Reitaku University Business Ethics & Compliance Research Center

R-bec

Working Paper No. 10

The Investment Value of Green Buildings

－ The Sustainability of Property Value －

Chihiro Shimizu

平成24年10月15日

発行者：麗澤大学企業倫理研究センター

The Investment Value of Green Buildings*

— The Sustainability of Property Value —

Chihiro Shimizu†

Oct 15, 2012

Abstract

Environmentally friendly (green) buildings are increasingly becoming a focus of attention. Additional costs are required in constructing green buildings in order to enhance their environmental performance, but do they have an added economic value commensurate with these costs? This paper aimed to clarify the investment value of green buildings. Specifically, it used the hedonic approach to clarify whether or not there is an added economic value, focusing on the new condominium market in the Tokyo metropolitan area. Based on the hedonic theory framework indicated by Rosen (1974), the paper specified an estimation model that accounts for buyer characteristics, and combining it with a producer offer price function, it estimated a function for the market price, which is the intersection point of the offer price function and buyer bid price function. This showed that green buildings have an added economic value of 5.8% for the asking price (producer offer price) and 4.7% for the market (transaction) price. This finding is consistent with findings focusing on other countries, and it has many policy-related implications with respect to the future development of green building policies both in Japan and abroad. As far as the author is aware, this is the first study of green buildings' economic value based on a hedonic function incorporating buyer characteristics.

Key Words :Green building; green label; hedonic approach; offer price; bid price; market price function; omitted variable bias.

JEL Codes : G51; M14; D92

1 Introduction

It is anticipated that, henceforth, increasingly proactive efforts will be undertaken on a global scale aimed at achieving a low-carbon society. In December 2011, at the United Nations Framework Convention on Climate Change (COP17) held in Durban, South Africa, the "Durban Accord" was adopted, which integrates the extension of the Kyoto Protocol with the creation of a new greenhouse gas reduction system.

At this conference, Japan stated a position opposing the extension of the Kyoto Protocol. One of the likely reasons is the impact of the nuclear accident caused by the Great East

*This paper was presented at "ZEMCH2012, International Conference (8/20-22, 2012, Glasgow, UK)". The author thank acknowledge very helpful discussions with Jiro Yoshida ,Franz Fuerst, Masa Noguchi and Paul McManara. This research is a part of the project funded by a JSPS Grant-in-Aid for Scientific Research (B 23330084) and Business Ethics and Compliance Research Center of Reitaku University.

†Correspondence: Chihiro Shimizu, Reitaku University & The University of British Columbia, Kashiwa, Chiba 277-8686, Japan. E-mail: cshimizu@reitaku-u.ac.jp.

Japan Earthquake in March 2011 has necessitated a major shift in energy policy. However, having stated this position does not mean the country can avoid the low-carbon society-focused international framework that will likely develop henceforth. Instead, addressing this problem will become an issue of increasing importance.

In aiming to achieve a low-carbon society, the role that should be played by the property market is by no means a small one.[1] Under such circumstances, interest is continuing to grow with respect to environmentally friendly (green) buildings.

Compared to normal buildings, green buildings (although there is no precise definition) are buildings equipped with features that suppress the carbon-based compounds (CO_2) generated through economic activities, daily activities, etc., that are conducted within them. Needless to say, when it comes to both the social and economic activities of companies and private individuals, it is extremely important that property owners and users attempt to fulfill their share of the responsibility for achieving a low-carbon society by promoting the spread of buildings equipped with these kinds of features.

The question of whether there is an added economic value in green buildings is therefore extremely important. And in order to move forward with green building policy, there are a number of problems that must be resolved.

The first problem is the cost burden involved in pursuing this policy. Compared to non-environmentally friendly buildings, added costs are incurred in the construction and renovation of green buildings. If all of these costs are to be borne by companies and households, there must be a return corresponding to or exceeding these added costs. Otherwise, it will become a new way of shifting the public burden to the private sector, as typified by taxes.

