Are There Price Premiums for Certified Wood?

Empirical Evidence from Log Auction Data in Japan

Yuki Yamamoto

Graduate School of Economics, Kobe University
yuuki00007@hotmail.com

Kenji Takeuchi

Graduate School of Economics, Kobe University
takeuchi@econ.kobe-u.ac.jp

Takayoshi Shinkuma

Faculty of Economics, Kansai University
shinkuma@ipcku.kansai-u.ac.jp

Abstract

By using data on more than 38,000 log auction transactions from market in Shizuoka Prefecture, Japan, we estimate whether there is a price premium for certification of sustainable forest management. We found a positive and significant effect of certification for logs, especially in the smaller diameter category. The reason for the difference between diameter size can be attributed to demand from pulp and paper manufacturers. The premium found was 1.8% of the price of conventional logs, in the lower range of additional willingness to pay found in previous studies that used stated preference techniques. An analysis that includes a pre-certification equilibrium price suggests that Japanese certification is unsuccessful despite the existence of a price premium.

Keywords: Forest certification, Price premium, Log auction, Japan

1 Introduction

Certification of sustainable forest management has been increasingly promoted throughout the world over the last two decades. According to UN-ECE/FAO (2011), as of May 2011, the total area of forests certified worldwide was approximately 375 million hectares, or about 9.3% of the world's forests. The area above has been those endorsed by one or other of the two dominant international organizations: the Forest Stewardship Council (FSC), or the Programme for the Endorsement of Forest Certification (PEFC), which evaluate both forest management activities (forest certification) and tracking of forest products (chain-of-custody certification). There is a considerable variety of certified forest products on the market, from papers to furniture items. Certified products often bear labels declaring that they come from forests that meet the standard of sustainable forest management. Through such labeling, forest certification acts as a tool for producers to be able to transfer information on sustainability to consumers.

Haener and Luckert (1998) raise the existence of a green price premium as one of the contentious issues with regard to the impact of forest certification. Since additional willingness to pay for certified wood products is an important factor in the existence of a price premium, many studies have estimated it by using stated preference surveys (Ozanne and Vlosky, 1997; 2003; Ozanne and Smith, 1998; Forsyth et al., 1999; Grönroos and Bowyer, 1999; Pajari et al., 1999, Veisten, 2002; 2007; Kozak et al., 2004; O'Brien and Teisl, 2004; Aguilar and Vlosky, 2007; Aguilar and Cai, 2010). Table 1 is a brief summary of findings by these studies. Most of them found there is a positive willingness to pay among consumers in North America and Europe, and estimates of a willingness to pay more than the price of conventional forest products have ranged from 1.4% to 18.7%. Other studies (Vlosky et al., 1999; Bigsby and Ozanne, 2002; Teisl et al., 2002a; Anderson and Hansen, 2004a; Thompson et al.,2010) also attempted to investigate the preference structure and motivation for willingness to pay by using a similar technique.

Table 1: Estimated willingness to pay in stated preference studies

Authors	Area	Results
Ozanne and Vlosky (1997)	US	18.7% for a $1 stud 4.4% for a $100,000 new home
Ozanne and Smith (1998)	US	18% of homeowners prefer certified wood products
Forsyth et al. (1999)	Canada	5% (67.3% of sample) 10% (28.3% of sample) more than 10% (13% of sample)
Grönroos and Bowyer (1999)	US	$2500 per home built
Pajari et al. (1999)	EU	1.4% - 4.9%
Veisten (2002)	UK, Norway	5% or less (32% - 39% of sample)
Ozanne and Vlosky (2003)	US	11.7%
Kozak et al. (2004)	Canada	5.6% - 14%
O'Brien and Teisl (2004)	US	positive
Aguilar and Vlosky (2007)	UK	at least 10%
Veisten (2007)	UK, Norway	2% - 16% (median)
Aguilar and Cai (2010)	US, UK	5% higher price can capture 34 to 50% of the market

Note: Additional willingness to pay is indicated by the ratio to the price for conventional products.

While the willingness to pay on the part of environmentally conscious consumers plays a key role in the existence of a price premium, it also depends on the supply side. By using a qualitative survey for suppliers in Finland, Owari et al. (2006) confirmed that it was not possible for most of the surveyed Finnish companies to charge a price premium. Certification has not helped them improve their financial performance but was positively evaluated by customers, and, as such, was a tool to enhance reputation. For suppliers in countries like Finland and Austria, where all forests are certified and therefore all forest products could bear a label, there is little incentive to use this tool to signal a difference from competitor's products (UNECE/FAO, 2005). Hence, if we want to know what sort of premium exists in the market, we need to take into account the interaction of supply and demand, as we shall see in the theoretical review in the next section.

