ECONOMIC BENEFIT OF MAXIMUM TRUCK WEIGHT REGULATION CHANGE FOR ESTONIAN FOREST SECTOR

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Abstract

Current paper is focused on analysing the economic benefit of increasing maximum allowed truck weight for Estonian forest sector. It is producing economic benefits to the firms of forest sector in two broad areas. The change in truck weight limit regulation is causing the reduction of transportation costs for forest sector firms. Increase of the truck weight limit from current 44 up to 60 tonnes is going to reduce the share of transportation costs in roundwood material prices from 17.7% to 14.2%. Secondly, the growth of demand for roundwood as the result of decreasing transportation costs was determined. Using own and cross elasticities between road and rail transportation, the apparent domestic consumption is expected to grow in the range from 0.7 – 4.6 % depending on the change of regulation from 44 to 60 tonnes, whereas in the most probable situation (change from 52 to 60 tonnes) the growth in apparent domestic consumption is 0.3 − 1.1%.

Keywords: maximum truck weight, forest sector, transportation demand, modal shift, economic benefit, elasticities

JEL Classification: L51, L92

1. Introduction

Transportation is playing an important role in the well functioning of every economic system. The reduction in transportation costs is seen as an important trigger of improving competitiveness of many industries, which are heavily dependent on frequent and significant materials flows. Therefore legal maximum weight of trucks plays important role in the competition between industries in competing nations. Currently the maximum limits in the Baltic Sea Region differ significantly, from 40 tonnes in Lithuania up to 60 tonnes in Sweden and Finland (see table 1).

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Table 1. Permissible weight (in tonnes) for 5 axle road train in Baltic Sea region

Country	**Permissible weight (in tonnes)**
Estonia	44
Latvia	40
Lithuania	40
Finland	60
Sweden	60
Poland	40
Germany	40

Source: Permissible maximum … 2010.

Increasing maximum truck weight enables firms to consolidate loads, reduce the amount of required vehicle movement in order to distribute a given quantity of freight. Although the increase in maximum truck weight may produce under certain conditions economic, environmental, social benefits and costs, it can also cause reduction of tax revenues and increase of infrastructure investments (roads and bridges). The above provided variety of potential positive and negative results of maximum truck weight regulation change reveals its importance for the transportation policy in narrower, and economic policy in wider sense.

Current paper is based on a research commissioned by the Estonian Government and Estonian Association of Forest Industry in 2009-2010 about the case of increasing maximum weight of trucks from 44 tonnes to 52 or 60 tonnes (afterwards marked as 44→52 and 44→60). The paper outlines only some results of the interdisciplinary research and is therefore limited only to the economic aspects of changing weight limits for the Estonian forest sector. Results about the impact of the weight increase on traffic frequency and safety, environmental conditions etc. have not been reflected in current paper, but were part of the integrated research mentioned above. Derived from previous aspect a cost-benefit analysis covering all aspects of regulation change has not been conducted in current study.

The paper is focused to figure out the economic benefits of increasing maximum truck weight for Estonian forest sector (incl. forest transportation). Economic benefits of regulation change are assessed in two broad areas. Firstly, the reduction in transportation costs for forest sector firms due to regulation change is estimated. Secondly, the possible impact of decreasing transportation costs on the demand of roundwood and also resulting transportation demand considering different transportation modes are determined.

Selection of forest sector as a research object is explained by its important role in Estonian economy, forming around one fifth of total sales, and its strong material intensity, which leads to the relatively high share of transportation costs in the total costs of sector. Transportation costs are currently forming around 17% of the total cost of materials in forest sector, which is remarkably more when compared to Kiisler (2008: 357-358) estimates for other sectors. In addition, Estonian forest sector is facing strong competition from the neighbouring Baltic Sea region countries.

