Renewable energy trade in Europe: Efficient use of biofuels

by

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Abstract

The purpose of this study is to examine the factors affecting the trade flow on forestry products within the European Union. A gravity model is used to estimate the factors affecting the trade flow. The study uses a panel data set with observations of two forestry commodities between 28 EU member countries over the years 2005 to 2014. The commodities are Wood chips and particles (HS4401) and Industrial roundwood (HS4403). The parameters are estimated with fixed effects, the result shows for HS4401 that exporting countries GDP affect the trade flow positively (0.64) and the importing countries GDP affect positively as well (0.36). For HS4403 the exporting countries GDP affect the trade flow negatively (-0.69) and the importing countries GDP affect positively (0.80). With the estimated parameters a forecast of HS4401 over the years 2015 to 2020 is made, the forecast shows an increase in the trade flow by 29.3%. This suggests an improved efficiency in reaching the EU climate and energy targets. That is, the trade in biofuels is expected to increase due to economic growth, which in turn works towards achieving the renewable and CO_2 emission targets in Europe.

1. Introduction

The forestry sector can play a big role in the transition from a fossil-based economy to a bioeconomy. This includes reducing CO_2 emissions by carbon sequestering and by fuel and product substitution for metals, plastic and concrete (Colombo and Ogden, 2015). In addition, forest products can be used as renewable energy sources, which stand for a major part of the renewable energy supply and six percent of the total global energy supply (FAO, 2016a).

Trade with forest products can help to achieve national targets on renewable energy and emission levels by increasing the efficiency. That is, trade generate a cost efficient solution, where countries with comparative advantages in producing forest products should produce the most and trade with countries with a cost disadvantage. In 2015, the GHG emissions in EU had fallen 22% below 1990 levels, the share of renewable energy has increased to 16.6% and the primary energy consumption has decreased by 12% (European Commission, 2017). Thus, more efforts are thus need in order to archive the renewable and efficiency targets set by the EU. When investigating trade flow between countries, the most standard method used since the 1970s is the gravity model. Studies has been made with both simple forms of the gravity equation and with more elaborate specifications (e.g., Anderson, 1979; Anderson, 2010; Stay and Kulkarni, 2015; Frankel and Wei, 1993). However, only a few studies have been made estimating trade of forest products (e.g., Buongiorno, 2015; Buongiorno, 2016; Akyüz et al., 2010).

The main purpose of this study is to estimate the value of forest products and to determine the effects of the trading countries' economic characteristics. In addition, the study also aims to make a forecast of the trade flow for the years 2015 to 2020 based on economic growth projections. A trade gravity model is developed and implemented on EU28 countries for the period 2005-2014. The study includes woodchips and particles (HS4401) and an aggregated industrial roundwood (HS4403) according to

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FAO Forestry database. Woodchips and particles is wood that has been reduced into small pieces from wood in the rough or from industrial residues suitable for pulping, particle board, fiberboard production and fuelwood. Industrial roundwood is products such as sawlogs or veneer logs and pulpwood (FAO, 2017).

2. Forest biofuels and economic growth in EU

In 2015, forests and other wooded land in the EU covered roughly 182 million hectares, which corresponds to about 41% of the total land area (European Union, 2017). Figure 1 illustrates the volume of standing forest (million m^3) across EU member states for the year 2010. The most endowed countries are, not surprisingly, also amongst the largest countries in terms of land area and include: Germany, Sweden, France, Poland and Finland.

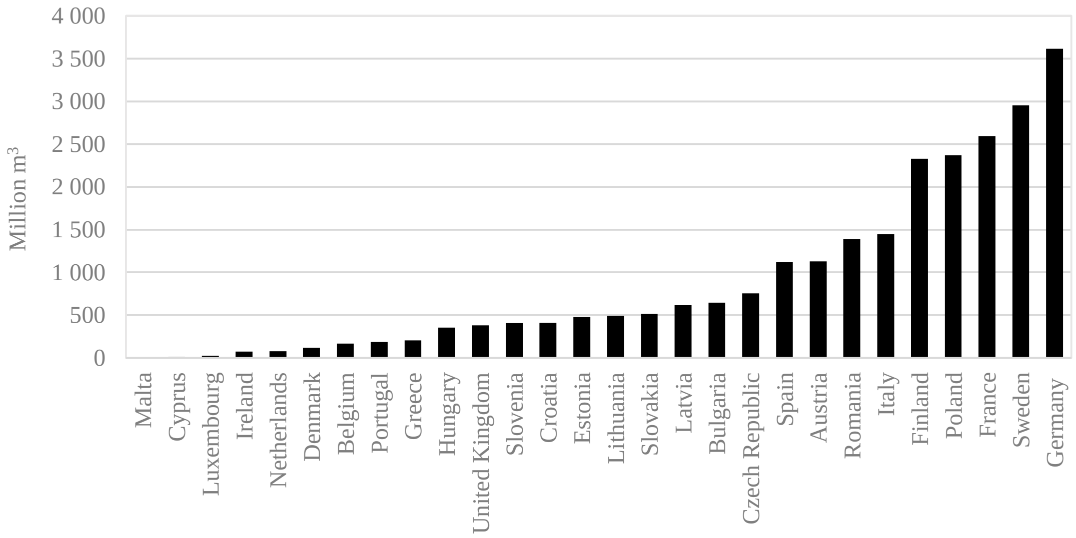

Figure 1: Standing forest volume in EU28 in 2010 (million m^3)
Source: Eurostat (2017).

