDI. In general this log-based model gave less reliable results, and showed less significance in relationship of elasticities of individual factors and area of planted forests.

The statistically significant elasticities at the 5% significance level were banking credit, FDIs, Tariff and woodpulp production. All these indicated a positive effect on the dependent variable (Table 15).

Table 15. Model 2, global data set.

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	1.22	1.52	0.81	0.42	0
GDP	1	-0.04	0.27	-0.17	0.87	9.30
Banking credit	1	0.61	0.26	2.39	0.02***	2.73
Long-term political risk	1	-0.16	0.42	-0.39	0.70	6.55
Foreign direct investments	1	0.24	0.09	2.75	0.01***	1.63
Exchange Rate	1	0.01	0.06	0.24	0.82	1.95
Tariff	1	0.58	0.27	2.17	0.03***	5.06
Corruption	1	-0.60	0.47	-1.30	0.20	3.99
Unemployment	1	-0.24	0.24	-1.02	0.31	1.55
Days to start business	1	-0.17	0.15	-1.13	0.26	2.41
Days to register property	1	-0.13	0.13	-0.99	0.32	1.74
Cost of insolvency	1	0.08	0.18	0.46	0.64	1.78
Roundwood production	1	0.09	0.15	0.62	0.54	5.19
Woodpulp production	1	0.23	0.11	2.04	0.04***	4.90
Forest productivity	1	-0.21	0.23	-0.92	0.36	2.40

According to the tests and visual examination there is no heteroscedasticity (Appendix Q) and the residuals are normally distributed (Appendix R). The p-value of White-test was 0.580.

3.8.3 Model 2: Regression results in OECD countries

Data screening

Italy was an outlier and not included in the data set. The reasons are the same as earlier.

Model fit statistics

There were 76 observations used in this analysis. The value of F-statistics is 2.96 and the associated p-value 0.0048. The model is significantly different from the base model. The R-square is 0.550 and adjusted R-square 0.364. The mean square error was 0.175.

At the 5% significance, GDP, Tariff, unemployment, roundwood production and woodpulp production were significant. At the 10% significance level banking credit, foreign direct investment and productivity were significant (Table 16).

According to the tests and visual examination there is no heteroscedasticity (Appendix Q) and the residuals are normally distributed (Appendix R). The p-value of White's test was 0.718.

Table 16. Model 2, OECD countries data set.

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	-10.84	3.67	-2.95	0.01	0
GDP	1	1.73	0.65	2.67	0.01***	3.45
Banking credit	1	0.87	0.51	1.70	0.10**	2.29
Long-term political risk	1	0.86	1.80	0.48	0.63	1.64
Exchange Rate	1	0.10	0.13	0.75	0.46	1.91
Foreign direct investments	1	0.21	0.11	1.99	0.05**	1.65
Tariff	1	1.19	0.37	3.21	0.003***	2.48
Corruption	1	2.20	1.54	1.43	0.16	3.36
Unemployment	1	0.85	0.40	2.14	0.04***	1.85
Days to start business	1	0.05	0.19	0.28	0.78	2.48
Days to register property	1	0.21	0.23	0.91	0.37	4.07
Cost of insolvency	1	-0.31	0.35	-0.87	0.39	2.07
Roundwood production	1	-0.64	0.23	-2.79	0.01***	8.87
Woodpulp production	1	0.80	0.20	3.96	0.0004***	9.23
Forest productivity	1	0.75	0.38	1.97	0.06**	2.83

3.8.4 Model 2: Regression results in Non-OECD countries

The best model specification for non-OECD countries differed from the global model. Both of the roundwood production and woodpulp production were not included into the model, because they showed high variation inflation factor values. The roundwood production was kept in the model. However, GDP and HDI were both included in the model. The multicollinearity was not an issue in this dataset.

There were 52 observation used for this analysis. The F-statistics value was 29.74 and the p-value <.0001. The R-square was 0.91 and adjusted r-square 0.88. The mean square error was 0.089

At the 5% significance level banking credit, exchange rate, FDIs, corruption and roundwood production were significant (Table 17). Availability on banking credit had a negative impact on area of planted forests. The exchange rate affected plantation area negatively, as well, which matched expectations. Foreign direct investments and roundwood production had a positive effect. A positive sign for corruption indicated that the cleaner the country the more plantations. Political risk and HDI had negative effects on plantation are development and were significant at the 10% significance level.

According to the White's tests and visual examination, there is no heteroscedasticity and the residuals are normally distributed (Appendix R). The residuals don't show any trends (Appendix Q). The p-value of White's test was 0.862.

Table 17. Model 2, non-OECD countries data set.

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|	Variance Inflation
Intercept	1	2.13	1.48	1.44	0.16	0
GDP	1	-0.42	0.33	-1.29	0.21	8.40
Banking Credit	1	-0.82	0.24	-3.42	0.002***	3.11
Political Risk	1	-0.74	0.42	-1.74	0.09**	2.98
Exchange rate	1	-0.15	0.06	-2.41	0.02***	2.91
Foreign direct investments	1	0.51	0.11	4.63	<.0001***	3.27
Tariff	1	-0.05	0.31	-0.18	0.86	3.17
HDI	1	-3.72	1.97	-1.89	0.07**	8.10
Corruption	1	0.97	0.44	2.18	0.04***	2.45
Unemployment	1	-0.17	0.26	-0.65	0.52	3.13
Days to start business	1	-0.40	0.23	-1.73	0.09**	2.64
Days to register property	1	-0.16	0.13	-1.21	0.23	1.99
Cost of insolvency	1	0.09	0.19	0.46	0.65	2.51
Roundwood production	1	0.65	0.09	7.03	<.0001***	3.76
Productivity	1	0.002	0.256	0.01	0.99	1.92

3.9 Regression results for Model 3 –lack of robustness of the analysis

The Model 3 was examined in a same way as the previous two models. Calculation of the differences of variables between the different years resulted into a lower number of observations, especially in the OECD and non-OECD subgroups. The model also did not differ significantly from the base regression model, where all the parameter estimates are zeros, indicating no association between dependent and independent variables. The p-value associated with the F-statistics was large, indicating the models do not fit to the

data. Also the difference in the intervals between the observations made this model questionable already at the first place, which might have increased the instability of the data. Between the first and second observation there was a 10 years difference, whereas between the following observations the difference was only 5 years. Based on these facts it was concluded that this particular model is not good for explaining the data. Summary statistics of the Model 3 analysis for each subgroup are presented in Appendix S.

3.10 Summary of the Results

The summary and interpretation of the results are presented next. The effects of the different variables are the most interesting and therefore the actual values of parameter estimates are not presented. All the significant factors at least at the 15% significance level are highlighted with orange color. Co indicates that the factor had collinearity issues and was excluded from the analysis. As previously, *** indicates significance at the 5% level, ** at the 10% level and * at the 15% level.

3.10.1 The results of Model 1

Macro-economic factors

GDP was highly significant and correlated positively with the area of planted forest in OECD countries. Globally GDP was significant at the 15% level. Banking credit was highly significant at global level, but not in the sub groups of OECD and non-OECD. Exchange rate (foreign currency per $US) was highly significant and positively correlated in OECD countries. In non-OECD countries the correlation was negative and significant at the 15% significance level. Foreign direct investments showed strong positive correlation with area of planted forests in all the groups. Tariffs showed negative correlation in OECD countries at the 15% significance level. Table 18 summarizes the effects and significances of the variables.

Table 18. Significant macro-Economic factors in Model 1.

	Global	OECD	NON-OECD
Macro-economic			
GDP	+*	+***	+
Banking Credit	+ ***	-	+
Long-term political risk	- **	+	-
Exchange rate	-	+***	-*
Foreign direct investments	+***	+***	+***
Tariff	+	-*	+

Institutional factors

The human development index was significantly and negatively correlated with the plantation area. Unemployment was positively and significantly correlated in OECD countries. Table 19 summarizes the effect and significances of the variables.

Table 19. Significant institutional factors in Model 1.

	Global	OECD	NON-OECD
Institutional			
HDI	- ***	-**	- ***
Corruption	-	+	-
Unemployment	-	+***	-
Days start business	+	+	-
Days Register property	-	-	+
Cost of Insolvency	+	+	+

Forestry related factors

Roundwood production was significant and positively correlated with the planted area. Also productivity was correlated and highly significant in a global scale and in OECD countries. Large roundwood exports compared to the domestic consumption were significant at the 5% level globally and in OECD countries. For woodpulp this ratio was significant and positively correlated in all the groups. Globally and in OECD countries the correlation is significant at the 5% level and in non-OECD countries significant at the 15% level. Table 20 summarizes the effects and significances of the variables.

Table 20. Significant forestry factors in Model 1.

	Global	OECD	NON-OECD
Forestry			
Roundwood production	+***	+**	+***
Productivity	+***	+***	+
Roundwood net export / consumption	+***	+***	-
Woodpulp net export / consumption	+***	+***	+*

Interactions

The only interaction that showed significant correlation with the dependent variable was roundwood production x productivity at a global level. The interaction was negative and significant at the 5% level. Table 21 summarizes the effects and significances of the studied interactions.

