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Italian Consumers' Willingness to Pay for Eucalyptus Firewood

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Abstract: Eucalyptus trees cover about 20 million hectares globally and are used to produce pulp, paper and firewood for domestic uses. From an environmental perspective, these trees have fewer impacts than other crops. In Italy, plantations of eucalyptus can provide a large amount of biomass to satisfy part of the country's internal demand. However, eucalyptus cultivation is less profitable than cultivation of traditional crops due to the low market prices of wood. This study aims both to analyze the willingness of a sample of Italian consumers to pay for eucalyptus firewood and to investigate the main factors that may affect this willingness. Data are collected from a sample of 231 consumers using a web-based survey. The double-bounded dichotomous choice contingent valuation model is then applied. The findings show that information, the energetic density of firewood, consumers' interest in environment issues, and the age of respondents are aspects that are positively associated with respondents' willingness to pay for eucalyptus firewood. Conversely, interest in both firewood species and packaging are factors that reduce consumer willingness to pay for eucalyptus firewood. Even though these results cannot be generalized to the whole Italian population, the findings may indicate new opportunities for eucalyptus, while growing demand for eucalyptus could offer an interesting opportunity for firms to enter the sector and develop marketing strategies targeted towards specific market niches.

Keywords: consumer choices; contingency valuation method; double-bounded dichotomous choice contingent valuation model; Eucalyptus Willingness to pay (WTP)

1. Introduction

Globally, eucalyptus is the most commonly used species for fast growing plantations (with a 10–16 year rotation) and have the potential to help meet global demand for wood [1,2]. Eucalyptus trees cover about 20 million hectares in more than 90 countries around the world, particularly in countries such as Brazil, India, and China [3]. Eucalyptus is used to produce pulp and paper, charcoal, sawn timber, wood panels for industries, and also firewood for domestic uses [3].

Moreover, eucalyptus management (e.g., tree density, fertilization, harvesting cycles, etc.) is less intensive than the management of conventional agricultural crops but is more intensive than conventional forestry [1], which means that eucalyptus occupies a niche between highly productive forestry and conventional forestry [4]. Eucalyptus is an efficient biomass producer and can produce more biomass than many other tree species [5]. In addition, from an environmental perspective, eucalyptus is less impactful than other crops [6], contributes to the conservation of biodiversity [5,7], and shows high carbon sequestration potential during its growth [8,9]. In fact, eucalyptus can play an important role in mitigating climate change since it is fast growing and can fix more CO_2 by the process of photosynthesis [5]. Moreover, properly managed eucalyptus plantations can control soil erosion, and the litter which accumulates under most eucalyptus plantations can improve soil fertility [5].

In Italy, there are more than 100,000 ha planted with agro-forest species such as poplar, eucalyptus, and acacia [10], and plantations of eucalyptus [11] can provide a large enough amount of biomass to satisfy about 72% of Italian demand [12,13]. Eucalyptus presents similar characteristics to other common firewood species in Italy, such as beech and oak. While focusing on gross calorific value, Pereira [14] reported a range of 18.8–19.2 MJ kg^{-1} for various eucalyptus species, while a range of 19.3–19.4 MJ kg^{-1} was detected for oak species [15] and a value of about 19.5 MJ kg^{-1} was shown for beech firewood [16]. Also, the ash content of eucalyptus firewood is similar to the content for oak and beech. In particular, Pereira [14] reported an ash content range of 0.10–0.18% for eucalyptus species, while 0.3–0.4% was shown for oak firewood [15] and 1.0–2.0% was shown for beech [16].

However, from an economic perspective, eucalyptus cultivation is less profitable for farmers than traditional crops, due to having higher production costs and lower market prices for its wood [6,17]. In other words, short rotation forestry (SRF) biomass diffusion, as the diffusion of eucalyptus, should be possible only with an increase of its market values or with the adoption of new process innovations to reduce its production costs at the farm level [18,19]. Since the price of wood is the most important factor underpinning the profitability of agro-forest farms [6,20,21], it could be useful to study the price that people are willing to pay for eucalyptus firewood to investigate the main factors that may affect it.

To the best of our knowledge, no other study has been conducted concerning consumers' willingness to pay for eucalyptus firewood in Italy. Thus, the current study aims to fill this gap by analyzing the willingness to pay (WTP) for eucalyptus firewood of a sample of Italian consumers. Moreover, this study investigates the main factors that may affect the WTP to address marketing strategies for eucalyptus firewood. This is an interesting case study, given that the technical characteristics of eucalyptus firewood such as its calorific power value are similar to that of other firewood species such as oak [22].

This paper is structured as follows: Section 2 provides a brief review of the literature on the WTP and contingent valuation approach; Section 3 describes the materials and methods used. The results are presented in Section 4 and are discussed in Section 5. In addition, Section 5 concludes also with some hints.

2. Willingness to Pay and Contingent Valuation Method: An Overview

The contingent valuation (CV) method is part of a wider family of approaches called stated preference methods; the CV method estimates economic values such as willingness to pay (or to accept) using responses to survey questions [23,24]. The CV is a method in which people are asked to express their preference [25] and respondents are asked the maximum price range they are willing to pay (WTP). The economic theory underlying CV assumes that the accepted price yields the highest utility for respondents [26]. There are two approaches for assessing WTP: revealed preference and stated preference. In the first approach, participants bid real money for real goods, but these market data are hardly available [27]; while in the second approach, WTP is elicited based on a hypothetical situation. However, the latter approach is prone to hypothetical bias [27]. The stated preference-based contingent valuation experiment is currently one of the most important WTP and it involves field experiments and survey data collection to elicit the preferences of participants [27]. Another important method, among stated preference approaches, is discrete choice experiments (DCE), where preferences are elicited from responses to hypothetical alternatives, meaning participants' bids are incentive-compatible [27].