The paper is structured as follows. After introduction, the first section provides a short overview of the previous research on the impact of changes in truck weight and dimension regulations on the whole economy or particular economic sectors. Next section is devoted to the explanation of methodology and empirical calculations for identifying the impact of the change in truck weight limits on the transportation costs of Estonian forest sector firms. Following section of the paper is devoted to determining possible impact of decreasing transportation costs on the demand of roundwood and also resulting transportation demand. Final section is discussing the obtained results and concludes.

2. Previous research of maximum truck weight changes

The impact of changes in truck weight and dimension regulations has been a research object for academics and organisations for a long time. The main reason for conducting such research is the potential increase in competitiveness through more effective transportation system (see e.g. Mačiulis, 2009). Beside competitiveness aspect there have been other research reasons, like the European Union transportation policy implementation, environmental cost reduction etc. The topic is still very novel, as many European countries (including Baltic countries) are considering the increase of maximum truck weight limit in the framework of EU Directive 96/53.

Previous research by its nature has been both, theoretical and practical. Many studies focus only on the economic benefits, but others consider truck weight and dimensions changing effects on society as a whole (including environmental, safety, infrastructure etc aspects). Most of the research has been considering the macroeconomic view and sector specific approaches are quite rare, which probably is connected with the (political) difficulties of changing weight and dimension constraints for only single sector of the economy.

Outstanding research has been carried out on the example of USA and European Union. *Comprehensive truck size and weight study* (2000) calculates different scenarios for changing truck dimensions and maximum weight on the example of USA. Although the study does not sum different effects on society level, it finds that regulation changes can impact shippers total cost negatively or positively. *Regulations of weights, lengths and widths of commercial motor vehicles* (2002) sums methodological background for regulation change analysis on the example of USA. Important analysis in the EU context is *Effects of adapting the rules of weights and dimensions of heavy commercial vehicles within Directive 96/53/EC* (2008), which provides similar methodological background used in current analysis. Several analyses have been conducted to research the effects of decreasing allowed weight limits on the example of Finland and Sweden, where the norms have been more favourable than in other EU countries (Consequences arising … 1994; Kuorma-autoyhidistelemien … 1993; Harmonization of vehicle … 1994). Theoretical external costs problems of transport regulation changes have for instance been viewed by Verhoef (1994), Friedrich and Bickel (2001), Išoraite (2003). Both, theoretical and practical studies on British experience conducted by McKinnon (see the most comprehensive McKinnon (2005)) are very thorough. As current study focuses on the economic impact of maximum weight regulation change for Estonian forest sector, then we find methodologies in McKinnon (2005) and European Union (2008) studies as most suitable for the current analysis. The summarised calculation mechanism for economic impact measurement from those studies is as follows:

1. Detect the share of weight-constrained loads from total tonne-kms moved.
2. Calculate migration to new weight and dimensions.
3. Take into account tonne-km cost increases or decreases for changed situation.
4. Use elasticity figures to forecast modal shift and change in demand.

In previous list the three first analytical stages view the situation as *ceteris paribus*, not taking into account that cheaper road transport can result in shifts from other transport modes (mainly railway) and greater demand for road transport service because of price decrease. That is why the economic benefit increase or decrease estimation would remain partial without modal shift or demand change calculations.

In McKinnon (2008) several problems have been brought out concerning previous regulation impact assessment, of which very important are questions concerning calculating degree of load consolidation, freight modal split and induced road freight traffic growth. Those questions have also been addressed in current analysis.

3. Analysis of benefits arising from maximum truck weight limit change for Estonian forest sector

The first stage of analysis is to find out the change of transport cost share in roundwood price after increasing maximum truck weight. The analytical procedure had the following steps and also some limitations of analysis have been brought out.