In terms of aggregate production, the EU area increased its production of industrial roundwood (HS4403) from 293 to 351 million m^3 between 1990 and 2015. The financial crises of the early 90s as well as the later 2008 crisis, and their following recessions, affected the level of production negatively and place the production path on a lower (but still increasing) level. The production of wood chips and particles (HS4401) did not experience the same decline during the 2008 crisis (no data exists before 1998). Instead, the production level has constantly increased over time (with a few minor exceptions) and reach 62.4 million m^3 in 2015, an increased by 33.7 million m^3 compared to 1998. On a disaggregated scale, Sweden, Finland, Germany, Poland and France are, in descending order, the largest producers of industrial roundwood. Sweden accounted for 67.3 million m^3, followed by Finland (51.4), Germany (45.1), Poland (36.5) and France (25.5). For wood chips and particles, Poland is replaced by Italy as the 5th largest producer, as illustrated in Figure 2. Sweden produced 10.3 million m^3 wood chips and particles closely followed by Germany on 10.2 million m^3. Finland, France and Italy had a production of 8.3, 6 and 4.8 million m^3, respectively.

In 2010, the European Commission launched the *Europe 2020 strategy*. The strategy centers on employment, innovation, education, social inclusion and climate/energy with objectives to be reached by 2020. Of particular interest to this study is the target for climate and energy, which is divided into three separate targets: (1) a 20% reduction of GHG emissions compared to the levels in 1990; (2) a 20% share of renewable energy sources in the energy mix and (3) a 20% increase in energy efficiency[1]. Biofuels have been a large contributor to this development. In 2012 it consisted of half the gross inland consumption of renewable energy.

[1] On 30 November 2016 the European Commission proposed an update to the energy efficiency target to 30% by 2030.

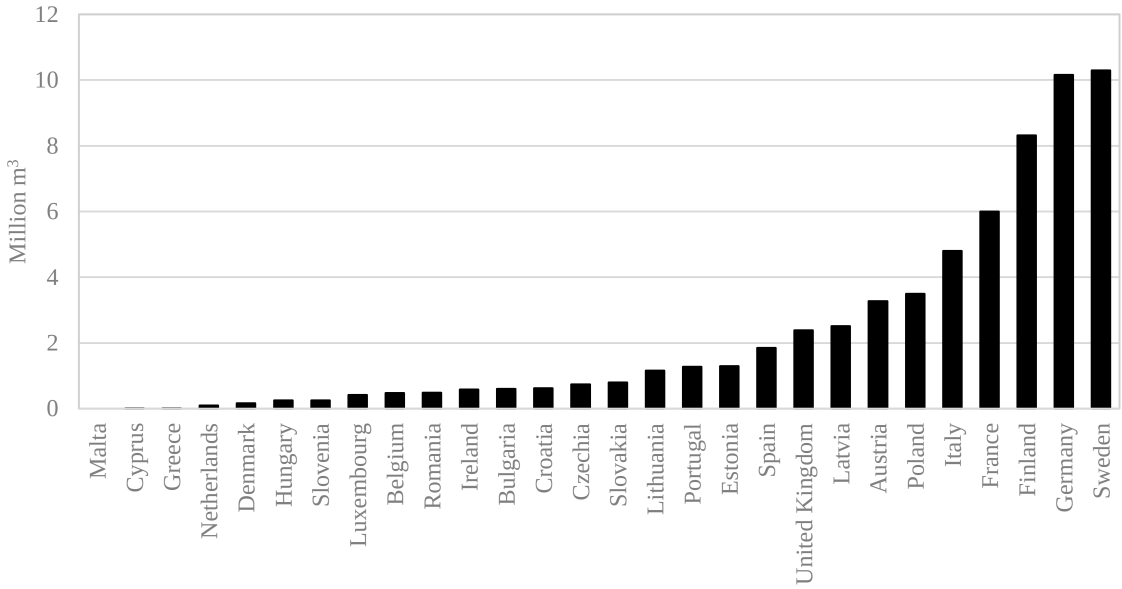

Figure 2: Production of wood chips and particles by country in 2015 (million m^3)
Source: FAOSTAT (2017).

In terms of future trade flows, and as an explanation for past trade in forest biofuels, the economic size of the trading partners is an important determinant according to the trade gravity model. Figure 3 presents the development of GDP (as a measure for economic size) by EU members over time. The period 2015-2020 is based on GDP growth projections by the International Monetary Fund (IMF, 2017).