Table 21. Significant interactions in Model 1.

	Global	OECD	NON-OECD
Interaction			
RW production x productivity	-***	co	-
RW production x FDI	+	+	co
RW production x tariff	-	+	co
RW production x political risk	+	co	co

3.10.2 The results of Model 2

Macro-economic

The elasticity of GDP in OECD countries was elastic at the 5% significance level. The banking credit had a significant effect on plantation area at the 5% level globally and the 10% level in OECD countries. In non-OECD countries it was correlated negatively at the 5% level. Long-term political risk had a negative effect in non-OECD countries at the 10% level and exchange rate at the 5% level. Foreign direct investments were positively correlated in all the groups at the 5% level. Table 22 summarizes the effects and significances of the variables.

Table 22. Significant macro-economic factors in Model 2.

	Global	OECD	NON-OECD
Macro-economic			
GDP	-	+***	-
Banking Credit	+***	+ **	-***
Long-term political risk	-	+	- **
Exchange rate	+	+	-***
Foreign direct investments	+***	+***	+ ***
Tariff	+***	+	-

Institutional

The human development index was significant at the 10% level and had a negative effect on area of planted forests. The corruption has positive effect in non-OECD countries at the 5% level. Corruption has an inelastic relationship with planted area. Unemployment was significant in OECD countries at the 5% level and the relationship with plantation area was inelastic. The number of days to start business was negatively and inelastically correlated with planted area in non-OECD countries. Table 23 summarizes the effects and significances of the variables.

Table 23. Significant institutional factors in Model 2.

	Global	OECD	NOT OECD
Institutional			
HDI	co	co	-**
Corruption	-	+	+***
Unemployment	-	+***	-
Days start business	-	+	-***
Days Register property	-	+	-
Cost of Insolvency	+	-	+

3.10.2.3 Forest sector

The roundwood production was negatively and significantly correlated with plantation area at the 5% significance level. At non-OECD countries the relationship was equally significant but the direction was opposite. Woodpulp production was positively correlated in a global scale and in OECD countries at the 5% level. Productivity was significant only in OECD countries at the 5% level (Table 24).

Table 24. Significant forestry factors in Model 2.

	Global	OECD	NON-OECD
Forestry			
Roundwood production	+	-***	+***
Woodpulp production	+***	+***	co
Productivity	-	+***	+

4 Conclusions

This research provides insight into the factors that have prompted investment in forest plantations. I examined literature and theory of direct investment, collected publicly available secondary data, and used regression analysis to examine the important macroeconomic, institutional and forestry factors.

4.1 Macro-economic effects

According to the literature, GDP is the factor that systematically has been proven to show positive and significant effect on foreign direct investments (e.g. Chakrabarti 2001). Model 2 suggests that GDP is significant factor only in OECD countries. The parameter of GDP was also very elastic: 1% increase in GDP leads to 1.73% increase in plantation area. The results of the Model 1 respectively align with the previous literature. This research validates the Chakrabarti's (2001) observation that GDP is positively related to investment rates, a finding replicated in numerous studies.

Availability of credit provided by banking sector (banking credit) indicates the functioning of the capital market and the business environment in general. In high income level countries it is possible to direct money to domestic savings which are later used for investments (e.g., Greene and Villanueva, 1991). This is different from low-income countries, which are constrained by credit availability. Model 1 showed that

banking credit was significant and positively correlated globally. In OECD and non-OECD subgroups, it did not have a significant role. The Model 2 showed that banking credit was significant in all groups. In non-OECD countries, the access to banking credit was negatively correlated with plantation area, which might not be a very reliable result. Although, the negative result may indicate that the establishment of new plantations is financed by foreign capital, and so domestic banking credit is not needed to support plantation development.

The foreign direct investments are a major source of an economic growth and they are desirable from the countries' point of view. The relationship of area of plantation forest and foreign direct investments tells that timberland investments are directed mostly to countries that attract foreign capital. The foreign direct investments indicate that countries with economic growth potential are desirable destinations. Foreign direct investments were significant and positively correlated in all the groups for both of the models at the 5% level. This likely indicates that the behavior of timberland investors is not significantly different from other investor behavior.

Exchange rate (foreign currency / $US) indicates how strong the currency is compared to the dollar. Studies have indicated both positive and negative relationships with investments. Positive relationships indicate that weaker foreign currency is a preferable factor and negative indicates that the weaker the currency, the less attractive the investment destination. According to the marginal effect model 1, from the investors point of view, the weak currency is desirable in OECD countries but not in non-OECD countries. The strong currency in non-OECD countries may be associated with relatively stable economy. OECD countries should have stable economic structures, and the weak exchange rate may not indicate any serious structural problems. Weak currency in a host country may provide possibilities to gain profits from exchanges: The weak currency may decrease exporting prices. Affordable exports can increase the number of buyers in importing country.

According to the literature, the tariffs are likely to correlate positively with investments, because investors might go into a country and establish a business locally to avoid exportation costs. This is likely to happen if the host country has abundant resources or large markets (e.g., Mundell 1957). Plantations are used as an indicator of direct investment in this study, but it might not be rational to expect plantation area to follow the theory of tariff discrimination.

Tariff rate had negative effect on plantation area in OECD countries (Model 1). Globally and in non-OECD countries the relationship was positive although not significant. The negative correlation between plantation area and tariff might indicate that those countries which have higher tariff rates don't have much interest in forestry. As we see from the summary statistics tables the mean tariff rate in OECD countries 3.0% whereas it is in non-OECD countries 12.0% and the global mean is 7.8%. Model 2 suggest that the tariffs have a positive effect on plantation area at a global level meaning that on average higher tariffs do attract plantations.

4.2 Institutional effects

Interestingly, the human development index showed strong negative effect on plantation area. In marginal effect Model 1 the negative relationship was present in all the groups. In Model 2, the effect was examined only in non-OECD countries, where the relationship was similarly significantly negative. It is likely that the index is correlated with the land prices or other similar factors that are absent in my research. Countries with higher development might have higher land prices, which affect the analysis.

Contrary to prior expectations, corruption does not seem to be an important factor in plantation area development. The assumption was that the relationship between high corruption and plantation area should be negative in general. In my analysis, a positive sign of the regression parameter estimate indicates positive relationship between low

level of corruption and the planted area. The effect was negative globally and in non-OECD when observing the Model 1. In OECD countries the corruption had a positive effect, though it was not significant. The lack of variation in OECD countries may affect the significance. However, the elasticity of corruption was positive and significant in non-OECD countries (Model 2). Corruption was also identified as main constrain in almost half of the firms according to *The World Business Environment* and *World Investment Report* surveys (Asiedu 2006); therefore, the positive significant results of Model 2 were not surprising.

Unemployment does not seem to be a major factor in explaining the plantation development. Interestingly it had a highly significant positive effect on plantation area in OECD countries in both models. Unemployment might indicate that there is labor available for low-income jobs needed for establishing planted forests.

The ease of doing business indicators seem not to be significant factors driving plantation area development. The only significant negative effect was found in number of days required to start the business in non-OECD countries in Model 2.

4.3 Forestry sector effects

Roundwood production was correlated positively with area of plantations. It was no surprise that the effect was highly significant when observing the marginal effects (Model 1). The Model 2 showed positive and significant effect in non-OECD countries but in OECD countries the relationship was negative. One could assume that this relationship displays a positive significance and it can be argued that there might be something special in Model 2 that makes this relationship negative.

The effect of woodpulp production on plantation area development was examined for the Model 2. Woodpulp production was significantly and positively correlated with planted forest globally and in OECD countries. For non-OECD countries it could not

have been included in the model because value of the variation inflation factor was too high, violating statistical assumptions.

As presumed the productivity in forest was also positively correlated with plantation area. The productivity has positive and significant effect on the plantation area globally and in OECD countries. For the non-OECD countries there was also a positive correlation but the relationship was not statistically significant. This might indicate that in OECD countries included in this research the circumstances for forest growth are similar, and the productivity is not good at explaining the plantation development. Model 2 did not show significant relations between productivity and plantations in any other group than OECD.

The marginal effect of relative net exports compared to domestic consumption was examined to see if the capacity to produce roundwood and woodpulp for exportation needs was important. This was done only in Model 1 because the net export were often negative number and not able to be log transformed. In general the relationship was positive and significant. Only in non-OECD countries the roundwood net export over domestic consumption was not significant and the effect seems to be negative. It might be that the investors who invest in new plantation in non-OECD countries emphasize the role of domestic markets. This is interesting from a sustainability point of view: The negative or insignificant relationship indicates that the developing countries are not used as so called “export platforms”, only used for production of high-value goods needed by other countries. Woodpulp was however positively correlated at the 15% significance level.

4.4 Interaction effects

The interactions effects between certain factors were examined in Model 1. It would have been interesting to study the effects of certain logical interaction such as HDI and GDP, productivity and long-term political risk, FDI and corruption, but this increased multicollinearity problems significantly, it could not be done. The examination was used

only for roundwood production, which was already found to be one of the most significant factors in plantation area development.

