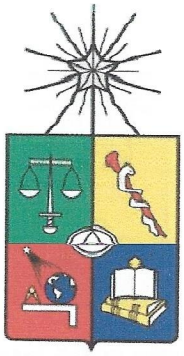

"DISPOSICIÓN A PAGAR PARA PROTEGER BIODIVERSIDAD EN PLANTACIONES FORESTALES: UN RESULTADO DE VALORACIÓN CONTINGENTE"

Seminario de Titulo entregado a la Universidad de Chile en cumplimiento parcial de los requisitos para optar al título de Biólogo con mención en medio Ambiente.

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Se informa a la Escuela de Pregrado de la Facultad de Ciencias, de la Universidad de Chile que el Seminario de Título, presentado por la Sr. Nicolás Antonio Gómez Fernández.

"DISPOSICIÓN A POR PAGAR PARA PROTEGER BIODIVERSIDAD EN PLANTACIONES FORESTALES: UN RESULTADO DE VALORACIÓN CONTINGENTE"

Ha sido aprobado por la Comisión de Evaluación, en cumplimiento parcial de los requisitos para optar al Título de Biólogo con mención en Medio Ambiente.

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Evaluador

Santiago de Chile, Abril 2013

"Tengo una pregunta que a veces me tortura: ¿Estoy loco yo o los locos son los demás?"

Albert Einstein

Agradecimientos

A mi familia que siempre me ha apoyado y ayudado en todo lo que han podido.

A Romina Acevedo, Nahuel Canelo, Paulina Herrera, Valentina García, Camila Palacios, Diego Peñaranda, Constanza León y Tomás Poch por ayudarme.

A los 525 encuestados que amablemente regalaron cinco minutos de su vida para que yo pudiera completar esta tesis.

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Todos aquellos que teniendo tiempo no quisieron responder mi encuesta.

INDEX OF CONTENTS

INDEX OF TABLES

INDEX OF FIGURES

DISPOSICIÓN A PAGAR PARA CONSERVAR BIODIVERSIDAD EN PLANTACIONES FORESTALES: UN RESULTADO DE VALORACIÓN CONTINGENTE

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Resumen

Plantaciones que mantengan un sotobosque desarrollado ayudan a conservar biodiversidad en áreas destinadas a producción, ya que la riqueza y abundancia de aves y mamíferos aumenta en plantaciones con sotobosque comparadas con plantaciones estructuralmente más simples. Sin embargo, un sotobosque desarrollado podría implicar una disminución de la rentabilidad ya sea por reducciones en la productividad del sitio o aumentos en costos. Si la ciudadanía valorase el incremento en biodiversidad, ella podría asumir parte de este costo pagando más por productos forestales amigables con la biodiversidad. Este trabajo determina si existe una valoración por incrementos en biodiversidad a través de la estimación de la disposición a pagar (DAP) por conservar biodiversidad en plantaciones forestales mediante el Método de Valoración Contingente.

En 525 encuestas en Santiago, Chile, se evalúa la DAP por productos de consumo masivo: cuadernos y tableros de melamina. Las personas presentan una DAP de 130% más que el precio original por cuadernos y 80% más por tableros de melamina, si éstos provienen de plantaciones que ayuden a conservar biodiversidad. La disposición a pagar depende positivamente del nivel educacional, y la frecuencia de uso incide positivamente en el precio por tableros pero negativamente por cuadernos. Plantaciones forestales que conserven biodiversidad son entonces más valoradas y existiría apoyo social para asumir parte de los costos, facilitando el cumplimiento de las Metas de Aichi, las que establecen que las zonas destinadas a plantaciones forestales deberán gestionarse de manera que garanticen la conservación de la biodiversidad.

Abstract

Plantations that maintain a developed understory help preserve biodiversity in areas for production, because the richness and abundance of birds and mammals increases in plantations with understory compared with plantations that are structurally simpler. However, a developed understory could lead to a reduction in profitability either by reductions in site productivity or cost increases. If citizens were willing to valuing an increase of biodiversity, it could pick up some of this cost by paying more for forest products that are biodiversity friendly. We determine whether there is a valuation for an increase in biodiversity by estimating the willingness to pay (WTP) for conserving biodiversity in plantation forests by the Contingent Valuation Method.

Applying 525 surveys in Santiago, Chile, we evaluated the WTP for massive consumer products: notebooks and melamine boards. People have a WTP 130% higher than the original price for notebooks and 80% higher for melamine boards, when they come from plantations that help to conserve biodiversity. The willingness to pay depends positively on the level of education, and the frequency of use has a positive effect on the price per board but a negative effect for notebooks. Forest plantations that conserve biodiversity are valued and thus there is a social support to bear part of the costs of conserving biodiversity, facilitating compliance with the Aichi Targets, which state that areas under forest plantations should be managed so as to ensure the conservation of biodiversity.

1. Introduction

Land-use and land-use change is an important form of global pressure affecting biodiversity (e.g. Sala et al., 2000, Zebisch et al., 2004). Thus, land-use change, once considered as a local issue, has become an issue of global importance (Foley et al., 2005). Research on the impacts of land-use change on biodiversity has focused mainly on broad categories such as agriculture and forest plantations, among others. For example, FAO (2006) focusing on the broad category of forest plantations shows that this driver of biodiversity loss has increased by about 2.8 million hectares per year in the period 2000–2005, 87 percent of which are productive forest plantations. This growth rate is likely to increase at an accelerating rate in conjunction with increasing human populations and demand for wood (Paquette *et al.,* 2010). Additional pressures on biodiversity conservation come from increased demand for plantation forests as a climate change mitigation strategy through 'carbon forestry' and also due to the potential use of timber as a source for biofuel (Brockerhoff *et al.*, 2010).