The second problem is the extent of the role that should be played by the property market in achieving a low-carbon society. Here, let us focus on carbon emission amounts. Socio-economic activities in the office and household sectors, which are conducted with property stocks as the setting, account for a significant proportion of carbon emission amounts. However, when it comes to the development of environmental policy, neither the role that should be played by the property market nor the extent of that role is clear. If green building policy is only pursued haphazardly with the extent of the property market's role remaining ill-defined, there is a possibility that the burden assumed by this market may be excessive.

After first specifying the CO_2 reduction amount that should be borne by the property market, policy-makers should perhaps clarify the level of environmental investment needed in order to achieve this target.

However, even if one assumes that these policy objectives have been made clear, there are strong location constraints in the property market. As a result, with respect to shouldering the burden, the problem of regional distribution remains. It is necessary to clarify whether

[1] In a 2010 breakdown of CO_2 emission amounts by sector, the proportion was 19% for the "business sector" (offices, stores, schools, etc.), and it exceeded 30% when combined with the household sector (14%). (These proportions are the figures after allocating the power load for each sector.) The proportion is 19% for the "transportation sector" (automobiles, boats, airplanes, etc.). As well, since approximately 50% of the transportation sector's emissions are from private automobiles, if private automobiles are allocated to the household sector, the proportion for this sector exceeds 20%. Combining offices and so forth with the household sector accounts for 40% of total emissions. Restricting ourselves to Tokyo only, this figure jumps to 76%.

green building development is a problem that should be borne by Japan as a whole or a problem that should be shouldered by certain large urban areas. If it is to be pursued across Japan as a whole, it should be implemented through legal reforms; if it is a regional problem, pursuit of green building development should be centered on local governments.

Here, I will outline the relationship to the property investment market.

Investment management companies prioritize maximizing investors' profits above all else. But when it comes to property investment in green buildings, they are faced with a difficult decision between maximizing investor profits and enterprise value or carrying out their corporate social responsibility. This is not just a problem for property investment management companies; general businesses are likewise confronted with this difficulty in decision-making when it comes to the issue of making maximization of shareholder profit an objective.

What about the household sector? Housing is the biggest investment item and asset. Since there is a possibility that purchasing a green building – i.e., an environmentally friendly home – could have a major impact on the housing price at the time of resale, it is an issue that has to be considered very carefully.

The ideal scenario is for the profit generated due to added investment in green buildings to surpass the investment amount. Only in this case will the objectives of management companies and general businesses, which seek to maximize investor and shareholder profits, be aligned with the benefits to society as a whole, which aims to achieve a low-carbon society. The same may be said of the household sector.

On the other hand, if there is no added investment profit with respect to green buildings, or if the profit does not surpass the investment amount, those involved will be saddled with a difficult decision – because the maximization of investor/shareholder/household profits and the objectives of society as a whole (social responsibilities as corporate/global citizens) will not be aligned.

Having said that, even if the added investment profit for green buildings surpasses the added investment amount, one cannot simply say that this will accelerate investment in green buildings. Many property management companies and business companies already own a lot of property. If regulations are implemented in order to increase environmentally friendly standards and investment in green buildings is accelerated, there is a risk that the price of existing properties that are not environmentally friendly will be dragged down, leading to a decline in the value of property stocks as a whole.

In other words, it is not enough to just consider the matter from the macro perspective of increasing the property price of green buildings themselves. Through the implementation of green building policy, instead of a zero-sum game, consideration should be given to measures that enable price maximization for all properties owned throughout society as a whole. Of course, it would be difficult in the first place to build social consensus for policies that would cause the price of property stocks as a whole to decline. What is desired is the selection of policies that maximize property stock prices.

If attempts are made at market inducement via strong public policy measures (e.g., regulations) due to green building stocks still being low at the current time, there is a possibility of causing distortion in the market. A localized bubble could occur in the green building market, and existing stocks in the non-environmentally friendly building market could be temporarily transacted at a level below their inherent fundamental price. Green building policy trends, which may cause this kind of situation, could become a key issue in property investment as well. With the increasing possibility of future environmental regulations, problems relating to environmental friendliness in property investment must surely become a focus of property investment risk management.