Roundwood production and productivity in forestry had a significant interaction in a global scale. The aim was to get the overall effects for different factors, and closer look at the nature of significant interaction effect was not done. There was a significant relationship with interaction of productivity and roundwood production in plantation area in the global scale. In the smaller OECD and non-OECD subgroups the interaction effect was not significant. Roundwood production and foreign direct investment were insignificantly positively correlated with plantation development. Roundwood production and political risk in a global scale had a similar relationship. Roundwood production and tariff –interaction was also insignificant, although the relationship with plantation area was negative on a global scale and positive in OECD countries.

4.5 The model fit

The statistics are not exactly comparable between the models because they contain different sets of variables. Generally, we can see that the marginal effect Model 1 had a more adequate fit. The mean square error were smaller for global and OECD data sets for Model 1 than for Model 2 (Table 25). The non-OECD data were better modeled with the elasticity Model 2. According to the residual plots there was not a significant difference in model fit.

Also, AIC values were generally smaller for Model 1 (Table 26). The smaller the AIC-value, the better fit the model. This comparison also provides support for better fit of Model 2 for non-OECD.

Table 25. Model fit statistics for Model 1 and Model 2.

Marginal effect Model 1	Global	OECD	NON-OECD
R-square	0.749	0.798	0.868
adjusted R-square	0.691	0.705	0.788
MSE	0.118	0.083	0.111

Elasticity Model 2	Global	OECD	NON-OECD
R-square	0.522	0.550	0.918
adjusted R-square	0.436	0.364	0.888
MSE	0.210	0.175	0.089

Table 26.AIC model selection criterion values for different data set in Model 1 and Model 2

Data set	**Model 1**	**Model 2**
Global	-212	-131
OECD	-129	-73
NON-OECD	-88	-113

4.6 Method and model evaluation

The largest challenge of this analysis was to find good secondary data that are available at no cost. The data collection process was time intensive. It was also problematic that there are not standardized methods and set of variables on the investments. This provided a good research exercise, but also created some challenges.

The comparison of several different model specifications was done to see what would be the best approach to take. Two out of three models that were applied seemed to fit adequately. The "simplest" model, model of marginal effects seemed to be the best for several reasons. The Akaike's information criterion was met better, R-square values were higher in general and the model was equally good for all the groups. The residuals were closer to normal distribution in Model 1 and the results were closer to the previously done studies on investments in general and in forestry investments. Looking at parameter estimates of the elasticity Model 2, the values estimated are unrealistically high. The sub segment analyses with Model 1 should examine changing the scale effects for better interpretation. The current model allows one to see the explanatory effects and concentrate on the direction and significance rather that the percent changes.

The elimination of Italy and Panama from certain data sets was based on statistical analysis and data screening. The aim was to include all possible country-specific series in the analysis, but for getting best estimates and the best results, Panama and Italy were excluded based on careful statistical deliberation. In the forestry sector these countries are not large operators and their relative effect on the analysis was desired to keep low, especially because of data quality concerns. Hence, the different data sets contain different number of observations. However, the sufficient number of observations was secured for all data sets for robust statistical analysis by careful variable selection.

Due to the issues discussed above, the set of variables is slightly different for models and groups of analysis. The variables with net values were not included into the elasticity analysis because they were often negative. The values could have been

transformed to ensure them to be positive for example by using a transformation like log(X+k). This would have been difficult because of the large variability in the data.

Despite the careful data screening, there were data-related issues in the later stage of the analysis process. The collinearity problems required elimination of certain variables. The HDI and GDP showed multicollinearity which led to the elimination of HDI in Model 2. In the marginal effect model the VIF values stayed below the critical value, so both of them were included.

It would have been also interesting to include for example woodfuel or sawnwood production, exports, imports, and consumption. These variables were excluded from the analysis due to the data availability problems. I also wanted to include for example land prices and qualitative information in governmental incentives for planting, but the data availability in a global scale, as already mentioned earlier, became too challenging.

4.7 Conclusion

The macroeconomic factors were found significant. Together with GDP and FDIs also the exchange rate showed high significance. GDP correlates positively with area of planted forests. Exchange rate was found significant determinant for investment. The effect of exchange rate differed in OECD and non-OECD countries: In OECD countries, the weak currency compared to the US$ affected positively the area of plantations, whereas in non-OECD countries strong country currency attracts investments.

The institutional factors were not found significant, which suggests that the investments in forestry and plantations occur despite the challenges in a country. The human development index was the most significant factor, and was found to be negatively correlated with area of planted forests. The HDI might be correlated with land prices, and the negative relationship suggests that the more developed a country the less plantations there are.

The forestry related factors were found to be the most significant among explanatory variables. Roundwood production, productivity in forestry, and capability to produce for export markets were positively correlated with the plantation area. Productivity and net exports compared to the domestic consumption of forest products were not significantly correlated with plantation area in non-OECD countries. The plantation investment decision between different non-OECD countries does not depend on these factors. Beneficial biological circumstances for tree growth are so similar within the analyzed countries that the other that the macro-economic factors became more important in terms of distinguishing between the different options of investment in a host country.

In comprising the forest investment attractiveness index (IAIF), it is assumed that the 'supra' sector factors have the least emphasis on in the attractiveness in forestry. The supra sector factors were adapted as macro-economic factors in my study. The analysis showed that macro-level factors are more important than expected using country level data from four intervals between 1990 to 2010. In IAIF the inter-sector factors, in this study are called institutional factors, have larger weight than the supra sector. This analysis showed different results. The institutional factors were less significant than the macro-economic. The inter-sector had the largest weight in the IAIF, as did the forest sector factors in this study.

Where will we expect more plantations in the future? The increasing trend of foreign direct investment inflows in developing countries will exhibit little change. Many of the non-OECD countries are located in regions where conditions for tree growth are superior. These countries have potential for development: Emerging economies with potential market growth and potential to produce large quantities are attractive from an investors' standpoint. However, stable macroeconomic factors have positively influenced plantation area development. This stability is one argument for investing in OECD countries, which tend to be more stable and wealthier; stability also is connected to lower investment risks. Foreign direct investments are a source of economic growth, and investments in non-OECD countries have a positive effect on countries' stability.

Forest plantation investors with long term perspectives are likely to invest in developing countries, such as in Brazil, which has started to show signs of socioeconomic development, and where investment risks have been declining.

In sum, these estimation results suggest that a country's macroeconomic factors are key in determination of a direct investment in forestry sector. However, these variables cannot be significantly affected by forest investors. Forestry related factors can be affected by country level policies, and forestry investors can choose politically favorable countries and at times influence those factors. Overall, these results can help firms in forest industry in evaluating investment decisions and help governments in countries that are considering policies to attract both foreign and domestic investments.

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APPENDICES

Appendix A. Products that are target to tariffs according to Standard International Trade Classification, Rev. 3. Sections 5–8.

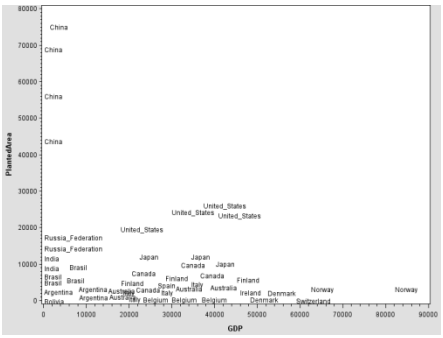
5 - Chemicals and related products, n.e.s.
- 51 - Organic chemicals
- 52 - Inorganic chemicals
- 53 - Dyeing, tanning and colouring materials
- 54 - Medicinal and pharmaceutical products
- 55 - Essential oils and resinoids and perfume materials; toilet, polishing and cleansing preparations
- 56 - Fertilizers (other than those of group 272)
- 57 - Plastics in primary forms
- 58 - Plastics in non-primary forms
- 59 - Chemical materials and products, n.e.s.

6 - Manufactured goods classified chiefly by material
- 61 - Leather, leather manufactures, n.e.s., and dressed furskins
- 62 - Rubber manufactures, n.e.s.
- 63 - Cork and wood manufactures (excluding furniture)
- 64 - Paper, paperboard and articles of paper pulp, of paper or of paperboard
- 65 - Textile yarn, fabrics, made-up articles, n.e.s., and related products
- 66 - Non-metallic mineral manufactures, n.e.s.
- 67 - Iron and steel
- 68 - Non-ferrous metals
- 69 - Manufactures of metals, n.e.s.