However, less attention has been paid to the impacts of different intensities of land-use (e.g. Sala *et al.,* 2000). In general, forest plantations have been considered to be homogenous matrices but in practice, there is a large heterogeneity in forest systems and management practices. For example, monoculture forest plantation systems have negatively influenced biodiversity (Hartley *et al.*, 2002), since they usually support fewer species than the original native forest (Allen *et al*, 1995). In recent years attention has shifted from global trends of land-use change to forest management systems searching for methods that protect biodiversity within plantations and surrounding landscapes

(Hartley, 2002; Lindenmayer and Hobbs, 2004; Carnus *et al.*, 2006, Brockerhoff *et al.*, 2008).

Forest plantations today are thus expected to be productive but at the same time managed sustainably conserving biodiversity, as agreed in the Aichi Target 7 of the Convention of Biological Diversity (CBD 2010). To be ecologically sustainable, forestry plantations must perpetuate ecosystems processes which, in turn, depend on species richness, composition and abundance (Lindenmayer *et al.*, 2000). A way to achieve this objective is to increase the structural complexity of plantations, such as allowing for the existence of a well-developed understory, rendering forest plantations as multi-purpose plantations ensuring both the production of goods and the conservation of biodiversity and thus mitigate the negative impacts of forestry (Paquette *et al.*, 2010).

Increasing evidence shows that forest plantations with a developed understory increases species richness and abundance of birds and mammals and act as biological corridors (Lindenmayer *et al.*, 2000; Nájera and Simonetti, 2010; Ramírez and Simonetti, 2011). Recent studies have researched changes in species richness and in the abundance of the avifauna and mammals between monoculture forest plantation systems without an understory and multipurpose forest plantations that are structurally more complex (Nájera and Simonetti, 2010; Ramírez and Simonetti, 2011). These studies show that species richness and mammals abundance increased by 90% and 60% of cases respectively in structurally complex plantations compared to simples ones and, in the case of birds, species richness and abundance increased by 80% and 90%, of cases respectively in structurally complex plantations compared to simples ones (Nájera and Simonetti, 2010; Ramírez and Simonetti, 2011). The presence of a

developed understory could then enhance the occurrence of native fauna in planted forests, contributing the fulfillment of the Aichi targets.

However, the presence of a well-developed understory generates competition between these plants and forested trees, potentially resulting in a lower tree biomass yields at harvest (Matsushima and Chang, 2006). Therefore, a developed understory as a biodiversity-friendly practice could involve a reduction in profitability (Foley *et al.* 2005). Such a loss could be compensated if a portion in the case that buyers are willing to pay premium price for wood products derived from forest plantations that ensure the conservation of biodiversity by allowing for a fully developed understory (Vlosky *et al.*, 1999). This will be the case if consumers prefer environmentally friendly products (Campello *et al.*, 2011; Laroche *et al.*, 2001).

Research has been conducted to estimate consumer willingness to pay (WTP) for wood products that conserve biodiversity in a context of developed as well as developing countries (Ozanne and Vlosky; 1997, O'Brien and Tiesl, 2003; Shukri and Awang Noor, 2012). The results show that eco-labeled products are preferred to non-certified products, since the certification ensures sustainable productive practices (Ozanne and Vlosky, 1997). Consumer's willingness to pay for environmentally certified wood products that ensures biodiversity conservation has been estimated employing the contingent valuation method and results show that consumers are willing to pay a premium price for certified wood products; consumer's WTP presents a range from 4.4 to 18.7 percent of the current price for biodiversity certified wood products (Ozanne and Vlosky, 1997). This range can be explained by the influence of different willingness to pay determinants such as age, education, income, social and cultural background

(Ozanne and Vlosky, 1997). This paper contributes to the discussion of WTP for the adoption of biodiversity conservation measures in forest plantations in the context of a developing country.

This study estimates consumer's WTP for biodiversity conservation certified wood products and addresses the question of the determinants of this WTP in Chile, a country that has experienced a notable forestry boom in Latin America. The forestry sector has presented an annual average GDP growth of US $38.4 million per year since 2003 accounting, at present, for approximately 20% of Chile's exports and 4% of its gross domestic product, GDP (Infor, 2011). This sector's imports increased at an average annual growth rate of US $16.7 million over the past 10 years, with the exception of the year 2009, when imports decreased. Finally, Chile presents a positive trade balance in forest products which has increased steadily during the past 10 years, reaching U.S. $4.9 billion in 2011 (Infor, 2011)

Forest industry is characterized by large-scale, management-intensive monocultures of *Eucalyptus globulus* and *Pinus radiata* (Paquette *et al.*, 2010). These species account for 92.4% of the total forest plantation surface in Chile in 2010 (Infor, 2010).

Previous research on the social preferences for different habitats and citizen´s opinion concerning the interaction between pine plantations and biodiversity, has found that Chileans prefer plantations that maintain a developed understory over structurally simple plantations, and would be willing to pay premium prices for products that come from biodiversity-friendly plantations (Püschel-Hoeneisen and Simonetti, 2012). However, it is unknown how much more they are willing to pay and how this decision

would be affected by factors such as age, socio-economic level and education of the consumers.