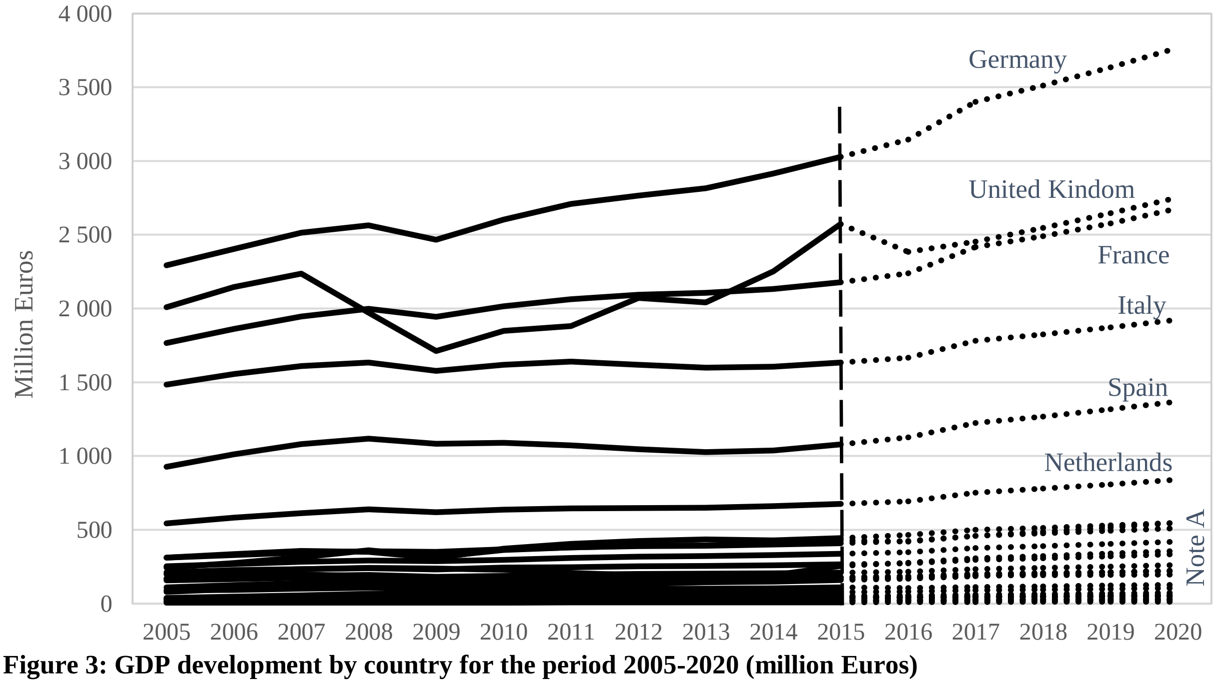

Figure 3: GDP development by country for the period 2005-2020 (million Euros)
Source: IMF (2017).

Note A: In descending order Poland, Sweden, Belgium, Austria, Ireland, Denmark, Finland, Romania, Greece, Portugal, Czech, Hungary, Slovakia, Luxemburg, Bulgaria, Croatia, Lithuania, Slovenia, Latvia, Estonia, Cyprus, Malta.

3. Trade gravity model

The trade gravity model has become a commonly used empirical method to evaluate and predict trade patterns. The model has been applied in numerous specifications and contexts. Anderson (2010) argues that the gravity model is the leading empirical model in economics regarding international trade flow. Anderson (1979) concludes that the gravity model is appropriate to use when the trading countries (or regions) have similar structure of goods, trade taxes and transport costs. This line of research is advanced by Feenstra et al. (2001) who investigate if alternative trade models, i.e., Armington, monopolistic-competition and oligopoly models, differ from the gravity model under the assumption of homogenous and differentiated products and under barriers to entry. They conclude that the gravity model can be adjusted for both differentiated and homogenous products but it will result in different home market effects compared to the other models, i.e., when the export elasticity is higher for the exporter's income than for the importer's income (Krugman, 1980). They also conclude that with no entry barriers, export is more sensitive to changes in domestic income than on changes in trading partners' income. In a later study, Stay and Kulkarni (2016) test the validity of the gravity model by examine United Kingdom (UK) and its trading partners. More specifically, they investigate how the trade flow between UK and its trading partners is influenced by colonial history and membership in the European Union. They conclude that the gravity model is good at predicting the trade flows.

There have been a few attempts to apply the gravity model on forestry products, including forest biofuels. Among the first empirical studies is Kangas and Niskanen (2003) who analyzed trade in forest products between EU and central and eastern European countries (CEE) by using a gravity model. The data include trade between 15 EU and ten CEE countries and has 498 observations. The result showed that the trade and production of forestry products under the 1990s increased in CEE countries. According to estimates with the gravity model, the trade between EU countries and CEE countries did not reached its expected value. Later, Akyüz et al. (2010) examines the trade with forestry products between Turkey and the EU countries using a gravity model. They use panel data for the period 2000-2006. The results indicate that Turkey is below its potential export with EU countries and they conclude that it would be beneficial for both Turkey and EU if Turkey joins EU. Buongiorno (2015) analyzed if the introduction of the European monetary union had any effect on the trade flow of forestry products. He applies a gravity model on three forest products using a panel data on bilateral trade between twelve Euro-countries for the time period 1988-2013. By applying the gravity model in differential form, the time-invariant effects, e.g., distance between countries and common borders, was eliminated. The model was estimated using fixed effects. He found that trade increased for all products and countries after the introduction of the monetary union. In a later study, Buongiorno (2016) studied forestry product trade flow and made forecasts of the value of trade between member countries in Trans-Pacific Partnership (TPP) for the same forest products as in Buongiorno (2015). The data used is a panel of TPP participant for the period 2005-2014. The model was estimated using both fixed and random effects, resulting in similar results. The trade in all three forest products were positively affect by the TPP.