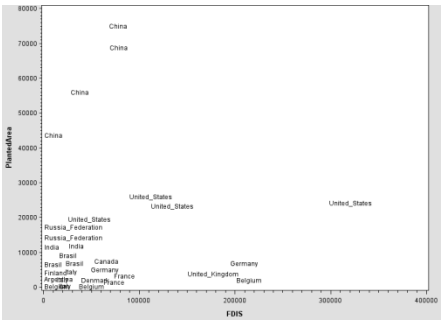
7 - Machinery and transport equipment
- 71 - Power-generating machinery and equipment
- 72 - Machinery specialized for particular industries
- 73 - Metalworking machinery
- 74 - General industrial machinery and equipment, n.e.s., and machine parts, n.e.s.
- 75 - Office machines and automatic data-processing machines
- 76 - Telecommunications and sound-recording and reproducing apparatus and equipment
- 77 - Electrical machinery, apparatus and appliances, n.e.s., and electrical parts thereof (including non-electrical counterparts, n.e.s., of electrical household-type equipment)
- 78 - Road vehicles (including air-cushion vehicles)
- 79 - Other transport equipment

8 - Miscellaneous manufactured articles
- 81 - Prefabricated buildings; sanitary, plumbing, heating and lighting fixtures and fittings, n.e.s.
- 82 - Furniture, and parts thereof; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings
- 83 - Travel goods, handbags and similar containers
- 84 - Articles of apparel and clothing accessories
- 85 - Footwear
- 87 - Professional, scientific and controlling instruments and apparatus, n.e.s.
- 88 - Photographic apparatus, equipment and supplies and optical goods, n.e.s.; watches and clocks
- 89 - Miscellaneous manufactured articles, n.e.s.

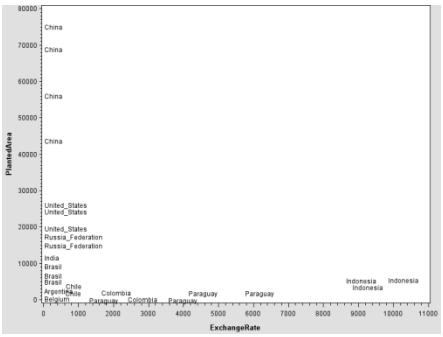
Appendix B. Macro-economic factors and linearity with area of planted forests, Model 1.



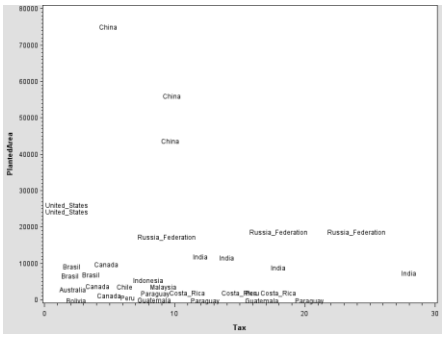
a) Planted area by GDP



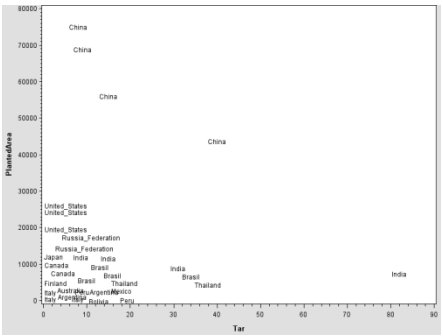
b) Planted area by FDI



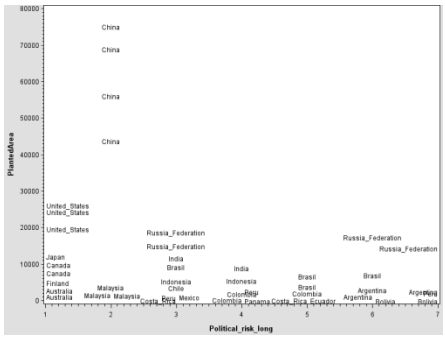
c) Planted area by exchange rate



d) Planted area by tax

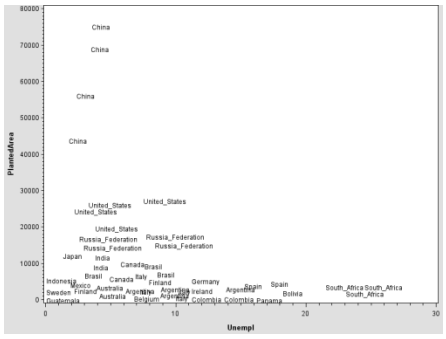


e) Planted area by tariff

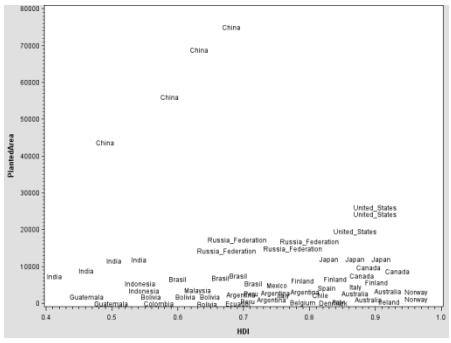


f) Planted area by long-term political risk

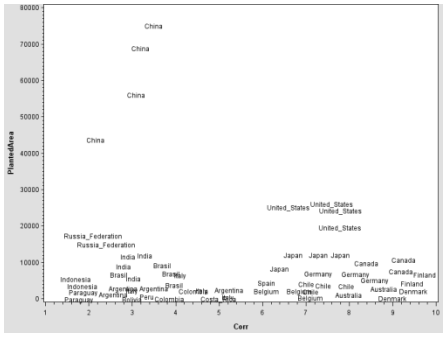
Appendix C. Institutional factors and linearity with area of planted forests, Model 1.



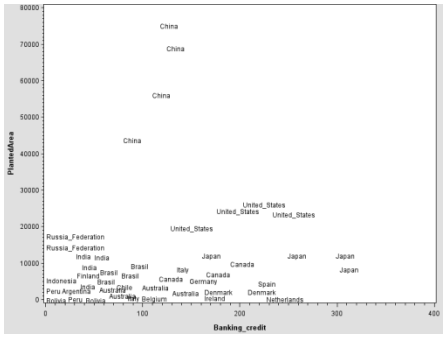
a) Planted area by unemployment



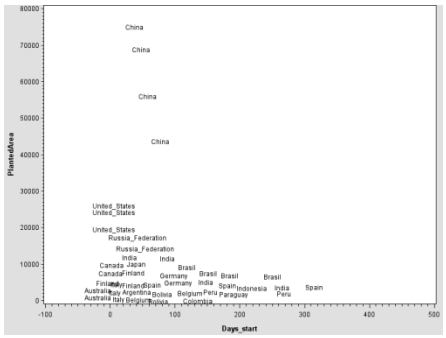
b) Planted area by HDI



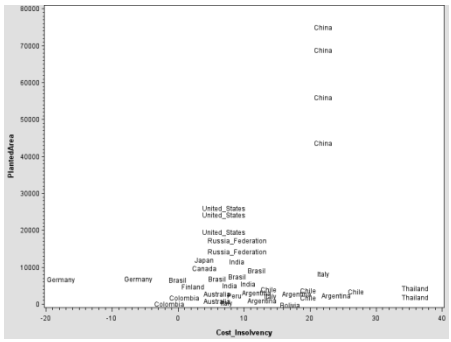
c) Planted area by corruption



d) Planted are by banking credit

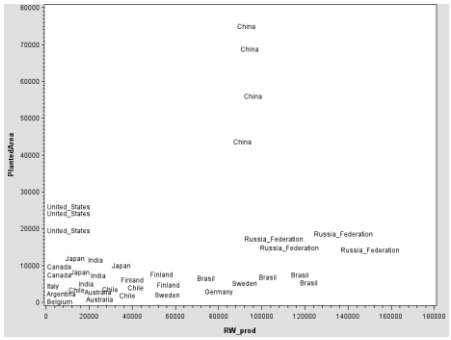


e) Planted area by days to start business

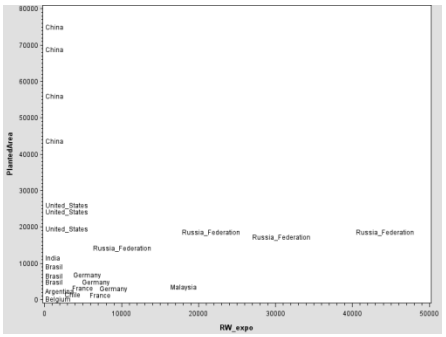


f) Planted area by cost of insolvency

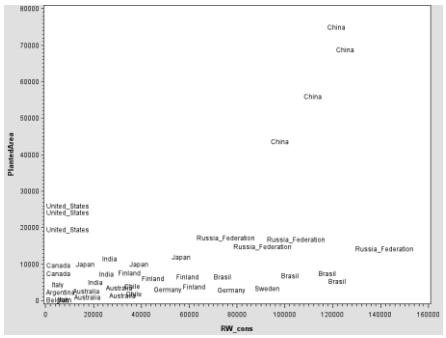
Appendix D. Forestry factors and linearity with area of planted forests, Model 1.