This study investigates the dimensions of a price premium by using market data on log auctions in Shizuoka Prefecture in Japan. While there are plenty of studies that have estimated willingness to pay for certified wood products by using a stated preference survey, as far as we know, there have been no attempts to use actual price data to investigate the size of a price premium. Two exceptions to the stated-preference-survey method are experimental studies by Anderson and Hansen (2004b) and Anderson et al. (2005), in which consumer behavior was studied at two home improvement retailers and two university bookstores in the US. The findings of these studies, however, rely on the observation of behavior in an artificial situation, and the number of observations and period of experiment were relatively limited. Since there is a difference between stated intention to pay and actual behavior (List and Gallet, 2001; Murphy et al., 2005) and possibly between behavior in an artificial situation and that in a real situation, using the data from a real market would be valuable to understand the profitability of forest certification.

This study relates to a body of empirical analyses that have investigated the existence of price premiums for eco-labeled goods (Henion, 1972; Teisl et al., 1999; Blamey and Bennett, 2001; Bennett et al., 2001; Nimon and Beghin, 1999; Roe et al., 2001; Teisl et al., 2002b; Bjørner et al., 2004). For example, Teisl et al. (1999) investigated the effect of the dolphin-safe label on the overall market share of canned tuna by using aggregated sales data. As another example, Bjørner et al. (2004) used a large body of Danish consumer panel data to estimate the impact of the Nordic Swan eco-label on consumers' shopping behavior. While these studies focus mainly on final consumer goods sold in retail shops, we focus on the premium for certified logs, which are used as primary inputs or intermediate goods. The existence of price premium at the earlier stage of the supply chain has an important implication for the economic viability of sustainable resource management, since it is more directly relevant to the decision making of resource managers.

The rest of this paper is structured as follows. Section 2 summarizes findings from theoretical studies on the price premium of forest certification. Section 3 presents statistical details of our data and the results of an econometric analysis. Section 4 discusses the implication of our results in comparison with those of previous analyses and theoretical prediction. Section 5 presents our brief concluding remarks.

2 Theoretical Findings

Consumers often have a willingness to pay more for goods that are made by environmentally friendly processes or methods. When there is an information asymmetry between producers and consumers, an eco-labeling scheme can help consumers identify environmentally friendly products in markets. It would provide an incentive for producers to supply these products in the expectation of gaining an additional benefit (a price premium) attributable to consumers' willingness to pay.

A few studies have attempted a theoretical analysis of the roles of eco-labeling and its impact on markets. One of the earliest study is that of Mattoo and Singh (1994), who considered the conditions under which eco-labeling would lead to a reduction in the supply of conventional (environmentally unfriendly) products in a competitive market. They assumed that there are two types of consumers: eco-consumers and non-eco-consumers. Eco-consumers prefer environmentally friendly products to environmentally unfriendly products, regardless of price. Non-eco-consumers prefer products that have lower prices. There are also two types of suppliers: one that supplies eco-products and one that supplies non-eco-products and cannot choose which products to supply. Mattoo and Singh found that the existence of a price premium, i.e., additional willingness to pay, for environmentally friendly products is a necessary condition for the functioning of eco-labeling schemes. They also pointed out that implementation of an eco-labeling scheme might increase the supply of environmentally unfriendly products by increasing the prices of both types of product.

Sedjo and Swallow (2002) analyzed the necessary condition for a successful certification scheme with a more reasonable assumption than that of Matoo and Singh: they assumed that a supplier can choose a producing technique that is either environmentally friendly or not. They attended to the fact that the existence of additional willingness to pay for environmentally friendly products does not necessarily mean that a price premium arises in the actual market. They found that the existence of a willingness to pay a premium is not a sufficient condition for a price premium. They found that a certification scheme can fail even when there is a price premium between certified and non-certified products. For a successful eco-labeling scheme, the equilibrium price of certified products should be higher than that of non-certified products, and both prices should be above the pre-certification equilibrium price.

To summarize these two contributions, eco-labeling schemes can be regarded as successful in competitive markets when the following conditions are satisfied: a) there is a price premium on certified goods compared to non-certified goods; b) the prices of goods of both certified and non-certified goods under the certification scheme are higher than the pre-certification equilibrium price. We examine these conditions for competitive markets in the following section, using market data on log auctions in Japan.