The fundamental gravity model includes information on trade flows, economic size of the trading partners and the distance between them (e.g., Stay and Kulkarni, 2016):

$$T_{ijt} = A\left(\frac{Y_{it} \times Y_{jt}}{D_{ij}}\right) \qquad [1]$$

Where T is the trade between countries i and j in time-period t, A is a constant, Y is the economic size of the trading countries and D is the distance between them. As equation suggest, the model stipulates a positive relationship between trade and the size of the trading economies and an inverse relationship to the distance between them. The specification outlined in Equation [1] has been expanded or modified in the applied studies. For instance, Anderson (2010) excludes the constant (A) and squares the distance variable. The model is regularly modified to include a dummy variable for a common border between trading partners (e.g., Akyüz et al., 2010; McCallum, 1995; Frankel and Wei, 1993; Feenstra et al., 2001). Feenstra et al. (2001) also include dummy variables for common language and for free trade agreement, Frankel and Wei (1993) test for different regional groupings and Buongiorno (2015) test common currency effects. Anderson (1979) and Akyüz et al. (2010) expands the economic size concept by including a population variable. In connected to this, Frankel and Wei (1993) instead opted to include a GNP per capita variable. Finally, the distance concept is modified by Feenstra et al. (2001) who include a "remoteness" variable defined as a GDP-weighted distance.

4. Econometric specification and issues

Since the gravity model outline in Equation [1] is non-linear, it is necessary to log-linearize the model in order to use fixed effects regression. In addition, the model is expanded by including variables for common borders, common currency and forest endowments. The common border and common currency are designed as dummy variables set to unity if the exporting country shares a common border with the importing country and if they have the same currency, i.e., Euro, respectively. The forest endowment variable represent how rich the trading countries are in forest products and is proxied by the total production of industrial roundwood, woodchip and particles in the countries. Thus, the estimated model is expressed as:

$$T_{ijt} = A_i + Y_{it} + Y_{jt} - D_{ij} + BORD_{ij} + EURO_{ijt} + END_{it} \qquad [2]$$

where all variables now are expressed as logarithmic values. From the theory, economic size (*Y*) is expected to affect the forestry product trade positively. The distance variable (*D*) is expected to be negative (this is a theoretical restriction more than an empirical expectation). Common border (*BORD*) is expected to affect the trade positively due to e.g., shared culture and common values. The common currency (*EURO*) is also expected to affect the trade positively because of low currency risk and lower administration burden. For instance, Rose (1999) argues that trade increases by three times more between countries in a monetary union than between countries with their own currencies. The endowment variable (*END*) is expected to affect the trade positively.

By using panel data with fixed effects, heterogeneity in the fundamental relationship across countries and time can be avoided and thus reducing the possibility for inconsistent estimators. Instead, by assuming fixed effects, the explanatory variables are strictly exogenous, which implies that the value of each explanatory variable in every given time period should be uncorrelated with the model error term. The aggregate disturbance term is divided into three components:

$$U_{it} = v_i + \lambda_t + \varepsilon_{it} \qquad [3]$$

where v_i is a country-specific component, λ_t is a year-specific component and ε_{it} is the error term. The value of v_i represents the country-specific effect on forestry trade, making the intercept shift different for each country in the regression.

5. Data

The panel data set include trade between 28 countries over a 10-year period with two forestry products, containing some 15,120 observations. The data on trade is collected from FAOSTAT database and is measured as annual export values in thousands US dollars from each reporting country to each partner country, for the years 2005-2014 (FAO, 2016c). The trade value was first converted into constant 2005 dollar value using the consumer price index from the U.S. Bureau of Labor Statistic database (2016) and afterwards to Euros using IMF exchange rates (IMF, 2016a). The income variable is measured by Gross Domestic Product (GDP), which is collected from the IMF database (IMF, 2016b) for the years 2005-2020. The years 2016-2020 is projected GDP. The distance variable is measured as the distance in kilometers between the capital cities. The data on distance is collected from the European Commission distance calculator (European Commission, 2016). Data on the endowment variable is collected from FAOSTAT database (FAO, 2016d). Table 1 presents the descriptive statistics followed by the correlation matrix in Table 2.