1. Find out vehicle kilometres for weight-constrained loads in case of 44 tonne limit and calculate vehicle kilometres in case of 52 tonne and 60 tonne limit. For those purposes Estonian University of Life Sciences analysis (Kaimre *et al.* 2010) of roundwood consumption, roundwood resources location and roundwood transport routes was used. As the transport routes are dependent on where the lumbering exactly takes place, then on specific year the routes might not perfectly reflect the real situation, but in an average it provides us proper understating of the situation.
2. Find out fuel consumption in case of 44, 52 and 60 tonne weight limits. Using the Estonian Road Administration data and survey conducted among roundwood material transport firms it was figured out that the average empty weight of wood material carrier is 20 tonnes and fuel consumption for abovementioned truck weights are 57.25 litres per 100 km (44 tonnes), 58.96 litres per 100 km (52 tonnes) and 60.73 litres per 100 km (60 tonnes). The fuel consumption figures (3% fuel increase per each additional 8 tonnes of load) are

also supported by the information collected from wood material transporters' round table, where the majority of sector representatives were present, and by the test results made available for authors by one transporter. As fuel price the wholesale price of diesel fuel in Estonia as of 27.06.2010 has been used.

3. Weight limit increase results in changes of driver work hours. The calculations assume 2/3 of work time for driving and 1/3 work time for loading for 44 tonne weight limit. For other weights the driving time decreases, but there are no changes in loading time because of the constant quantity transported. Sector average hourly wage of 8.69 EUR (all taxes included) has been used in calculations.
4. All other costs (except previously mentioned fuel and labour costs) are considered to account for 2/3 of the sum of fuel and labour costs, which is based on the data provided by transport firms. In case of three different weight limits no changes are considered in other costs (e.g. depreciation, maintenance, administration etc costs). Firstly, because of different firm policies, work practices, trucks used etc. it is very difficult to generalise the possible changes in one firm's costs to whole sector. Secondly, transporters admit, that changes in other costs, if they occur at all, would be marginal. Thirdly, there is no clear calculation methodology to find out changes (increase or decrease) of those costs.
5. All calculations are made with total annual quantity of 4.6 million tonnes of roundwood material (scenario 1; 5.75 million m^3) and 6.72 million tonnes of roundwood material (scenario 2; 8.4 million m^3). The forecasted 4.6 million tonnes figure corresponds to year 2009 (but also to year 2005) lumbering amount and 6.72 million tonnes is hypothetical lumbering amount in the future (although it is the same as for year 2000). Table 2 sums kilometres covered by trucks for mentioned two scenarios.

Table 2. Vehicle kilometres for two scenarios taking into account only weight constrained loads

Weight limit	**Annual vehicle kilometres for 4.6 million tonnes roundwood**	**Annual vehicle kilometres for 6.72 million tonnes roundwood**
44 t	33 636 604	49 139 886
52 t	24 666 843	36 035 916
60 t	19 473 823	28 449 408

Source: Composed by authors.

Tables 3 and 4 summarize costs of previously mentioned scenarios. The share of transport costs from roundwood material is the same for both scenarios and it can be seen that weight constraint change has remarkable effect on roundwood transport costs.

Table 3. Costs in case of 4.6 million tonnes roundwood transported and transport cost share in roundwood material price (in thousand EUR)

Variable / Weight limit	44 tonnes	52 tonnes	60 tonnes
Fuel costs	20 363	15 790	13 148
Labour costs	10 867	8 839	7 665
Other cost	20 820	20 820	20 820
Total costs	52 050	45 449	41 633
Transport cost share from roundwood material price	17.7%	15.5%	14.2%

Source: Composed by authors.

Table 4. Costs in case of 6.72 million tonnes roundwood transported and transport cost share in roundwood material price (in thousand EUR)

Variable / Weight limit	44 tonnes	52 tonnes	60 tonnes
Fuel costs	29 749	23 068	19 208
Labour costs	15 875	12 913	11 198
Other costs	30 416	30 416	30 416
Total costs	76 040	66 397	60 822
Transport cost share from roundwood material price	17.7%	15.5%	14.2%

Source: Composed by authors.