Although we focus on the question of whether eco-labeling can work well in competitive markets, several studies have examined it in a duopolistic market structure. In their duopoly models of vertical product differentiation both Amacher et al. (2004) and Ibanez and Grolleau (2008) show that eco-labeling can be used as a means of increasing environmental quality that is too low.

On the other hand, there are several theoretical studies that examine the effectiveness of eco-labeling under asymmetric information (Kirchhoff, 2000; Baksi and Bose, 2007; Hamilton and Zilberman, 2006). When consumers are heterogeneous, although a self-policing scheme is the first best when firms are honest, third-party certification should be implemented when firms can cheat with the labeling process (Baksi and Bose, 2007). In the case of voluntary certification in a monopoly, Kirchhoff (2000) argued that cheating can be prevented by an exogenous labeling system enforced with an appropriate fine. Forest certification schemes can be considered a kind of eco-labeling policy with both the voluntary and third-party certification.

3 Empirical Investigation

3.1 Data

Two forest certification schemes are dominant in Japan; Sustainable Green Ecosystem Council (SGEC) and the Forest Stewardship Council (FSC). The SGEC is a Japan-originated certification scheme and has certified more than 0.86 million hectares or 3.5% of the total forest area in Japan, while the FSC has certified more than 0.35 million hectares or 1.5% of that area. With regard to the CoC (chain-of-custody) certification, Japan has the third-largest number of companies in the world, after Europe and North America (UN-ECE/FAO, 2005). As of 2011, more than 1,500 Japanese companies had acquired CoC certification that 402 under the SGEC, and 1,107 under the FSC.

Our empirical study uses more than 38,000 log auction transactions in 2011 at three markets in Shizuoka Prefecture. The Shizuoka Forest Owners' Association has been actively involved in sustainable forest management and forest certification. Out of the 899,000 hectares of forest area of Shizuoka Prefecture, 8,169 hectares (0.9%) and 37,966 hectares (4.2%) have been certified as sustainable forest by the SGEC and the FSC, respectively. Furthermore, 32 companies have acquired CoC certification from the SGEC and 63 from the FSC.

Log auction markets emerged in the first half of the 1960s throughout Japan and played the role of distribution centers, given the existence of small-scale and scattered forest stands and log suppliers (Ito, 2002). Logs produced by suppliers are trucked to the auction market and sorted into selling units (*hai*) by species, diameter, length, quality, and shipper. Buyers create a price for each *hai* by auction or bidding and then purchase their logs. Auction markets generally are financed and managed by sales commissions from buyers and sorting charges from shippers. The number of log auction markets in Japan was 516 as of 2006 and the log volume they handled was 7.11 million cubic meters, approximately 51.4% of the total domestic log supply for sawn timber (Ministry of Agriculture, Forestry and Fisheries of Japan, 2007).

Our data on the timber trade in Shizuoka Prefecture include the clearing price per cubic meter, diameter, length, information on defects (such as crooks, knots, and scars), and forest certification. The Shizuoka Forest Owners' Association consists of three offices: the Shizuoka Office, the Fuji Timber Center and the Tenryu Office. Each office holds log auction markets typically twice a month by a first-price sealed-bid auction. On the day of the auction, logs sorted into *hai* are set out in the yard of the market. Buyers put cards with bids written on them into a box in front of each *hai*. Bidding closes at noon and each *hai* goes to the highest bidder. Sellers can tell the reserve price to the auctioneer, but it is not announced to bidders. Since information on reserve prices was unavailable, they are not included in our analysis. Timbers is sold to industrial sectors such as paper and pulp manufacturers, the construction sector, and furniture manufacturing companies. Table 2 is a summary of descriptive statistics. The timber in our data mostly consists of Japanese cedar (*Cryptomeria japonica*), Japanese cypress (*Chamaecyparis* *obtusa*), and Japanese pine (*Pinus thunbergii*). We found that 29.8% of the timber is certificated but we could not identify which institution (the SGEC or the FSC) issued each certification.

Table 2: Descriptive statistics of data

Variable name	Explanation	Mean	S.D.
y	Sale price (yen) per cubic meters of log	15930.56	9787.98
Length	Length of the log (m)	3.808	0.802
Diameter	Diameter of the log (cm)	26.602	9.384
Certified	Certified log =1; otherwise =0	0.295	0.456
Defects	Defects =1; otherwise =0	0.172	0..378
Cedar	Cedar =1; otherwise =0	0.520	0.500
Cypress	Cypress =1; otherwise =0	0.448	0.497
Pine	Pine =1; otherwise =0	0.004	0.0611
Fuji	Fuji Timber Center =1; otherwise =0	0.152	0.359
Tenryu	Tenryu Office =1; otherwise =0	0.590	0.492
Shizuoka	Shizuoka Office =1; otherwise =0	0.258	0.438
House	Number of new homes built per month	2075.19	381.00
NBidders	Estimated number of potential bidders	444.68	229.43

Note: 100 Japanese yen were worth approximately 1.21 US dollars as of January 2011.