Takagi and Shimizu (2010) have analyzed the issue of environmental risk factors that should be considered when conducting property investment. In this paper, they present risk factors focusing on trends related to the Principles for Responsible Investment developed by the United Nations. Furthermore, Shimizu (2010) has examined what kind of economic value exists in environmentally friendly buildings. Focusing in particular on green labels for buildings such as Japan CASBEE, U.K. BREEAM, and U.S. LEED and Green Star rating systems, this study analyzed the relationship between green labels provided in the property market and property prices and evaluation methods for property appraisals.

Accordingly, taking these studies as a starting point, the present paper aims to outline subsequent new social trends, as well as clarify the relationship between green buildings and investment values.

2 Changes in the Social Environment Surrounding Environmentally Friendly Buildings and Investment Values

2.1 Previous Research

Do green buildings truly have an added economic value? With interest in the added economic value of green buildings growing, a number of empirical analyses of this question have been reported.

Focusing on the green label system that indicates green buildings' environmental performance, empirical analysis – using the method known as the hedonic approach – has clarified to what extent there is a rent or price premium for buildings that have been granted a green certification (label) showing their environmental performance level.

Systems that quantitatively evaluate/certify green buildings' environmental performance have appeared, centered on the U.K., U.S., Japan, etc. (Shimizu, 2010). The leading systems are Green Star and LEED in the U.S., BREEAM in the U.K., and CASBEE in Japan.[2]

In Japan, besides versions of CASBEE at the local government level, certification systems are starting to appear at the private-sector level, such as the DBJ Green Building Certifi-

[2]In Japan, the certification system known as CASBEE (Comprehensive Assessment System for Built Environment Efficiency) is the leading green building certification system. With CASBEE, a building's "environmental load reduction" is evaluated in terms of "energy," "resources and materials," and "off-site environment."

cation System introduced by the Development Bank of Japan.[3] How buildings evaluated via such green label systems are evaluated in the property market and how they have an impact on revenue and price are issues that strongly interest not just policy-makers but also property investors.

Let us take a look at previous research that has analyzed the relationship between these kinds of environmental certifications (green labels) and rent/price. First, Eichholtz et al. (2009), in an empirical study focusing on the U.S. office market, verified that there is a rent increase of slightly less than 3% due to the granting of green labels indicating environmental friendliness, and they showed that there is an approximately 6% increase in the effective rent taking the occupancy rate into account. Moreover, the findings of Fuerst et al. (2009, 2010), similarly focusing on the U.S. property market, showed that the occupancy rate increases by approximately 3% to 8%. Meanwhile, for the housing market, older research by Dian and Miranowski (1989) showed that housing prices increase when their energy efficiency is increased, while Banfi et al. (2005) have published research findings indicating that tenants are prepared to pay up to 13% higher rent for buildings that have adopted energy-saving measures.

In contrast to the research by Dian and Miranowski (1989) and Banfi et al. (2005), which focused only on energy-saving performance, what is distinctive about the other studies is that they examine the effect of the green labels that have been developed in recent years.

It has been empirically demonstrated that the existence of such green labels that certify and represent property having a certain level of environmental friendliness increases rental income, occupancy rates, and prices.

In the case of Japan, the Ministry of Land, Infrastructure, Transport, and Tourism (2010, 2011), the Tokyo Association of Real Estate Appraisers (2010), and Yoshida and Shimizu (2012) have clarified what kind of effect green labels have on new condominium prices, likewise based on hedonic analysis as used in the previous overseas studies described above, using Tokyo Green Labeling System for Condominiums data focusing on the Tokyo condominium market. In addition, the Ministry of Land, Infrastructure, Transport, and Tourism (2011) and Sugata, Kawamura, and Shimizu (2011) have reported empirical analysis focusing on the Tokyo office market.