It is important to note that the benefits of biodiversity conservation are public goods that are characterized by non-exclusion and non-rivalry. It is for this reason that under regular market conditions there are no incentives to take these benefits into account. However, if producers can certify that their wood based products are from forest plantations that maintain a developed understory and, thus, help conserve biodiversity, then consumers who value these benefits will prefer these products and be willing to pay a premium price for these products. This incentive mechanism for forest firms to allow for a developed understory in their plantations will be feasible only if the revenues accrued to this price premium at least compensate the increased production costs associated to this forest management scheme. Thus, it is important to assess this willingness to pay for biodiversity conservation management systems in order to determine if such an incentive scheme will contribute to the Aichi targets of the CBD and represents a way to confront the global environmental challenges of land use change and its inherent trade-offs between meeting immediate human needs and maintaining the capacity of ecosystems to provide goods and services for future generations (Foley *et al.*, 2005).

This analysis is based on the econometric estimation of a linear willingness to pay model which allows us to identify its determinants in Chile for two mass consumption products: paper notebooks and melamine boards. Thus, this study addresses the question of the determinants of willingness to pay for certified wood products that

ensure biodiversity conservation in Chile, a country that has experienced one of the most notable forest booms in Latin America (FAO, 2009).

2. Estimation of an individual´s willingness to pay (WTP) for certified wood products that ensure biodiversity conservation

Our choice set is binary in nature. The choices available are: forest plantations with a developed understory versus forest plantations without this developed understory. Recent research shows that the significant increases in species richness and in the abundance of the avifauna and mammals occur in monoculture forest plantation systems that are structurally more complex since they possess a fully developed understory (Nájera and Simonetti, 2010; Ramírez and Simonetti, 2011). That is, a monoculture forest plantation system that possesses a not fully developed understory does not significantly improve biodiversity. Thus, an intermediate scenario is not enough to meet the goal of Aichi 7 of increasing biodiversity conversation and least minimize the damage that this economic activity has done to biodiversity. However, interest has grown in the so called conjoint stated preference methods that do not ask for willingness to pay directly (Holmes and Adamowicz, 2003). The objective of a conjoint stated preference study is to estimate economic values for a technically divisible set of attributes of an environmental good (Holmes and Adamowicz, 2003). Responses to survey questions regarding questions of an environmental good that vary in levels of its attributes can provide resource managers and policy makers with detailed information about public preferences for multiple states of the environment (Holmes and Adamowicz, 2003). However, given the binary choice set, our research

employs a contingent valuation method (CVM) approach to estimate an individual's WTP for products that come from forest plantations that help conserve biodiversity.

As is well known, the proposed scenario in the CVM study is critical for the validity of the estimated WTP. In this study, individuals were presented with a graphic description of plantations with and without a developed understory (Figure 1), and were offered an explanation of the consequences of the developed understory for biodiversity conservation in forest plantations (see next section for more details on the CVM scenario). The interviewer also pointed out that forest plantations with developed understory are less profitable due to potential productivity loss and cost increases (Matsushima and Chang, 2006).

To gather the WTP information, the CVM survey applied a closed-ended take it or leave it elicitation mechanism, since open-ended elicitation has been criticized on validity grounds (Desvousges *et al.*, 1993; NOAA Panel, 1993). Carson *et al.* (2001) points out that open-ended questions tends to lead to a larger number of nonresponses or protest bids since respondents either find it difficult to answer or do not face the proper incentives to provide true answers. Additionally, it is been argued that open-ended questions may lead to strategic bias where people do not reveal their true value since they strategically answer (Hanemann, 1994). A take it or leave it elicitation avoids this bias by confronting respondents with a proposed amount that they are asked to accept or reject (Mitchell and Carson, 1989).

In our survey, each surveyed individual was asked if they would be willing to pay an additional amount of $X/unit of certified biodiversity conservation wood product *i*, over

its market price, where *i* = notebook or melamine panels. The additional value $X is randomly chosen from a range of values for product *i* that are presented in Table I. Contingent Valuation surveys can, and generally do, credibly convey the condition that everyone will have to pay for the good if it is provided for in their taxes or through higher prices for consumer products (Mitchell and Carson, 1989). This condition eliminates much of the free rider incentive that is a prominent feature of strategic behavior (Mitchell and Carson, 1989).

Table I presents the Bid values used for each certified biodiversity conservation wood product *i*, each value represents a premium to be paid over the current price. The surveys were then shuffled in order to insure that the Bid value offered to a selected individual is randomly allocated. Additionally, respondents were shown the current market price as a reference, US$ 1.71 for notebooks and US$ 49.07 for melamine panels. Those values are an average of three prices of different shops.

Table I. Values offered in the study environmentally-friendly products in the surveys in US$. Each figure is the amount of money raised over the current price.

Increased price for Noteboosk	Percentage of increased over current market price	Increased price for melamine panels	Percentage of increased over current market price
0.077	5	2.405	5
0.154	10	4.811	10
0.231	15	7.216	15
0.308	20	9.621	20
1.232	72	24.053	50
1.462	85	30.307	62
1.924	113	32.712	67

Despite its advantages, our single-bounded dichotomous choice approach presents some disadvantages as well. One of the disadvantages is that although protest responses are minimized, they still may occur. Individuals who object to the survey may simply not respond; some may give positive, but invalid bids (outliers); while others may state a zero value for a good that they actually value (protest zero bids). To confront and minimize these disadvantages, we realized a pre-test of in-person surveys (see next section for more details on the Pre-testing of in-person surveys), which allowed us to correct our valuation questions and to clarify the hypothetical scenario.