Moreover, among stated preference approaches, there are models with the dichotomous choice: the first is the single-bounded model where an individual is asked if he/she is willing to pay a stated amount for a product and he/she answers "Yes" or "No" to that question. In this approach, the individual provides little information about its WTP, and to have an accurate estimation of WTP, large samples are needed. Moreover, this method could lead to hypothetical bias, which means that individuals tend to overstate the amount he/she would be ideally willing to pay for a product as compared to when he/she would actually pay for it. The second approach, with the dichotomous choice model is the double-bounded model (DBDC-CV) proposed by [26,28,29] to improve the efficiency of

the estimation. In the DBDC-CV model, the market simulated by the dichotomous-choice approach is very similar to the consumer decision-making process in the real market [30]. The respondent must choose between "Yes" and "No" answers, and this can effectively avoid bias in the model due to unfamiliarity with goods [31]. Unlike the single-bounded model, the DBDC-CV is advisable with small samples [32] and involves two questions: the first on whether the respondent is willing to pay a stated amount for a product; and the second about its WTP for a higher (and lower) amount of the initial bid. The respondent's WTP lies between the two offered bid prices if either response is positive, between the second bid and the limit of the WTP if both responses are positive, and below the second bid if both responses are negative. According to [33], the double-bounded approach shows an internal inconsistency in the response strategies between the first and second bounds by people; while the use of the bid range statement reduces the perceived difference between the two questions by respondents. Moreover, since an unrealistic bid price range can lead to a bias in the double-bounded dichotomous choice model [27,34] proposed realistic bid range to reduce the bias in the model.

The DBDC-CV model is widely used to investigate subjects such as WTP for clean energy use [31,35,36], WTP for environmental goods [37–39] and for consumer goods [40,41].

For reasons mentioned above, in this study the DBDC-CV model is applied and realistic bid range prices are assigned to minimize bias.

3. Materials and Methods

3.1. Data Collection, the Sample, and the Questionnaire

A market survey is a research method used to investigate market development and marketing opportunities [42]. In this study, data are collected from an initial sample of 253 consumers in Italy by using a web-based survey administered during the period October–December 2019. Later, 22 respondents were excluded from the sample because they were not firewood consumers. The final sample is of 231 consumers and is not representative of the Italian population, as happens in many studies about consumer behavior (see e.g., [43,44] for wood sector or [45–47] for food sector). The survey is implemented through social media, emails, and word of mouth. The choice to use a web-based survey is due to both its wide use in the general literature about consumer choices (see e.g., [44,48,49]) and its undoubted cost advantage [48]. Before starting the survey, a pilot study with a sample of 60 consumers was carried out in order to validate the questionnaire.

The questionnaire (Tables 1 and 2) is split into three sections: (1) socio-demographic information of sample, (2) consumers attitudes towards to firewood; and (3) consumers' perceptions about eucalyptus firewood.

The last two sections ask questions by using a five-point Likert scale (from 1 = totally disagree to 5 = totally agree). It is important to underline that the respondents that did not have any opinion about eucalyptus firewood answered to be indifferent (3 in the Likert scale). For the reliability of the scale, Cronbach Alpha coefficient for each item group was used and it was found that the scale had good levels (from 0.60 to 0.86) of reliability.

In the first section of the questionnaire, socio-demographic aspects such as age, gender, area of residence, and education were collected [50–52].

In the second part, instead, we investigated the consumers attitudes towards to firewood species and its use (*use*), ethical aspects of consumers' firewood choice, its geographic provenience (i.e., if firewood comes from tropical countries or Mediterranean ones), and its origin (i.e., if firewood comes from an agro-forestry plant or natural woodland) [53]. The questionnaire aims also at characterizing consumers in terms of their attitude towards collecting information from some sources (such as friends, internet, TV, expert of the sector—i.e, agronomists, forestries, and sellers) (*friend_info, internet_info, tv_info, expert_info, and rivend_info*).

Table 1. The sample (N = 231).

Section 1: Socio-Demographic Information		
Variable	**Label**	**%**
Gender	*sex*	
Male		61.90
Female		38.10
Total		**100.00**
Area of residence	*place*	
City (more than 250,000 inhabitants)		4.76
Medium town (50,000–250,000 inhabitants)		12.99
Little town (5,000–50,000 inhabitants)		57.14
Village (less than 5,000 inhabitants)		25.11
Total		**100.00**
Education level	*edu*	
Primary or secondary school		59.31
University or postgraduate degree		40.69
Total		**100.00**

Source: our elaboration on data survey.

Table 2. Variables used in the model and descriptive statistics of sample (N= 231).

Items	**Labels**	**%**
Section 2: consumer attitudes towards to firewood		
Reasons to consume firewood	*use*	
domestic use		91.77
work		8.23
Total		100.00
When you buy firewood, you pay attention to firewood species (*How much do you agree with the following statements? Express your judgment by putting a tick from 1 to 5. 1 = totally disagree. 5 = totally agree*)	*species*	
1 = totally disagree		12.99
2 = disagree		10.39
3 = indifferent		16.01
4 = agree		23.81
5 = totally agree		36.80
Total		100.00
When you buy firewood, you pay attention to ethical aspects of your firewood choice (*How much do you agree with the following statements? Express your judgment by putting a tick from 1 to 5. 1 = totally disagree. 5 = totally agree*)	*ethic_aspects*	
1 = totally disagree		12.55
2 = disagree		14.72
3 = indifferent		20.78
4 = agree		29.87
5 = totally agree		22.08
Total		100.00
When you buy firewood, you pay attention to geographic provenience of firewood (i.e., if firewood comes from tropical countries or Mediterranean ones) (*How much do you agree with the following statements? Express your judgment by putting a tick from 1 to 5. 1 = totally disagree. 5 = totally agree*)	*prov*	
1 = totally disagree		12.99
2 = disagree		9.95
3 = indifferent		20.78
4 = agree		25.97
5 = totally agree		30.31
Total		100.00

