

## ADOPTION OF CASBEE BY JAPANESE HOUSE BUILDERS

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### ABSTRACT

The Comprehensive Assessment of Systems for Built Environment Efficiency (CASBEE) for Home is the first national voluntary Green Building Program for residential structures in Japan. The effect of builder demographic factors on the adoption of the CASBEE for Home program were investigated since the success of CASBEE for Home will be heavily reliant on the usage of the program. In this study, the adoption of the CASBEE for Home program by home builders is modeled as a two-stage process with builder awareness preceding the actual use of CASBEE for Home. The results show that both firm size and the type of homes built influence Japanese builder's awareness of the CASBEE for Home program. In addition, respondents who had participated in the 200-Year House Program, another voluntary program, were significantly more likely to use CASBEE for Home. Finally, the number of years a builder has been in business both increased their awareness and usage of the CASBEE for Home program. Our results suggest that the likelihood of adopting the CASBEE for Home program was influenced by the internal resources available, the type of customers being served, and the business experience of the firm.

### KEYWORDS

Japanese Housing Industry, Green Business Strategy, Green Building, Policy Adoption, Hurdle Model

### INTRODUCTION

Green building programs (GBPs) are voluntary environmental certifications that are obtained for building sustainable structures that minimize impacts on the environment (EPA 2010). GBPs have been introduced in many countries, and they are becoming a popular tool for increasing the use of sustainable building materials, building practices and construction technologies. While the use of GBPs have become relatively well established within North America

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and Europe, they are in the infancy stage in many Asian nations (e.g., Sasatani and Eastin 2012, Gou et al. 2013). Japan introduced the Comprehensive Assessment of Systems for Built Environment Efficiency (CASBEE) for Home program in 2007 as a voluntary national residential green building program.

The success of a voluntary environmental program is heavily reliant on its appeal to firms (Videras and Alberini 2000) and the varying business strategies of Japanese home builders might influence their adoption of the CASBEE for Home program. Home builder's use of a GBP has to be preceded by awareness of the program (Ganguly et al. 2013). Thus, this study differentiates a firm's awareness and usage of the CASBEE for Home program as two consequent decisions with the adoption process and identifies those builder characteristics which might influence the adoption of the CASBEE for Home.

In the following sections, the Japanese housing industry and the CASBEE for Home program are discussed. Then hypotheses related to Japanese home builder's adoption of CASBEE for Home are proposed, followed by a discussion of the research methodology used and our research results. The final section provides a discussion of the research results.

## 2. BACKGROUND

### *a. Japan's housing industry*

Housing starts in Japan reached 1,643,266 units in 1996 before dropping to 834,117 units in 2011 (MLIT 2011a). As with most countries, Japan's residential housing industry is highly decentralized with most builders working within local markets (Eastin and Rahikainen 1997). The Japanese residential housing industry consists of a few large home builders, while the vast majority are small to medium-sized home builders (Ogi 2002). The large, capital-intensive home manufacturers usually build prefabricated houses, while medium-sized companies, called regional builders, tend to specialize within local areas (Eastin and Rahikainen 1997). Medium-sized firms typically build between twenty to several hundred houses per year and provide a wide range of services that include home design, construction, sales and home maintenance (Sasatani et al. 2010). In contrast, small builders (called *komuten*) typically build between one to five custom houses per year and have historically represented the largest segment of the housing market in Japan (Ogi 2002). Since depopulation is a problem facing Japan, the housing market is highly competitive and consequently many small builders have had to consolidate or leave the industry (Sasatani et al. 2010).

Wood framed housing starts in Japan comprised 55.7% of the housing market (464,837 units) in 2011, with 75% using the post and beam construction technique, 22% using 2x4 construction, and 3% were prefabricated (MLIT 2011a). Traditionally, most of the single family houses built in Japan are custom, although some firms have begun to sell lower priced built-for-sale tract houses that are targeted towards younger, first-time home buyers (Sasatani et al. 2010).

### *b. CASBEE for Home*

In Japan, there had not been an assessment tool or method that could be used to evaluate the environmental impacts of building structures. Thus, the Japanese construction industry and its governmental regulators worked together to develop an internationally recognized green building assessment framework designed to reduce the environmental footprint of the

residential building sector (Kimata 1999). The Japan Green Build Council (JaGBC), a collaborative organization between industry, government, and academia, started developing the CASBEE evaluation system in 2001. The CASBEE evaluation system includes a variety of CASBEE assessment tools for specific construction applications, and JaGBC and the Japan Sustainable Building Consortium (JSBC) provide overall management of the CASBEE program (JSBC 2005).

