

Article

The Effect of Forest Certification on Log Sale Prices: A Case Study in Northwestern Turkey

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Abstract: Forest certification is a tool contributing to the achievement of sustainable and responsible forest management. It also presents consumers with a market to purchase products coming from responsibly managed forests and provides forest managers with improved market access for their products. Even if forest certification incurs higher costs that affect the sale price, consumers generally have a greater willingness to pay more for certified products than for uncertified products. The objective of this study is to analyze the changes in the sales prices of oak and beech log in auction sales occurring during certified and uncertified periods at Demirköy Forest Enterprise, which received an FSC Certificate in 2014. For this aim, the Chow test was used and linear regression models were developed. It was found that the log sales prices of certified and uncertified periods are statistically different from each other at $p = 0.05$ significance level. As a consequence, it was determined that there was an increase in price of approximately 12% for oak and 19% for beech at log sales after certification. This study deals with only part of the economic impact of certification. The results can contribute to the forest certification database in order to support the decision-makers (managers and wood manufacturers) in their strategic decisions. The study will enable the forestry sector to see the possible reflections of certification practices in the country and the world markets. The effect of certification should be further investigated by including other factors (supply-demand situation of the forest industry, sales of neighboring enterprises, market conditions, etc.) affecting log sales prices.

Keywords: FSC certification; log sale price; forest enterprise; auction sale; chow test



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1. Introduction

Forest certification emerged as a market-based mechanism to support the sustainable management of forest resources in the 1990s. It was initially used to address concerns about deforestation and forest degradation and promote the maintenance of biological diversity, especially in the tropics. At first, pushed by environmental groups, it quickly evolved as a potential instrument to promote sustainable forest management (SFM). Forest certification shares the aim of promoting SFM with another tool, namely criteria and indicators (C&I) for SFM. C&I sets are mainly developed for the national level to describe and monitor the status and trends in forests and forest management [1].

Forest certification is a system used for the purposes of promoting the sustainable management of forest resources on an international level. This system means a process allowing the assessment and monitoring of all the forest stewardship activities by an independent institution, following the defined criteria and indicators. Thereby, sustainable management of forest resources is ensured, and consumers are guaranteed that the products stem from a forest resource that is managed considering sustainability [2,3].

The basic purposes of forest certification are divided into two groups to improve the social, environmental, and economic quality of forest management, thereby providing a tool to contribute to the achievement of sustainable or responsible forest management, and to allow the market to reliably differentiate and purchase products coming from

responsibly managed forests, and to provide forest managers with improved market access for their products [4,5].

Certificate programs seek to lead consumers' behaviors by way of providing information to support sustainable forest stewardship that is environmentally suitable, socially beneficial, and economically applicable. While environmentally appropriate means practices that ensured the maintenance of the forest's biodiversity, productivity, and ecological processes, socially beneficial means that local people and society as a whole would commit to the long-term management of forests, thus guaranteeing future forest benefits. Lastly, economically viable means that profits would be generated without endangering the forest resource, the ecosystem, or affected communities [6–9].

Forest certification determines whether the forests are managed following certain standards [10]. There are many certification authorities for forestry, and certificates are granted to forests and forest products by these institutions. The main forest certificate programs are the Forest Stewardship Council (FSC), the Programme for Endorsement of Forest Certification (PEFC), and the Sustainable Forestry Initiative (SFI). In 1993, the Forest Stewardship Council (FSC) was officially founded in Toronto, Canada, by the World Wide Fund for Nature (WWF), other environmental NGOs, timber traders, indigenous peoples' groups, forest worker organizations, and other stakeholders to globally support sustainable forest management. The FSC was founded in 1993. The triggering power that made the FSC appear was the failure of the International Tropical Timber Organization (ITTO) and the Tropical Forestry Action Plan (TFAP) in stopping deforestation and ensuring a solid approach to sustainable forest management [6–9].

FSC provides a certification system applicable to all forest systems on an international level. FSC tries to get forest stewardship into good positions all around the world and creates an environment for forest owners and stewardship for them to follow the best social and environmental practices through certification. There are approximately 193.9 million hectares of FSC-certified forest area in the world. European forests constitute 35% of this area [9]. PEFC is a leading global alliance of national forest certification systems. As an international non-profit, non-governmental organization, it took on the task of promoting sustainable forest management through independent third-party certification [11]. Today, 440.3 million hectares of forest land worldwide have been certified by FSC and PEFC. This number represents 10.7% of the total global forest area of 4.03 billion hectares [12]. In the world, three-quarters (75%) of all certified forests are certified to PEFC, according to an estimation based on the latest PEFC and FSC figures [11].

It would be wrong to evaluate certification studies only with a sustainable forest management certificate. In this context, the Chain of Custody (CoC) certification is important in order to ensure that there is no break in the steps in the production chain of the certified products, which are to be produced only with raw materials obtained from certified forests. In fact, when the emergence of certification is examined, it is seen that it started with the idea of not using products produced with illegal wood. Although certification is not obligatory today, the fact that organizations that process or market forest products in developed countries do not want to buy uncertified products makes certification in forests obligatory. The CoC is a channel through which products are distributed from their origin in the forest to their end-use [9].

Forest certification aims to implement standards for the sustainable management of forests and communicate them to the outside world. It is a tool that structures market interactions. A market mechanism is mainly based on market access, price premiums, and reputation. Price premiums may result from increasing consumer demand, which is willing to pay more for sustainable products [13]. Consumers have a willingness to pay more for certified products than for uncertified products.

Some studies [14,15] mentioned the market benefits of forest certification, such as potential access to new markets, improvement of public image, price premium, and research in a dynamically changing industry. In addition, they demonstrated there are non-market benefits of certification, such as an improvement in social and ecological responsibility.

Carrera et al. [16] determined the social, economic, and environmental effects of forest certification in the Petén region of Guatemala. They found that access to certified product markets was easier for some certified enterprises, which had a positive effect. Increased costs of forestry operations were assessed as a negative effect. Ahas et al. [17] researched the effects of forest certification in Estonia. They determined that the general price of roundwood had increased due to a shortage of raw materials. Hence, rising prices are not a result of certification.