4. Forecasting changes in roundwood road transportation demand and modal shifts

4.1 Methodological remarks

The second part of the analysis focuses on determining the possible impact of decreasing transportation costs on roundwood demand and also resulting transportation demand. The total predicted change in demand incorporates domestic consumption (including imports) and export of roundwood, which all are expected to increase due to lower costs of transportation. The quantitative assessment of this impact requires several simplifying assumptions:

1. The price of transportation services is decreasing in the amount of the cost difference resulting from maximum truck weight regulation and this price cut is channelled to roundwood price (i.e. we are excluding cost shifting possibilities).
2. The elasticity of domestic roundwood supply is disregarded, instead the two scenarios of roundwood supply are analysed as described above.
3. For two scenarios, different starting positions in terms of proportions of domestic consumption, import and export demand have to be determined. The market situation in the past (see also Fig.1) has been used for that purpose: for the first scenario, the situation of the year 2005, and for the scenario 2, year 2000 are selected as closest proxies. Respective proportions of imports were 34% and 4%, and export proportions 35% and 50% from the domestic production. The apparent

domestic consumption (production plus imports minus exports) was in 2005 (first scenario) 5.5 million m^3 and in 2000 (second scenario) 4.8 million m^3.

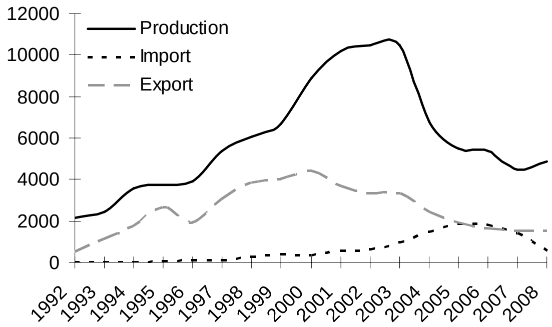

Fig. 1. Production, imports and exports of roundwood in Estonia (in million m^3) (FAO ForesSTAT 2010).

4. Total domestic roundwood transportation is split between two modes (truck and rail), the waterways are excluded, because these are practically not used for domestic roundwood transport, but used only for exports.

For assessing the shifts in roundwood and transportation demand, the mechanism of price elasticity is used that reflects the responsiveness of volumes on the changes in price as follows (Effects of … 2008: 39):

$$q^D_{T,t+1} = q_{T,t} \cdot \left(\frac{p_{T,t+1}}{p_{T,t}}\right)^{\xi_{T/T}} \quad (1)$$

$q^D_{T,t+1}$: quantity after price change;

$q_{T,t}$: initial quantity;

$p_{T,t+1}$: new price;

$p_{T,t}$: initial price;

$\xi_{T/T}$: price elasticity of demand.

As the limitations in data do not allow us to assess demand elasticity directly for Estonia, the elasticity estimates from the literature are used. It is generally found in the literature, that the transportation demand is relatively inelastic to price changes in case of wood products. It is more elastic in cases where different transportation modes are easily substitutable. By reviewing different elasticity estimates (mostly for USA and Canada) Oum *et al*. (1990) show that in case of wood the absolute values of elasticity remain in the range of 0.14−1.55; however taking into consideration methodological and other issues Oum *et al*. (1990) narrow this range down to 0.1−0.6. In the Global Forest Production Model of UN Food and Agriculture Organization (FAO), the Estonian domestic roundwood demand elasticity is set to 0.3 in absolute value and supply elasticity accordingly to 0.8 (Zhu *et al.* 1998). However, in this study we use the elasticity range $\xi_{T/T} \in [-0.3;-1.2]$ taken from a similar study for European countries (Effects of … 2008) probably the closest to Estonian conditions.