3.2 Price premium of certified logs

This section estimates the impact of forest certification on log price. We include length, diameter, certification, defects, and dummy variables for species (cedar, cypress and pine), markets (Fuji, Tenryu and Shizuoka), and months to explain the variation in the prices of logs. The certification variable is a dummy variable that takes one when the log is produced in a certificated forest, and zero otherwise. The defects variable is a dummy variable that takes one when the log has defects such as crooks, knots and scars and zero otherwise. We regress the sale prices of logs on these various factors. Since our data contains zero price when the logs have not been sold, we use a Tobit model for estimation (Huang and Buongiorno, 1986; Boltz, 2002).

$$\begin{aligned} MV_i^* &= \beta' X_i + \epsilon_i \\ y_i &= MV_i^* \quad \text{if } MV_i^* > RP_i \\ y_i &= 0 \quad \text{if } MV_i^* < RP_i \end{aligned} \tag{1}$$

where MV_i is the latent market value per cubic meters of log i, y_i is the sale price per cubic meters of log i, X_i is a vector of exogenous variables for log sales i, β is a vector of coefficients corresponding to the variables X, ϵ_i is the error term, and RP_i is the reserve price for log i. In our analysis, we excluded the top one percent of data to remove outliers. Prices in the top one percent are more than several ten times higher than the median log price; these extremely high prices are mainly due to trades of old-growth or high-quality logs for special events. The estimated model is as follows:

$$\begin{aligned} MV_i^* = f(&Length_i, Diameter_i, Certified_i, Defects_i, Cedar_i, Pine_i \\ &Shizuoka_i, Fuji_i, Month_{ij}, House_{j-1}, NBidders_t), \end{aligned} \tag{2}$$

where $Length_i$ denotes the length of log i, $Diameter_i$ denotes the diameter of log i, $Certified_i$ denotes whether log i has been certified for sustainable forest management, $Defects_i$ denotes whether log i has defects, $Cedar_i$ and $Pine_i$ are dummy variables for wood species, $Shizuoka_i$ and $Fuji_i$ are dummy variables for market i, $Month_{ij}$ denotes dummy variables for the month j that the auction was held, $House_{j-1}$ denotes the number of new homes built in Shizuoka Prefecture in the month $j-1$, $NBidders_t$ is the estimated number of potential bidders, and ϵ_i is the error term. $NBidders_t$ is included because a larger number of bidders in an auction would result in higher bids (Boltz

2002). However, we could not directly observe the potential bidders in our data, so we estimated their number by using the number of sales held on the same day in the same market.

The estimation results by OLS and Tobit are summarized in Table 3. Heteroskedasticity-robust standard errors are given in parentheses under estimated coefficients. Most of the coefficients have the expected sign and are statistically significant in the models 1 and 2. The coefficients of cedar and pine are negative and statistically significant at the 1 % level, indicating that the price of cypress is higher than the prices of cedar and pine. The coefficients of length and diameter are positive and statistically significant at the 1% level, as expected. The signs of the coefficient of forest certification are positive and statistically significant, indicating that there are price premiums for certified timbers. The coefficients of certification are 280.96 and 284.66; this means that certification adds only 1.8% to the average price. The estimated number of bidders has a positive effect on the sale price, and this supports the theoretical prediction that prices might increase because of the competition effect. The sign of the coefficient of Fuji is negative and statistically significant, while that of Shizuoka is statistically insignificant, indicating that logs traded in the Fuji market are cheaper than those traded in the other two markets. With January taken as a base category, the months dummies of February and March are positive and statistically significant, while those of all the other months except April are negative and statistically significant. There is little difference in coefficients between model 1 and model 2; this might be because our data contain only a small number of failed trades.

The diameter of a log can be regarded as an important indicator of the intended use of the log. Thus, timber of a larger diameter is mainly used for construction material and timber of a smaller diameter tends to be in demand by paper and pulp manufacturers. Since this suggests that the price premium of certification might vary for different final wood products, we then estimate the impact of certification on timber price for different sizes of diameter. The estimated model is basically the same as above, except that we divided the whole sample according to diameter size into three categories: under 20 centimeters, from 20 to 28 centimeters, and over 28 centimeters. These categories are typically used for classification in the Japanese log market.