Table 1: Descriptive statistics ('000 Euro)

Country	Wood chips and particles			Industrial roundwood		
	Mean	*Std. err.*	*Max*	*Mean*	*Std. err.*	*Max*
Austria	557	2 289	56 766	2 712	8 981	56 766
Belgium	331	1 078	16 829	2 381	6 337	34 224
Bulgaria	76	392	3 671	448	1 788	13 666
Croatia	273	985	6 361	1 308	3 480	20 175
Cyprus	0.26	3.94	65	6.52	42	525
Czech Republic	364	1 362	10 128	8 903	32 748	198 309
Denmark	102	411	2 916	1 096	3 769	27 293
Estonia	970	4 223	36 413	3 788	11 684	60 368
Finland	388	2 030	15 336	1 779	5 793	37 347
France	706	1 689	8 283	7 973	18 037	121 953
Germany	2 483	6 568	47 795	10 014	30 351	239 836
Greece	3.51	25.57	321	51	237	2 721
Hungary	123	664	6 060	2 136	6 609	38 011
Ireland	20	108	1 357	791	4 074	30 234
Italy	44	349	3 730	387	1 568	14 468
Latvia	2 713	8 262	66 725	7 013	24 705	183 822
Lithuania	226	823	6 496	2 757	7 097	47 854
Luxembourg	148	507	3 188	817	2 533	15 890
Malta	.01	.15	2.53	.09	1.19	19
Netherlands	282	1 106	8 895	1 427	4 936	35 166
Poland	95	503	7 169	3 341	18 804	215 457
Portugal	118	557	5 737	3 978	10 757	86 431
Romania	153	971	9 974	414	848	5 279
Slovak Republic	327	1 164	10 498	4 902	14 244	88 236
Slovenia	251	1 003	6 869	1 999	7 924	74 163
Spain	172	591	7 069	2 482	14 193	135 814
Sweden	210	1 303	19 401	2 452	9 795	92 174
United Kingdom	127	492	5 182	1 194	3 618	29 646

All countries do not trade with all countries all years. Due to this, the data set includes a number of observations where the value of the trade is zero. According to Silva and Tenreyro (2006) zeros in the data set for gravity models can be explained by no trade between countries for a specific year. As such it is important to include them in the regression. To be able to log-linearize the model the zero values are set to unity before the linearization as to become zero after the linearization.

Table 4: Correlation matrix

	Y_{it}	Y_{jt}	D_{ij}	END_{it}
Y_{it}	1.00	-0.04	-0.07	0.35
y_{jt}	-0.04	1.00	-0.07	-0.01
D_{ij}	-0.07	-0.07	1.00	-0.04
END_{it}	0.35	-0.01	-0.04	1.00

6. Estimation results

The Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) tests are performed to test for unit root. The Akaike Information Criteria (AIC) is used to determine the number of lags in the tests. The result from the ADF-test showed that the null hypothesis can be rejected for a majority of the variables at a

1% significance level. This result is supported by the PP-test. In the Appendix a complete summary of the test statistics is presented.

Table 5 shows the results from the estimation. The majority of the variables are statistical significant on a 1% level, except the forest endowment variable for wood chips and particles. An F-test indicates that the fixed effect model has a better fit than a pooled OLS model. The fixed effect generates an individual country-specific effect that shifts the intercept. The fixed effects for industrial roundwood are statistical significant at 1% level for all countries. For woodchips and particles only five countries have statistical significant, at 1% level, fixed effects (see Appendix for details). The results indicate that a 10% increase in the exporter's GDP (Y_i) will increase the trade value by 6.4% (±1.7%) for woodchips and particles (HS4401) and decrease it by 6.9% (±2.2%) for industrial roundwood (HS4403). The effect of a 10% increase in the importer's GDP (Y_j) will increase the trade value of woodchips and particles (HS4401) by 3.6% (±0.1%) and by 8% (±0.2%) for industrial roundwood (HS4403). The distance between the countries affect the trade value negatively. For woodchips and particles a 10% increase in distance, decreases the trade value by 10.6% (±0.4%) and for industrial roundwood by 15.4% (±0.5%). A 10% increase in forestry endowment will increase the trade flow value by 2.2% (±1.1%) for woodchips and particles and by 4.4% (±1.5%) for industrial roundwood. Furthermore, if the trading countries share a common border the trade value increases by 3.3 and by 3 million Euros for woodchips and particles and for industrial roundwood, respectively. If the both trading countries are have the same currency (i.e., Euro) the trade value increases by 0.17 million Euro for woodchips and particles and by 0.41 million Euro or industrial roundwood.

Table 5: Estimates with the gravity model on trade with forestry products

Variable	Woodchips and particles		Industrial roundwood	
	Coefficient		Coefficient	
Y_i	0.64 (0.17)	***	-0.69 (0.22)	***
Y_j	0.36 (0.01)	***	0.80 (0.02)	***
D	-1.06 (0.04)	***	-1.54 (0.05)	***
END	0.22 (0.11)	*	0.44 (0.15)	***
$BORD$	3.31 (0.08)	***	3.04 (0.11)	***
$EURO$	0.17 (0.05)	***	0.41 (0.07)	***
R^2	57.5		60.5	

***, **, * indicates a statistical significance of the coefficients at 1%, 5% and 10% level, respectively. Standard error in parenthesis