In order to facilitate and integrate the assessment of the interior and exteriors of residential structures, CASBEE introduced a concept that they refer to as eco-efficiency, which is defined as the “value of products and services per unit of environmental load” (JSBC 2006). The Building Environmental Loadings are defined as “the negative environmental impact that extends outside to the public environment”. Building Environmental Quality is defined as “the improvement in living amenities for building users” (JSBC 2006). The consideration of both of these factors leads to the definition of Building Environmental Efficiency (BEE), which is the ratio of Building Environmental Quality (Q) to Building Environmental Loadings (L):  $BEE = Q/L$  (Murakami et al. 2011). Although the CASBEE assessment tools are designed to be used as a self-assessment tool to increase the environmental performance of a structure, JSBC (2006) advises that only CASBEE Accredited Professionals should conduct these assessments. To become a CASBEE Accredited Professional, candidates must attend a CASBEE Accredited Professional Registration System training course and pass the examination. The CASBEE program is a voluntary certification program that is audited by accredited professionals (Eastin 2008). As a part of the audit of a building’s environmental performance, a five-point star rating is assigned based on the BEE values.

Developing an assessment tool for residential housing as a component of the CASBEE program was essential given the size and resource consumption of the residential construction industry in Japan. The seasonally adjusted values of private residential investments between 2001 and 2010 hovered between 2.6% and 4.0% of Japan’s total GDP (ESRI 2011). In addition, it is estimated that a total of  $2,044 \times 10^{15}$  Joules (14.2% of Japan’s total energy usage) was consumed within the housing sector in 2009 with 50.6% of the energy being electricity that was consumed during home operation (METI 2011). In addition to this energy consumption, the housing sector also consumes a large volume of natural resources, including wood, steel and concrete (Sasatani and Eastin 2012). For example, Japan’s housing industry accounts for approximately 40% of the wood products consumed in Japan (Japan Forestry Agency 2011).

“CASBEE for Home (Detached House)<sup>1</sup>” was introduced in 2007 as the CASBEE assessment tool designed to be used within the residential housing sector. The Q and L categories of the CASBEE for Home program reflect the sustainability of the home and its operations. Category Q of CASBEE for Home includes: 1) indoor environmental quality enhancement, 2) the durability of house, and 3) enriching city scape and biodiversity. Category L includes: 1) energy and water conservation, 2) waste reduction and recycling, and 3) minimal impact on the global, local and neighboring environments (JSBC 2006). Scoring for CASBEE for Home is based on the points (stars) awarded under the Q and L designations<sup>2</sup>. As of 2014, there are a variety of incentives and tax breaks available to home owners to encourage the adoption of CASBEE for Home. For example, some local governments have developed programs with

1. Referred to as CASBEE-Sumai in Japan.

2. A five-point star rating is assigned based on BEE values, where  $BEE = Q/L$ .

local banks and provide favorable mortgage rates to home owners based upon the number of stars that a new home has received under the CASBEE for Home program.

### 3. HYPOTHESIS DEVELOPMENT

#### 3.1 Firm size

In the environmental policy and business fields, the literature suggests that firm size has a positive effect on the likelihood of environmental action (e.g., Nakamura et al. 2001, Welch et al. 2002, Nishitani 2009, Ganguly et al. 2010). One reason for this positive relationship between firm size and likelihood of adoption is that many environmental programs require an initial investment, and they often have long-term maintenance costs, which can be a greater burden for small firms as opposed to large firms (Nakamura et al. 2001, Nishitani 2009). Another reason is that large firms are more likely to be targets of regulators and environmental activists looking to encourage the adoption and usage of environmental programs within an industry since large firms tend to generate more business and have more customers than small firms. Therefore, large firms may have additional pressures to adopt these environmental programs as opposed to small firms (Welch et al. 2002).

Based on these trends, firm size is likely to be an important factor in the adoption of CASBEE for Home. Yet, it is important to note that empirical evidence from previous studies does not distinguish between a firm's awareness and usage of environmental programs primarily because these studies relied on secondary data. Thus, it is important to investigate how firm size impacts a builders' awareness and usage of the CASBEE for Home program individually.

H1: Larger builders will be more likely to be aware of (H1a), and use (H1b), the CASBEE for Home program.

#### 3.2 Usage of other programs

The Long-Term Superior Housing System<sup>3</sup>, or 200-Year House program, was introduced by the Japanese government in 2009. The 200-Year House program provides a large variety of incentives and tax breaks designed to encourage home owners and homebuilders to incorporate products and technologies in new and older homes that increase the durability, seismic resistance, ease of maintenance and repair, and ease of renovation or retrofitting of homes (MLIT 2011b). These factors all contribute to increasing the lifespan of a house. Although the 200-Year House program is not technically a GBP, it should be noted that since the program is designed to increase the life span of a home, it will directly reduce resource use within the housing sector. The 200-Year House program is a voluntary building program that has become very popular with the Japanese public; 103,716 housing units (12.6% of total housing starts) were certified under the 200-Year House program in 2010 (MLIT 2011b).