Cashore et al. [18] determined the microeconomic and macroeconomic effects of forest certification. They underlined that market access and price premiums are the two most important microeconomic effects of certification. They found that price premiums appear available to most producers in the Asia-Pacific region, ranging from a 15% price premium reported in Indonesia to a 37% increase in Malaysia. In addition, the most explicit negative effect of certification is increased costs. From the macroeconomic side, they emphasized that improvements are noted in taxation collection, market transparency, employment and wages, and investment. Paletto and Notaro [19] determined the secondary wood manufacturers' attitudes, awareness, and willingness to pay for certified and local wood materials in Italy. They calculated that 29.7% of the wood manufacturers would be willing to pay a mean premium price of 2.40% for certified wooden planks, while 19.0% of them would be willing to pay a premium of 2.68% for certified wooden panels.

In Turkey, regarding certification, mostly the compatibility of forest stewardship with certification, criteria, and indicators, and the awareness of managers and consumers Koçak et al. [20] and Akyol and Yıldız [21] were researched. In the studies related to certification in the literature, although the effects of obtained certificates were researched, no clarification was made on their effect on log sales and prices. Durusoy and Özdemir [22] researched the price premiums in certified forests in the Bolu Forest Regional Directorate. They found that scots pine sawlog received a price premium of 1.74%, while black pine pulpwood and scots pine pulpwood fetched price premiums of 1.9% and 2.2%, respectively. However, no research could be found on the effect of the certification on log sale prices using the Chow test in Turkey.

On the other hand, there are several studies that used the Chow test to analyze the timber market in some countries. These studies especially were done to search structural changes in timber markets. For example, Toppinen and Kuuluvainen [23] investigated, using the Chow test, the effects of structural changes in sawlog and pulpwood markets on the success of short-term market modeling in Finland. Pulpwood prices were found to be directly proportional to sawlog prices during the study period, and the cross-price effects were not statistically significant. The results indicated that the price sensitivity of wood supply in Finland increased during the 1980s and early 1990s. Zakaria et al. [24] examined by Chow test the structural change of the exchange rate regime and wood export in the Malaysian wood industry, which has been a major wood producer and exporter since the 1970s. The results presented show that there is a structural break from the third quarter of 2005 to the fourth quarter of 2008, during which the real exchange rate is significant and positively correlated to timber exports under a managed floating exchange rate regime. On the other hand, Chen et al. [25] determined that forest certification has asymmetric trade effects. They found that the export competitive effect of forest certification in developing countries is greater than that in developed countries.

Forest certification studies in Turkey started with the selection of Bolu Aladağ Forest Sub-district as a pilot area in 2010 by the General Directorate of Forestry (GDF). FSC Forest Stewardship Certificate has been preferred by GDF due to the lack of a national certificate system for PEFC in Turkey and more demand for FSC-certificated raw materials in European countries and Turkey [20]. During the inspections for FSC, the inspections are performed in line with 10 principles, 56 criteria, and more than 200 indicators [26]. According to 2023 figures, GDF has certified approximately 6.6 million hectares of forested area in 67 forest enterprises and 1 forest sub-district under 11 of the 30 forest regional directorates in Turkey [9]. Since Turkey has 22.9 million hectares of forest area, it can be

said that the ratio of certified forests to the total forest area has reached 34% in Turkey. The certified forest areas in Turkey constitute 8% of the certified European forests.

The main hypothesis of the study is to reveal whether the FSC certification affects the sale prices of logs. Therefore, it is aimed to obtain and compare regression models that predict log sales price for pre-FSC, post-FSC, and all periods.

2. Materials and Methods

2.1. Study Area

The research area of the study is Demirköy Forest Enterprise, which is located in the most mountainous and hilly part of the Thrace Region and reaches its highest point with Mahyadağ Hill (1031 m), which is the highest place in Thrace. Demirköy District is located in (27°46'24" east longitude, 41°49'26" north latitude, and Y-564277, X-4630647 coordinates) the Western Black Sea Climate region and has the characteristics of this climate. While the average annual temperature is 13.9 °C, the average annual rainfall is 89.3 mm in Demirköy District [27]. Winters are mild and summers are cool. The hottest months are July–August, and the coldest months are December–January. Demirköy Forest Enterprise was established in Demirköy District within the borders of Kırklareli Province. Demirköy is bordered by Bulgaria in the north and the Black Sea in the east (Figure 1).

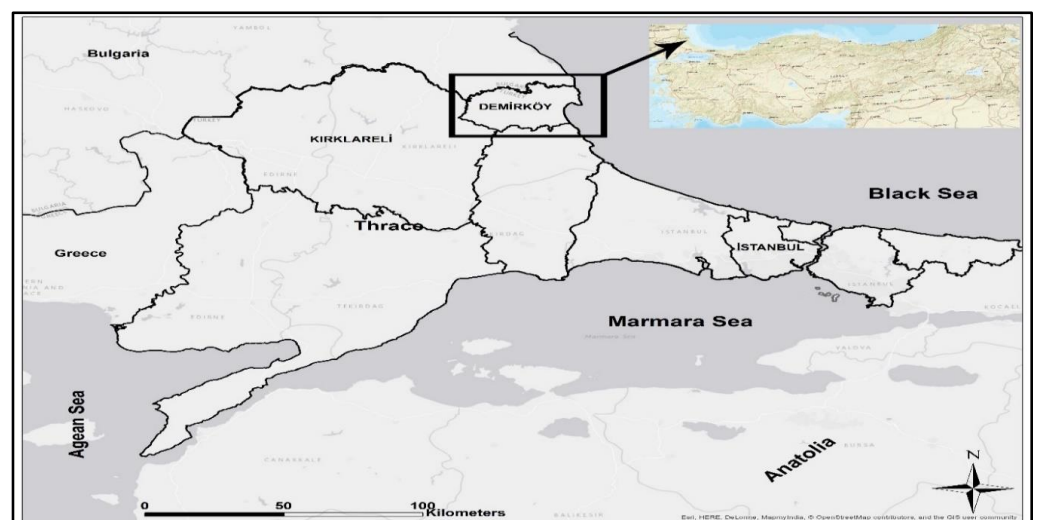


Figure 1. The location of the study area.

The reason for choosing this enterprise is that there is the most production and sales in terms of oak and beech species. Demirköy Forest Enterprise is a unit FSC-certified in the Istanbul Forest Regional Directorate. While the total area of Demirköy Forest Enterprise is 81,329.80 ha, 73,253.49 ha (90%) of this area is forest area [28].