Table 2. *Cont.*

Items	Labels	%
When you buy firewood, you pay attention to origin of firewood (i.e., if firewood comes from an agro-forestry plant or natural woodland) (*How much do you agree with the following statements? Express your judgment by putting a tick from 1 to 5. 1 = totally disagree. 5 = totally agree*)	*origin*	
1 = totally disagree		12.99
2 = disagree		7.79
3 = indifferent		14.72
4 = agree		29.87
5 = totally agree		34.63
Total		100.00
When you buy firewood, you take information from friends (*How much do you agree with the following statements? Express your judgment by putting a tick from 1 to 5. 1 = totally disagree. 5 = totally agree*)	*friend_info*	
1 = totally disagree		7.36
2 = disagree		8.66
3 = indifferent		13.85
4 = agree		42.86
5 = totally agree		27.27
Total		100.00
When you buy firewood, you take information from the internet (*How much do you agree with the following statements? Express your judgment by putting a tick from 1 to 5. 1 = totally disagree. 5 = totally agree*)	*internet_info*	
1 = totally disagree		49.35
2 = disagree		19.91
3 = indifferent		19.91
4 = agree		9.52
5 = totally agree		1.31
Total		100.00
When you buy firewood, you take information from the TV (*How much do you agree with the following statements? Express your judgment by putting a tick from 1 to 5. 1 = totally disagree. 5 = totally agree*)	*tv_info*	
1 = totally disagree		51.95
2 = disagree		19.04
3 = indifferent		22.51
4 = agree		5.63
5 = totally agree		0.87
Total		100.00
When you buy firewood, you take information from experts of the sector (i.e., agronomists, forestries) (*How much do you agree with the following statements? Express your judgment by putting a tick from 1 to 5. 1 = totally disagree. 5 = totally agree*)	*expert_sector*	
1 = totally disagree		18.18
2 = disagree		9.53
3 = indifferent		12.99
4 = agree		22.50
5 = totally agree		36.80
Total		100.00
When you buy firewood, you take information from sellers (*How much do you agree with the following statements? Express your judgment by putting a tick from 1 to 5. 1 = totally disagree. 5 = totally agree*)	*rivend_info*	
1 = totally disagree		9.10
2 = disagree		7.34
3 = indifferent		13.42
4 = agree		20.35
5 = totally agree		49.79
Total		100.00
Section 3: consumers' perceptions about eucalyptus firewood		
Are you willing to consume eucalyptus firewood?	*will*	
Yes		64.93
No		35.07
Total		100.00

Table 2. *Cont.*

Items	Labels	%
Do you have familiarity with eucalyptus firewood?	*fam*	
Yes		44.59
No		55.41
Total		100.00
Did you use eucalyptus firewood in the past?	*pass*	
Yes		17.75
No		82.25
Total		100.00
Which supply would you prefer?	*forn*	
loose firewood		58.00
firewood arranged in pallets		17.75
firewood in 10-15 kg bags		24.25
Total		100.00
You are willing to consume eucalyptus firewood for curiosity (*How much do you agree with the following statements? Express your judgment by putting a tick from 1 to 5. 1 = totally disagree. 5 = totally agree*)	*curiosity*	
1 = totally disagree		33.33
2 = disagree		6.93
3 = indifferent		10.82
4 = agree		23.38
5 = totally agree		25.54
Total		100.00
You are willing to consume eucalyptus firewood if it has an attractive aesthetic form of packaging (*How much do you agree with the following statements? Express your judgment by putting a tick from 1 to 5. 1 = totally disagree. 5 = totally agree*)	*pack*	
1 = totally disagree		46.32
2 = disagree		9.96
3 = indifferent		24.68
4 = agree		16.01
5 = totally agree		3.03
Total		100.00
If it were true that eucalyptus is less impactful (in terms of lower agricultural inputs, GHG emissions) than other firewood species, you would consume it (*How much do you agree with the following statements? Express your judgment by putting a tick from 1 to 5. 1 = totally disagree. 5 = totally agree*)	*low_env_impact*	
1 = totally disagree		11.25
2 = disagree		6.50
3 = indifferent		9.10
4 = agree		26.84
5 = totally agree		46.31
Total		100.00
You are willing to consume eucalyptus firewood if it had a higher energy density (wood burning duration) than other firewood species (*How much do you agree with the following statements? Express your judgment by putting a tick from 1 to 5. 1 = totally disagree. 5 = totally agree*)	*energetic*	
1 = totally disagree		13.42
2 = disagree		6.93
3 = indifferent		9.09
4 = agree		22.08
5 = totally agree		48.48
Total		100.00

Source: our elaboration on data survey.

The third section of the questionnaire investigates respondents' willingness to consume eucalyptus firewood (*will*) that is set out as a binary choice (Yes *vs.* No).

Consumers were also asked to indicate their familiarity (*fam*) with eucalyptus firewood by answering if they have heard about eucalyptus firewood or not (dummy variable). In addition, it was asked if respondents have consumed eucalyptus firewood in the past (*pass*) [54].

Three different eucalyptus firewood supply methods (*form*) were also proposed: loose firewood, firewood arranged in pallets, and firewood in 10–15 kg bags.

Respondents are firstly allowed to choose their preferred supply method and then to indicate their willingness to pay (WTPi) according to the supply method chosen.

The WTPi questions follow a format to which respondents only states Yes (I agree) or No (I disagree), meaning whether their willingness to pay is greater or lower than the bids (Euros X) they are offered.

It is important to underline that the bids were expressed in realistic range prices [27,33] that come from the informal local market [55] since an unrealistic bid price range could have led to a bias in the double-bounded dichotomous choice model [34].

Following some studies [27,28,56,57] and considering the range 11 €/quintal ≤ WTPi ≤ 15 €/quintal as initial bid (all realistic range prices were selected using information from the informal local market [55]) value, the second bid amount have the following pattern:

- If the first bid value is 11 €/quintal ≤ WTPi ≤ 15 €/quintal and the answer is "yes", the second bid value is WTPi > 15 €/quintal, and if the answer to second bid value is "yes", it is WTPi >15 €/quintal;
- If the first bid value is 11 €/quintal ≤ WTPi ≤ 15 €/quintal and the answer is "yes", the second bid value is WTPi > 15 €/quintal, and if the answer to second bid value is "no", it is 11 €/quintal ≤ WTPi ≤ 15 €/quintal;
- If the first bid value is 11 €/quintal ≤ WTPi ≤ 15 €/quintal and the answer is "no", the second bid value decreases to 6 €/quintal ≤ WTPi ≤ 10 €/quintal, and if the answer to second bid value is "yes", it is 6 €/quintal ≤ WTPi < 11 €/quintal;
- If the first bid value is 11 €/quintal ≤ WTPi ≤ 15 €/quintal and the answer is "no", the second bid value decreases to 6 €/quintal ≤ WTPi < 11 €/quintal, and if the answer to second bid value is "no", it is WTPi < 6 €/quintal.