Certification programs are used by firms as a way to differentiate their products from those of their competitors (Roy and Vézina 2001). A low cost strategy and a product differentiation strategy are typical generic strategies designed to provide a competitive advantage (Porter 1980). If home builders are assumed to adopt rational business strategies, then differentiated builders would be expected to provide their customers the choice of using a number certification programs, while low cost builders would be less likely to offer certification

3. Referred to *Choki Yuryo Jutaku* in Japanese.

programs to their customers. In addition, home builders who have experience using voluntary programs should be more experienced and have more knowledge about the required resources and paperwork needed to participate in those programs. Past studies of ISO certifications as voluntary programs have found that firms who have adopted ISO 9000 (a quality management system) are more likely to adopt the ISO 14000 series (an environmental management system) because both systems are based on similar processes even though their objectives are quite different (Corbett and Kirsch 2001, Nakamura et al. 2009). Similarly, home builders who have experience using the 200-Year House program would be expected to perceive lower costs when considering, and be more likely to use, the CASBEE for Home program.

H2: Builders who have used the 200-Year House program will be more likely to be aware of (H2a), and use (H2b), the CASBEE for Home program.

### **3.3 Industrial experience**

Firms need to acquire additional knowledge as they seek to develop new applications and survive (Kogut and Zander 1992). Knowledge and resources often reside within inter-firm networks (Gulati 1999, Zaheer and Bell 2005) and younger firms often cannot take advantage of these network resources because they have yet to establish an extensive network of business relationships with other firms (Stinchcombe 1965). The CASBEE program was developed through a collaborative effort between industry, government, and academia. Older, more experienced home building firms that have developed close ties to industrial organizations can gain information about CASBEE for Home faster than younger, inexperienced firms that may not belong to these industrial organizations.

Furthermore, the threat of legislation can be a key reason to adopt voluntary environmental programs (Segerson and Miceli 1998). Since CASBEE for Home is partly supported by the government, not adopting CASBEE for Home may be perceived as being risky for home builders anxious to establish or maintain their relationships with government regulators. In Japan, where private firms have an unusually close relationship with government entities, many experienced firms might perceive that government regulators may directly or indirectly penalize them in the future if they are reluctant, or refuse, to participate in the program (Segerson and Miceli 1998). Given these considerations, firms that have been in the industry longer and are more experienced will have more networks and relationships that will influence their decision to participate in voluntary programs, even though they may require some initial investment.

H3: Builders who have been in business for a longer period of time will be more likely to be aware of (H3a), and use (H3b), the CASBEE for Home program.

### **3.4 Customer orientation**

In the U.S., builders and architects who are customer-oriented are more likely to adopt the Leadership in Energy and Environmental Design (LEED) green building program (Gauthier and Wooldridge 2012). One consideration for builders who are considering using GBPs are their customers' requests. The decision to use a voluntary environmental program is strongly influenced by market forces and customer preferences. A builder would be more likely to use an environmental program if they perceive that it would be an effective strategy for attracting new customers or retaining current customers. On the other hand, if a builder is targeting price sensitive customers, they would be less likely to adopt any program that would increase the price of their products.

Sasatani et al. (2010) found Japanese home builders implemented two distinct business strategies depending on their target customers. One group of builders targeted current home owners looking to replace their existing home with a new custom home, while a second group of builders focused on building spec houses targeted towards young, price sensitive, first-time home buyers. Custom house builders in Japan are customer oriented since they work with existing home owners and are required to build a home based on the customers' requests (Barlow et al. 2003). Custom home builders have the opportunity to assess their customer's attitude towards, and willingness to pay for, an environmentally friendly home. In contrast, spec home developers do not typically work with the home owner ahead of time and are generally not aware of their potential customers' willingness to pay for an environmentally friendly house, particularly since their business model is based on delivering a standardized, low-cost house to a price-sensitive buyer (Sasatani et al. 2010). Consequently, custom home builders might be expected to be more aware of, and willing to use, CASBEE for Home than spec home builders.

H4: Firms that build custom houses will be more likely to be aware of (H4a), and use (H4b), the CASBEE for Home program.

## METHODOLOGY

### 4.1 Data Collection

To better understand Japanese home builders' awareness and usage of the CASBEE for Home program, a series of surveys were administered at the Japan Home and Building Show in Tokyo in 2009 and 2010. First, preliminary interviews were conducted with several builders in Japan to gain a broader understanding of the issues confronting green buildings and the housing industry in Japan. A preliminary questionnaire was developed based on these interviews. Then, the questionnaire was pre-tested by ten Japanese residential housing experts to assess the validity and content of the questions.

The convenience sampling method was used for conducting the surveys. This sampling method was adopted because it is a cost effective way to survey a readily available target population (Greene 1981). Since most convenience sampling is collected with the target population on hand, the selection of the survey venue is critical for this kind of sampling method. The Japan Home and Building Show was selected as the preferred venue for the survey because it is the largest exhibition in Japan for the home building industry. Each year, almost 500 building material suppliers, industrial groups, and foreign traders have exhibits at this show and large to small-sized homebuilders from all over Japan attend this show to gather information on new construction materials and technologies and to network. During the 2009 and 2010 Home Shows, a display booth was stationed on the show floor with five professional staff members randomly selecting home builders to complete a paper-based survey.