There are at least three types of potential response categories under the heading of protests, all based on an assumption that these are respondents who do not report their true values. The first category includes people who protest some component of the contingent valuation exercise. These respondents may answer $0, which biases the estimate of central tendency downward (Boyle, 2003). The second category consists of people who do not understand what they are being asked in the survey and who answer the contingent valuation question anyway (Boyle, 2003). The effect of this misunderstanding may not introduce a bias into estimates of central tendency, but increases the standard deviation of the mean estimator (Boyle, 2003). The third category represents people who behave strategically in an attempt to influence survey results and ultimately the policy decision (Boyle 2003). Thus, our CVM survey considers screening questions to identify protest bids where we asked the reason for their negative answer. Our survey registered 15 protest bids (2.9% of the total survey); following Boyle (2003) these invalid responses are not included in the WTP estimation procedure.

Another objective that we consider in this research is the study of the importance of WTP determinants such as age, income, social and cultural background. These variables are often study in this kind of researches (e.g. Moon *et al.*, 2002; Laroche *et al.*, 2001), because their combined results could portray a highly socially conscious person (Laroche *et al.*, 2001). The specific variables considered are presented in Table II.

Table II: Determinants of WTP for certified wood products

WTP Determinant	Type of Variable
Frequency of product use	
Does not use the product	Binary (1 if it is not used, 0 any other case)
Daily	Binary (1 if uses daily, 0 any other case)
Once a week	Binary (1 if uses once a week, 0 any other case)
Once a month	Binary (1 if uses once a month, 0 any other case)
Estimated expenditure on the proposed forest product	Continuous ($\Re_+$)
Gender	Binary (1 if male, 0 if female)
Age	Continuous ($\Re_+$)
Education Level	
Incomplete Primary	Binary (1 if did not complete primary, 0 any other case)
Complete Primary	Binary (1 if completed primary, 0 any other case)
Incomplete Highscool	Binary (1 if did not complete highschool, 0 any other case)
Complete Highschool	Binary (1 if completed highscool, 0 any other case)
Tecnical	Binary (1 if has technical degree, 0 any other case)
University	Binary (1 if has university degree, 0 any other case)
Income Level	Categorized (Each level represents an income range)

The coefficients of these determinants (Table II) were estimated with a logit regression (Wallmo and Lew, 2012). The significance of each individual determinant is estimated with the statistic t-student. The equality of the logit coefficients between those determinants subgroups that are significant is tested with the likelihood ratio test (LRT):

(1) $$LRT = -2 \ln (Lr/Lu)$$

where Lu is the unrestricted maximum likelihood function and Lr is the constrained maximum likelihood function. Under regularity conditions and under Ho: $R(\beta) = 0$, the large sample distribution of the Likelihood Ratio Test is Chi-squared, with degrees of freedom equal to the number of restrictions imposed (Green, 2003).

3. The Biodiversity Conservation Scenario

To give appropriate information about the context of the biological problem, all respondents were shown two scenarios, plantation with and without understory. Both are forest plantations, which sustain low species richness and abundance of animals than the native forests they replace (e.g. Chazdon et. al., 2009; Pimentel et al, 1992). Since we are interested in estimating an individual´s WTP for a change in production practices of an established forest plantation that helps conserve biodiversity, we do not explore the individual's preference for a natural ecosystem such as native forests. Thus, the choices are an established forest plantation that helps conserve biodiversity versus another that does not.

Scenario A, the plantations without understory, is business as usual, and they are considered biological deserts inasmuch as they usually support fewer species than the original native forest and is the scenario at which there is no change in prices of notebooks and melamine boards. This scenario generates wood products that the respondant can easily find in the market. Scenario B, on the other hand, forest plantations with a developed understory that implies an increase of species richness and abundance of mammals and birds approaching to accomplish the Aichi Target 7 and minimize the damages that this economic activity had produced to biodiversity (Figure 1). However, since this scenario could generate increased production costs and potentially higher equilibrium prices, the respondent is presented with a price premium, and asked whether they are willing to pay this increased price. (Figure 1).

The scenario informs respondents that structural complexity within plantations increases species richness and abundance of the avifauna and mammals assemblages and that there is often a positive correlation between elements of biodiversity and measures of the variety and/or complexity of structural components within an ecosystem (Nájera and Simonetti, 2010; Ramírez and Simonetti, 2011; McElhinny *et al.*, 2005). In the same way, they are informed that it has been recognized that the maintenance of the understory vegetation can improve habitat quality within plantations by providing resources for mammals (Ramírez and Simonetti, 2011; Bellows *et al.* 2001). Resources provided by multiple vegetation layers in plantations can benefit birds from all dietary habits, taxonomic orders, and sizes (Nájera and Simonetti, 2010). This suggests that structural complexity generally triggers higher richness and abundance of avian assemblages in plantations (Nájera and Simonetti, 2010).

Structural complexity within plantations also enhances the connectivity among forests stands and natural ecosystems that allows for the exchange of seeds, pollen and individual animals and it can be important for many processes (Lindenmayer *et al.*, 2000), and could work as biological corridors. This connectivity depends of the retentions of some components of the original vegetation on logged areas within managed forest landscapes (Lindenmayer *et al.*, 2000).

Figure 1. Visual information given to the respondents. A) Forest plantation unfriendly with biodiversity without an understory environment developed and B) forest plantation friendly with biodiversity with a developed understory.