2.2. Data

Forest Enterprise organizes official tenders for each auction and records them. The records of these sales have been the data source for the research. In this context, the main material of the research is the factsheets of the auction results. In some of the cases where there was missing information (length, number, etc.), pre-auction factsheets that are published before the auction tenders, were also used.

Demirköy Forest Enterprise was visited between September 10 and 12, 2018 to collect data. The enterprise received an FSC certificate in 2014. Therefore, the study considers the period covering 2010–2013 as the pre-certificate period and 2014–2017 as the post-certificate period.

Within the scope of the research, 3rd class-normal length-thick diameter-log (3CNLT-Doak and 3CNLTDbeech) sales of the most commonly sold oak and beech types in Demirköy Forest Enterprise have been taken into account.

In cases, where no buyer could be found at the auctions for the log batch, the factsheet of the result of the sale is indicated as “under negotiation” in the column related to the buyer. This information has been used especially for the calculation of the supply–demand levels. The data relating to the levels of supply and demand have been calculated separately for each tree species, considering the sale amount that has been put on the market, sold, and left for negotiation. To this end, the sold amount of products represents the level of demand, whereas the total of the products that have been sold and left for negotiation represents the supply level (Equation (1)).

$$\text{Supply level} = \text{demand level (sold amount)} + \text{amount left for negotiation (unsold)} \quad (1)$$

The effect of months has been determined using the effect of months on the log sale prices (SP); monthly index values (MI) of log sale prices on the basis of the monthly mean; and the effect of months (EM) formulas (Equations (2) and (3)), utilized by Daşdemir (2008).

$$\text{MI} = (\text{SP of each month} / \text{SP mean of months}) \times 100 \quad (2)$$

$$\text{EM} = \text{MI of each month} - 100 \quad (3)$$

The effect of seasons, which is one of the variables affecting the sale prices, has been determined using the seasonal index values. As stated by Daşdemir [29], the effect of seasons on the sale prices has been calculated with Equations (4) and (5), that is, the index value of each season (SI) and the effect of season (ES) on the basis of the ten-year average of sale prices of logs in each enterprise.

$$\text{SI} = (\text{SP of each season} / \text{SP mean of seasons}) \times 100 \quad (4)$$

$$\text{ES} = \text{SI of each month} - 100 \quad (5)$$

2.3. Data Analyses

In this study, the Chow test was used to determine whether there is a difference between the periods regarding the log sale prices. The Chow test is one of the methods used to test the existence of a structural change in econometrics. In econometrics, if the coefficients of a model change in time, rather than remaining stable, it is called structural change. The Chow test measures whether there is a structural change in the data of a specific period after some time when applied to the time-relevant data [30].

This research assumes the existence of a structural change experienced through the grant of the certificate. The Chow test is actually related to the F test and addresses the harmonious relation between the data of two periods. In other words, it is researched whether the relation between the dependent and independent variables of the data from both periods is the same in both periods. Through the Chow test, the equality of regression equations for different periods with the same variables is compared. When the compliance between the parameters in both periods is the same, the values in these two periods are handled in a single regression equation. If the compliance between the parameters in both periods is not the same, then it is retrieved that the demonstration of the values of these two periods is not meaningful, i.e., that a structural change is experienced between the periods [31]. Toyoda [32] stated that the Chow test depended on two conditions. The first of these is the statistical significance of F values, and the second one is the sufficient sampling size of at least one of the two examined periods. The Chow test gives significant results even under heteroscedasticity (constant variance) conditions, as long as at least one of the sampling sizes is large.

For this purpose, firstly, stepwise regression analysis was carried out for determining the significant independent variables with real sale price for the whole period. Length

of log, number of logs in the sale party, sale amount, supply level, demand level, real estimated price, effect of months, and effect of seasons were used as independent variables in the model (Equation (6)).

$$\text{Real sale price of log} = a_0 + a_1 \text{length} + a_2 \text{number} + a_3 \text{sale amount} + a_4 \text{supply level} + a_5 \text{demand level} + a_6 \text{real estimated price} + a_7 \text{effect of months} + a_8 \text{effect of seasons} + e \quad (6)$$

Data related to the independent variables in the model established for log sales in Demirköy Forest Enterprise was obtained from the factsheets of sales, and estimated prices and tender prices were refined off inflation and then analyzed as real estimated prices and real tender prices as increased to the prices of 2017. The data related to supply and demand levels were calculated considering the sale amount presented to the market, sold, and left for negotiation. Supply and demand levels were calculated based on this data.

It was observed that Demirköy Forest Enterprise had a total of 1164 3CNLTDoak log auction sales in the pre-FSC period, whereas it had 836 in the post-FSC period and a total of 2000 sales. It was seen that there were 454 batches left for negotiation in the pre-FSC period and 201 batches in the post-FSC period.

In relation to beech log, it was observed that Demirköy Forest Enterprise had a total of 1708 3CNLTDbeech log auction sales in the pre-FSC period, whereas it had 1018 in the post-FSC period and a total of 2726 sales. It was seen that there were 339 batches left for negotiation in the pre-FSC period and 204 batches in the post-FSC period.

As a result of the stepwise regression analysis, the linear regression model that includes the statistically significant independent variables and the real sale price was obtained for the whole period. After that, linear regression analyses were applied using these significant independent variables for the pre-FSC and post-FSC periods. Thus, the linear regression models were developed for the whole period, pre-FSC and post-FSC periods, separately.