a) Planted area by roundwood production

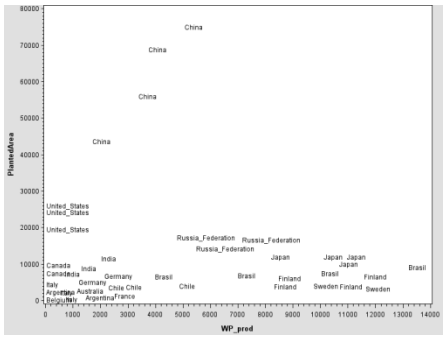


b) Planted area by roundwood exportation



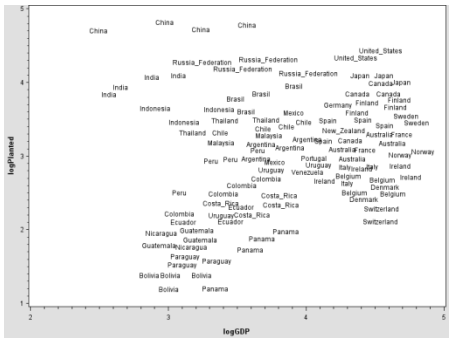
c) Planted area by roundwood consumption

d) Roundwood by productivity

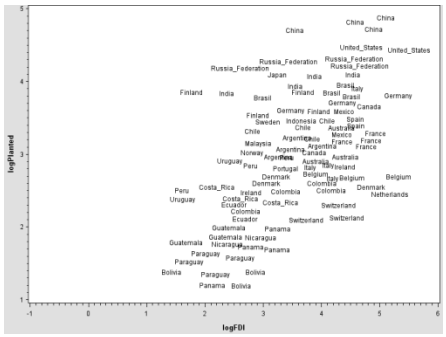


e) Planted area by woodpulp production

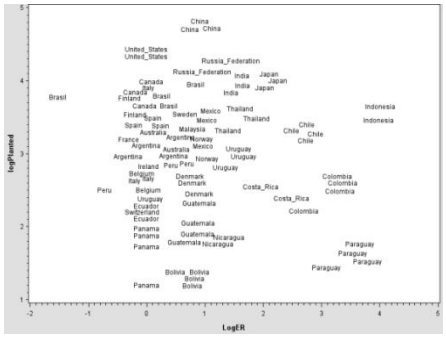
Appendix E. Macro-economic factors and linearity with area of planted forests, Model 2.



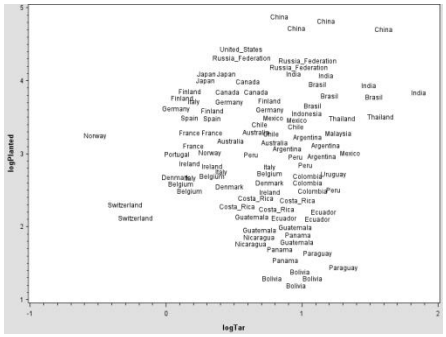
a) Planted area by GDP



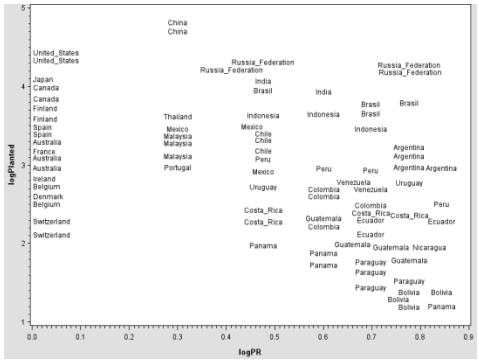
b) Planted area by FDI



c) Planted area by exchange rate

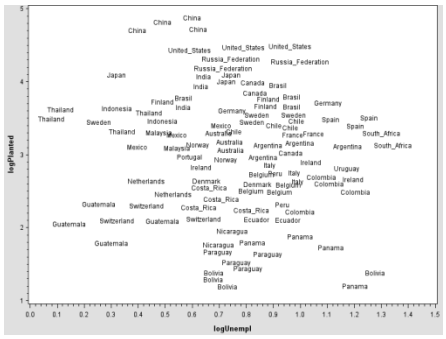


d) Planted area by tariff

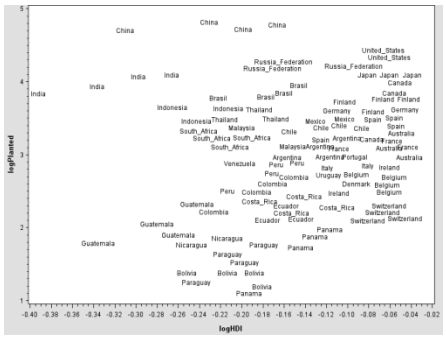


e) Planted area by long-term political risk

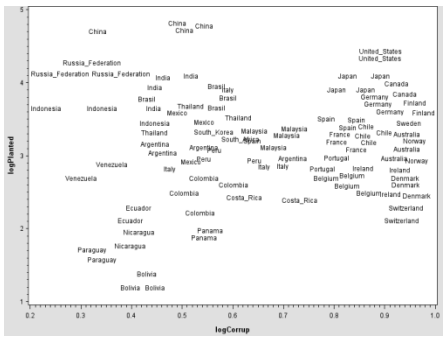
Appendix F. Institutional factors and linearity with area of planted forests, Model 2.



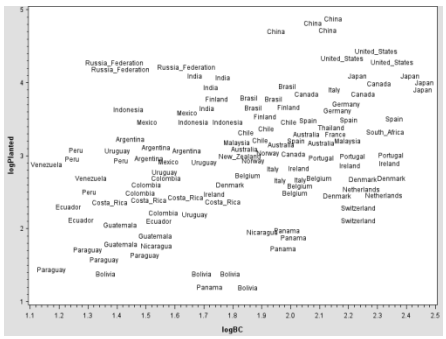
a) Planted area by Unemployment



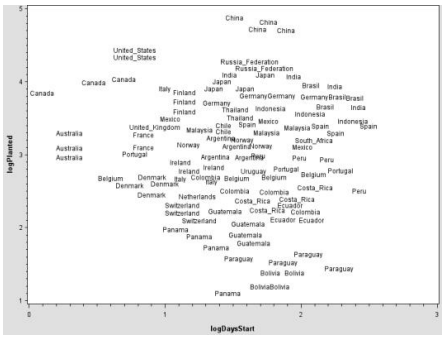
b) Planted area by HDI



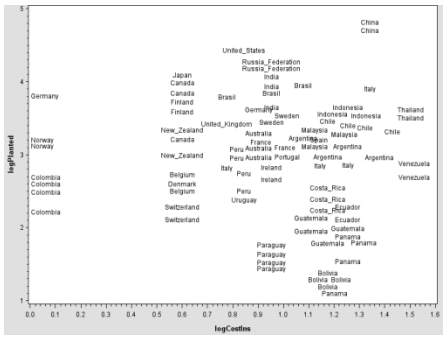
c) Planted area by corruption



d) Planted are by banking credit

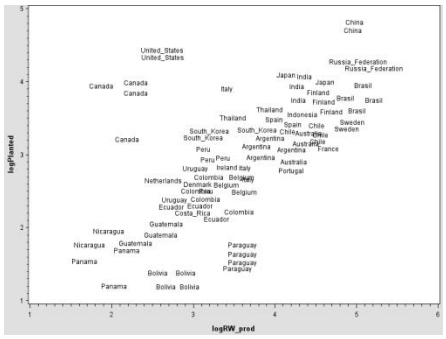


e) Planted area by days to start the business

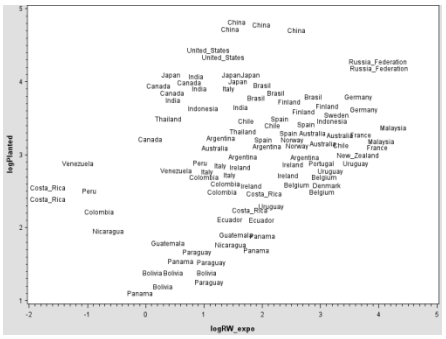


f) Planted area by cost of insolvency

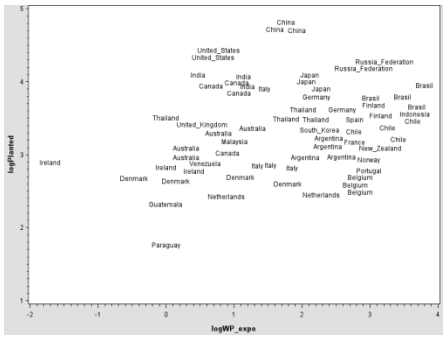
Appendix G. Forestry factors and linearity with area of planted forests, Model 2.



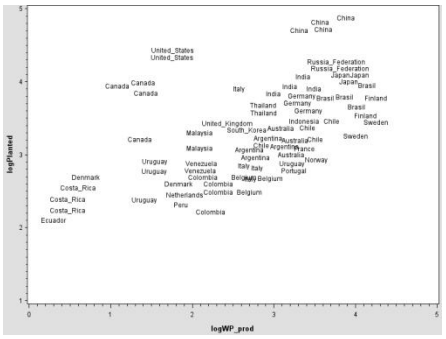
a) Planted area by roundwood production



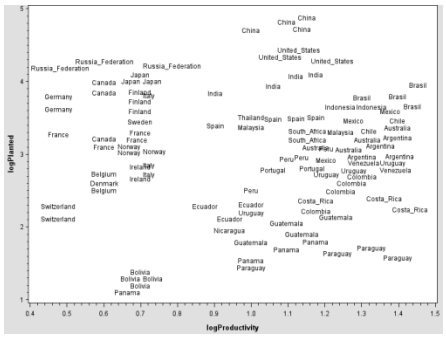
b)Planted area by roundwood exportation



c) Planted area by woodpulp exportation production



d) Planted area by woodpulp



e) Planted area by productivity

Appendix H. The Pearson correlation coefficients for independent variables, Prob > | r | under H0: Rho=0.