These results are consistent with previous studies and in line with expectations. For instance, previously estimated income effects ranged between 0.93 and 1.12 (Akyüz et al., 2010; Buongiorno 2015; Buongiorno, 2016; Kangas and Niskanen, 2003). Akyüz et al. (2010) and Kangas and Niskanen (2003) estimated the effect of distance to -1.86 and -1.75, respectively and the effect for and common border to 0.35 and 0.47, respectively. Buongiorno (2015) found the effect of a common currency to 0.068 million Euro. He also found that the introduction of the Euro had increased the average annual rate of growth of the bilateral trade of forest products by 6.5 from 2002 to 2013. Moreover, Frankel and Wei (1993) examine how the trade flow is affected by trade blocs in e.g., Europe. They conclude that a country that joined the European common market in 1980 have, as a consequence, increased its trade with other member countries by 68%. Similar results are found by McCallum (1995) who investigate border effect between Canada and USA. They conclude that open borders would increase trade by 43%. Anderson and van Wincoop (2003) also use a border dummy to estimate the trade effects of national borders. They found that the border between the US and Canada reduces the trade by about 44% and other industrialized countries with about 30%, thus supporting the results by McCallum (1995).

On one issue the model did not produce expected results. The income variable for the exporting country exhibit a negative sign for industrial roundwood, instead of a positive sign as expected by the trade gravity model. That is, the negative sign of the exporter's GDP for industrial roundwood (HS4403) contradicts the theory of the gravity model and previous studies on forestry products (Akyüz et al., 2010; Buongiorno, 2015; Buongiorno, 2016; Kangas and Niskanen, 2003). This can have a number of explanations. For example, it is possible, but not likely, for the exporting country's GDP to have a negative effect on the trade value. However, following the argument by Baudin et al., (2011), it is more likely that the production of industrial roundwood has decreased and according to FAO (2013) the production suffered a decline after the economic recession in 2008. Since then the level of production has not recovered to its pre-recession level in 2007.

7. Forecasting trade for woodchips and particles until 2020

The estimated results is used to forecast trade in woodchips and particles by using projections on the trading countries income levels. For simplicity, the forest endowment is assumed to be constant during the forecasted period. Figure 4 illustrate the forecast in aggregate trade value due to projected income changes for the sample countries for woodchips and particles (HS4401). The dashed line is the projected trade values and the solid line is the observed trade values. As can be seen in Figure 4, the aggregated trade value of woodchips and particles are projected to increase by almost 100 million Euro until 2020, corresponding to a 29.3% increase.

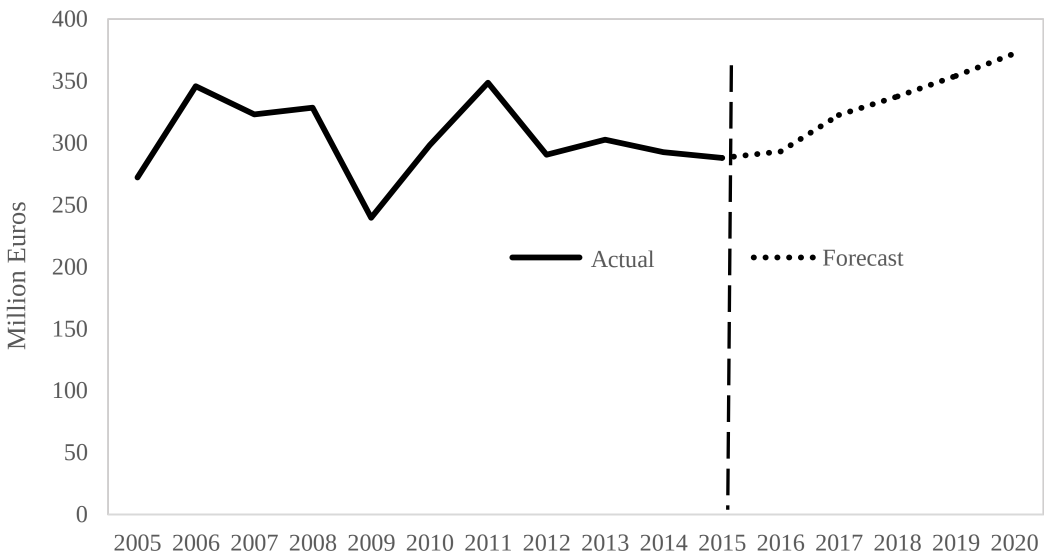

Figure 4. Forecast of wood chips and particles trade value, 2015-2020

In Figure 5, the forecasts for a number of four top producing countries are presented: Finland, France, Germany and Sweden. These four countries have a positive trend for the future trade values, following the aggregated forecast. France and Germany have a higher growth in absolute trade values compared to Sweden and Finland. They are also expected to have a higher growth rate. The trade values are projected to increase by almost 2.9 and by 2 million Euros for Sweden and Finland, respectively. For France and Germany the trade value is projected to increase by 9.6 and 13.8 million Euro, respectively.