Convenience sampling does have distinct advantages and disadvantages over probability sampling methods. For this research the positives associated with convenience sampling far outweighed the negatives associated with the sampling method. To obtain similar coverage of the target population using probability sampling methods, the researchers would have had to travel all over Japan to get individual appointments with Japanese homebuilders (time and cost prohibitive) or they would have had to mail out questionnaires to a randomly selected group of home builders (high cost of obtaining a mailing database and low response rate)

(Dillman 1978, 2000). The research team was highly cognizant of the selection biases associated with the convenience sampling methodology (Greene 1981) and regional and demographic biases were evaluated prior to making any conclusions.

#### 4.2 Variables

The dependent variable in this study is the level of commitment to the CASBEE for Home program by builders. The commitment level was recorded as “0” when a respondent was not aware of CASBEE for Home, as “1” when a respondent was aware of the CASBEE for Home program but had never used it, and as “2” when a respondent had used the CASBEE for Home program.

A set of independent variables were collected about builder characteristics that could impact respondents’ awareness and use of the CASBEE for Home program. First, in order to approximate builder size, the number of housing starts in the previous year (“HS”) was collected. In the Japanese home construction industry, builders have been traditionally ranked by their housing starts (Eastin and Rahikainen 1997, Ogi 2002, Sasatani et al. 2010). Although the number of housing starts in a year can depend on many factors (e.g., geographic region and market competition), discrepancies in these numbers can be assumed to be distributed unsystematically. As firm size in Japan generally has a right-skewed distribution (higher number of small builders), a phenomenon known as Gibrat’s law, a natural logarithm is used to transform “HS.” Second, a dummy variable was used to indicate whether or not a respondent had used the 200-Year House Program (“200Yr”). Third, the number of years the firm had been in business (“Year”) was used to reflect the industrial experience of a respondent. Finally, the ratio of spec houses to custom houses built (“Spec”) was used to reflect the customer orientation of a builder.

Several other control variables were also included in the survey. A dummy variable was used to indicate if the survey was collected in 2010 (“2010”) or 2009 (“2009”) as well as to indicate if a respondent had done business in the Tokyo metropolitan area (“Tokyo”). The ratio of post and beam houses built relative to the total number of wood houses built (“P&B”) and the ratio of multi-family houses relative to the total number of single family houses built (“Mutif”) were also included.

#### 4.3 Models

Respondent awareness of CASBEE for Home program is nested within the decision to use the program or not, a process that is tailored for the hurdle model. Hurdle models combine a left-truncated count component with a right-censored hurdle component (Mullahy 1986). The first stage, or hurdle, in the process is the “awareness” of the CASBEE for Home program. The second stage in the process is the “use” of CASBEE for Home. Only those respondents who indicated that they were aware of the CASBEE for Home program passed the first hurdle. Decisions in these two steps (i.e., aware or not aware; use or not use) are mutually exclusive and the choice sets are collectively exhaustive. Discrete choices are often derived under an assumption of utility-maximizing behavior by the decision-maker (Train 2003). The decision maker obtains a certain level of unobservable utility, or a latent factor, from each alternative decision which is explained by the explanatory variables of the model. The assumption being that the latent factors inside each decision making process follow the cumulative distribution function of a normal distribution,  $\Phi$ . Therefore, the probability function of this hurdle probit model is the product of two different normal distributions as follows:



$$\begin{aligned}\Pr(y_i=0 | \beta_1, \beta_2) &= p_{i0} = \Pr(\text{aware.}=0 | \beta_1) = 1 - \Phi(X_1\beta_1), \\ \Pr(y_i=1 | \beta_1, \beta_2) &= p_{i1} = \Pr(\text{aware.}=1 | \beta_1) * \Pr(\text{experience}=0 | \beta_2) = \Phi(X_1\beta_1) * [1 - \Phi(X_2\beta_2)], \\ \Pr(y_i=2 | \beta_1, \beta_2) &= p_{i2} = \Pr(\text{aware.}=1 | \beta_1) * \Pr(\text{experience}=1 | \beta_2) = \Phi(X_1\beta_1) * \Phi(X_2\beta_2),\end{aligned}$$

where  $\beta_1$  is the coefficient of covariate  $X_1$ ; the products,  $X_1\beta_1$ , are latent factors which influence the awareness of the CASBEE for Home program;  $\beta_2$  is the coefficient of covariate  $X_2$ ; and the products,  $X_2\beta_2$ , are latent factors which influence the respondents' use of the CASBEE for Home program. The parameters of the model were estimated using the maximum likelihood estimation (MLE) technique and the most parsimonious model was selected using the Akaike Information Criteria (AIC) (Buckland et al. 1997).

The estimated effects in the model translate into the individual probabilities of the using the CASBEE for Home program in a complex and non-linear manner. The transformation of these coefficient estimates into counterfactual probabilities aids in the interpretation of the relative magnitude of each type of effect on a hypothetical builders' characteristic. A simulation-based approach was applied where 10,000 draws were taken from the multivariate-normal distribution with means at the point estimates from the model and a variance matrix as the estimated variance-covariance matrix for the coefficients estimated in the model (King et al. 2000). The 10,000 simulated coefficients were then placed into vectors and simulated to predict the counterfactual probability for a hypothetical builder who has given independent variables of a commitment to the CASBEE for Home program. Graphically reporting differences in these predicted probabilities will deliver a meaningful interpretation of nonlinear models in the business strategy field (Zelner 2009).