For example, say respondents say "yes", they are willing to pay 11 €/quintal ≤ WTPi ≤ 15 €/quintal of eucalyptus. At this point all we know they are willing to pay at least 11 €/quintal ≤ WTPi ≤ 15 €/quintal. We have no upper bound estimate of their WTPi. If we then ask the respondents a follow up question, such as are they willing to pay WTPi > 15 €/quintal, and the respondent says "yes", we have gained some information: they are willing to pay at least 15 €/quintal, but if the respondents say "no", we know that their WTPi is 11 €/quintal ≤ WTPi ≤ 15 €/quintal. The situation is similar for initial responses that are "no", where the next question uses a lower bid amount.

Another important aspect considered in the questionnaire on eucalyptus firewood acceptance is consumers' motivation to use it: such aspects are measured by asking a number of questions related to appeal, curiosity, to technical characteristics, as well as to environmental aspects [53].

3.2. Econometric Modelling

The willingness to pay for eucalyptus firewood is evaluated using the contingent valuation method (CV). Respondents were asked the maximum range of price they are willing to pay.

To estimate the willingness to pay for eucalyptus firewood and to explore factors influencing willingness to pay, the double-bounded dichotomous choice contingent valuation model (DBDC-CV) [26,28,33,56] was used. In addition, following [27,33] studies the realistic bids ranges, come from the informal local market [55] were used.

Respondents are requested to answer a first question like the following "If eucalyptus for firewood cost 11 €/quintal ≤ WTPi ≤ 15 €/quintal, would you agree or disagree to it?", and a second question (for the respondents who agree to the first question) "If the price is > 15 €/quintal, would you agree or disagree to it?" or "If the price is 6 €/quintal ≤ WTPi < 11 €/quintal, would you agree or disagree to it?" (for the respondents who disagree to the first question).

In the DBDC-CV question, as mentioned above, there are four possible response outcomes: (yes, yes); (yes, no); (no, yes); and (no, no). If the respondent i's answer is (yes, yes), it can tell WTPi > 15 €/quintal. Similarly, (yes, no) means 11 €/quintal ≤ WTPi ≤ 15 €/quintal; (no, yes) means 6 €/quintal ≤ WTPi < 11 €/quintal, and (no, no) means WTPi < 6 €/quintal.

In formula, the final model is:

$$\begin{aligned} Pr\,(WTPi = Yes/bid1, bid2) = \beta 0 + \beta 1\ species + \beta 2\ ethic\_aspects + \beta 3\ prov + \beta 4\ origin + \beta 5\ friend\_info + \beta 6 \\ internet\_info + \beta 7\ tv\_info + \beta 8\ expert\_sector + \beta 9\ rivend\_info + \beta 10\ fam + \beta 11\ pass + \beta 12\ will + \beta 13 \\ curiosity + \beta 14\ pack + \beta 15\ energetic + \beta 16\ low\_env\_impact + \beta 17\ sex + \beta 18\ age \end{aligned} \quad (1)$$

where *bid1* and *bid2* are the prices ranges in euros asked in the first and second question, respectively. All computations were carried out using R version 3.6.2 [58] and packages DCchoice [59] and lmtest [31].

4. Results

4.1. Descriptive Statistics

The sample (Table 1) is composed of 231 individuals, of which 143 males, with a mean age of about 43 years (S.D. = 12.21; range 25 to 80 years) and 59% of respondents have a low education level (i.e., primary or secondary school). Moreover, 57% of sample come from little towns.

Our findings show (Table 2) that about 92% of sample buys firewood for domestic use, 38% consume firewood more than 3 times a week and 13% of respondents consume oak as firewood specie.

Based on the percentage of answers reported per each item, the percentage value for the item groups reveals a high attention to origin of wood (64.50%), followed by firewood species (60.61%), and by provenience (56.28%) of wood. Also, ethical aspects are important for 51.95% of respondents.

In addition, the chance to take information on firewood seems important; in this regard, people seemed more interested to take information from sellers (70.14%) followed by friends (70.13%) and from experts of the sector (59.30%). TV and internet as information sources are not highly perceived; in fact, only 10.83% of sample takes information by internet and only 6.50% of respondents by television.

In addition, 65% of the sample is willing to consume eucalyptus firewood, 55% had not heard about it, and 82% of respondents had never consumed eucalyptus in the past. However, about 49% of sample is willing to consume eucalyptus for curiosity and about 71% is willing to consume it if eucalyptus firewood showed a higher energy density than other firewood species. Moreover, under environmental aspects, 73% of respondents are willing to use it if eucalyptus was less impactful than other firewood species.

Finally, 58% of sample would prefer to buy loose firewood, followed by 24% of people that would prefer firewood in 10–15 kg bags. In addition, 46% of sample is not interested to packaging aspects of firewood.

4.2. Results of the Econometric Model

The double-bounded dichotomous choice model is performed on the WTPi for loose firewood, since this was the demand method most frequently chosen by respondents. 47% of the sample is willing to pay 6 €/quintal ≤ WTPi < 11 €/quintal of eucalyptus firewood, followed by 20% of respondents are ready to pay WTPi >15 €/quintal.

Table 3 shows the results of the model with the estimated coefficients (β), their standard errors, marginal effects, significance levels, and goodness-of-fit statistics. The goodness of fit as measured by McFadden's pseudo-R^2 is equal to 0.26.

Table 3. Econometric model results.

	β	Standard Errors	Marginal Effects	Sig.
(Intercept)	1.80	1.22	0.34	0.141
BID	−0.68	0.18	−0.13	0.000 ***
Species	−0.40	0.19	−0.07	0.041 *
ethic_aspects	0.28	0.22	0.05	0.205
prov	0.03	0.20	0.007	0.849
origin	−0.23	0.23	−0.04	0.314
friend_info	0.47	0.20	0.08	0.021 *
internet_info	−0.04	0.27	−0.007	0.877
tv_info	0.31	0.30	0.06	0.293
expert_sector	0.34	0.16	0.06	0.035 *
rivend_info	−0.11	0.17	−0.02	0.527
Fam	−0.13	0.42	−0.02	0.755
pass	0.49	0.61	0.09	0.413
will	0.008	0.47	0.001	0.985
curiosity	−0.21	0.19	−0.04	0.256
pack	−0.55	0.21	−0.10	0.008 **
energetic	0.99	0.31	0.18	0.001 **
low_env_impact	0.72	0.34	0.13	0.034 *
sex	−0.48	0.37	−0.09	0.199
age	0.03	0.01	0.006	0.048 *
Number of obs	231			
log-likelihood	−108.22			
McFadden's pseudo-R^2	0.26			
AIC	258.45			
BIC	330.74			
*** Significant at 0%	** Significant at 0.1%		* Significant at 1%	

Source: our elaboration on data survey.