The estimation results by OLS and Tobit are summarized in Table 4. Although most coefficients are much the same as in the results discussed above, there are differences for some coefficients. The coefficients of certification in models 3, 4, 6, and 7 are positive and statistically significant at the 5% level. It means that certification has a positive effect for logs of a smaller diameter. On the other hand, the coefficients of the certification for the largest diameter category are statistically insignificant.

Our estimation results show that there is a price premium for certified timber of a smaller diameter. The reason for a difference with respect to diameter size can be attributed to demand structure for timber. In Japan, timber whose diameter is larger than 26 centimeters is mainly used for construction material. Since paper and pulp manufacturers can use any size of timber for their products, timber of smaller diameter tends to be in demand among them. Furthermore, paper and pulp manufacturers are the principal holders of CoC certification in Japan, while the construction sector is still at the beginning stage in this regard (Owari and Sawanobori 2007). Hence demand for certified timber might be mainly driven by paper and pulp manufacturers, and a price premium is found especially for timber with smaller diameters. The coefficient of $House_{t-1}$ also supports this, for it is positive and statistically significant only in the model for the category of largest diameter, which would be used in the construction sector.

Table 3: Estimation results on the price premium

	OLS	Tobit
model	1	2
	-9868.89^{***}	-9927.12^{***}
Cedar	(92.43)	(93.99)
	-19153.39^{***}	-19204.01^{***}
Pine	(329.86)	(331.43)
	2728.54^{***}	2721.39^{***}
Length	(55.27)	(56.06)
	361.76^{***}	365.22^{***}
Diameter	(5.58)	(5.66)
	280.96^{***}	284.66^{***}
Certified	(91.29)	(92.09)
	-6153.71^{***}	-6176.60^{***}
Defects	(71.69)	(74.63)
	32.12	−85.56
Shizuoka	(157.89)	(159.52)
	-1672.88^{***}	-1818.21^{***}
Fuji	(169.65)	(172.01)
	−0.01	0.04
$House_{t-1}$	(0.33)	(0.34)
	2.28^{***}	2.28^{***}
NBidders	(0.35)	(0.35)
	501.18^{**}	475.08^{*}
Feb	(252.10)	(252.44)
	790.92^{***}	811.85^{***}
Mar	(235.10)	(235.42)
	186.22	190.95
Apr	(175.76)	(175.99)
	-1175.47^{***}	-1160.26^{***}
May	(245.63)	(246.43)
	-2841.07^{***}	-2838.43^{***}
Jun	(213.48)	(214.54)
	-3204.48^{***}	-3406.83^{***}
Jul	(186.56)	(193.61)
	-3253.92^{***}	-3478.68^{***}
Aug	(184.96)	(190.57)
	-1336.58^{***}	-1429.87^{***}
Sep	(353.04)	(354.25)
	-1034.44^{***}	-1037.45^{***}
Oct	(208.76)	(209.21)
	-407.03^{**}	-499.14^{***}
Nov	(185.32)	(187.43)
	-1007.69^{***}	-1025.91^{***}
Dec	(199.02)	(200.83)
	2604.79^{***}	2512.92^{***}
Constant	(829.41)	(831.53)
R^2	0.442	
$Pseudo R^2$		0.028
N	38,004	38,004

$***$, $**$, and $*$=statistically significant at 1, 5, and 10%. Heteroskedasticity-robust standard errors are given in parentheses under estimated coefficients.