#### 4.4 Results And Hypothesis Testing

The surveys were carefully screened and those respondents who were outside the target population (e.g., architects, distributors, and retailers) were removed from the sample. The analysis presented in this section is based on 252 completed survey responses from Japanese home builders; 145 were collected in 2009 and 107 were collected in 2010. Among the valid surveys, 130 respondents (51.6%) reported that they had never heard of the CASBEE for Home program while 86 respondents (34.1%) answered that they had heard of it but had never used it, and 36 respondents (14.3%) reported that they had used it. Table 1 shows descriptive statistics of the independent variables. The housing starts reported by the survey respondents represented approximately 12.6% of total Japanese single family housing starts built in both 2008 and 2009.

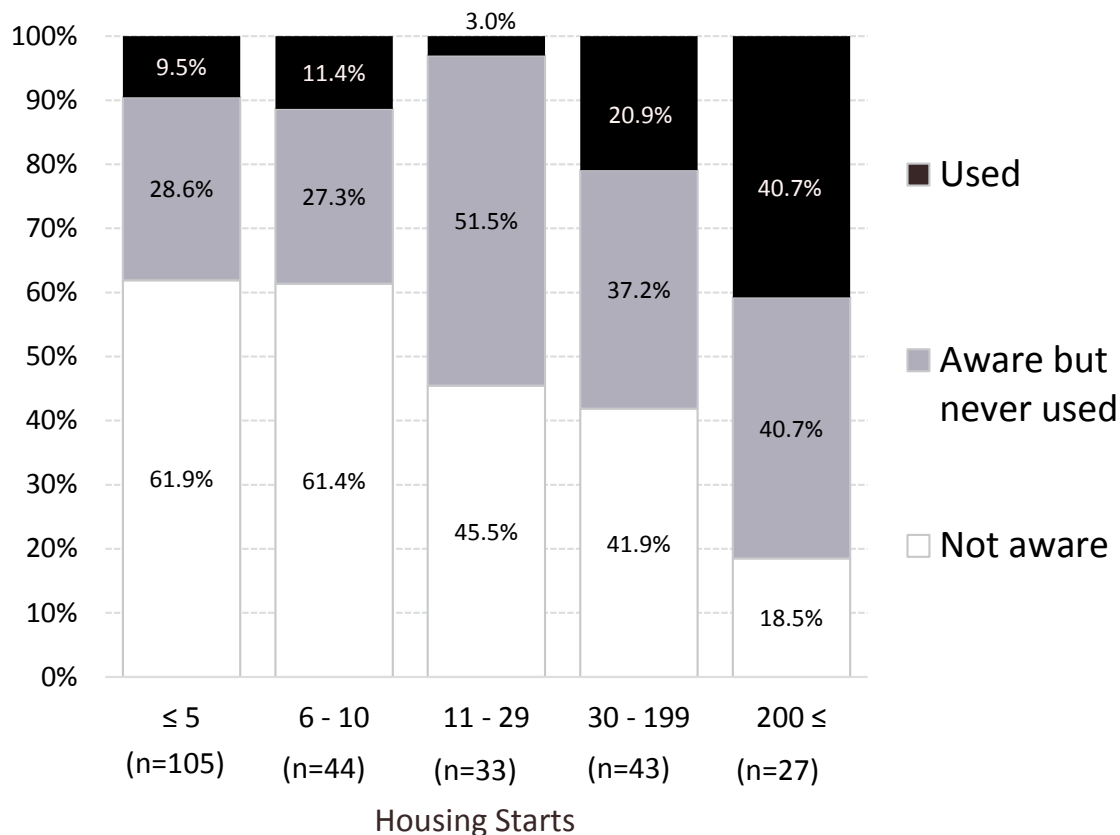
**Table 1:** Summary of the descriptive statistics for the independent variables.

Variables	Description	N	Mean	Std. Dev.
Year	Year in Business	246	24.8	22.4
HS	Annual housing starts	240	257.4	1,200.7
Multif	Ratio of multi-family houses built	227	0.093	0.227
P&B	Ratio of post and beam houses built	225	0.700	0.414
Spec	Ratio of spec houses built	222	0.085	0.226
200Yr	Experienced 200-Year House program (dummy)	249	0.500	0.501
Tokyo	Sell houses in Tokyo or not (dummy)	243	0.450	0.498



Considering firm size, 105 respondents built five or less houses (41.7%), 44 respondents built between six and ten houses (17.5%), 33 respondents built between 11 and 29 houses (13.1%), 43 respondents built between 30 and 199 houses (17.1%) and 27 respondents built 200 or more houses (10.7%). Since large builders tend to send their employees to trade shows more often than small builders, large builders were oversampled. Yet, this fact does not bias the results of the model estimation since our analysis controlled for firm size (based on number of housing starts). As shown in Figure 1, large builders are more likely to be aware and have used CASBEE for Home before controlling for other factors; 40.7% of large builders (200 or more housing starts) reported using the CASBEE for Home program.