The Tokyo Association of Real Estate Appraisers (2010), which conducted analysis focusing on Tokyo using unit transaction prices for used properties and new condominiums, has suggested that there is a possibility that environmental evaluations are being discounted. They reported findings that, on the one hand, energy-saving and greening have a low or negative effect, whereas lifespan extension has the most positive effect. Yoshida and Shimizu (2012) have shown that among environmentally friendly condominiums for which a condominium environmental performance assessment report has been disclosed, the price increased by approximately 5%. They also showed that this effect was pronounced in 2006 and 2007, but disappeared in 2008. The Ministry of Land, Infrastructure, Transport, and Tourism

[3] The Development Bank of Japan has established its own green certification system, which performs a four-step environmental evaluation. For details, see http://www.dbj.jp/service/finance/g_building/.

(2011) and Sugata, Kawamura, and Shimizu (2011) analyzed what kind of effect green label differences have on office rents, focusing on the Tokyo office market. Looking at Sugata, Kawamura, and Shimizu's results shows that rental income increases by approximately 2.2% for buildings that obtain an evaluation of A or more for ERR[4]ÅCwhile rents for buildings that obtain an evaluation of A or more with PAL may increase by 7.8% compared to those that do not.

Compared to analysis that has been conducted focusing on the U.S., however, it is difficult to claim that there has been sufficient empirical research focusing on Japan, due to the data limitations. Therefore, it could be said that the economic theory basis for green buildings to have additional economic value has not been sufficiently outlined. Empirically clarifying whether or not they have an added economic value is extremely significant. However, unless the generating mechanism is explained, it is not be possible for this value to be recognized within the economic system. As long as this mechanism is unexplained, the added economic value likely cannot (should not) be evaluated in property appraisals, and it will likely not be acknowledged by investors either. Accordingly, this paper will outline the generating mechanism of added economic value below, with an appendix presenting the results of empirical analysis focusing on the Tokyo condominium market.

2.2 Added Economic Value of Green Buildings

Theoretical Model of Property Value While outlining the determining mechanism of property value, I shall outline what kind of mechanism enables green buildings to have a premium.

The determining mechanism of property value may be formulated using a durable goods economic value model framework.

Here,V_v^t expresses the property value for a building aged v years in the period t. y_v^t is the income generated from the corresponding property aged v years in the period t, and O_v^t is the expenses corresponding to this income. r^t is the discount rate for the period t. All of the respective variables are predicted at the beginning of the period t.

Here, the income generated from the property is considered to be the amount received at the end of a given year. And the property's lifespan shall be taken to be m years. This being the case, the property's present value may be defined as in (Formula 1).

$$\begin{aligned} V_v^t = & \frac{y_v^t}{1+r^t} + \frac{y_{v+1}^{t+1}}{(1+r^t)(1+r^{t+1})} + \ldots + \frac{y_{m-1}^{t+m-v-1}}{\Pi_{i=t}^{t+m-v-1}(1+r^i)} \\ & - \frac{O_v^t}{1+r^t} - \frac{O_{v+1}^{t+1}}{(1+r^t)(1+r^{t+1})} - \ldots - \frac{O_{m-1}^{t+m-v-1}}{\Pi_{i=t}^{t+m-v-1}(1+r^i)} \end{aligned} \tag{1}$$

In addition, the discount rate r for the property is determined as the result of comparison with investments in stocks, bonds, etc. (asset choice), and may be strictly defined as $(R_{ft} +$

[4]Under CASBEE, effects on rents are calculated based on ERR (Energy Reduction Rate: the energy consumption reduction rate with the building's equipment/systems) and PAL (Perimeter Annual Load: annual thermal load coefficient).

$R_{pt} - g$). Taking the return on safe investments (R_{ft}) on government bonds – which are a benchmark for financial investments – and the like as a base, this is determined based on the risk premium for the relevant property (R_{pt}) and the income appreciation rate for the relevant property (g_i) (Gordon, 1959). Moreover, this risk premium (R_{pt}) may be expressed as the following equation.

$$R = f\left(L(z), \xi\right) \tag{2}$$

Here, L indicates the liquidity risk, and the "unforeseen risk (ξ)" that could not be forecast at the time of investment is also included.