4. Pre-test of in-person surveys

Surveys were pre-tested in order to determine if it contained errors, such as misinterpretation of the questions or that respondents did not understand the problem and the proposed scenarios. Based on the pre-test results, further changes of the scenario description and questions were made in order to count with an effective scenario and diagrams to elicit people's willingness to pay for an additional amount for notebooks or melamine boards that come from plantations that ensure the conservation of biodiversity. Thus we built scenarios as realistic as possible delivering the cultural, intellectual and aesthetic benefits and economic costs to the interviewees of both plantations, so they could make an informed decision. Also, any additional information required by the interviewees was delivered and explained to them personally during the interview.

5. Sample Size and Data Collection

Based on a statistical tolerance formula, sample sizes between 200 and 2500 are probably appropriate (Mitchell and Carson, 1989, Chapter 10, footnote 13, p. 225). The economic academic literature on CV has little more useful to say about sample size (Vaughan and Darling, 2000). However, in the statistic literature, it has been established that for large populations, a representative sample of proportions can be obtained as follows (Cochran, 1963):

(2) $$n = \frac{Z^2 pq}{e^2}$$

where n is the sample size, Z is the abscissa of the normal curve at the desired confidence level, *e.g.*, 95%, e is the desired level of precision, p is the estimated proportion of an attribute that is present in the population, and q is $1-p$. Since there is no prior information on the proportion of the population that presents a higher WTP for certified wood products than the established amount proposed in the survey (Bid levels), this study assumes maximum variance (*i.e.* $p = q = 0.5$). Establishing a confidence interval of 95% and a maximum sample error of 5%, the optimal sample determined is 385 surveys.

Once these 385 surveys were collected in Santiago, Chile, the initial analysis of the sample proportion of the population that presents a higher WTP for certified wood products than the established amount proposed in the survey, $\hat{p}$, was too high indicating that the proposed Bid levels were too low. Additional surveys were then conducted with higher Bid levels in order to reduce $\hat{p}$. Thus, a total of 525 surveys were performed between November 2011 and May 2012 in public places: parks, streets and subway in the municipalities of Santiago, Lampa, Quilicura, Nuñoa, Maipu and San Joaquin in Chile. The only requirement to answer this survey was be over 18 years old. Each respondent answered this survey with their consent and could withdraw if they did not wish to continue answering.

6. Results and Discussion

Respondents were on average 35.4 ± 0.7 (SE) years of age, who spend US$ 41.4 ± 2.8 (SE) on forest products per month. The average income of the respondents was US$ 777.8 ± 26.9 (SE), close to the national mean income of US$ 693 (INE 2009). Of the respondents, 251 were male and 274 were female where the proportion is for every one hundred women we interviewed 92 men, a similar gender ratio as in the Chilean population where for every one hundred women there are 96 men (INE 2011). Regarding the educational status of the respondents, more than 58.0% of them present university studies, 18.9% are from institutes of technical education, 18.3% have complete high school and 4.8% have incomplete high school or less.

Of the sample, 87% of interviewees are willing to pay the presented Bid in case of notebooks, indicating that the great majority of notebook users are willing to pay a higher price for it if they are produced with wood from forest companies that allow the presence of a developed understory in their forest plantations so as to contribute to biodiversity conservation. In the case of melamine boards, 65% of interviewees are willing to pay the presented Bid. This is a lower proportion than the case of notebooks, possibly because it is already an expensive product with a lower consumption frequency. In fact, the price of each unit of notebooks represents only the 0,2% of the income, but the price of each unit of melamine board equals 6,7% of the income of the sampled population. Fifteen protest bids were registered and these surveys were not considered in the analysis.

6.1. Notebooks

The estimation of the determinants of the WTP for notebooks that are produced with wood from plantation forests that ensure the conservation of biodiversity is presented in Table III. With respect to the frequency of use of notebooks, we dropped the binary variable that identifies individuals who do not use notebooks in order to avoid perfect multicolineality. Of the respondents of the surveys whose elicitation mechanism are notebook prices, 57.1% use them every day, 23.8% use them once a week, 10.3% use notebooks once a month and 8.8% never use notebooks. Only the parameter associated with a weekly frequency of use is significant at a 10% level of significance (Table III). The parameter estimate for this binary variable is -1.36 , indicating that with respect to non-users, the probability of accepting the proposed Bid level is lower (Table III). This result is intuitive since a higher frequency of use implies a higher total expenditure on notebooks and, thus, a higher price has a greater impact on the individual's budget constraint. However, an even higher frequency of daily use is not significant, which is counterintuitive given the previous result (Table III). This could, in part, be explained by the insignificance of the parameter estimate associated with the expenditure on forest products; but this argument would imply that all use frequency parameters should not be significant, which is not the case. Another explanation could be that the higher percentage of people with university or technical degree are daily users of notebooks, being the education an important determinant of the willingness to accept a higher price for notebooks from certified forests. Alternative formulations of this determinant should be tested in future research in order to evaluate its importance in accepting to pay a higher price for biodiversity conservation certified notebooks.

Gender is a significant determinant at the 5% level of significance (Table III). Its point estimate indicates that males are less willing to accept higher prices for notebooks that are produced with wood from biodiversity conservation certified forest plantations. However, this variable is not often reported in valuation studies as a variable that significantly affects the preference for natural environment or the willingness to pay for environmental friendly products or to conserve biodiversity. Notwithstanding, in general, women are more environmentally concerned, usually willing to pay more for environmentally-friendly products (Laroche *et al.*, 2001).