**Figure 1:** Proportion of dependent variable by housing starts cohort



There were some missing values for some of the independent variables in the hurdle model, and a multiple imputation method was utilized to impute the missing values to reduce bias in both the coefficients and the standard errors (King et al. 2001). Table 2 provides the results of the model estimation for both the awareness and usage of the CASBEE for Home program on a variety of independent variables. In the Full Model, all of the independent variables were included. Applying step-wise methods utilizing the AIC criteria, the most parsimonious model (labeled Best Model) was found.

The Best Model shows that builder awareness of the CASBEE for Home program increased from 2009 to 2010 (1% level of significance), even though builder usage of the CASBEE for Home program did not significantly increase from 2009 to 2010, after

**Table 2:** Summary of the variable coefficients obtained from the hurdle regression model.

	Full Model				Best Model			
	Coeff.	S.E.	t-test		Coeff.	S.E.	t-test	
<b>Hurdle: Awareness of CASEBEE for Home</b>								
(Constant)	-1.191	0.297	-4.01	***	-1.121	0.198	-5.65	***
2010 <sup>a</sup>	0.790	0.178	4.42	***	0.800	0.172	4.65	***
200Yr <sup>a</sup>	-0.011	0.187	-0.06					
Tokyo <sup>a</sup>	-0.065	0.183	-0.36					
Year	0.008	0.004	1.92	*	0.007	0.004	1.76	*
log(HS)	0.244	0.059	4.11	***	0.233	0.053	4.44	***
Multif	-0.727	0.437	-1.67	*				
P&B	0.126	0.227	0.56					
Spec	-0.741	0.462	-1.60		-0.803	0.440	-1.83	*
<b>Use of CASBEE for Home</b>								
(Constant)	-1.728	0.511	-3.38	***	-1.731	0.318	-5.44	***
2010 <sup>a</sup>	-0.275	0.280	-0.98					
200Yr <sup>a</sup>	1.224	0.338	3.62	***	1.226	0.299	4.10	***
Tokyo <sup>a</sup>	0.186	0.285	0.65					
Year	0.010	0.006	1.81	*	0.012	0.005	2.32	**
log(HS)	0.013	0.071	0.18					
Multif	-0.697	1.318	-0.53					
P&B	0.154	0.355	0.43					
Spec	-0.520	0.781	-0.67					
log-likelihood	-208.1				-212.5			
AIC	456.2				441.0			
BIC	526.8				469.2			

Note 1: Coeff. and S.E. represent point estimates and standard errors of coefficients, respectively.

Note 2: "a" implies a dummy variable.

Note 3: \*, \*\* and \*\*\* imply that the coefficient is significantly different from zero at the 10%, 5% and 1% levels, respectively.

controlling for awareness. This result follows the diffusion of innovations theory where Rogers (1962) argues that diffusion is the process by which an innovation is communicated through certain channels over time among the participants of the system. The longer that an innovative idea exists, the more likely it is that information about the idea will be diffused (Bass 1969).

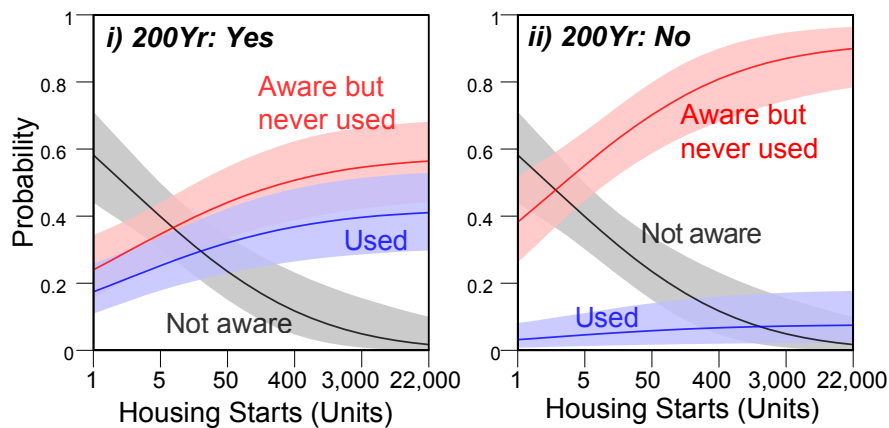
Our results also show that firm size (based on the number of housing starts) increased the awareness of the CASBEE for Home program significantly (1% level of significance), but that it did not significantly increase the usage of the program, which supports the awareness part (H1a) of H1, but fails to support the use part (H1b) of H1. Similarly, respondent's use of the 200-Year House program was found to increase their use of the CASBEE for Home program (10% level of significance), but it did not have a significant impact on their awareness of the CASBEE for Home program, which supports the use part (H2b) of H2, but not the awareness part (H2a) of H2. In addition, respondent's experience (number of years in business) significantly increased their awareness of the CASBEE for Home program (10% level of significance) and usage (5% level of significance), which supports both the awareness

(H3a) and usage (H3b) components of H3. Finally, respondents who build a higher ratio of spec houses had a lower level of awareness of the CASBEE for Home program (10% level of significance), but this did not impact their usage of the CASBEE for Home program. Hence, this result supports awareness (H4a), but does not support the usage part (H4b) of H4.