Some stages are followed to determine whether there is a difference between the periods via the Chow test. First of all, the H_0 hypothesis (null hypothesis) is established and the regression equation is formulated as in Equation (6). The main hypotheses of the study are as follows:

H_0 : *There is no difference between the sale prices of logs in pre-and post-certification periods in forest enterprises in Turkey.*

H_1 : *There is a difference between the sale prices of logs in pre-and post-certification periods in forest enterprises in Turkey.*

Equation (6) is formulated separately for all periods, and they are solved separately, by which the sums of squared errors of the whole and two separate periods are calculated ($\Sigma e^2_{\text{whole period}}$; $\Sigma e^2_{\text{first period}}$; $\Sigma e^2_{\text{second period}}$). After that, using Equation (7), the F statistics are calculated, and the result obtained is compared with the critical value (F_{table}) at a certain significance level. Here, the meanings of the terms are as follows: k: number of parameters in the model, $(n - 2k)$: sample size in the first period (number of observations) + sample size in the second period $- 2 \times$ number of parameters. Then, calculated F values according to Equation (7) ($F_{\text{calculation}}$) are compared to F_{table} values with a certain level of significance (0.05), and for those cases, where $F_{\text{calculation}} > F_{\text{table}}$ is obtained, there is a difference between two periods, and the H_0 hypothesis is rejected [31–34].

$$F_{\text{calculation}} = \frac{[\Sigma e^2_{\text{whole period}} - (\Sigma e^2_{\text{first period}} + \Sigma e^2_{\text{second period}})] / k}{(\Sigma e^2_{\text{first period}} + \Sigma e^2_{\text{second period}}) / (n - 2k)} \quad (7)$$

For the tree species under the scope of the H_0 hypothesis, it can be acknowledged as a common hypothesis. During the application of the research, it was established that H_0 : *x forest enterprise's obtaining a certificate does not have any effect on the sale prices of product y* and separate hypotheses were set and tested for each species. Data analyses were conducted in IBM SPSS 21.0 statistical software.

3. Results

The annual log production between 2010 and 2017 of the Demirköy Forest Enterprise is presented in Figure 2. The average annual production (period 2010–2017) of the enterprise is 28,754.875 m³. According to Figure 2, it can be observed that the amount of log production follows a fluctuating course in the examined period.

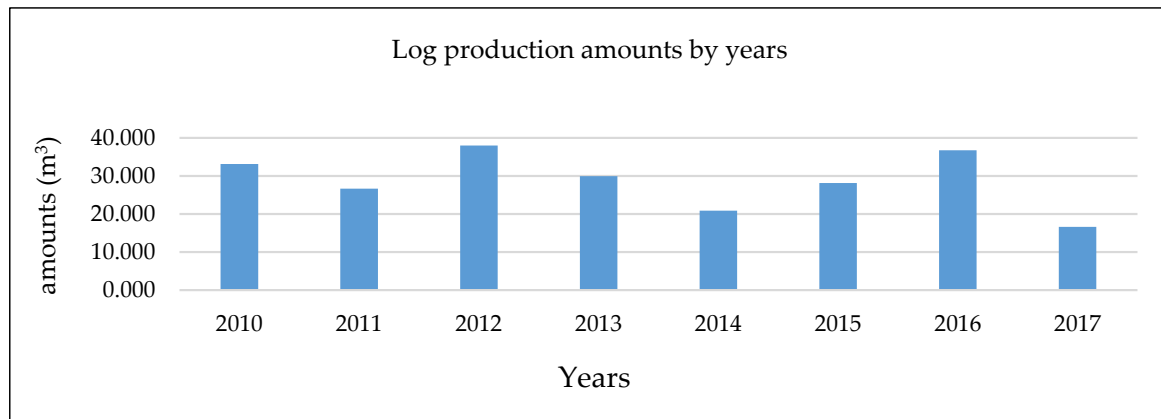


Figure 2. The annual log production amounts of Demirköy Forest Enterprise (2010–2017).

The amounts of log sales are presented in Figure 3. As can be seen in Figure 3, log sales in the period of 2010–2017 followed a fluctuating course in line with the amounts of production at Demirköy Forest Enterprise. Sale amounts have decreased significantly, except in 2012. The reason for these fluctuations in sales is that the effect of the global economic recession was felt in Turkey as well from 2013–2015. The forest products industry in Turkey was affected by this recession, which reduced production. The decrease in production was also reflected in sales.

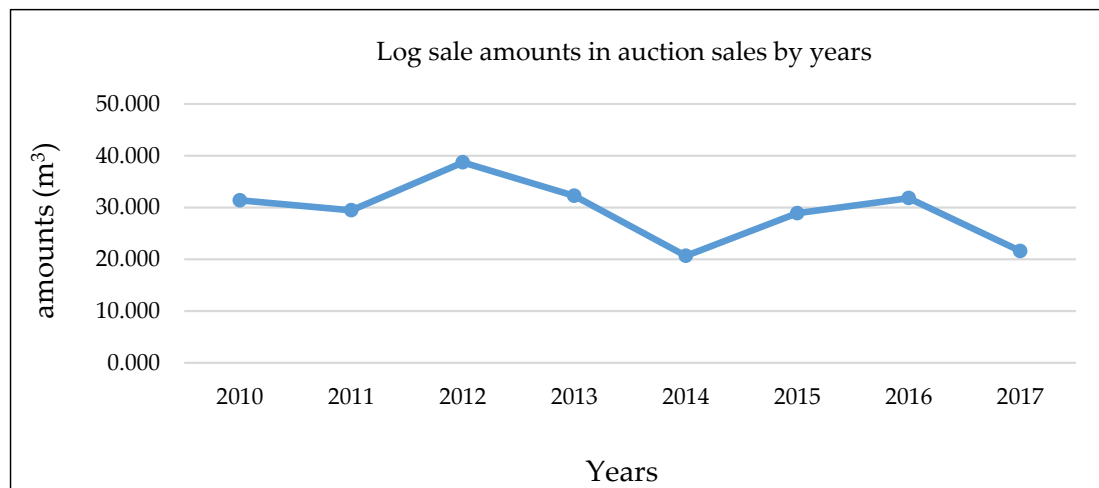


Figure 3. The log sale amounts in auction sales of Demirköy Forest Enterprise (2010–2017).

The effect of months on the log sale prices has been determined using Equations (2) and (3). Effect of season that is deemed effective on sale prices has been calculated using Equations (4) and (5). Mean real tender prices for months and seasons have been used in the analyses of the effects of months and seasons. For oak log, the monthly real tender price was USD 76.64 (1 USD (United States Dollar) equals TRY 3.78 (Turkish Lira) with real prices of December 2017) in the pre-FSC period, whereas for the post-FSC months, the mean tender price was calculated as USD 92.17. Furthermore, the mean real tender price for seasons before FSC was USD 75.44 and USD 83.26 for the post-FSC period. For beech log, the

monthly tender price was USD 82.19 in the pre-FSC period, whereas for the post-FSC months, the mean tender price was calculated as USD 91.54. Furthermore, the mean real tender price for seasons before FSC was USD 81.45 and USD 90.96 for the post-FSC period.