	Forest area	GDP	Banking credit	Private credit	Pol.Risk long	Pol.Risk short	HDI
Planted Area	0,38	-0,06	0,18	0,17	-0,12	-0,13	-0,11
	<.0001	0,46	0,02	0,03	0,14	0,11	0,18

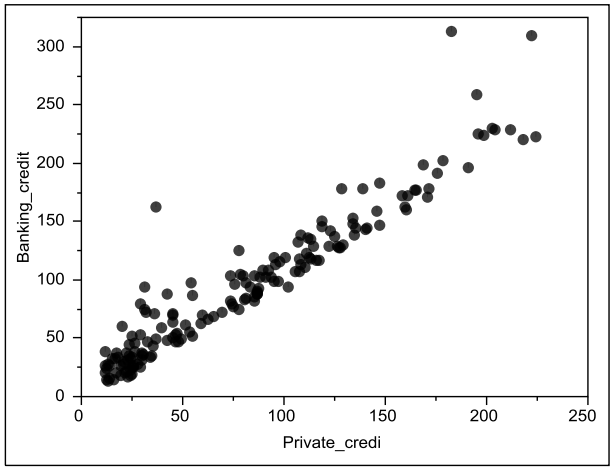
	Corruption	Unemployment	Tax	Tar	RW prod	RW expo	RW cons
Planted Area	-0,16	-0,15	0,11	0,13	0,50	0,11	0,59
	0,05	0,06	0,32	0,10	<.0001	0,18	<.0001

	WP prod	WP expo	WP cons	SW prod	SW expo	SW cons	WF prod
Planted Area	0,20	-0,07	0,55	0,47	0,14	0,52	0,55
	0,03	0,44	<.0001	<.0001	0,09	<.0001	<.0001

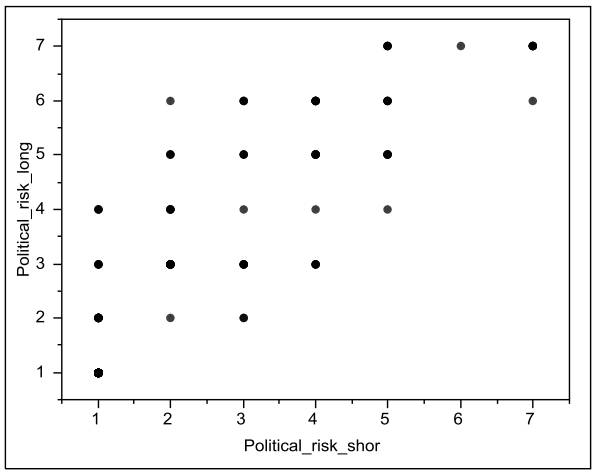
	WF expo	WF cons	Days start	Exchange Rate	FDIS	Cost start	Procedures_Register
Planted Area	-0,03	0,55	-0,03	-0,05	0,30	-0,11	-0,14
	0,78	<.0001	0,73	0,50	0,00	0,18	0,07

	Days Register	Cost register	Years Insolvency	Cost Insolvency	Recovery Insolvency	Productivity
Planted Area	-0,11	-0,08	0,01	0,13	-0,01	-0,01
	0,16	0,32	0,90	0,10	0,86	0,92

Appendix I. Eliminating independent factors that are highly correlated and measure the same phenomenon. Correlation between banking credit and private credit.

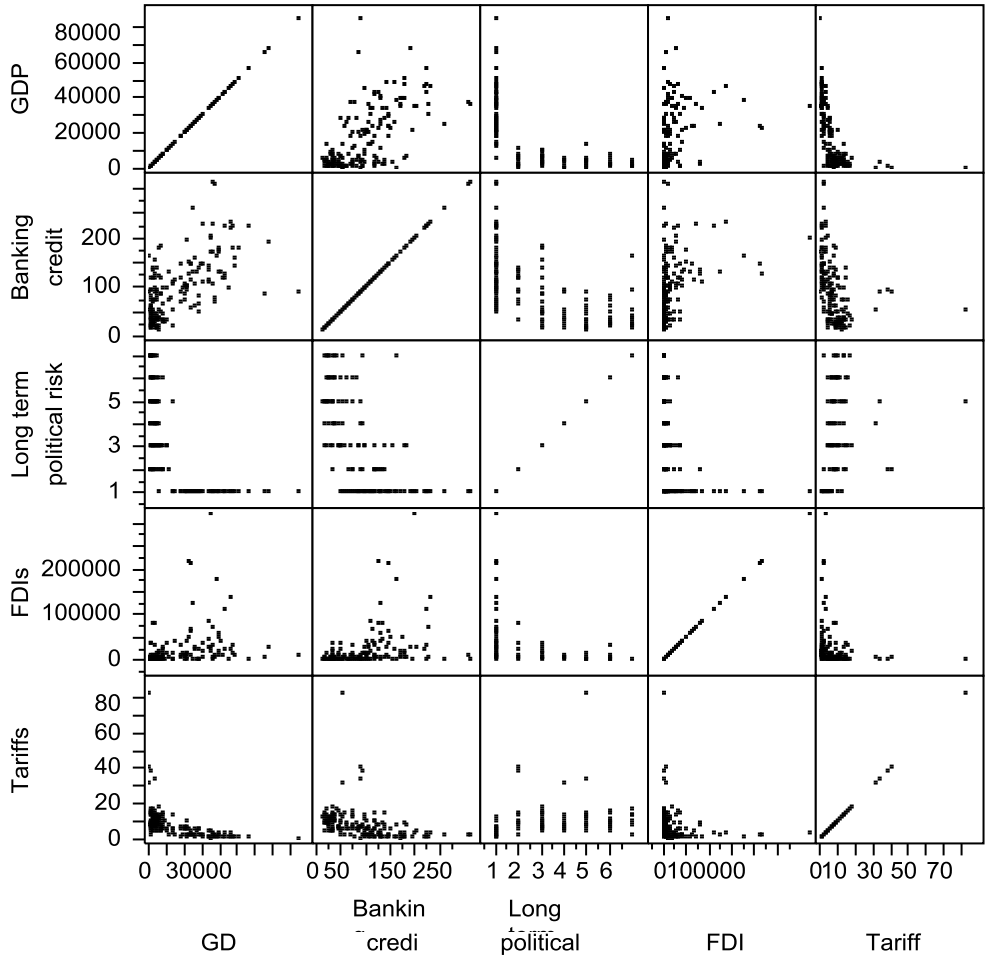


a) Correlation between private and banking credit.

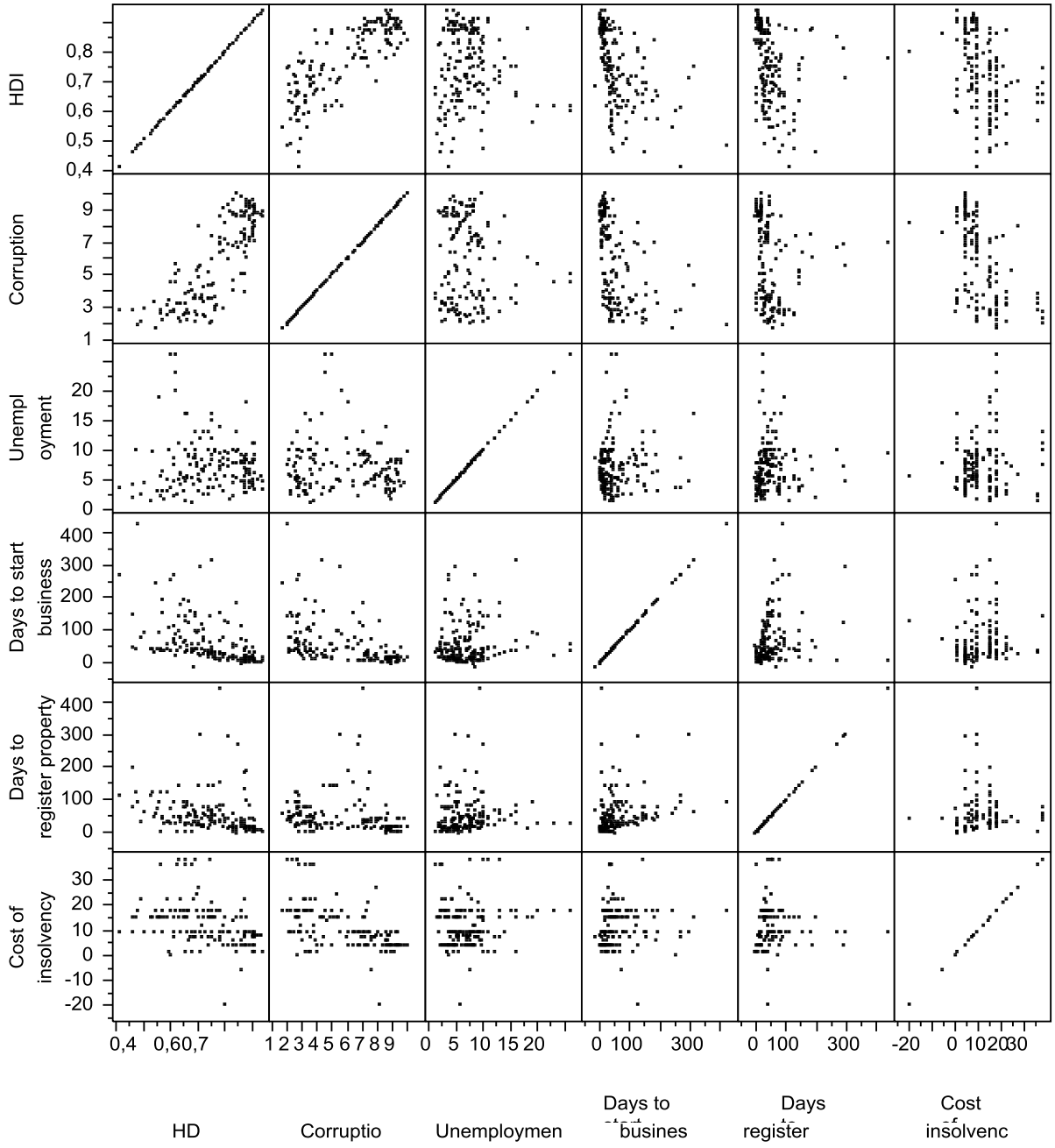


b) Correlation between long term and short term political risk.