Transportation demand is derived from the roundwood demand; however, the specific demand of a transportation mode depends from the relative prices of other modes as well. For assessing this aspect, the cross-price elasticities of road transport demand with other modes are used according to the following formula (Effects of … 2008: 39):

$$q^D_{R,t+1} = q_{R,t} \cdot \left(\frac{p_{T,t+1}}{p_{T,t}}\right)^{\xi_{R/T}} \cdot \left(\frac{p_{R,t+1}}{p_{R,t}}\right)^{\xi_{R/R}} \qquad (2)$$

$q^D_{R,t+1}$: the quantity of rail transportation after price change;

$q_{R,t}$: initial quantity transported via rail;

$p_{T,t+1}$: new price of road transportation;

$p_{T,t}$: initial price of road transportation;

$p_{R,t+1}$: new price of rail transportation;

$p_{R,t}$: initial price of rail transportation;

$\xi_{R/T}$: elasticity of rail transportation to the price of road transportation;

$\xi_{R/R}$: elasticity of rail transportation to the price of rail transportation.

The cross-price elasticities of road and rail transportation are also taken from the literature and they remain in the range of $\xi_{R/T} \in [0.9;3.3]$ (Effects of …, 2008).

As no changes in prices of rail transportation are considered, $\left(\frac{p_{R,t+1}}{p_{R,t}}\right)^{\xi_{R/R}} = 1$.

This assumption means that the rail firms are not responding to the changed conditions in transportation markets. In reality when railway firms adjust their service price, the quantity reduction may be even smaller. In case of roundwood imports to Estonia, the modal shifts concerning waterway (sea) transportation have to be accounted as well, but there the sensitivity to road transportation is even lower and remains in the range of 0.9−0.1 (Effects of … 2008).

In Estonia, most of the roundwood in domestic market is transported via road. The share of rail transportation has been in 2002−2005 around 11%, but in recent years dropped to 6% and this share has been also taken as a basis for forecasts. In case of exports, it is assumed that the transportation regulations and prices are not changed in export markets; therefore export behaves like domestic transportation (the same proportions between rail and road transportation to harbours are taken as basis). In case of imports, the situation is more complicated (see also Fig. 2).

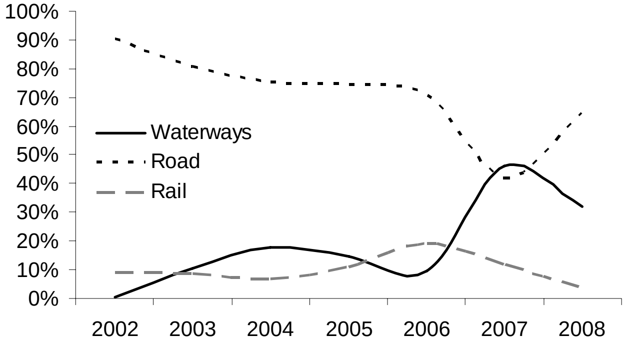

Fig. 2. The shares of road, rail and waterway transportation in Estonian roundwood import (Composed by authors based on Statistics Estonia and FAO ForesSTAT).

In period of 2004−2006, rail and waterways seem to be mutually substitutable; however in 2007−2008 road and waterways have become substitutable modes of transportation for roundwood. The reasons here have been associated with rail transportation failures from Russia in 2007, which also significantly disturbed the road transportation. Rail and road transportation even more lost their positions to waterways. It still seems that the long-term patterns are going to be recovered and therefore the average proportions of the whole period of 2002−2008 are used (road 71%, waterway 19% and rail 10%).

Another difficulty arises in assessing the impact of the regulation, because the 44t assumption may not be realistic. A survey of roundwood transportation firms pointed to the fact that despite of 44t restriction, it is often not followed and significantly larger loads are common (smaller than 44t weights are only occasional). However, reliable statistics about the distribution of weights (and exceeding of weight limits) is missing. The existing sources give biased estimates. For example, sawmills or other firms procuring roundwood have transportation statistics about loads in cubic meters, but the weight of the loads cannot be derived from those data, because it varies across the species and grades of wood, but depends also from other factors like moisture content etc. The authorities responsible for the inspection of truck weights possess statistics of their inspection results; however that data may be biased towards larger loads. Still taking into account the survey results, current situation with average weight of 52t may seem most reliable. Therefore impacts of the regulations 44→52 and 44→60 are largely overestimated in this study. This is also the reason, why the possibility for increasing maximum weight from 52→60 is additionally considered.