$MI > 0$ creates a positive effect on the sale prices of oak log and the highest value of EM is in the months with the highest positive effect on sale price. Accordingly, the months of March before FSC and January after FSC are the months with the highest positive effect on the prices. $EM < 0$ means there is a negative effect on prices. The smallest value of EM is in the month with the most negative effect on the sale price. In light of this, the months of July before FSC and October after FSC are the months with the most negative effect (Figure 4).

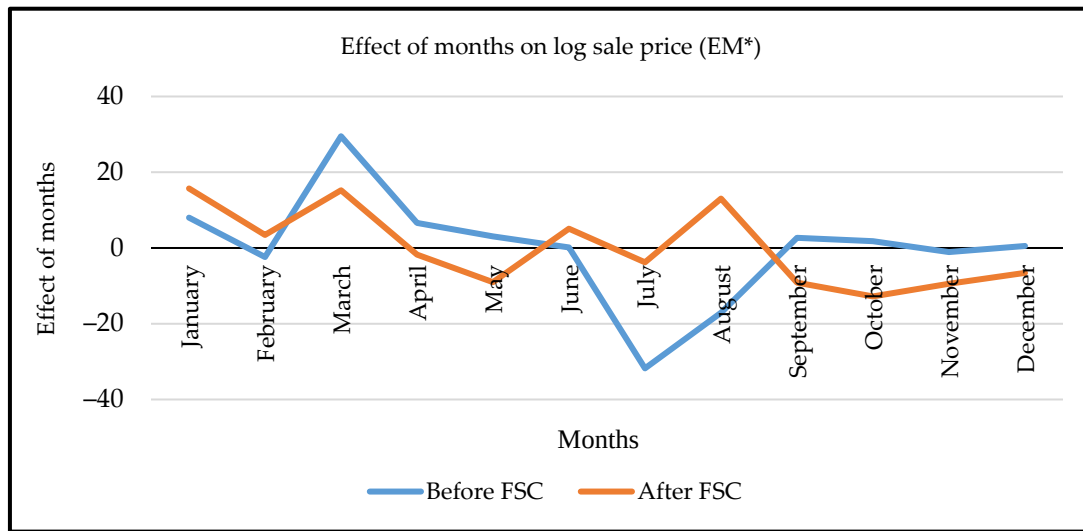


Figure 4. Effect of months on the sale price of oak log.

$EM > 0$ creates a positive effect on the beech sale prices, and the highest value of EM is in the month with the highest positive effect on sale prices. Accordingly, the month of March in the pre-FSC period and February in the post-FSC period are the months with the biggest positive effect on the price. $EM < 0$ means there is a negative effect on prices. The smallest value of MI is in the month with the most negative effect on the sale price. Accordingly, the months of August in the pre-FSC period and October in the post-FSC period are the months with the most negative effect (Figure 5).

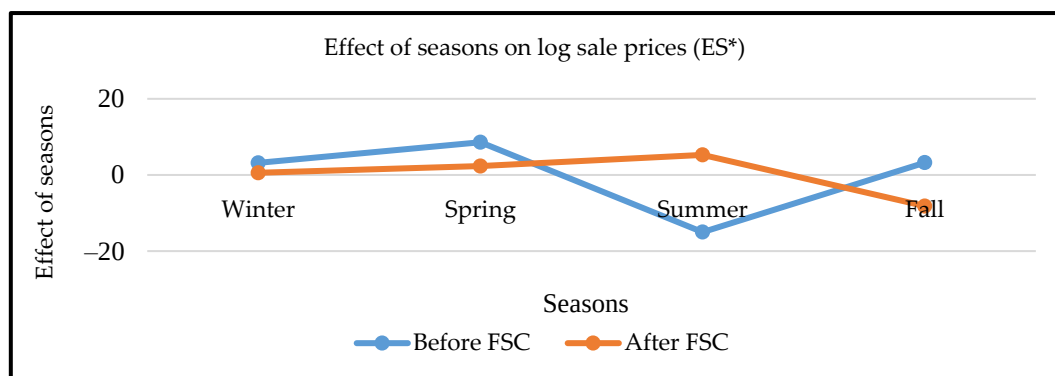


Figure 5. Effect of seasons on the sale price of oak log.

Similarly, seasons of $SI > 0$ creates a positive effect on the sale prices of logs and the highest value of ES is at the season with the highest positive effect on the sale price. Accordingly, the seasons of spring before FSC and summer after FSC are the seasons with the highest positive effect on prices. $ES < 0$ means there is a negative effect on the sale

prices of oak log. The smallest value of ES is in the season with the most negative effect on the sale price. In light of this, the summer season before FSC and the fall season after FSC are the seasons with the most negative effect (Figure 6).

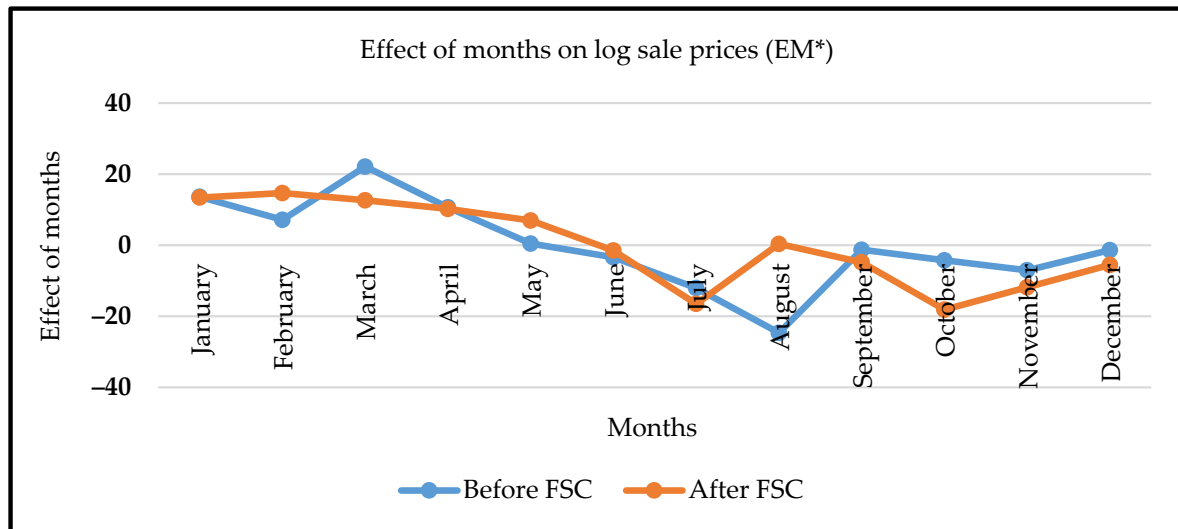


Figure 6. Effect of months on the sale price of beech log.