The model makes it possible to highlight influential variables on the consumers' willingness to pay for eucalyptus firewood.

Our findings show that aspects such as information from friends and experts of the sector (i.e., agronomists, forestries), energetic density of firewood can shape the probability that respondents would be willing to pay.

Also, respondents' age and consumers' attention towards environmental issues are positively associated with their willingness to pay. This aspect could be an interesting point if you consider that firewood extraction is one of the many causes of deforestation and forest degradation at a world level [60].

Moreover, participants who pay attention to both firewood species and packaging are less willing to pay than other consumers.

Finally, in addition to the variables discussed above, the model also considered other variables as determinants of the willingness to pay, but none of these were found to be significant.

5. Discussion and Conclusions

This study aims to contribute to the current literature on willingness to pay for eucalyptus firewood by investigating the main factors that might affect the Italian consumers' willingness to pay. Although our sample is not representative of the Italian population, and thus the findings cannot be over-generalized, the findings should be interesting hints to address marketing strategies. Unfortunately, there are not many studies evaluating the willingness to pay for eucalyptus firewood that could help us to evaluate the findings. The sample composed of 62% males, with a mean age of about 43 years, confirming the current literature [61] and 40.69% of respondents have a high education level [61]. Moreover, 55% has not heard about eucalyptus firewood and 82% of respondents have

never consumed eucalyptus in the past. In this regard, some authors (e.g., [62]) noted that the lack of familiarity with analyzed goods could cause unreliable responses in CV surveys; however, the question is a controversial issue [63]. In fact, [64] showed, according to standard micro-economic theory, that familiarity with goods is not a precondition for decision-making, but that in existing markets consumers also have to make decisions about new goods for which they do not have previous experience. So, lack of familiarity with analyzed goods does not affect the responses in surveys. Similar results are also reached by [65], who showed no relationship between previous experience of people and their willingness to pay.

Moreover, the initial range of prices offered in the study (11 €/quintal ≤ WTPi ≤ 15 €/quintal) was higher than willingness to pay of our sample (6 €/quintal ≤ WTPi < 11 €/quintal), confirming the current literature [6] where the sale price of eucalyptus was of 9 €/quintal even if according to [5] to have a profitable farm of eucalyptus, the sale price of wood should reach a value of 14.50 €/quintal.

Respondents' age is an important driver for willingness to pay; in fact, according to [54,66], the likelihood a respondent is willing to pay increases with age; while according to other authors [67], respondents' age is not statistically significant on the stated preference of paying.

The high willingness to consume eucalyptus firewood (65% of sample) may indicate that people are becoming more receptive towards eucalyptus as a good firewood alternative.

In addition, 73% of respondents would be willing to use it if eucalyptus was less impactful than other firewood species. Our findings showed consumers' attention towards environmental issues may be important drivers for willingness to pay. In fact, those with a higher environmental concern are willing to pay. This is an important aspect if you think that firewood use contributes to deforestation, particularly of native forests [55]. In fact, among researchers there is an unanimous consensus that the current level of biomass consumption threatens the sustainability of forests in many countries [68,69] and that the growth of firewood markets is correlated with environmental impacts like the degradation of forests and deforestation [55,70]. According to [55], there is a negative relationship between increases in firewood consumption and the sustainability of forest resources. In this framework, it could be useful to recourse to short rotation forestry (SRF) biomass (as eucalyptus cultivation) to avoid environmental impacts like deforestation. Moreover, since eucalyptus plantations in some countries (except USA) are managed under the auspices of sustainable forestry certification program [71], it could be interesting to study consumers' attitudes, preferences, and willingness to pay a premium price for certified eucalyptus. This is an area that will require further investigation.

According to [55], the most valued attributes by people are related directly to environmental issues and to technical aspects (energetic density and humidity). These aspects are linked, as stove exchange programs, focused on improvement the technical aspects as efficiency of firewood combustion, can lead to a decrease of environmental impacts like deforestation [72,73]. Improving production processes may help reduce the overexploitation of forests and increase wood combustion efficiency and improve air quality through establishing and enforcing wood quality standards (such as the humidity level) [74,75]. In our case, environmental and technical (as energetic density) aspects can shape the probability that respondents would be willing to pay.

Moreover, it is interesting to notice that the willingness to pay increases when people do not pay attention to firewood species. In other words, people are not loyal to particular wood species and are interested in the energetic density of wood, and they are willing to pay more. Similar behaviors are observed in other studies (e.g., see [76]) where consumers appreciate the intrinsic attributes of products rather than extrinsic ones. This is an interesting result given the calorific power value of eucalyptus is similar to that of the oak [22], and therefore the possible replaceability of eucalyptus to oak.

Finally, information received can also shape the probability that respondents would be willing to pay. In fact, [43] showed that information on firewood significantly affects consumer choices. According to our results, correct information may be a leverage to increase the willingness to pay for firewood, confirming the current literature [55].

The present study has a main limitation, common to most papers dealing with studies on the consumer: the sample is not representative of the Italian population. However, the use of web-based surveys is well established and broadly accepted in the literature on consumer choice. Moreover, on one hand, the result of the double-bounded choice could be affected by an initial bid during the interaction process; on the other hand, it allowed us to have accurate answers due to closed questions [57]. For these reasons, we are aware that the conclusions of this study cannot be over-generalized; however, we believe that the usefulness of pilot studies carried out on market issues should not be dismissed so easily. In fact, the emerged results could open new spaces for eucalyptus firewood, since the quantity and quality of information received, in particular on the environmental and technical aspects (energetic density), could shape the probability that people would be willing to pay. Even though we cannot over-generalize our results to the whole Italian population, we could conclude that a growing eucalyptus demand would offer an interesting opportunity for firms to enter the sector and develop marketing strategies targeted to specific market niches.