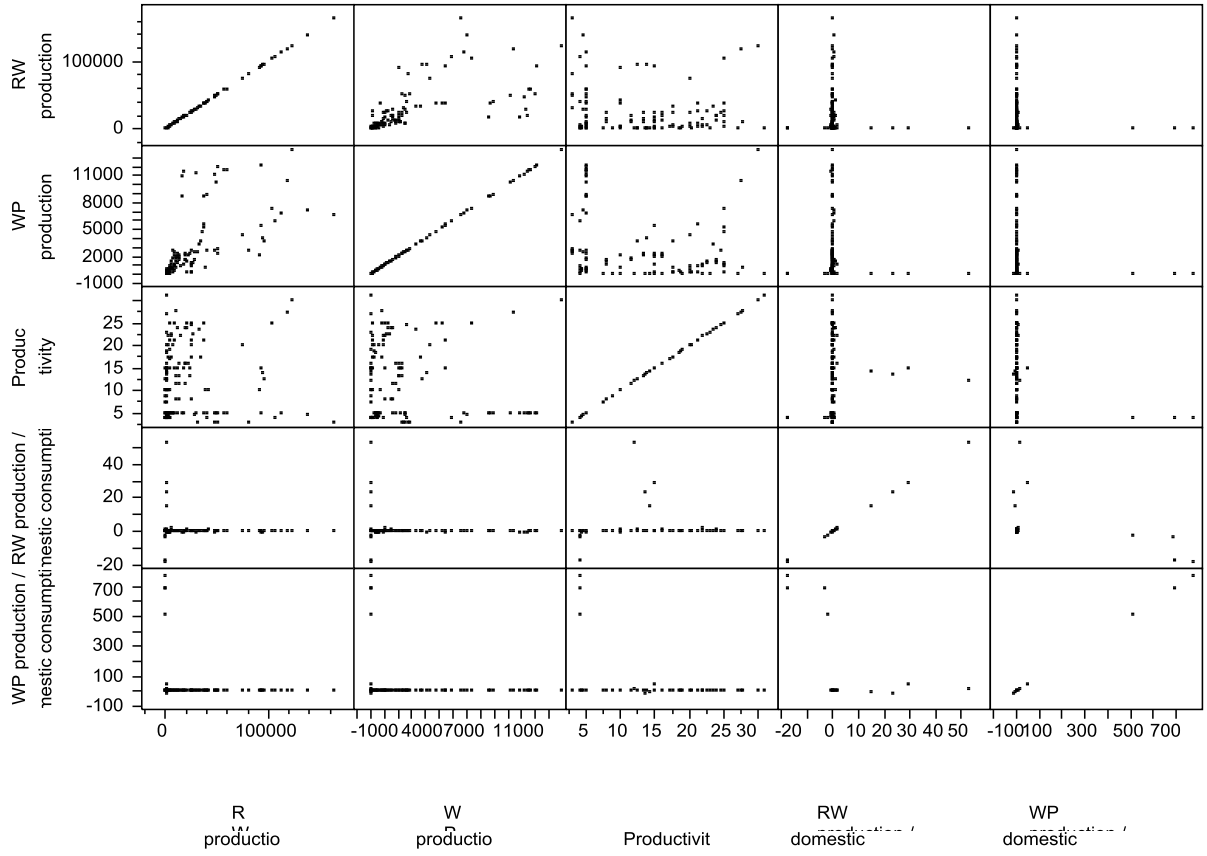
Appendix J. Correlation matrix between macro-economic independent variables.



Appendix K. Correlation matrix between institutional independent variables.



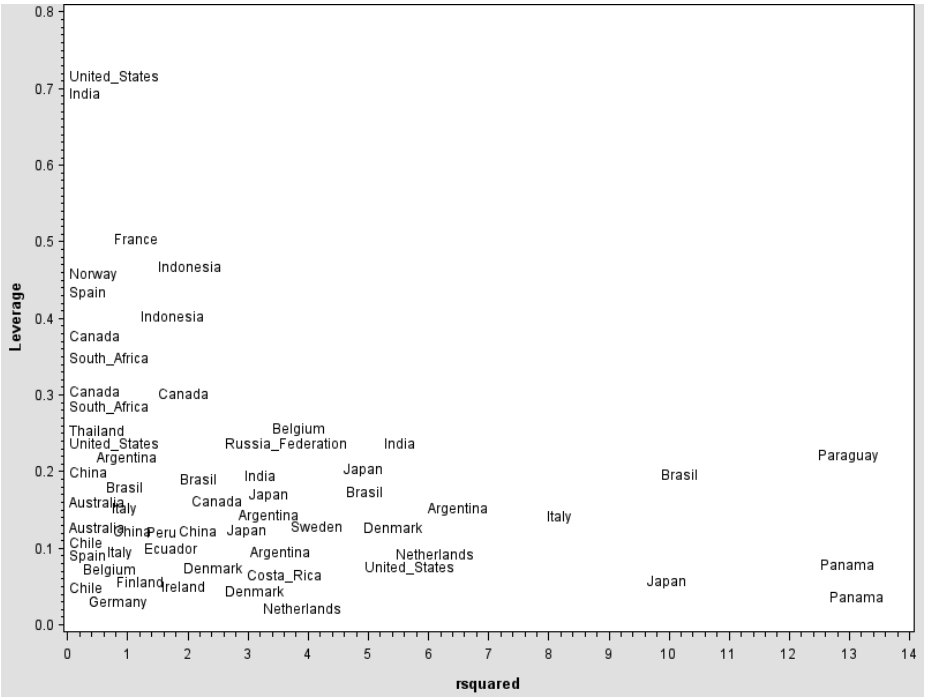
Appendix L. Correlation matrix between forest sector independent variables.



Appendix M. Outcome of detection of poor data series, that resulted in elimination of Panama from the global data set. Residuals, and squared residual against leverages, Model 1.

a) Observations with large residual values.

Country	Year	r
Panama	2005	-2.60
Panama	2010	-2.58
Paraguay	2005	-2.56
Brasil	2010	-2.27
Netherlands	2010	-1.76
Denmark	2010	-1.65
Brasil	2005	-1.58



b) Squared residuals against leverages.

Appendix N. Detection of bad quality data series in OECD countries. Observations exceeding the cut-off values of large residuals and Cook's distance. The analysis resulted in eliminating Italy. Model 1.

a) Observations with large residual values.

Country	Year	r
United States	1990	1.36
United States	2005	1.71
Canada	2005	1.97
Italy	2010	2.02
Canada	2000	2.35
Canada	2010	2.76

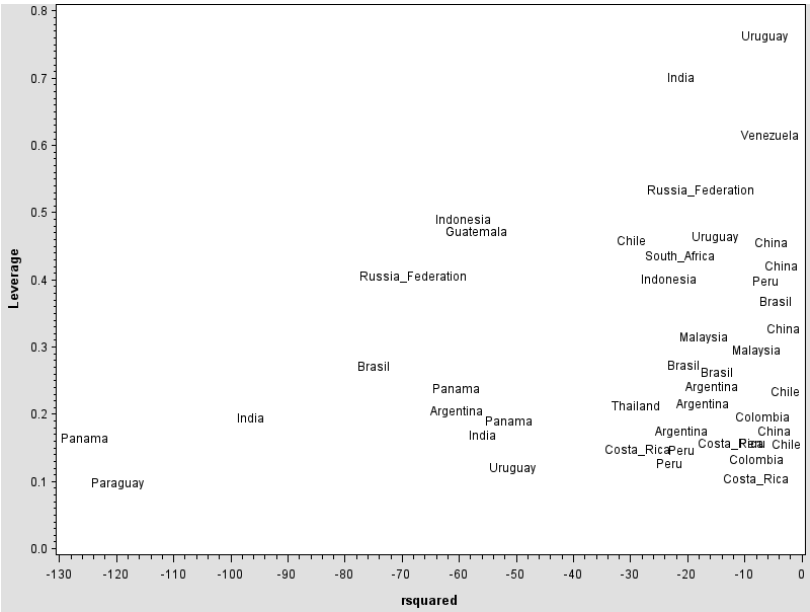
b) Observations that exceed the cut-off value of Cook's distance.