Education is an important determinant of the willingness to accept a higher price for notebooks from certified forests. There is no significant difference between individuals with incomplete o complete primary education (Table III). However, all other levels of education present a higher probability of accepting a higher notebook price (Table III). Nevertheless, a price increase will not be equally accepted by people who have high school (Likelihood Ratio Test = 16.3, df = 2, X^2 = 5.99 at 95% confidence) or institute of technical education and university together (Likelihood Ratio Test = 18.7, df= 2, X^2 = 5.99 at 95% confidence). This effect coincides with our expectations under the hypothesis that higher education is correlated with a greater environmental awareness and, thus, a greater WTP for products that contribute to conserve biodiversity. The educational level could be associated to the level of knowledge and understanding about environmental problems and how those problems affect our lives. Hence, with more education, people would be more concerned about environmental problems and would be more willing to pay for environmentally-friendly products. However, while education sometimes does affect willingness to pay (Cerda, 2011; Sanchez *et al.*,

2001), it often does not (Loomis *et al.*, 2001; Laroche *et al.*, 2001), which suggests it might be product or service-dependent.

On the other hand, age and income and levels are not significant determinants that affect the probability of accepting the proposed Bid for notebooks. Age is not significant in determining the probability that an individual will accept the proposed Bid level (Table III). This contradicts studies where age was significant (Ozanne and Vlosky's 1997). In some other studies the age of the respondents did not affect willingness to pay (Loomis *et al.*, 2000).

It is noteworthy that income is also not significant (Table III) which could imply that respondents value more important the benefits for biodiversity than the extra expenses. This result contrast with most WTP studies which found that income is a significant determinant and that its effect on the probability of accepting the presented Bid is positive (Cerda, 2011; Lee and Chun, 1999; but see Laroche *et al.*, 2001). This could imply that Chileans environmental concern is increasing in all incomes levels.

The higher the Bid value the lower the probability of accepting the proposed price increase for notebooks from certified forests. The estimate associated with the Bid value is significant at the 1% level. (Table III).

The estimates of WTP indicate that people are willing to pay on average US$ 2.2 ± 0.1, an approximately 131% more than the current price for notebooks that come from forest plantations that are friendly with the environment and have a developed understory. Additionally, the WTP median is US$ 2.1.

Table III. Results of the logit model for notebooks

	Coefficcient.	t- student	p	β
Bid	-2.1E-03	-5.01	<<0.01	-
Use it Every Days	-1.28	-1.64	0.11	-607.19
Use it Once a week	-1.36	-1.71	0.09	-649.18
Use it Once a month	-1.07	-1,22	0.22	-508.86
Expenditure on products	-1.23E-06	-0.38	0.71	<<-0.01
Gender	-0.59	-1.99	0.05	-279.12
Age	-0.01	-0.30	0.98	-0.20
Complete school	15.47	0.02	0.99	7360.02
Incomplete high school	3.29	2.19	0.03	1562.30
Completa high school	3.29	2.49	0.01	1562.61
Technical education	3.13	2.38	0.02	1490.24
University education	3.53	2.65	0.01	1682.25
Income	0.09	1.58	0.12	42.98
Constant	0.34	0.21	0.83	-

6.2 Melamine boards

The estimation of the determinants of the WTP for melamine boards that are produced with wood from plantation forests that ensure the conservation of biodiversity are presented in Table IV.

With respect to the frequency of use of melamine boards, we dropped the binary variable that identifies individuals who do not use melamine boards in order to avoid perfect multicolineality. Of the respondents of the melamine board survey, 47.8% use them every day, 8.9% use them once a week, 9.7% use melamine boards once a month and 33.5% never use them. Only the parameter associated with a daily frequency of use is significant at a 5% level of significance (Table IV). The parameter

estimate for this binary variable is 0.45, indicating that with respect to non-users, the probability of accepting the proposed Bid level is higher (Table IV). This result could be counterintuitive since a higher frequency of use would imply a higher total expenditure on melamine boards; however, the purchase frequency is low, because they are more durable than notebooks, so the people do not need buy it periodically. This could in part be explained by the insignificance of the parameter estimate associated with the expenditure on forest products, but this argument would imply that all use frequency parameters should not be significant, which is not the case (Table IV). Alternative formulation of this determinant could be that respondents who use it daily value more biodiversity conservation than those who use it less. However, this hypothesis should be tested in future research in order to evaluate its importance in accepting to pay a higher price for biodiversity conservation certified melamine boards.

Education is an important determinant of the willingness to pay a higher price for melamine boards from forest plantations that ensure the conservation of biodiversity. There is no significant difference between individuals with incomplete, complete primary education and incomplete high school (Table IV). However, all other levels of education present a higher probability of accepting higher melamine boards prices at a 10% level of significance (Table IV). But, an increase of price for this product would not be equally accepted by people that have studies in institutes of technical education or in university than those who do not have higher education levels (Likelihood Ratio Tests = 8.05, df= 3, X^2 = 7.81 at 95% confidence). Similarly as in the case of notebooks, this effect coincides with our expectations under the hypothesis that higher education is correlated with greater environmental awareness and, thus, a greater WTP for products that contribute to conserve biodiversity. This result also follows the trend of other studies

that conclude that the educational level significantly affects the willingness to pay for environmentally friendly food (Sanchez *et al.*, 2001), although education does not always affect willingness to pay for environmental friendly products (Laroche *et al.*, 2001).