Macro-level market fluctuations (g) are the same regardless of whether or not a property is a green building. Moreover, if the "unforeseen risk (ξ)" to which the property market is uniformly exposed is ignored, the added economic value of green buildings may be differentiated based on changes in three factors: the income variation effect (y_v^t) based on whether or not higher rent may be obtained compared to buildings not outfitted with environmentally friendly features; the expense reduction effect (O_v^t), and the discount rate/liquidity risk variation effect ($L(z)$) based on how much the liquidity risk changes compared to non-green buildings. Below, I shall outline the effect of each component.

Income Variation Effect As outlined in the previous section, it has been reported that a premium exists with respect to income for green buildings. Assuming that these findings are correct, the question of why income increases for green buildings is an important one. This is because the sustainability and extent of future premiums will change significantly based on the underlying factors. Eichholtz et al. (2009b) analyzed what kinds of companies are located in environmentally friendly buildings. Their results showed that companies with a strong preference for being located in environmentally friendly buildings can be categorized into six types: a) tertiary industry companies, for which energy cost savings have a major effect on ensuring profits, b) companies at which there is strong demand for Corporate Social Responsibility (CSR) from shareholders, c) companies which are sensitive to their environmental load (companies such as those in the oil and energy industries that deal in commodities which are a factor in environmental loads), d) companies with many highly educated personnel who generate high added value, e) government or public institutions, and f) companies sensitive to consumer behavior (companies such as food manufacturers whose profits are directly linked to their reputation with consumers).

In the case of a), the tenant company forecasts a relatively significant expense reduction effect, and even if the nominal paying rent is high, it will be offset by this effect. Based on this, it may be anticipated that the company judges that a practical rent reduction effect can be expected. This falls under the expense reduction effect discussed in the next section.

In the case of b), c), d), e), and f), paying high rent is justified for various reasons at the respective companies due to an indirect effect, which is independent of the direct effect in the case of a),$\left(y_v^t + y_{v+1}^{t+1} + \ldots + y_{m-1}^{t+m-v-1}\right)$ increases, and the value of green buildings increases. However, questions arise here with respect to the issue of whether the results indicated by Eichholtz et al. (2009) are also applicable in Japan and whether or not the effect continues to occur throughout a building's lifetime of m years.

First, there is a limit to the number of companies such as those in the energy industry that are sensitive to the environment as in c). In the case of d) and f) as well, it is difficult to believe, based on Japan's industrial structure, that many such companies necessarily exist. With regard to government-related institutions and public organizations in e), there is an underlying contraction due to the effect of public servant system reforms, regulatory reforms, etc.

Therefore, when it comes to advancing environmental policy via green building policies, it is vital to maximize the effect on companies corresponding to b). This is because the effect is not limited to specific industries/companies but relates to all industries/companies. The demand for green buildings and amounts paid for them will likely change in future based on how companies expand their CSR activities, including environmental policies.

Moreover, since the lifespan of property is long, it is necessary to make decisions from a long-term perspective. Just because green buildings do not currently have a premium does not mean that one will not exist in future.

Conversely, as the number of stocks represented by green buildings changes, it is to be expected that the extent of their added economic value will also change. If green building stocks increase, buildings that are not outfitted with environmentally friendly features may incur a penalty.

In addition, if one considers that green technology is constantly advancing, there will likely also be a gap between the technology introduced in current green buildings and the green technology that will be supplied to buildings in future. It is possible that even if a green building is currently outfitted with environmentally friendly features, it could be exposed to the risk of economic obsolescence in future. These problems do not just affect the income variation effect, they have an equal impact with respect to liquidity.

Expense Reduction Effect (O_v^t) In comparison to other buildings, green buildings are designed so that they have greater energy efficiency. Specifically, energy costs will decrease by increasing insulation and the like. This kind of effect is greater in cold regions (i.e., it changes based on climate). Furthermore, technologies have been introduced that reduce the various kinds of energy generated by activities in buildings, by means of facilities that increase energy efficiency such as lighting. There is also a movement toward attempting to control carbon emission amounts by using alternative energy such as solar power and geothermal power. The economic value accompanying these kinds of increases in energy efficiency is linked to the increased value of green buildings through the reduction of $\left(O_v^t, O_{v+1}^{t+1}, ..., O_{m-1}^{t+m-v-1}\right)$. This effect is the added economic value indicated by Dian and Miranowski (1989) and Banfi et al. (2005).