In order to facilitate a visual representation of the results, a simulation-based method was adopted (King et al. 2000). Two sets of simulations were run by utilizing the empirical estimations of the hurdle model on a set of counterfactual builders. The first set considered the influence of familiarity with the ‘200-Year house’ program on the awareness and use of the CASBEE for Home program. The second simulation represents the role of builder experience with spec housing on the awareness and use of the CASBEE for Home program. As builder size plays a significant role in the awareness of the CASBEE for Home program, in both the scenarios an interaction was developed between builder size and the variable under consideration.

In the first set of simulations, two different scenarios were created. A hypothetical builder (i) has either used the 200-Year House program or (ii) has not used the 200-Year House program. All of the continuous independent variables for the hypothetical builder were set to a constant (i.e., the respective sample mean values) with the exception of housing starts and the simulated results are presented in figure 2. The central lines in the figures represent the point estimates while the shading represents the 95% confidence interval around the mean for the respective housing starts values. The left panel of figure 2 represents a builder who has used the 200-Year House program while the right panel of figure 2 represents a builder who has not used the 200-Year House program. The probability of awareness and use of the CASBEE for Home program increased with firm size within each of the sub-sample groups. The graphs also clearly reveal that under similar conditions, a builder’s likelihood of using the CASBEE for Home program is significantly higher if it has experience using the 200-Year house program.

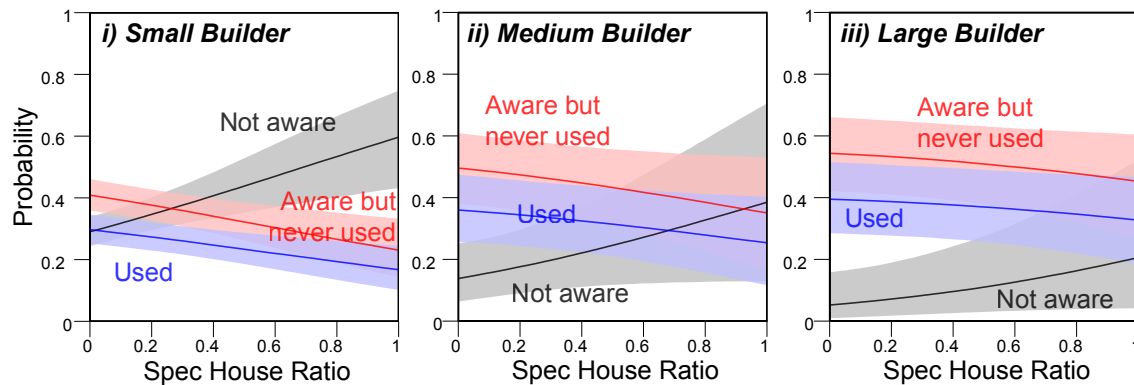
**Figure 2:** Counterfactual probabilities for discrete changes in respondents’ awareness level of the CASBEE for Homes program given their use of the 200-Year House program and their level of housing starts.



The second simulated scenario was developed based on the relationship between the ratio of spec houses built and builder size. In this set of simulations, the firms are categorized in three categories based on their firm size; (i) “small builder” (builds 20 units per year), (ii) “medium builder” (builds 200 units per year) and (iii) “large builder” (builds 2,000 units per year). Similar to the previous simulation, all of the continuous independent variables of a

hypothetical builder were set to their sample mean values except for the ratio of spec houses built and the simulated results are presented in figure 3. The central lines in the graphs are the point estimates while the shading around the lines represents the one standard deviation confidence interval<sup>4</sup>. As with the earlier simulation, an increase in firm size is positively correlated with a builder's awareness and usage of the CASBEE for Home program. Similarly, as the ratio of spec houses increases, the counterfactual probability that a builder was aware of, and had used, the CASBEE for Home program decreased.

**Figure 3:** Counterfactual probabilities for discrete changes in respondents' awareness of the CASBEE for Homes program given their firm size and based on their ratio of spec. homes built.



## 5. DISCUSSION AND CONCLUSION

One of the main benefits of GBPs is the increased awareness of environmental issues during the construction and operation of a building. The CASBEE for Home program encourages positive environmental practices while helping to stimulate the market for green homes in Japan. However, since the CASBEE for Home program is voluntary, it is expected that only those builders who expect to benefit from the program without significantly changing their business model would be most likely to implement it into their construction practices. Even though the CASBEE for Home program is the only national GBP in Japan, more than half of the survey respondents reported that they were unaware of the program. In order to become the *de facto* standard for green building in Japan, the CASBEE for Home program needs to find more efficient ways of communicating and marketing the program to home builders. This research was designed to look at the factors that influenced builders' awareness and use of the CASBEE for Home program during its initial introduction in Japan. The utilization of the hurdle model provides a unique perspective given its ability to look at Japanese builders' awareness and usage of the CASBEE for Home program in two separate stages (awareness and use).