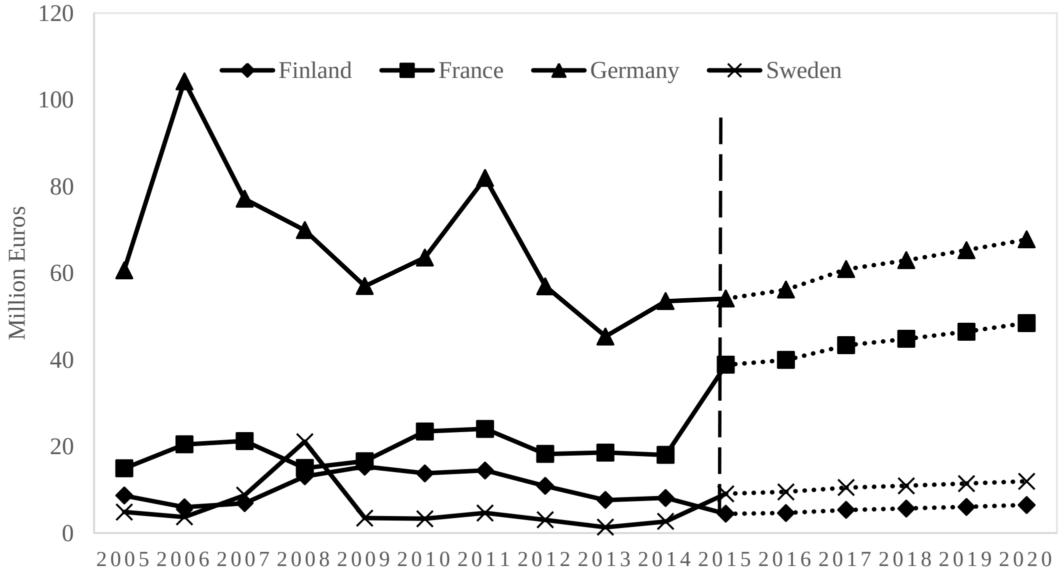

Figure 5. Forecast of wood chips and particles trade value for Finland, France, Germany and Sweden, 2015-2020

8. Conclusions

The purpose of this study has been to estimate and predict the trade value of two forestry products, wood chips and particles (HS4401) and industrial roundwood (HS4403) between the EU member countries. As the result indicate, the trade value increases by 29.3% from 2015 to 2020 in the European Union for wood ships and particles (HS4401) suggesting that the utilization of the commodity should increase in the future. This, in turn, will facilitate a smoother transition towards a bioeconomy and help achieving the EU 202020-targets, both in terms of renewable energy and carbon emissions.

From the forecast values, Sweden's import for the time-period 2015-2020 is set to increase with 4.6 million Euros. The import is projected to be bigger than the export, which implies that Sweden utilization of wood chips and particles is likely to increase until 2020. Sweden is one of the sample countries that are not a member of the European monetary union. By joining the monetary union, the trade value of woodchips and particles would increase. This would most likely increase the efficiency and effectiveness in achieving the country specific climate and energy targets.

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Appendix

Table A1: Fixed effects estimates

	Woodchips and particles	Industrial roundwood		Woodchips and particles	Industrial roundwood
Austria	-0.08	8.84***	Italy	-1.29	10.73***
Belgium	-0.10	9.42***	Latvia	3.51***	8.15***
Bulgaria	1.20	6.65***	Lithuania	2.14***	8.77***
Croatia	0.94	7.66***	Luxembourg	1.22	7.08***
Cyprus	3.06***	8.50***	Malta	2.31***	4.91***
Czech	0.23	7.95***	Netherlands	0.16	10.66***
Denmark	0.37	9.34***	Poland	-0.41	10.37***
Estonia	2.82***	8.32***	Portugal	0.84	7.98***
Finland	-0.23	9.19***	Romania	0.62	8.81***
France	-0.19	11.45***	Slovakia	0.73	7.75***
Germany	1.03	11.50***	Slovenia	0.65	6.83***
Greece	0.25	8.31***	Spain	-0.09	9.58***
Hungary	-0.01	8.74***	Sweden	-0.36	9.29***
Ireland	0.19	7.42***	UK	-1.29	9.89***

***, **, * indicate statistical significance at 10%, 5% and 1% level, respectively.

Table A2: Predicted annual percent growth of exports value for woodchips and particles ('000 Euro)