For beech log, $SI < 0$ means a negative effect on the sale prices. The smallest value of SI occurs in the season with the most negative effect on sale prices. In light of this, the summer season before FSC and the fall season after FSC are the seasons with the most negative effect (Figure 7).

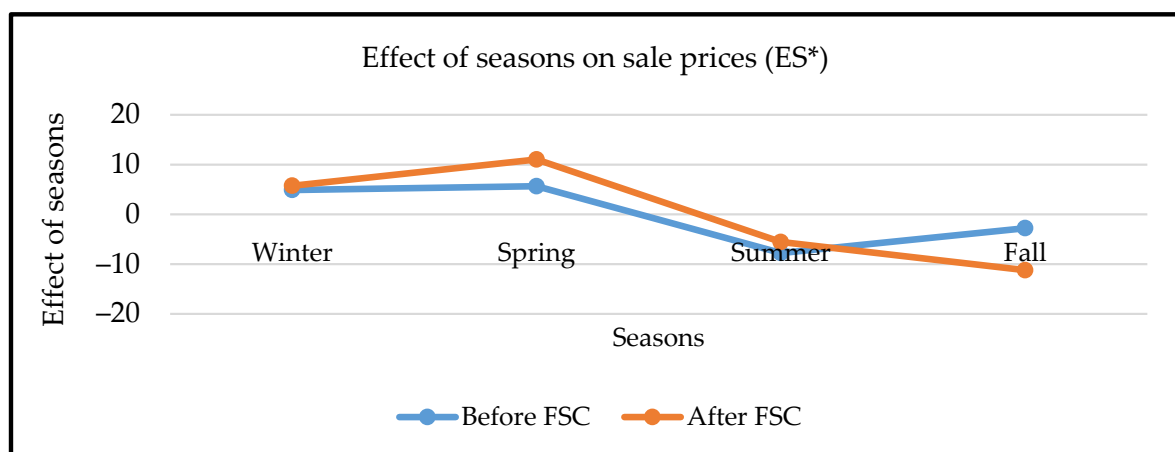


Figure 7. Effect of seasons on the sale price of beech log.

Related to oak log, the correlation analysis of the variables revealed a positive correlation at the 99% confidence level by 82% in real tender price and real estimated price; by 24% in length; and by 19% in effect of season; and a negative correlation by 24% in numbers; by 14% in demand level; and 12% in supply level. For beech log, the correlation analysis regarding the variables revealed that at a 99% confidence level, real tender price and real estimated price indicated a positive correlation by 83%; length by 29%; effect of season by 33%; and a negative correlation in number by 39%; demand level by 4%; supply level by 9%; sales amount by 8% (Table 1).

Table 1. Pearson’s correlation coefficients and significance levels between real sale prices of the logs and various variables.

VARIABLES	Oak	Beech
LENGTH (length of log)	0.235 **	0.288 **
NUMBER (number of log in sale part)	−0.248 **	−0.386 **
SA (sale amount)	0.000 ^{NS}	−0.076 **
REP (real estimated price)	0.819 **	0.832 **
SUPPLY (supply level)	−0.124 **	−0.094 **
DEMAND (demand level)	−0.141 **	−0.042 *
EM (effect of months)	0.301 **	0.420 **
ES (effect of seasons)	0.193 **	0.330 **

^{NS} non-significant; * correlation is significant at the 0.05 level; ** correlation is significant at the 0.01 level.

The mean data on the independent variables by period are presented in Table 2. It can be observed that the sale prices for every log type increase during the certification period. The selling price of the oak log was USD 76.70 before FSC and USD 91.49 after FSC. Likewise, the selling price of beech log has increased by approximately 12% in the post-FSC period.

Table 2. The mean values for log sale price and independent variables affecting sales price in all periods.

Variables	Pre-FSC		Post-FSC		The Whole Period	
	Oak	Beech	Oak	Beech	Oak	Beech
Mean length of log (m)	3.46	3.56	3.44	3.50	3.45	3.54
Mean number of log	87	79	102	87	93	82
Mean sale amount (m ³)	21.84	27.32	24.27	28.65	22.85	27.82
Mean supply level (m ³)	659.22	1109.26	575.19	863.60	624.10	1017.52
Mean demand level (m ³)	571.23	985.26	519.88	800.02	549.77	916.09
Mean effect of months (%)	0.08	0.08	−0.73	0.91	−0.26	0.39
Mean effect of seasons (%)	1.66	0.99	1.2	1.56	1.47	1.21
Mean real estimated price (USD)	68.69	74.88	81.39	82.75	74.00	77.82
Mean real sales price (USD)	76.70	82.26	91.49	92.38	82.88	86.04

Pre-FSC: before certification; post-FSC: after certification; the whole period: the sum of before certification period and after certification period.

As a requirement of the Chow test, in order to determine whether there is a difference between the periods defined as pre- and post-FSC periods in terms of real sale price, separate regression equations were established primarily for certified, uncertified, and the whole period. To this end, taking the real sale price of oak log as a dependent variable and length, number, sales amount, supply level, demand level, effect of months, effect of seasons, and real estimated price as independent variables, regression analysis was conducted using the stepwise regression technique. The result of the analysis revealed that all the variables, except for the effect of season, were statistically significant on the real sale price of oak log and beech log.

Regression analyses were also conducted for pre-FSC and post-FSC periods using the significant variables for the whole period, and the general regression analysis results are presented in Table 3 as a whole.

Table 3. Regression analysis results of all periods for the logs separately.