This study found that both a larger firm size (measured in housing starts) and greater firm experience (measured in the number of years in business) increased the likelihood that a respondent was aware of the CASBEE for Home program. Greater firm experience also increased the likelihood that a firm would use the program. This study also revealed that as the ratio of spec

4. One standard deviation rather than the 95% confidence interval was used since the standard deviation for the coefficient of the spec house ratio is fairly large.

houses built increased, the respondents' awareness of the CASBEE for Home program decreased significantly. Finally, this study found that a respondents' participation in the 200-Year House program increased their likelihood of using the CASBEE for Home program. These results have three distinct marketing implications for the CASBEE for Home program.

First, promoting the CASBEE for Home program aggressively through different channels is required to diffuse information about the CASBEE for Home program through builder networks thereby increasing awareness of the program. Many small, young and inexperienced builders were not aware of the CASBEE for Home program and this needs to be remedied if the program is to increase its use within the residential construction sector. Green building is a great opportunity to energize the housing industry in Japan where the single family housing market has been continuing to shrink because of rural depopulation and an aging population. The CASBEE for Home program managers need to be user- and consumer-oriented, so that information can be made easily accessible to both builders and home buyers since they might be more inclined to purchase a green home. Providing a diverse range of innovative green homes to the entire spectrum of Japanese home buyers can help increase the attractiveness of the CASBEE for Home program.

Second, it is also important not to waste programmatic resources trying to convince builders who are not interested in using the program. In today's environmentally focused society, it is generally expected that firms will voluntarily pursue a green business strategy. However, since firms often make these decisions based upon economic considerations, the adoption of a green building program is influenced by the business operations of the firm (Reinhardt 1998). According to Sasatani et al. (2010), the business strategy of spec house builders in Japan mainly focuses on providing affordable houses to young, first-time home buyers. During informal preliminary interviews with spec house builders in Japan, they mentioned that building green homes would result in a higher operating and materials costs, which is contradictory to their business model. One could argue that the adoption of CASBEE for Home may benefit home owners financially because central and local governments in Japan provide a variety of incentives ranging from subsidies and tax breaks to reduced interest rates for home loans, while a green home can also reduce energy use (and costs) over time. However, the results of this study clearly show that low-cost spec home builders appear to be unwilling to absorb higher costs to build green homes. This result is similar to that observed by Gauthier and Wooldridge (2012) who explored the adoption of the LEED program in the U.S.

Providing a clear message to builders about the benefits of building green while at the same time telling potential home buyers about the benefits of buying a green home can help in securing a price premium for green homes that may benefit the CASBEE for Home program in the long term. Economically oriented builders may still be interested in the program and should be informed as well, but it is important to realize that their business strategy has a different perspective and that they may not choose to use the CASBEE for Home program until it becomes a standard practice within the industry. Firms focused on differentiating their houses have an opportunity to use a variety of certification programs such as CASBEE for Home and the 200-Year House program<sup>5</sup>, whereas firms focused on

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5. The 200-Year House program provides a variety of direct benefits for home buyers, including subsidies, tax deductions, tax credits, and preferential interest rates on mortgages. On the other hand, the CASBEE for Home program does not provide as many incentives for home owners besides a small reduction in mortgage rates.

providing inexpensive houses are less likely to use any program that would raise the price of their homes. Promoting the CASBEE for Home program in conjunction with other certification programs may help increase the awareness and usage of the program.

Third, better and more appropriate incentives for home buyers who are looking to buy a green home are needed during this early “introductory” phase of the program. According to recent research conducted by MLIT (2014), 21.8% of custom home buyers didn’t use a mortgage to buy their new home in 2013. Typically, green home builders target wealthier individuals, who need small mortgages. Thus, a small reduction in mortgage rates may not significantly contribute to boosting the use of the CASBEE for Home program. Other, more effective strategies to encourage these high-net-worth households to use the CASBEE for Home program could include generous direct subsidies, deduction of real estate acquisition taxes, or deduction of gift/estate taxes. Deduction of gift/estate taxes especially make sense since one of the goals of CASBEE is sustaining the finite resources necessary to provide for the needs of future generations. Japan faces severe wealth imbalances between the young and old generations (Kotlikoff and Raffelhüschen 1999). Encouraging the older generation to transfer their wealth to the younger generations by investing in a green home could address both environmental and social problems. Incentives like these could effectively increase the popularity of the CASBEE for Home program without requiring home builders to substantially reduce the price premium of green homes.

This study considered an initial two year period to assess the factors that influence builders’ adoption of the CASBEE for Home program in Japan. However, it is important to note that these factors may change over time as the industry becomes more aware of the program or the demand for green homes in Japan increases. This research used a convenience sample (e.g., Greene 1981) of participants at the Japan Home and Building Show, which draws homebuilders from all over the country. This methodology resulted in a heterogeneous mix of respondents and a better representation of the diversity of the Japanese construction industry than other sampling approaches may produce.

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