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References

1. De Miguel Muñoz, A.; Sottocornola, M.; Cronin, B.; Kent, T. Exploring market opportunities for Short Rotation Forestry in the current Irish wood processing and solid biofuel sectors. *Irish For.* **2016**, *73*.
2. Laclau, J.-P.; de Moraes Gonçalves, J.L.; Stape, J.L. Perspectives for the management of eucalypt plantations under biotic and abiotic stresses. *For. Ecol. Manag.* **2013**. [CrossRef]
3. Laclau, J.P.; Mignard, E.; Bouvet, J.M.; Mareschal, L. *Eucalyptus 2018: Managing Eucalyptus Plantations under Global Changes*; Cirad: Paris, France, 2018; ISBN 978-2-87614-743-0.
4. O'Reilly, C.; Tobin, B.; Farrelly, N. Can short rotation forestry play a role in renewable energy demands. *For. Energy Rev.* **2014**, *4*, 32–34.
5. Bayle, G.K. Ecological and social impacts of eucalyptus tree plantation on the environment. *J. Biodivers. Conserv. Bioresour. Manag.* **2019**, *5*, 93–104. [CrossRef]
6. Sgroi, F.; Di Trapani, A.M.; Foderà, M.; Testa, R.; Tudisca, S. Economic assessment of Eucalyptus (spp.) for biomass production as alternative crop in Southern Italy. *Renew. Sustain. Energy Rev.* **2015**, *44*, 614–619. [CrossRef]
7. Boothroyd-Roberts, K.; Gagnon, D.; Truax, B. Hybrid poplar plantations are suitable habitat for reintroduced forest herbs with conservation status. *Springerplus* **2013**, *2*, 507. [CrossRef]
8. Burrows, W.H.; Henry, B.K.; Back, P.V.; Hoffmann, M.B.; Tait, L.J.; Anderson, E.R.; Menke, N.; Danaher, T.; Carter, J.O.; McKeon, G.M. Growth and carbon stock change in eucalypt woodlands in northeast Australia: Ecological and greenhouse sink implications. *Glob. Chang. Biol.* **2002**, *8*, 769–784. [CrossRef]
9. Du, H.; Zeng, F.; Peng, W.; Wang, K.; Zhang, H.; Liu, L.; Song, T. Carbon storage in a Eucalyptus plantation chronosequence in Southern China. *Forests* **2015**, *6*, 1763–1778. [CrossRef]
10. Pettenella, D.; Masiero, M. *Una Nuova Economia del Legno-Arredo tra Industria, Energia e Cambiamento Climatico*; Gargiulo, T., Zoboli, R., Eds.; FrancoAngeli: Monza, Italy, 2007.
11. Deidda, A.; Buffa, F.; Linaldeddu, B.T.; Pinna, C.; Scanu, B.; Deiana, V.; Satta, A.; Franceschini, A.; Floris, I. Emerging pests and diseases threaten eucalyptus camaldulensis plantations in Sardinia, Italy. *iForest* **2016**, *9*, 883–891. [CrossRef]

12. Pari, L.; Bergonzoli, S.; Suardi, A.; Scarfone, A.; Alfano, V.; Mattei, P.; Lazar, S. Produttività dell'eucalipto Un impianto quinquennale in Italia centrale. *Sherwood For. ed Alberi Oggi* **2019**, *241*, 70–72.
13. Mughini, G.; Rosso, L. Selezioni di cloni di eucalitto per la destinazione da biomassa. *Sherwood For. ed Alberi Oggi* **2017**, 45–52.
14. Pereira, B.L.C.; Oliveira, A.C.; Carvalho, A.M.M.L.; Carneiro, A.D.C.O.; Santos, L.C.; Vital, B.R. Quality of Wood and Charcoal from Eucalyptus Clones for Ironmaster Use. *Int. J. For. Res.* **2012**, *2012*. [CrossRef]
15. Ruiz-Aquino, F.; González-Peña, M.M.; Valdez-Hernández, J.I.; Revilla, U.S.; Romero-Manzanares, A. Chemical characterization and fuel properties of wood and bark of two oaks from Oaxaca, Mexico. *Ind. Crops Prod.* **2015**, *65*, 90–95. [CrossRef]
16. Orémusová, E.; Tereňová, L.; Réh, R. Evaluation of the gross and net calorific value of the selected wood species. *Adv. Mater. Res.* **2014**, *1001*, 292–299. [CrossRef]
17. Acuña, E.; Rubilar, R.; Cancino, J.; Albaugh, T.J.; Maier, C.A. Economic assessment of Eucalyptus globulus short rotation energy crops under contrasting silvicultural intensities on marginal agricultural land. *Land Use Policy* **2018**, *76*, 329–337. [CrossRef]
18. Manzone, M.; Bergante, S.; Facciotto, G. Energy and economic evaluation of a poplar plantation for woodchips production in Italy. *Biomass Bioenergy* **2014**, *60*, 164–170. [CrossRef]
19. Spinelli, R.; Magagnotti, N.; Nati, C.; Cantini, C.; Sani, G.; Picchi, G.; Biocca, M. Integrating olive grove maintenance and energy biomass recovery with a single-pass pruning and harvesting machine. *Biomass Bioenergy* **2011**, *35*, 808–813. [CrossRef]
20. Krasuska, E.; Rosenqvist, H. Economics of energy crops in Poland today and in the future. *Biomass Bioenergy* **2012**, *38*, 23–33. [CrossRef]
21. Rosenqvist, H.; Dawson, M. Economics of willow growing in Northern Ireland. *Biomass Bioenergy* **2005**, *28*, 7–14. [CrossRef]
22. Mughini, G.; Gras, M.; Salvati, L.; Filippelli, S.; Tanchis, U. Velino and Viglio: Two eucalypt hybrid clones for Italy. *Sherwood For. ed Alberi Oggi* **2012**, *18*, 41–45.
23. Oerlemans, L.A.G.; Chan, K.Y.; Volschenk, J. Willingness to pay for green electricity: A review of the contingent valuation literature and its sources of error. *Renew. Sustain. Energy Rev.* **2016**, *66*, 875–885. [CrossRef]
24. Kowalska-Pyzalska, A. Do consumers want to pay for green electricity? A case study from Poland. *Sustainability* **2019**, *11*, 1310. [CrossRef]
25. Carson, R.T. Contingent Valuation: A User's Guide. *Environ. Sci. Technol.* **2000**, *34*, 1413–1418. [CrossRef]
26. Hanemann, W.M. Welfare evaluations in contingent valuation experiments with discrete responses. *Am. J. Agric. Econ.* **1984**, *66*, 332–341. [CrossRef]
27. Shee, A.; Azzarri, C.; Haile, B. Farmers' Willingness to Pay for Improved Agricultural Technologies: Evidence from a Field Experiment in Tanzania. *Sustainability* **2019**, *12*, 216. [CrossRef]
28. Hanemann, W.M. Some issues in continuous-and discrete-response contingent valuation studies. *Northeast. J. Agric. Resour. Econ.* **1985**, *14*, 5–13. [CrossRef]
29. Hanemann, M.; Loomis, J.; Kanninen, B. Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation. *Am. J. Agric. Econ.* **1991**, *73*, 1255–1263. [CrossRef]
30. Zhou, Y.; Chen, H.; Xu, S.; Wu, L. How cognitive bias and information disclosure affect the willingness of urban residents to pay for green power? *J. Clean. Prod.* **2018**, *189*, 552–562. [CrossRef]
31. Xie, B.C.; Zhao, W.; Yin, Z.L.; Xie, P. How much will the residents pay for clean energy? Empirical study using the double bound dichotomous choice method for Tianjin, China. *J. Clean. Prod.* **2019**, *241*, 118208. [CrossRef]
32. Calia, P. Bias and Efficiency of Single vs Doublebound models for Contingent Valuation Studies: A Montecarlo Analysis. *CRENOS* **1998**. [CrossRef]
33. Powe, N.A.; Willis, K.G.; Garrod, G.G. Difficulties in valuing street light improvement: Trust, surprise and bound effects. *Appl. Econ.* **2006**, *38*, 371–381. [CrossRef]
34. Boyle, K.J.; Bishop, R.C.; Welsh, M.P. Starting point bias in contingent valuation bidding games. *Land Econ.* **1985**, *61*, 188–194. [CrossRef]
35. Entele, B.R. Analysis of households' willingness to pay for a renewable source of electricity service connection: Evidence from a double-bounded dichotomous choice survey in rural Ethiopia. *Heliyon* **2020**, *6*, e03332. [CrossRef]