Log	Period *	Number of Data(n)	SSE **(e ²)	R ²	F	Importance Level
OAK	Whole period	2000	1,553,830.953	0.713	707.687	$p < 0.001$
	Pre-FSC	1164	838,319.5259	0.690	367.518	$p < 0.001$
	Post-FSC	836	685,914.4011	0.703	280.351	$p < 0.001$
BEECH	Whole period	2726	942,907.6593	0.753	1184.295	$p < 0.001$
	Pre-FSC	1708	473,239.5526	0.765	790.217	$p < 0.001$
	Post-FSC	1018	453,414.4664	0.709	351.831	$p < 0.001$

*: Pre-FSC: before certification; post-FSC: after certification; the whole period: the sum of before certification period and after certification period; ** sum of squares error.

Regression models are statistically significant ($p < 0.001$), and the variation in the real sale price of oak log has been indicated as 71.3% for the whole period, 69% for the pre-FSC period, and 70.3% for the post-FSC period. Afterwards, in order to determine whether there is a difference between the pre- and post-FSC periods in terms of real sale price (Equation (7)), the F statistics of the Chow test were used.

k: number of variables in the model 8; ($n - 2 \times k$); (number of data for the whole period $- 2 \times k$); $2000 - 2 \times 8 = 1984$ and $F_{\text{calculation}}$ has been calculated as 4.82 using Equation (7), with the sum of square errors of all the periods provided in Table 3.

$$F_{\text{calculation}} = \frac{[1,553,830.953 - (838,319.5259 + 685,914.4011)]/8}{(838,319.5259 + 685,914.4011)/(2000 - 2 \times 8)} = 4.82$$

Calculated F value was compared with the F_{table} value calculated with $F_{0.05;8;1984}$

$$F_{\text{calculation}} (4.82) > F_{\text{table}} (1.94)$$

As the $F_{\text{calculation}}$ value was revealed to be bigger than the F_{table} value, it was observed that the oak log sale prices in Demirköy Forest Enterprise are different in the two periods defined as pre-FSC and post-FSC.

Regression models are statistically significant ($p < 0.001$), and the variation in the real sale price of beech log has been indicated as 75.3% for the whole period, 76.5% for the pre-FSC period, and 70.9% for the post-FSC period. Afterwards, in order to determine whether there is a difference between the pre- and post-FSC periods in terms of real sale price (Equation (7)), the F statistics of the Chow test were used.

k; number of variables in the model: 8; ($n - 2 \times k$); (number of data for the whole period $- 2 \times k$); $2726 - 2 \times 8 = 2710$ and $F_{\text{calculation}}$ has been calculated as 5.94 using Equation (7) with the sum of square errors of all the periods provided in Table 3.

$$F_{\text{calculation}} = \frac{[942,907.6593 - (473,239.5526 + 453,414.4664)]/8}{(473,239.5526 + 453,414.4664)/(2726 - 2 \times 8)} = 5.94$$

Calculated F value was compared with the F_{table} value calculated with $F_{0.05;8;2710}$.

$$F_{\text{calculation}} (5.94) > F_{\text{table}} (1.94)$$

As the $F_{\text{calculation}}$ value was revealed to be bigger than the F_{table} value, it was observed that the beech log sale prices in Demirköy Forest Enterprise are different in the two periods defined as pre-FSC and post-FSC.

To sum up, the real sale prices of both trees under the effect of the independent variables have been found to be statistically different at a significance level of $p = 0.05$ as the result of the Chow test. Table 4 represents the percentage of change in the sale prices of logs for each tree species in the certified period; thus, how the certification affected the sale price.

Table 4. Increase rates in the sale prices of logs and Chow test results.

Tree Species	Mean Real Sale Price (USD/m ³)			F _{calculation}	F _{table}	Importance Level
	Pre-FSC	Post-FSC	Price Increase Rate (%)			
Oak	76.70	91.49	19.28	4.82	1.94	$p < 0.05$
Beech	82.26	92.38	12.30	5.94	1.94	$p < 0.05$

Considering the values in Table 4, there is a significant and important difference in terms of mean real sale prices. As an example, an increase of USD 14.79 after the certification in oak log means an increased rate of 19.28% in the sale price. However, it should be taken into account that this increase might have also been affected by other variables that have not been analyzed, other than certification.

4. Discussion

Forest certification has positive effects on forest management practices and encourages sustainable forestry. It also helps prevent the reduction of natural forests by protecting forests. In this way, sustainable forestry is achieved. From an economic standpoint, customers are willing to pay more for certified products than for uncertified products. The existence of a price increase is also important for sustainable forest management.

Forest management certification has many ecological and economic aspects, such as better protection of forest resources in forestry activities, increasing environmental awareness, ensuring worker health and safety, standardization in production works, positive developments in production and marketing, providing jobs and income to local people, and training business employees. This situation has been demonstrated by various studies [20–35]. Among these, there are some studies using the Chow test for logging markets in the international literature. However, no study was found for the purpose of this study using the Chow test. In the study of Daşdemir [29], the factors affecting the sale price of third-class normal-length beech logs were defined. Accordingly, it was observed that the effect of season was effective on the sale price and that the most positive effect was experienced in the spring, whereas the most negative effect was in the winter. In addition, time of tender, supply level, size of the batch, demand level, production quality, and compliance with the standardization have been defined as the most important factors affecting the price of logs.

Several studies revealed that the most important variables affecting the prices in the auction sales of logs were demand level, tender time, supply level, size of the sales batch, quality of production, compliance with standardization, and other factors [36,37]. Therefore, for this study on Demirköy Forest Enterprise, regression models were created, taking the length, number of logs in a batch, size of batch, demand level, supply level, monthly effect, and seasonal effect variables as independent variables affecting the real sale price.

In the present study, the differences observed as a result of the Chow test in the log sale prices of the tree species in the periods with and without certification may be caused by certification as well as other variables. In the regression models established to compare the real sales prices before and after the FSC, the variables such as length, number, sales amount, supply and demand level, real estimated value, and the effect of months and seasons all affect the real sales price. Apart from these variables used in the study, other variables (supply–demand situation of the forest industry, sales of neighboring enterprises, market conditions, etc.) may lead to price differences between the periods. Therefore, this situation is the most important methodological weakness of the study.

As for the strengths of the study from a methodological point of view, the enterprise chosen as the study area is an enterprise that produces and sells a lot of logs. In this way, it was studied with a lot of data on log sales. This situation suggests that comparisons can yield reliable results. In addition, in the study conducted with different species at different times (month, season, year), data on the measured variables were easily reached.