Table 4: Estimation results for different diameters

	OLS			Tobit		
	3	4	5	6	7	8
model	$diameter < 20$	$20 \leq diameter \leq 28$	$diameter > 28$	$diameter < 20$	$20 \leq diameter \leq 28$	$diameter > 28$
	-6055.56^{***}	-8184.87^{***}	-14140.03^{***}	-6105.61^{***}	-8235.87^{***}	-14156.31^{***}
$Cedar$	(88.61)	(101.76)	(216.86)	(91.65)	(104.18)	(217.81)
	-13328.89^{***}	-17144.24^{***}	-24455.83^{***}	-13377.96^{***}	-17175.67^{***}	-24478.61^{***}
$Pine$	(667.97)	(430.75)	(560.76)	(669.47)	(431.54)	(560.74)
	1766.61^{***}	3168.97^{***}	3242.35^{***}	1756.49^{***}	3162.21^{***}	3238.61^{***}
$Length$	(87.85)	(75.86)	(102.72)	(88.55)	(77.13)	(103.99)
	849.39^{***}	417.97^{***}	329.63^{***}	854.25^{***}	419.29^{***}	330.78^{***}
$Diameter$	(23.30)	(20.64)	(16.07)	(23.75)	(21.00)	(16.13)
	362.62^{***}	276.17^{**}	226.40	358.40^{***}	286.68^{**}	229.61
$Certified$	(116.15)	(126.17)	(175.09)	(118.61)	(127.03)	(175.58)
	-6659.50^{***}	-5714.01^{***}	-6625.63^{***}	-6675.62^{***}	-5740.72^{***}	-6694.71^{***}
$Defects$	(99.79)	(103.95)	(162.22)	(102.59)	(107.90)	(166.96)
	1030.13^{***}	-499.01^{**}	-431.02	971.25^{***}	-637.40^{***}	-490.37^{*}
$Shizuoka$	(179.66)	(228.94)	(279.25)	(182.33)	(232.03)	(280.63)
	-126.50	-1225.28^{***}	-2931.19^{***}	-238.46	-1300.55^{***}	-3045.35^{***}
$Fuji$	(204.10)	(244.91)	(306.25)	(208.20)	(247.42)	(309.56)
	-0.71	0.01	1.34^{**}	-0.72	0.05	1.41^{**}
$House_{t-1}$	(0.44)	(0.55)	(0.56)	(0.44)	(0.55)	(0.56)
	0.89^{**}	1.48^{***}	3.04^{***}	0.91^{**}	1.49^{***}	3.01^{***}
$NBidders$	(0.38)	(0.51)	(0.60)	(0.38)	(0.52)	(0.60)

Feb	488.98	534.50	−149.13	487.93	519.03	−190.08
	(304.88)	(376.86)	(452.95)	(305.47)	(377.34)	(453.06)
Mar	212.25	572.61*	1528.96***	211.12	598.12*	1552.34***
	(295.83)	(348.08)	(407.80)	(296.52)	(348.52)	(407.94)
Apr	380.99*	184.33	165.69	378.99*	189.66	168.41
	(224.64)	(253.36)	(317.70)	(225.10)	(253.52)	(317.72)
May	−1227.08***	−1350.44***	−406.37	−1236.63***	−1338.76***	−372.54
	(321.44)	(371.43)	(428.00)	(323.21)	(372.53)	(428.36)
Jun	−2735.04***	−2995.74***	−2388.71***	−2747.43***	−2994.38***	−2362.62***
	(272.25)	(328.01)	(369.48)	(275.16)	(329.42)	(369.81)
Jul	−3428.34***	−3567.77***	−2890.76***	−3515.23***	−3784.87***	−2988.44***
	(257.15)	(270.33)	(360.10)	(266.52)	(281.82)	(365.57)
Aug	−4295.99***	−3349.45***	−2667.62***	−4478.82***	−3490.96***	−2758.01***
	(258.28)	(279.14)	(343.80)	(268.33)	(285.41)	(348.69)
Sep	−1517.32***	−1261.95**	−2352.36***	−1536.93***	−1337.81**	−2450.59***
	(446.02)	(562.11)	(594.05)	(447.78)	(563.98)	(595.25)
Oct	−1347.99***	−1123.44***	−846.85**	−1356.95***	−1118.17***	−843.71**
	(245.85)	(317.64)	(363.24)	(246.76)	(318.26)	(363.46)
Nov	−798.24***	−1175.98***	72.63	−825.45***	−1252.17***	−30.22
	(219.37)	(274.87)	(319.15)	(222.34)	(278.26)	(322.23)
Dec	−1107.70***	−743.40***	−1151.17***	−1084.94***	−757.87***	−1188.44***
	(236.61)	(288.37)	(355.06)	(237.60)	(291.09)	(358.14)
Constant	−722.37	−1245.06	2027.15	−713.20	−1271.12	1901.23
	(1123.81)	(1404.48)	(1512.04)	(1129.92)	(1410.36)	(1514.51)
R^2	0.604	0.448	0.423			
$Pseudo R^2$				0.045	0.028	0.026
N	7,770	14,658	15,576	7,770	14,658	15,576

∗∗∗, ∗∗, and ∗=statistically significant at 1, 5, and 10%. Heteroskedasticity-robust standard errors are given in parentheses under estimated coefficients.

4 Discussion

4.1 Implication of Results

Existence of a price premium is important for an effective forest certification system. On the demand side, it is a precondition for a price premium that customers have a willingness to pay more for certified wood products than for conventional products. Most previous studies have found that there is a positive willingness to pay more by using stated preference surveys. As the summary in Section 1 shows, previous estimates of a willingness to pay more than the price of conventional forest products have ranged from 1.4% to 18.7%.