Exporter	Value (2014)	Growth rate (%)				
		2016	2017	2018	2019	2020
Austria	9,528	3.3	10.2	4.4	4.7	4.8
Belgium	5,693	3.5	10.9	4.6	4.8	4.9
Bulgaria	4,363	4.5	21.0	9.0	9.2	9.2
Croatia	16,730	2.8	14.4	6.5	6.8	7.0
Cyprus	1	-6.4	-35.4	-28.4	-43.9	-84.9
Czech Republic	11,705	3.7	11.5	4.2	3.8	4.0
Denmark	1,835	2.9	12.0	5.3	5.8	6.0
Estonia	22,357	6.7	32.3	12.7	12.4	12.2
Finland	8,106	4.0	14.9	6.2	6.8	7.0
France	18,051	2.9	8.5	3.4	3.8	4.3
Germany	53,529	3.8	8.4	3.4	3.7	3.8
Greece	10	2.4	19.8	8.8	8.9	8.8
Hungary	6,467	0.4	11.7	6.2	6.5	6.2
Ireland	302	9.5	17.4	7.9	7.8	7.9
Italy	3,138	2.2	7.8	2.9	3.0	3.3
Latvia	46,778	4.7	22.6	9.7	9.8	9.7
Lithuania	4,162	4.4	20.1	9.0	9.1	9.1
Luxembourg	2,527	4.0	15.7	7.2	7.4	7.5
Malta	N/A	20.2	84.2	23.5	21.0	19.0
Netherlands	19,567	2.7	10.1	4.3	4.6	4.7
Poland	6,724	-0.5	11.0	6.3	6.5	6.6
Portugal	4,971	10.6	35.4	12.4	12.2	12.0
Romania	9,766	5.0	16.3	8.4	8.4	8.4
Slovak Republic	13,158	3.3	13.3	6.4	6.7	6.9
Slovenia	10,731	3.1	14.6	6.4	6.8	6.9
Spain	6,015	4.8	10.8	4.4	4.8	4.9
Sweden	2,684	4.9	10.3	4.0	4.7	4.4
United Kingdom	3,593	-6.9	3.7	4.1	4.2	4.3
Total	**292,488**	**0.2**	**10.2**	**15.3**	**21.0**	**27.2**

Table A3: ADF-test and PP-test

Country	ADF-test				PP-test			
	Woodchips and particles	Industrial roundwood	GDP	END	Woodchips and particles	Industrial roundwood	GDP	END
Austria	-4.1***	-4.2***	-2.8	-12.3***	-4.5***	-4.4***	-3.00	-40.1***
Belgium	-5.2***	-4.1***	-2.8	-11.1***	-7.3***	-4.3***	-4.0**	-113***
Bulgaria	-5.5***	-4.7***	-2.8	-18.6***	-6.8***	-4.3***	-4.0***	-45.2***
Croatia	-5.6***	-4.6***	-2.8	-12.4***	-6.1***	-5.2***	-4.0***	-60.0***
Cyprus	-11.6***	-11.3***	-2.8	-11.1***	-16.4***	-15.4***	-4.0***	-4646***
Czech	-5.5***	-4.9***	-2.8	-13.8***	-4.8***	-4.8***	-4.0**	-51.3***
Denmark	-4.9***	-5.0***	-2.8	-10.6***	-6.3***	-6.0***	-4.0**	-232***
Estonia	-4.8***	-4.1***	-2.8	-12.1***	-5.0***	-5.6***	-4.0**	-44.8***
Finland	-3.7**	-4.7***	-2.9	-14.2***	-4.0**	-4.8***	-4.0***	-35.7***
France	-4.5***	-5.3***	-3.4*	-11.8***	-5.1***	-6.7***	-4.6***	-62.7***
Germany	-5.1***	-8.4***	-3.2*	-17.4***	-4.9***	-4.3***	-4.7***	-39.8***
Greece	-7.7***	-7.0***	-2.8	-16.6***	-22.0***	-7.9***	-3.9**	-730***
Hungary	-5.6***	-4.6***	-2.8	-10.9***	-6.1***	-4.7***	-3.8**	-41.9***
Ireland	-8.2***	0.0	-2.8	-11.8***	-9.3***	-0.2	-3.9**	-3.3***
Italy	-10.6***	-7.3***	-2.5	-17.4***	-10.9***	-14.1***	-3.6**	-22.1***
Latvia	-5.9***	-5.6***	-2.8	-17.3***	-5.5***	-4.4***	-3.9**	-14.2***
Lithuania	-6.2***	-6.3***	-2.8	-14.8***	-7.3***	-7.2***	-3.9**	-57.5***
Luxembourg	-4.7***	-4.2***	-2.8	-19.7***	-6.4***	-4.5***	-3.9**	-72.8***
Malta	-11.6***	-10.9***	-2.8	N/A	-16.6***	-13.3***	-3.9**	N/A
Netherlands	-4.9***	-5.1***	-2.7	-20.3***	-4.8***	-4.9***	-3.8**	-44.5***
Poland	-6.6***	-6.4***	-2.8	-11.5***	-14.7***	-6.3***	-3.8**	-165***
Portugal	-9.9***	-5.8***	-2.8	-12.9***	-9.1***	-6.9***	-3.8**	-64.7***
Romania	-8.7***	-5.9***	-2.8	-14.8***	-5.9***	-7.1***	-3.8**	-45.6***
Slovakia	-6.7***	-5.4***	-2.8	-18.9***	-9.0***	-5.4***	-3.9**	-20.1***
Slovenia	-5.7***	-5.7***	-2.8	-11.7***	-4.8***	-6.8***	-3.9**	-60.4***
Spain	-5.9***	-6.1***	-2.6	-8.4***	-9.4***	-5.5***	-3.8**	-47.2***
Sweden	-9.1***	-7.1***	-2.6	-16.9***	-10.8***	-6.1***	-3.7**	-85.8***
UK	-8.8***	-5.6***	-3.1*	-10.9***	-10.6***	-5.5***	-4.4***	-462***

***, **, * indicates the statistical significance of the coefficients at 1%, 5% and 10% level, respectively.