In the study of Koçak et al. [20], two types of data collection tools were used to research the contributions of forest stewardship certification in Turkey. One of them was obtained from the surveys conducted with the resource managers, and the other was from the studies performed on the subject. As a result of the study, it was revealed that in the forest enterprises with an FSC certificate in Turkey, the forest stewardship certification had a positive contribution in the fields of labor safety, employee health, and environmental sensitivity but had no effect on the manufacture, demand, and sale prices of the products. However, this result was obtained with the qualitative data resulting from the surveys. In the present study, the effect of certification on the sale prices of logs has been obtained through the analysis of quantitative data based completely on the log sale prices. Furthermore, the contribution of certification to labor safety and environmental sensitivity has not been examined, and merely its effect on the prices of products has been addressed.

Forsyth et al. [38] determined the important factors considered by consumers in British Columbia when purchasing wood products are quality and price. The study results revealed that environmental attributes, including certification, are less important in their decision making. Similarly, Bigsby and Ozanne [39] researched the most important attribute when purchasing certified wood products for New Zealand consumers. The results indicated that the most important attribute for them was the origin of the wood. The next most important attributes were found to be the type of forest from which the wood is sourced (plantation forest rather than natural forest), whether the wood was environmentally certified or not, and the length of the warranty. Price was found to be the least important attribute. In the present study, the consumers' attitudes toward certificated wood products were not determined. We also studied log prices, not wood products prices.

In the study of Gan [40], it was stated that the certification increased the costs of forest products by 5%–25% and might have big effects on trade and price. However, in the present study, the direct effects on the costs have not been examined, as was done in [40], but instead, the effect of the estimated price on the price has been analyzed by keeping the costs within the scope of the estimated price.

Nebel et al. [41] obtained the result in the study of the development and importance of forest certification in Bolivia that there was a price increase of 5%–51% in the certified log export. Yet this study has determined that there is a price increase in the sales of oak and beech logs of 0.5% and 19%, respectively, after the certification and a mean increase of 8.5%. The value in this study for Demirköy Forest Enterprise can be observed to be within the range defined in [41].

Aguilar and Vlosky [42] examined the potential willingness of supply chain participants to pay a premium for certified products or raw materials. The study stated the willingness to pay for four wood products from the perspective of U.S. consumers. According to the analysis of marginal effects, it was suggested that consumers' willingness to pay a 10% premium for three of the four certified tropical wood products. The potential willingness of consumers to pay for certified wood products in our case was not researched.

Kollert and Lagan [43] determined the effect of forest certification on log prices. For this aim, they examined the time series of prices of certified and uncertified logs (from 2000 to 2004) provided by three forest management units from Sabah, Malaysia. According to the results of a comparative analysis (ANOVA), forest certification achieves a market premium for certified logs. In particular, while high-quality hardwoods fetch a price premium of 27% to 56%, lower-quality timbers also fetch a price premium of 2% to 30%. In the present study, it was not handled tropical logs, but it was found that the log prices increased between 12% and 19% after FSC.

Yamamoto et al. [44] investigated the impact of forest certification on log prices by using real auction market data in a Japanese market. The results revealed that certification had a positive and statistically significant effect. They also found that the effect of certification varies by wood species. According to this, the premium for cedar is 4.0%, while that for cypress is statistically insignificant. The present study researched the effect of certification on oak and beech log prices. It is seen that both studies have different results

from each other. Among the reasons for the difference, factors such as different tree species, different supply volumes, and using different analysis techniques can be counted.

5. Conclusions

This study revealed that the sale prices of logs in the certified and non-certified periods were different from each other. The reason for this, forest certification inevitably leads to an increase in direct and indirect costs, such as operating costs to meet certification standards, investment costs, silviculture, harvest, forest management, etc. As costs increase, selling prices also increase. While the estimated price, including the costs for oak log, increased by 18%, the sale price also increased by 19% in the post-FSC period. Therefore, there is a price increase of 1% in the costs. Similarly, the estimated price for beech log increased by 10.5%, and the sale price also increased by 12% in the post-FSC period. In other words, it can be said that there is a 2% price increase in costs. On the other hand, the contribution of certification to sustainable forestry is much higher than its cost.

The results of this study can contribute to the forest certification database in order to support decision-makers (owners and wood manufacturers) in their strategic decisions. Additionally, the results of this study have a widespread impact and can be used in the decisions to be taken in other forest enterprises. The results of the study are especially related to the Business and Marketing Department of the GDF. The broader implications of the study are that it may be effective in deciding whether to extend the certification practice to other forest enterprises and forest sub-districts. The study will also enable the GDF to see the possible reflections of certification practices in the country and the world markets.

The analysis of potential changes that can occur in different products through certification in the enterprises under the GDF would ensure the production of scientific information. This situation will help create more comprehensive policies for the certification applications of the GDF. Therefore, a healthier relation can be established between consumers and forest resource management. Furthermore, preparation of manufacturing programs, setting up of marketing mixes, and development of marketing strategies with measures that take into account the factors affecting the log sale prices of the forest enterprises are of importance to ensure the sustainability of the enterprises as well as the certificate.

It is very likely that there will be compulsory certification in the future for the international commerce of forest products. Therefore, GDF will continue to expand the certification studies in parallel with the international developments. Turkey must manufacture products within the standards required by international markets to get a place and to be able to compete. The most important advantage of forest certification for enterprises is market expansion. Furthermore, facilitation of access to international markets, improvement of market shares, and improvement of the image from an environmental point of view are other important advantages for forest enterprises. Certification studies would allow ensuring the integration of the forestry sector in many aspects of the global market and compliance with international conventions. For Turkey to compete in international markets, possible external market reflections of the certification system should be observed.

This study deals with only part of the economic impact of certification. Further research is needed regarding the ecological, economic, and social effects of certification. When such studies are increased, inferences for determining the price in the export and international markets of certified log products will be made easier. The future study topics can be suggested:

- The situation in certified and non-certified forest enterprises can be compared in terms of forest certification costs.
- It can be investigated how the ecological, social, and cultural effects of forest certification affect economic outcomes.
- The effect of certification can be further investigated by including other factors (supply–demand situation of the forest industry, sales of neighboring enterprises, market conditions, etc.) affecting log sales prices.

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