On the other hand, gender, age and income levels are not significant determinants that affect the WTP higher prices of melamine boards (Table IV). Gender is not significant in determining the probability that an individual will accept the proposed Bid level, which is consistent with other studies (Loomis *et al.*, 2000; Sanchez *et al.*, 2001), but contrary to our results for notebooks . The fact that age and income do not affect the willingness to pay for melamine boards, as in the case of notebooks, could suggest that concern about current environment problems is age and income independent (e.g., Laroche *et al.*, 2001; but see Loomis *et al.*, 2000; Cerda, 2011; Lee and Chun, 1999).

As was the case for notebooks, the higher the Bid value the lower the probability of accepting the proposed price increase for melamine boards from certified forests. The estimate associated with the Bid value is significant at the 1% level. (Table IV).

The estimates of WTP indicate that people are willing to pay on average US$ 41.0 ± 0.2, an approximately 84% more than the current price for melamine boards, that come from forest plantations that are friendly with the environment and have a developed understory in their forest plantations. The median WTP is US$ 41.6.

Table IV. Results of the logit model for melamine boards

	Co-efficient.	t-student	p	β
Bid	-1.2E-04	-6.54	<<0.01	-
Use it Every Days	0.45	1.96	0.05	-3565.92
Use it Once a week	-0.40	1.04	0.30	-3141.85
Use it Once a month	0.05	-0.14	0.89	400.46
Expenditure on products	4.27E-06	1.33	0.18	-0.03
Gender	0.01	-0.05	0.96	-85.33
Age	-0.01	0.95	0.34	-64.93
Complete school	1.63	0.96	0.34	12812.27
Incomplete high school	1.76	1.31	0.19	13913.38
Completa high school	2.11	1.69	0.09	16603.62
Technical education	2.03	1.63	0.10	16038.60
University education	2.01	1.60	0.10	15848.12
Income	0.01	0.35	0.726	103.04
Constant	-1.16	-0.89	0.374	-

7. Final comments

Change in land use is the main cause of biodiversity loss. Forestry activities is a major land use change that , implies the transformation of a natural ecosystem into artificially managed productive areas (Sala *et al.*, 2000; FAO, 2006). In addition, most forest plantations have been monocultures, which usually support less biodiversity than original ecosystems (Paquette *et al.*, 2010; Allen *et al.*, 1995). This biodiversity loss implies, also, a reduction of human welfare (Chapin *et al*, 2000).

However, it has been shown that developing understory vegetation within forest plantations could minimize these negative impacts on biodiversity, because more complex plantations can support more biodiversity than simple ones (Nájera and Simonetti, 2010; Ramírez and Simonetti, 2011). However, this practice could increase the prices of forest product, by potentially reducing productivity of the plantation, emerging from competition between the trees and understory (Foley *et al.* 2005; Matsushima and Chang, 2006). Based on econometric approaches, we have assessed that Chileans are willing to pay up to 130% more for forest products derived from biodiversity-friendly plantations. Additionally, our results show that the determinants that affect this willingness to pay are product-dependent.

This is not an isolated case. People in many countries are concerned about environmental problems and are willing to pay more for products if the production of these are environmental friendly (Campello *et al.*, 2011; Laroche *et al.*, 2001). Such products must be labeled as environmentally-friendly, certified by an independent third party, such as the Forest Stewardship Council (FSC) or from Sustainable Forestry Initiative (SFI) (Rickenbach and Overdevest, 2006), so producers provide the missing market information about production process attributes with the eco-labeling (Laroche *et al.*, 2001; Moon *et al.*, 2002).

The trend present in USA and European countries that Eco-labeled products and organic products, such as food, are rapidly proliferating, is an indication of consumer's WTP for these "environmentally friendly" products (Loureiro *et al.*, 2001; Sanchez *et al.*, 2001; Moon *et al.*, 2002). Studies also show that customers are willing to pay more for

certified wood products that come from forest plantations that are handled sustainably (Ozanne and Vloksky, 1997).

Our results are consistent with these studies, since we find that wood product cunsumers are willing to pay an additional amount for these products when they come from forest plantations with a developed understory that helps conserve biodiversity. Thus, if there is any extra cost associated to leaving a developed understory in forest plantations so as to ensure the conservation of biodiversity as requested in the target 7 of Aichi targets, Chileans are willing to make a financial effort to compensate forest operations that conserve biodiversity, by paying more for notebooks and melamine boards. Therefore, this work demonstrates that sustainable forestry is feasible and social and economic support exists for production systems that adopt biodiversity conservation approaches such as leaving a developed understory.

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APPENDIX 1

VALORACIÓN ECONÓMICA DE LA CONSERVACIÓN DE BIODIVERSIDAD EN PLANTACIONES FORESTALES

INFORMACIÓN A ENTREGAR VERBALMENTE A CADA POTENCIAL ENTREVISTADO ANTES DE REALIZAR LA ENCUESTA

Mi nombre es Nicolás Gómez. Soy alumno de pregrado de la Universidad de Chile y estoy realizando una investigación para entender mejor la forma en que podemos realizar acciones destinadas a conservar la diversidad. El proyecto se llama "Plantaciones forestales como hábitat de fauna" y es financiado por el Fondo Nacional de Desarrollo Científico y Tecnológico mediante su proyecto Fondecyt 1095046. El investigador responsable de este proyecto es el Dr. Javier Andrés Simonetti, académico de la Facultad de Ciencias, Universidad de Chile. Este proyecto y la encuesta que realizamos ha sido aprobada por los Comité de Ética de la Facultad de Ciencias de la Universidad de Chile y de Fondecyt. Los nombres y número de teléfonos del Dr. Simonetti y los encargados de los Comités de Ética aparecen al pie de la encuesta en caso Usted los requiera. El proyecto tiene como objetivo conocer si es posible que las plantaciones sean manejadas para que sean sustentables ambiental, económica y socialmente. Para un mayor conocimiento de las medidas a implementar, se le mostrarán dos escenarios posibles: a) una plantación donde no es factible proteger biodiversidad y b) una plantación donde es factible proteger algo de biodiversidad chilena.