4.2. Impact of change in maximum truck weight limits on the roundwood demand

Figure 3 describes changes in transportation quantities with regard to the price of road transportation. The demand is expected to grow in case of 44→52 regulation in the range of 0.7−2.8%; in case of 44→60 in the range of 0.7−4.6% and in most probable case of 52→60 in the range of 0.4−1.7%.

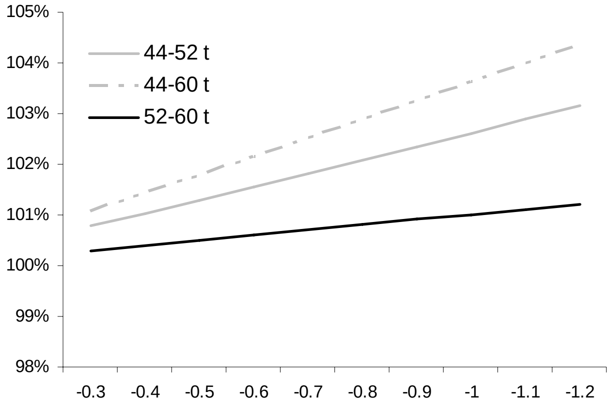

Fig. 3. Impact of own price elasticity on road transportation demand (Ccomposed by authors).

The quantities of estimates are brought out in Tables 5 and 6. Table 5 summarizes the growth for domestically produced roundwood (including both, domestic consumption and export demand) stemming from the lower transportation costs (calculated by the formula (1) in 4.1). Additional demand for truck transportation stemming from the rail transportation being relatively more expensive after the truck regulation change (calculated by using formula (2) in 4.1). Table 6 summarizes the growth of import demand, but in this case the additional demand for truck transportation from see transportation being relatively more costly is considered as well.

Considering the data difficulties with actual loads, the bias in 44→52 estimations may be very large (in case the actual loads are 52t, the bias equals the estimated change in quantity), in case of 44→60 the quantity is also over-estimated, but the magnitude of bias cannot be determined. Therefore the apparent domestic consumption is expected to remain 5.71−5.75 million m^3 or 6.48−6.53 million m^3.

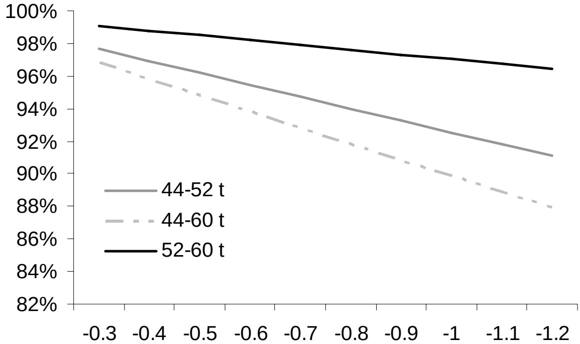

Fig.4. Impact of road transportation through cross-price elasticity on rail transport (Composed by authors).

Considering the impact on rail transportation, the quantity changes across different elasticity values (Fig. 4) remain in most probable situation in the range of 0.2−1.0%. The impact on waterways remains in the range of 0.4−1.7%.