Country	Year	cd
Belgium	2000	0.09
Sweden	2005	0.06
France	1990	0.15
United States	1990	0.26
Italy	2010	0.10
Canada	2000	0.08
Canada	2010	0.10

Appendix O. Detection of bad quality data series in non-OECD countries. Observations exceeding the cut-off values of large residuals and Cook's distance. The analysis resulted in eliminating Italy. Model 1.

a) Observations with large residual values.

Country	Year	r
Panama	2000	-2.32
Paraguay	2000	-2.24
Brasil	2010	-1.77
Panama	2005	-1.59
Paraguay	2005	-1.58
Guatemala	1990	-1.55
Panama	2010	-1.54



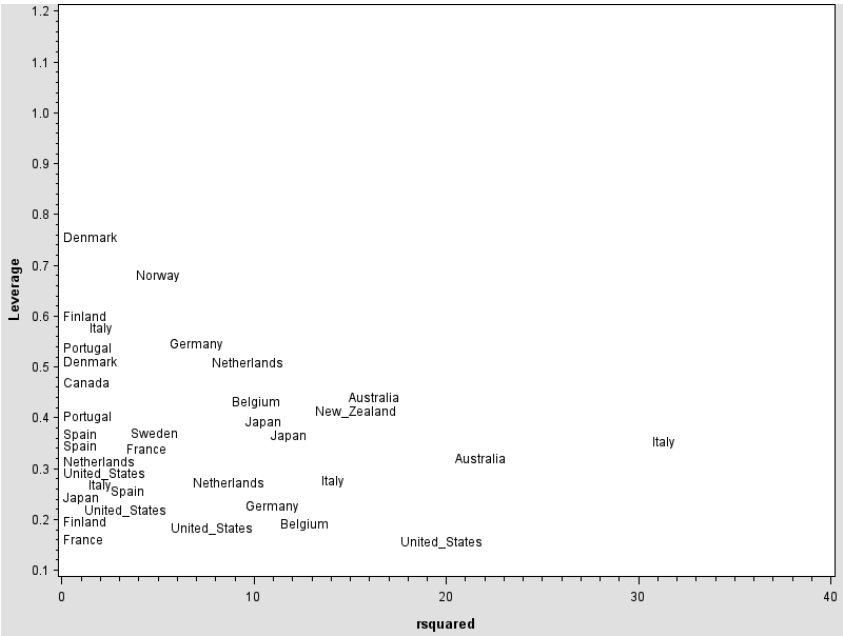
b) Squared residuals against leverages.

Appendix P. Detection of bad quality data series in OECD countries. Observations exceeding the cut-off values of large residuals and Cook's distance. The analysis resulted in eliminating Italy. Model 2.

a) Observations with large residual values.

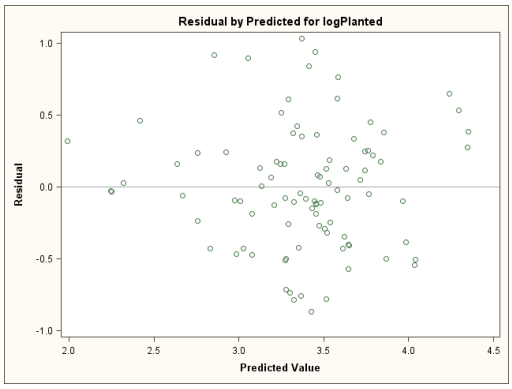
Country	Year	r
Australia	2010	-2.21
Australia	2000	-1.91
Italy	2005	-1.78
Belgium	2005	-1.69
Belgium	2000	-1.51
Netherlands	1990	-1.48
Netherlands	2010	-1.21

Country	Year	r
Germany	2005	1.26
Japan	1990	1.54
Germany	2010	1.57
New Zealand	2000	1.70
United States	1990	2.11
Italy	2010	2.65

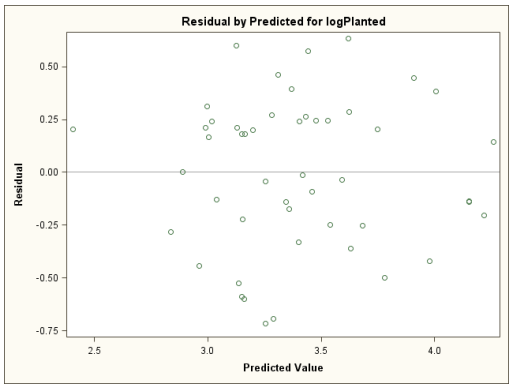


b) Squared residuals against leverages.

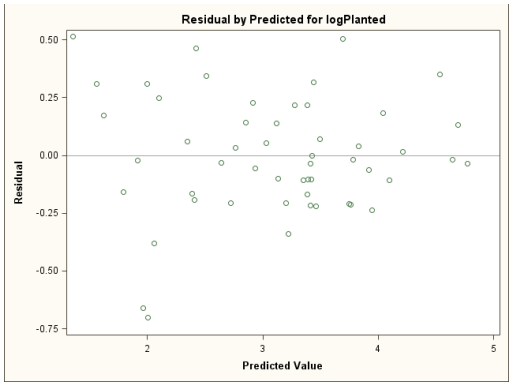
Appendix Q. Heteroscedasticity detection in Model 2.



a) Global dataset

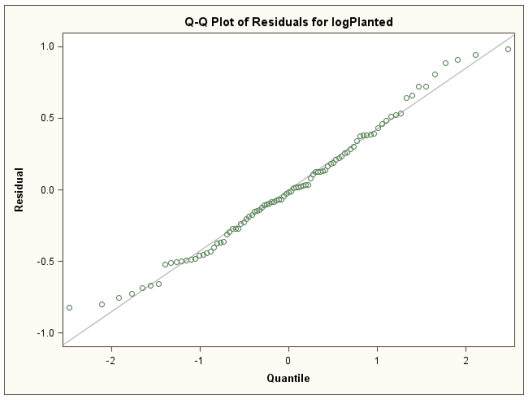


b) OECD dataset

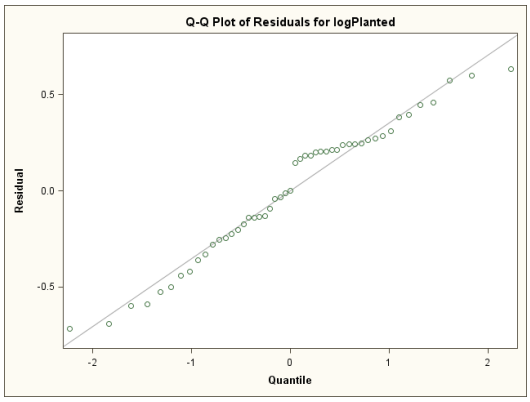


c) Non-OECD dataset

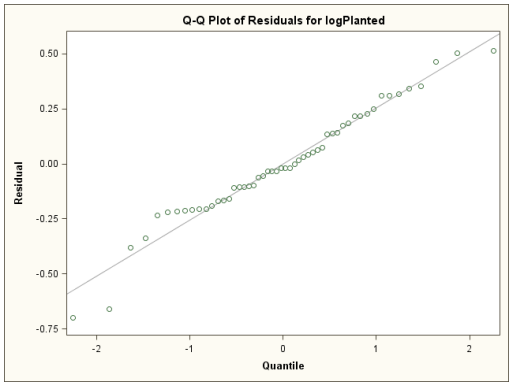
Appendix R. Normality of residuals in Model 2.



a) Global dataset



b) OECD dataset



c) non-OECD dataset

Appendix S. Summary statistics for Model 3. Number of observations, p-values, and R-squared values.

a) Global dataset

Number of Observations Read	**126**
Number of Observations Used	71
Number of Observations with Missing Values	**55**

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	17	0.39	0.02	1.12	0.36
Error	53	1.07	0.02		
Corrected Total	70	1.46			

Root MSE	**0.14**	**R-Square**	**0.265**
Dependent Mean	**0.07**	**Adj R-Sq**	**0.029**
Coeff Var	**212.71**		

b) OECD dataset

Number of Observations Read	60
Number of Observations Used	41
Number of Observations with Missing Values	19

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	17	0.43	0.03	0.60	0.86
Error	23	0.97	0.04		
Corrected Total	40	1.40			

Root MSE	**0.21**	**R-Square**	**0.306**
Dependent Mean	**0.07**	**Adj R-Sq**	**-0.208**
Coeff Var	**290.94**		

c) Not-OECD dataset

Number of Observations Read	56
Number of Observations Used	27
Number of Observations with Missing Values	29

Analysis of Variance					
Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	17	0.04	0.002	1.80	0.185
Error	9	0.01	0.001		
Corrected Total	26	0.06			

Root MSE	**0.04**	**R-Square**	0.773
Dependent Mean	**0.06**	**Adj R-Sq**	0.344
Coeff Var	**61.30**		