Es importante destacar que la plantación forestal donde es factible proteger algo de biodiversidad implica mayor costo de producción provocando un aumento del precio de los productos provenientes de ellas. De esta manera, el mayor costo de proteger algo de biodiversidad chilena es compartido entre las empresas forestales y los consumidores.

En este contexto, primero, me interesa conocer si usted utiliza productos provenientes de plantaciones forestales. Segundo, me interesa conocer si está dispuesto a pagar más por estos productos con tal de que ese dinero sea utilizado para ayudar a minimizar los impactos del cambio de bosque nativo a plantación forestal manteniendo así una mayor biodiversidad. Por último le haré preguntas de carácter socio-económicos que nos permiten caracterizar el público que responde esta encuesta.

La información que usted me entregue será utilizada exclusivamente en este estudio, sin ningún costo, riesgo o beneficio para usted o los investigadores. La información será manejada confidencialmente y el resultado del análisis de la información será utilizado en mi proyecto de tesis para luego ser publicado en una revista científica, sin revelarse los nombres de los entrevistados para mantener su anonimato. La información será almacenada en el Laboratorio de Conservación Biológica de Facultad de Ciencias, bajo responsabilidad del Dr. Javier Simonetti y no será usada para ningún otro fin que el presente proyecto.

La duración de la encuesta es de un máximo de 10 minutos. Si decide colaborar, le agradezco me firme su consentimiento en la hoja de respuestas. Por supuesto, Usted puede retirarse cuando lo desee sin dar explicación alguna. En este caso, los datos serán almacenados pero no serán empleados en los análisis. Para el estudio usaremos solamente las encuestas respondidas en su totalidad y exclusivamente aquellas provenientes de este estudio.

Esperamos nos ayude al responder las preguntas

<independiente de su participación, se agradece el tiempo prestado a esta entrevista>

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Estoy de acuerdo en responder este cuestionario. Declaro que lo hago voluntariamente, y que se me ha otorgado verbalmente toda la información necesaria para entender los objetivos y alcances de este estudio.

NOMBRE..... FIRMA.....

LUGAR..... FECHA.....

---

1. DISPOSICIÓN A PAGAR

1. ¿Cuán a menudo utiliza cuadernos para realizar sus tareas o labores cotidianas?

   Todos los días___ Algunas veces a la semana___
   Algunas veces en el mes___ No utiliza___

2. ¿Cuán a menudo utiliza tableros de melamina para realizar sus tareas o labores cotidianas? (la melanina es un producto que puede ser utilizado en muebles de cocina, hogar, oficina, hospitales, instalaciones comerciales y decoración de interiores)

   Todos los días___ Algunas veces en el mes___
   Algunas veces a la semana___ No utiliza___

3. ¿Cuánto dinero al mes destina Ud. y su familia en productos provenientes de plantaciones forestales? (papel, madera, tableros)

   _____

4. ¿Estaría dispuesto a pagar $X más por un cuaderno de 100 hojas? En el mercado, un cuaderno cuesta $890.

   Sí ___ No___

($ X es reemplazado aleatoriamente por $0, $40, $80, $120, $160, $640, $760 ó $1000)

5. Si la respuesta 4 es NO, preguntar:

¿Estaría dispuesto a pagar algo más por cuadernos de lo que cuestan actualmente con tal de que las compañías forestales realizaran esfuerzos para conservar biodiversidad?

Sí___ No___

6. Si la respuesta 5 es NO, ¿Cuál es la razón?

_____

7. ¿Estaría dispuesto a pagar $X más por cada unidad de tablero de melamina? (un tablero de 2.5m (largo), 1.83m (ancho) y 1.8 cm (espesor) en el mercado cuesta $25500)

Sí ___ No___

($ X es reemplazado aleatoriamente por $0, $1.250, $2.500, $3.750 $5.000, $12500, $ 15750 ó $17000)

8. Si la respuesta 7 es NO, preguntar:

¿Estaría dispuesto a pagar algo más por tableros de melamina de lo que cuestan actualmente con tal de que las forestales realizaran esfuerzos para conservar biodiversidad?

Sí___ No___

9. Si la respuesta 8 es NO, ¿Cuál es la razón?

_____

3. CARACTERIZACIÒN SOCIOECONÓMICA

10. Sexo: Hombre___ Mujer___

11. Edad: _____ años

12. Educación:

Básica completa___ Básica incompleta___ Media Completa___
Media incompleta___ Técnica___ Universitaria___

13. ¿Cuál es su actividad o profesión?

_____

14. ¿podría indicarnos en cuál tramo de ingresos mensuales se encuentra?

No tiene ingresos directos	
Menos de 150.000 pesos	
Entre 150.000 y 250.000 pesos	
Entre 250.000 y 350.000 pesos	
Entre 350.000 y 450.000 pesos	
Entre 450.000 y 550.000 pesos	
Entre 550.000 y 650.000 pesos	
Entre 650.000 y 750.000 pesos	
Entre 750.000 y 850.000 pesos	
Entre 850.000 y 950.000 pesos	
Más de 950.000 pesos	