36. Solino, M.; Vazquez, M.X.; Prada, A. Social demand for electricity from forest biomass in Spain: Does payment periodicity affect the willingness to pay? *Energy Policy* **2009**, *37*, 531–540. [CrossRef]
37. Aikoh, T.; Shoji, Y.; Tsuge, T.; Shibasaki, S.; Yamamoto, K. Application of the double-bounded dichotomous choice model to the estimation of crowding acceptability in natural recreation areas. *J. Outdoor Recreat. Tour.* **2018**. [CrossRef]
38. Gelo, D.; Koch, S.F. Contingent valuation of community forestry programs in Ethiopia: Controlling for preference anomalies in double-bounded CVM. *Ecol. Econ.* **2015**, *114*, 79–89. [CrossRef]
39. Latinopoulos, D.; Mallios, Z.; Latinopoulos, P. Valuing the benefits of an urban park project: A contingent valuation study in Thessaloniki, Greece. *Land Use Policy* **2016**, *55*, 130–141. [CrossRef]
40. Chen, K.J.; Marsh, T.L.; Tozer, P.R.; Galinato, S.P. Biotechnology to sustainability: Consumer preferences for food products grown on biodegradable mulches. *Food Res. Int.* **2019**, *116*, 200–210. [CrossRef]
41. Mostafa, M.M. Egyptian consumers' willingness to pay for carbon-labeled products: A contingent valuation analysis of socio-economic factors. *J. Clean. Prod.* **2016**, *135*, 821–828. [CrossRef]
42. Bell, E.; Bryman, A.; Harley, B. *Business Research Methods*; Oxford University Press: Oxford, UK, 2018; ISBN 0198809875.
43. Van Kempen, L.; Muradian, R.; Sandóval, C.; Castañeda, J.P. Too poor to be green consumers? A field experiment on revealed preferences for firewood in rural Guatemala. *Ecol. Econ.* **2009**, *68*, 2160–2167. [CrossRef]
44. Osburg, V.S.; Appelhanz, S.; Toporowski, W.; Schumann, M. An empirical investigation of wood product information valued by young consumers. *J. Clean. Prod.* **2016**, *110*, 170–179. [CrossRef]
45. Laureati, M.; Proserpio, C.; Jucker, C.; Savoldelli, S. New sustainable protein sources: consumers'willingness to adopt insects as feed and food. *Ital. J. Food Sci.* **2016**, *28*. [CrossRef]
46. Palmieri, N.; Perito, M.A.; Macrì, M.C.; Lupi, C. Exploring consumers' willingness to eat insects in Italy. *Br. Food J.* **2019**, *121*, 2937–2950. [CrossRef]
47. Palmieri, N.; Perito, M.A. Consumers' Willingness To Consume Sustainable and Local Wine in Italy. *Ital. J. Food Sci.* **2020**, *32*, 222–233.
48. Aguilar, F.X.; Cai, Z. Conjoint effect of environmental labeling, disclosure of forest of origin and price on consumer preferences for wood products in the US and UK. *Ecol. Econ.* **2010**, *70*, 308–316. [CrossRef]
49. Wöhler, M.; Andersen, J.S.; Becker, G.; Persson, H.; Reichert, G.; Schön, C.; Schmidl, C.; Jaeger, D.; Pelz, S.K. Investigation of real life operation of biomass room heating appliances—Results of a European survey. *Appl. Energy* **2016**, *169*, 240–249. [CrossRef]
50. Altamore, L.; Ingrassia, M.; Columba, P.; Chironi, S.; Bacarella, S. Italian Consumers' Preferences for Pasta and Consumption Trends: Tradition or Innovation? *J. Int. Food Agribus. Mark.* **2019**, 1–24. [CrossRef]
51. Ceschi, S.; Canavari, M.; Castellini, A. Consumer's Preference and Willingness to Pay for Apple Attributes: A Choice Experiment in Large Retail Outlets in Bologna (Italy). *J. Int. Food Agribus. Mark.* **2017**, 1–18. [CrossRef]
52. Ingrassia, M.; Sgroi, F.; Tudisca, S.; Chironi, S. Study of Consumer Preferences in Regard to the Blonde Orange Cv. Washington Navel "Arancia Di Ribera PDO". *J. Food Prod. Mark.* **2017**, *23*, 799–816. [CrossRef]
53. Paletto, A.; Notaro, S.; Pastorella, F.; Giacovelli, G.; Giovannelli, S.; Turco, R. Certificazione forestale in Calabria: Attitudini, preferenze e disponibilità a pagare delle imprese di seconda trasformazione del legno. *For. Silvic. For. Ecol.* **2017**, *14*, 107. [CrossRef]
54. Jensen, K.L.; Jakus, P.M.; English, B.C.; Menard, J. Consumers' willingness to pay for eco-certified wood products. *J. Agric. Appl. Econ.* **2004**, *36*, 617–626. [CrossRef]
55. Vásquez Lavin, F.; Barrientos, M.; Castillo, Á.; Herrera, I.; Ponce Oliva, R.D. Firewood certification programs: Key attributes and policy implications. *Energy Policy* **2020**, *137*. [CrossRef]
56. Carson, R.T. Three Essays on Contingent Valuation. Ph.D. Thesis, Iowa State University, Ames, IA, USA, 1985.
57. Brondi, L. *L'utilizzazione delle Surveys per la Stima del Valore Monetario del Danno Ambientale: Il Metodo della Valutazione Contingente*; Contributi ISTAT; Istituto Nazionale di Statistica: Rome, Italy, 2006.
58. Team, R.C. *Development Core Team. R: A Language and Environment for Statistical Computing*; R Foundation for Statistical Computing: Vienna, Austria, 2019.
59. Nakatani, T. DCchoice: A package for analyzing dichotomous choice contingent valuation data. In Proceedings of the R User Conference useR! 2013, Albacete, Spain, 10–12 July 2013; University Castilla-La Mancha: Albacete, Spain, 2013; Volume 10, p. 113.