Table 5. Impact of regulation change on domestically produced roundwood and road transportation demand (in m^3)

1. Domestic roundwood production (m^3)		5750000		8400000	
Own price elasticity:		-0.3	-1.2	-0.3	-1.2
2. Demand growth due to the drop in transportation costs	44t→52t	36251	146534	52958	214068
	44t→60t	58864	239506	85993	349886
	52t→60t	21935	88299	32044	128994
Cross price elasticity (road/rail):		0.9	3.6	0.9	3.6
3. Additional demand growth from costlier rail transportation	44t→52t	4028	16282	5884	23785
	44t→60t	6540	26612	9555	38876
	52t→60t	2437	9811	3560	14333
4. Total growth in road transportation (2+3)	44t→52t	40279	162816	58842	237853
	44t→60t	65405	266117	95548	388763
	52t→60t	24372	98110	35605	143326
5. Total demand (1+4)	44t→52t	5790279	5912816	8458842	8637853
	44t→60t	5815405	6016117	8495548	8788763
	52t→60t	5774372	5848110	8435605	8543326
5.1. Incl. export demand	44t→52t	2026598	2069486	4229421	4318927
	44t→60t	2035392	2105641	4247774	4394381
	52t→60t	2021030	2046839	4217802	4271663

Source: Composed by authors.

As can be seen from the tables 5 and 6, the economic impact from the regulation change is not large, because the increase in domestic roundwood consumption remains between 0.3-1.1%, in case of imports, the impact is larger (0.6-2.2%), because of the complementary road transportation arising from other transportation modes.

Table 6. Impact of regulation change on roundwood (road transportation) demand for imports (in m^3)

Import quantity (m^3)		195500		336000	
Own price elasticity:		-0.3	-1.2	-0.3	-1.2
Import demand growth due to the drop of road transportation costs	44t→52t	9723	39304	1671	6755
	44t→60t	15789	64241	2714	11041
	52t→60t	5883	23684	1011	4070
Cross price elasticity (road/rail)		0.9	3.6	0.9	3.6
Additional demand growth from costlier rail transportation	44t→52t	2602	10518	447	1808
	44t→60t	4225	17191	726	2955
	52t→60t	1574	6338	271	1089
Cross price elasticity (road/waterway)		0.09	0.1	0.09	0.1
Additional demand growth from costlier waterways transportation	44t→52t	1369	5536	235	951
	44t→60t	2224	9048	382	1555
	52t→60t	829	3336	142	573
Total growth of road transportation demand in imports	44t→52t	7999	32335	6567	26544
	44t→60t	12989	52851	10663	43386
	52t→60t	4840	19485	3973	15995
Total import demand	44t→52t	1962999	1987335	342567	362544
	44t→60t	1967989	2007851	346663	379386
	52t→60t	1959840	1974485	339973	351995

Source: Composed by authors.

5. Discussion and conclusions

Increase in the maximum truck weight in Estonia is producing economic benefits to the firms of forest sector. Economic benefits were revealed in two broad areas. Firstly, the change in regulation of truck weight limits is causing the reduction of transportation costs for forest sector firms. In case of allowing weight limit of 60 tonnes, the share of transport cost in roundwood material price decreases from 17.7% to 14.2%, creating therefore remarkable saving for the sector. Although it must be noted, that given impact value is valid only in case current regulations are followed. Secondly, the growth of demand for roundwood as the result of decreasing transportation costs was determined. The increase in domestic apparent roundwood consumption remains between 0.3-1.1%, in case of imports, the impact is larger (0.6-2.2%) because of the complementary road transportation arising from other transportation modes. Calculations show, that transportation regulation change would have modest impact on roundwood demand and derived from that transportation demand change.

Although results in current study show, that changing transportation policy to allow heavier loads creates remarkable saving for forest sector and increases demand, still a cost-benefit analysis covering all effects is needed to prove the efficiency of such regulation change. The economic benefits of the reduction of minimum truck weight could be extended to the other industries, which are freight intensive and using heavy trucks as transportation means. In Estonia the best examples are road construction, energy sector, peat industry. In road construction alone the total volume of transported sand and gravel is approximately four times bigger than the volume of wood materials transported annually. Hence the economic impact of the increase in the maximum truck weight covering all sectors could be much more significant. Therefore is necessity to launch this type of analysis in the near future.

Acknowledgements

The study has been prepared with financial support received from Estonian Science Foundation grant 7405, 8311, Estonian Ministry of Education and Research funding SF0180037s08.

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