Our estimation results show that there is a price premium of 1.8% for certified timber in the Japanese market. This is in the lower range of the additional WTP found in other studies. This can be attributed to institutional difference between Japan and other countries, the effect of supply volume, or overestimation resulting from use of the stated preference technique. Forsyth et al.(1999), for example, found that the important factors taken in to account when consumers purchase wood products are quality and price, and certification has less of an impact on their decision making. By focusing on forest certification, the stated preference techniques (especially contingent valuation) might put undue emphasis on the issue and make respondents to pay too much attention to the certification. Furthermore, respondents might answer questions in a socially desirable manner, thereby overstating the importance of a product's environmental attributes (Anderson and Hansen 2004b).

Our estimation results do not coincide with those of Owari and Sawanobori (2007), who implemented a mail survey of 132 Japanese companies that had been given a chain-of-custody certificate and found that they cannot receive a price premium. This can be attributed to two factors. The first factor is the delayed growth of a certification scheme in Japan. Certified forest areas in Japan have increased from 179 hectares in 2005 to 1,006 hectares in 2010 under the FSC and the SGEC. So in 2005, when Owari and Sawanobori conducted their survey, there might not have been enough recognition of, and a reputation for, certified products. The second factor is the difference in the recipient of the price premium. The premium found in our study is on logs to be used as a primary input or for intermediate goods, whereas the premium discussed by Owari and Sawanobori is mainly on final wood products such as paper and furniture. There is a possibility that demand for certified timber by manufacturers of final wood products would be motivated not by a price premium but by the goal of communicating with customers to improve the latter's perceptions about forest-related industries. While this would be a reasonable interpretation, considering the higher level of information asymmetry in the market of final goods, one might intuitively expect a higher level of price differentiation to be realized in a market closer to the final consumer. Further investigation of different price premiums at different stages of the supply chain is a subject for future studies.

4.2 Post-certification Equilibrium

According to Sedjo and Swallow (2002), there are three possibilities in regard to equilibrium prices under a forest certification scheme:

$$1) P^C > P^{NC} > P^0;$$
$$2) P^C > P^0 > P^{NC};$$
$$3) P^C = P^{NC} > P^0,$$

where P^C denotes the price of certified wood, P^{NC} denotes the price of non-certified wood, and P^0 denotes the equilibrium price under the pre-certification scheme. Sedjo and Swallow (2002) define a decrease in the supply of non-certified wood as the success of the certification scheme. It is assumed that producers can choose to produce their products either eco-friendly or eco-unfriendly products (woods). Producers make their decision on the basis of their profit calculations in comparing the two options, either eco-friendly or eco-unfriendly woods. If certification is costly to individual producers, a price premium of eco-friendly woods over eco-unfriendly woods is assured in market equilibrium or $P^C > P^{NC}$. Suppose the certification cost is so low that the higher price in the certified markets can generate sufficient revenues to cover the higher costs. Then some producers will exit the non-certified market and enter the certified market. The decrease of supply in the non-certified market also pushes the price P^{NC} up. This case describes the first possibility, $P^C > P^{NC} > P^0$.

Alternatively, suppose the certification cost is rather high. The price premium is insufficient to compensate the marginal producer of certified wood. As a result, certification can induce some producers to return to non-certified production. The increase of supply in the non-certified market also depresses the price P^{NC}. This case corresponds to the second possibility, $P^C > P^0 > P^{NC}$.

If certification is not costly and the supply of eco-friendly woods is sufficiently large relative to demand from eco-consumers, then certification may fail to generate a price premium and both eco-friendly and eco-unfriendly woods are sold at a common price. In addition, if eco-consumers reveal a willingness to pay a premium for eco-friendly woods, the common price would become higher than the initial price. Under this situation, the third possibility, $P^C = P^{NC} > P^0$, can arise.

To make a comparison with the theoretical predictions by Sedjo and Swallow possible, we must consider the relationships that exist among the prices of certified wood (P^C), of non-certified wood (P^{NC}), and of pre-certification equilibrium (P^0). The estimation result in Section 3.2 suggests that certified wood has a price premium: ($P^C > P^{NC}$). What we need to do next is to investigate the relationship between P^0 and P^{NC}. If we find that P^{NC} is higher than P^0, then the Japanese forest certification scheme can be regarded as successful.