60. Agurto Adrianzén, M. Improved cooking stoves and firewood consumption: Quasi-experimental evidence from the Northern Peruvian Andes. *Ecol. Econ.* **2013**, *89*, 135–143. [CrossRef]
61. Ozanne, L.K.; Vlosky, R.P. Willingness to pay for environmentally certified wood products: A consumer perspective. *For. Prod. J.* **1997**, *47*, 39–48.
62. Diamond, P.A.; Hausman, J.A. On contingent valuation measurement of nonuse values. *Conting. Valuat. A Crit. Assess.* **1993**, *220*, 3–38.
63. Kniivilä, M. Users and non-users of conservation areas: Are there differences in WTP, motives and the validity of responses in CVM surveys? *Ecol. Econ.* **2006**, *59*, 530–539. [CrossRef]
64. Carson, R.T.; Flores, N.E.; Meade, N.F. Contingent valuation: Controversies and evidence. *Environ. Resour. Econ.* **2001**, *19*, 173–210. [CrossRef]
65. Turpie, J.K. The existence value of biodiversity in South Africa: How interest, experience, knowledge, income and perceived level of threat influence local willingness to pay. *Ecol. Econ.* **2003**, *46*, 199–216. [CrossRef]
66. Ansong, M.; Røskaft, E. Local communities' willingness to pay for sustainable forest management in Ghana. *J. Energy Nat. Resour. Manag.* **2014**, *1*, 80–87.
67. Aguilar, F.X.; Vlosky, R.P. Consumer willingness to pay price premiums for environmentally certified wood products in the U.S. *For. Policy Econ.* **2007**, *9*, 1100–1112. [CrossRef]
68. Bhattacharya, S.C.; Salam, P.A. Low greenhouse gas biomass options for cooking in the developing countries. *Biomass Bioenergy* **2002**, *22*, 305–317. [CrossRef]
69. Ouedraogo, B. Household energy preferences for cooking in urban Ouagadougou, Burkina Faso. *Energy Policy* **2006**, *34*, 3787–3795. [CrossRef]
70. Davidar, P.; Sahoo, S.; Mammen, P.C.; Acharya, P.; Puyravaud, J.-P.; Arjunan, M.; Garrigues, J.P.; Roessingh, K. Assessing the extent and causes of forest degradation in India: Where do we stand? *Biol. Conserv.* **2010**, *143*, 2937–2944. [CrossRef]
71. Stanturf, J.A.; Vance, E.D.; Fox, T.R.; Kirst, M. Eucalyptus beyond its native range: Environmental issues in exotic bioenergy plantations. *Int. J. For. Res.* **2013**, *2013*. [CrossRef]
72. Gómez, W.; Salgado, H.; Vásquez, F.; Chávez, C. Using stated preference methods to design cost-effective subsidy programs to induce technology adoption: An application to a stove program in southern Chile. *J. Environ. Manag.* **2014**, *132*, 346–357. [CrossRef]
73. Gómez, W.; Chávez, C.; Salgado, H.; Vásquez, F. Lessons from a pilot program to induce stove replacements in Chile: Design, implementation and evaluation. *Environ. Res. Lett.* **2017**, *12*, 115001. [CrossRef]
74. Damette, O.; Delacote, P. Unsustainable timber harvesting, deforestation and the role of certification. *Ecol. Econ.* **2011**, *70*, 1211–1219. [CrossRef]
75. Henne, A. Green lungs: Good firewood, healthy air, and embodied forest politics. *Environ. Plan. A* **2010**, *42*, 2078–2092. [CrossRef]
76. Chironi, S.; Bacarella, S.; Altamore, L.; Ingrassia, M. Quality Factors Influencing Consumer Demand for Small Fruit by Focus Group and Sensory Test. *J. Food Prod. Mark.* **2017**, *23*, 857–872. [CrossRef]