We estimated a model to clarify the relationships among P^C, P^{NC}, and P^0. The data used is from the log auctions of the Tenryu market from July to December in 2009, 2010, and 2011. The Tenryu market did not trade any certified logs in 2009; assuming that the price levels of the Tenryu market are not affected by prices in the other markets, we can consider the 2009 data as that of the pre-certification equilibrium. Due to the limited availability of data for 2009, we are restricted to using only data for the second half of the years 2009 to 2011. The estimation model is basically the same as in the previous section, except for the inclusion of dummy variables for sale prices of certified and non-certified logs in the post-certification period (2010 and 2011). The prices were adjusted to 2010 prices by using the average consumer price index.

The estimation result by OLS is summarized in Table 5 (dummy variables for months were omitted). The coefficient of P^C is positive and statistically significant at the 5% level. The coefficient of P^{NC} is negative and statistically significant at the 1% level. This indicates that the price of non-certified wood P^{NC} is lower than the pre-certification equilibrium price P^0, while the price of certified wood P^C is higher than P^0. Our estimation result indicates that the Japanese certification system can be regarded as belonging to the second case ($P^C > P^0 > P^{NC}$). It means that certification does not lead to a decrease in non-certified logs, even though there is a price premium for certified logs.

The second possibility presented by Sedjo and Swallow corresponds to situations where the cost of certification is high. Although we cannot obtain enough detailed information about the cost of forest certification in Japan,

Table 5: Comparing P^0, P^{NC} and P^C

	OLS	Tobit
model	9	10
$Cedar$	-11272.62^{***} (112.85)	-11270.85^{***} (112.86)
$Pine$	-15711.98^{***} (596.30)	-15720.33^{***} (597.69)
$Length$	2500.03^{***} (60.56)	2500.97^{***} (60.57)
$Diameter$	511.37^{***} (7.33)	511.64^{***} (7.34)
$Defects$	-5571.36^{***} (107.07)	-5569.48^{***} (107.11)
P^C	281.66^{**} (132.01)	279.27^{**} (132.03)
P^{NC}	-346.20^{***} (123.60)	-353.66^{***} (123.69)
$House_{t-1}$	1.00^{***} (0.18)	1.01^{***} (0.18)
$NBidders$	-0.25 (0.29)	-0.25 (0.29)
Aug	785.67^{***} (196.44)	782.82^{***} (196.50)
Sep	690.66^{***} (168.75)	689.75^{***} (168.72)
Oct	1816.48^{***} (192.83)	1819.55^{***} (192.83)
Nov	1346.33^{***} (173.19)	1345.21^{***} (173.20)
Dec	1214.92^{***} (197.48)	1207.40^{***} (197.53)
$Constant$	-2218.28^{***} (550.27)	-2244.26^{***} (550.83)
R^2	0.374	
$PseudoR^2$		0.022
N	34,880	34,880

$***$, $**$, and $*$=statistically significant at 1, 5, and 10%. Heteroskedasticity-robust standard errors are given in parentheses under estimated coefficients.

some anecdotal evidence suggests that it is considerably high. As a rough estimate, FSC Japan states that the cost of certification for forest management is 1,500 to 4,000 yen (approximately 18.15 to 48.4 US dollars) per hectare at the initial process and 500 yen to 1000 yen (6.05 to 12.1 US dollars) per hectare as an annual charge. These figures are several times higher than the average cost of initial certification (4.975 US dollar for FSC and 2.17 US dollars for Sustainable Forestry Initiative) reported by Cubbage et al. (2003) for forest land in North Carolina.

5 Conclusion

This paper investigates the impact of forest certification on log prices in a Japanese market. On the basis of the results of our estimation, which used real auction market data, we can conclude that forest certification has a positive price premium on logs of small diameter. However, this does not mean that forest certification provides enough of a premium for sustainable forest management, because the estimated impact is relatively low compared to other factors.

As a major importer of timber from the South-East Asia region, Japan has a significant influence on the development of forest certification systems in Asia. The existence of a price premium found in this study provides good prospects for certified wood products to be imported from other regions to Japan. Consider what has happened in Finland: although there is no strong demand for certified timber in that country, Finnish companies trading in timber have turned to certified timber, so that they can export to the United Kingdom or Germany, where there is a strong demand for certified products. This means that whether companies will take the trouble to be a certified company, or not, depends entirely on the preferences of their customers, such as importers or final consumers (Owari et al., 2006). Stimulating the demand for certified products would be a key element for the diffusion of certification systems throughout the Asian region.

Acknowledgement

We gratefully acknowledge the cooperation of the Shizuoka Forest Owners' Association in providing us data for its log auction markets. Helpful comments from Yasushi Shoji is also acknowledged. Kenji Takeuchi would like to thank the Department of Economics at the University of Gothenburg for giving him the opportunity to conduct research as a visiting researcher.

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