Uncertainty remains, however. This is because it is extremely difficult to estimate the future cost reduction effect that will occur over a building's lifespan of m years. There is no guarantee current energy costs will be maintained in future, and price differentials between energy sources such as electricity, gas, etc. also change. In particular, the effect will change considerably depending on how one perceives the structural changes in energy costs accompanying the transformation of electric power policy due to the Great East Japan Earthquake. To put it another way, the more energy costs increase, the greater the expense reduction effect will become.

Even assuming that costs are reduced from an operating perspective, the possibility remains that if facilities become more sophisticated and have higher added value, the initial investment will become greater and higher costs will be incurred for investment in maintenance and repairs.

Discount Rate/Liquidity Risk Change Effect The discount rate is one of the most important factors in determining property values. In the matter of price sensitivity, the effect due to changes in discount rate is relatively large compared to the extent of fluctuations in expenses and income.

With regard to the issue of determining the discount rate for green buildings, research focusing on socially responsible investment funds is a useful reference. Socially responsible investment funds are composed of investment funds focusing only on companies with externalities that have satisfied certain standards relating to social contributions. Studies have been published indicating it is possible to obtain relatively high returns from investment in such funds, compared to regular investment funds. However, with regard to outcomes, different results have appeared based on differences in the analysis period, etc. (e.g., Renneboog and Zhang, 2008; Galema et al., 2008).

Even if profitability is not high, should liquidity increase, it is to be expected the discount rate will decrease via the risk amount decreasing. This being the case, the economic value would increase through this decrease in the risk amount. However, at the present time, not enough empirical research exists to indicate this. Furthermore, if the movement among the likes of the Development Bank of Japan and other private-sector financial institutions to actively provide low-interest financing for buildings with superior environmental performance gains momentum, liquidity will increase through the reduction in direct funding costs and this will be reflected in the value.

In addition, let us assume that during the lifespan of a property, tenants come to avoid locations other than green buildings due to the implementation of strong environmental regulations. In this case, it is not simply a matter of the income decreasing.

Given, as can be seen at the present time, investment behavior changes based on whether the year of construction of an investment property was before or after regulations regarding earthquake-proof capacity were implemented,[5] the possibility that properties with poor environmental performance will also be excluded from investment targets in future cannot be underestimated.

[5]Earthquake-proofing standards were specified in 1981, when revisions to the Building Standards Act were implemented. As a result, terms such as "new earthquake-proofing standards" and "old earthquake-proofing standards" appeared, and buildings built to old earthquake-proofing standards were frequently discounted as investment targets.

In other words, with regard to non-green buildings, one cannot deny the possibility they will be charged with penalties that result in the depletion of liquidity. Should such a situation occur, one must assume that property value could become almost zero due to the risk premium (R_{pt}) being increased or the risk of losing liquidity becoming unlimited.

According to the above explanation, the investment value of green buildings changes via changes in the "income variation effect," "expense reduction effect," and "discount rate and constituent liquidity risk." However, when comparing green buildings and buildings not outfitted with environmentally friendly features, since there is not enough empirical analysis on the extent to which the respective variables change, the question of how the investment value of green buildings changes has not yet been sufficiently elucidated.

3 Estimating the Economic Value of Green Buildings: The Case of the Tokyo Metropolitan Area

Now, I shall present the extent of the economic value possessed by green buildings based on the results of empirical analysis focusing on the new condominium market in the Tokyo metropolitan area. For details, please refer to "Appendix 1: Estimating the Economic Value of Green Buildings."

Looking at the obtained results makes it clear that, in comparison to property not equipped with environmentally friendly features, a premium of 5.7% for the base asking price and 4.6% for the base transaction price exists for green buildings.

There has been a tendency for these kinds of green building economic value analysis results to be viewed with skepticism.[6] In terms of the reasons for this, the following problems have been pointed out.

The first problem is that it is difficult to discriminate between the performance of green buildings and that of non-green buildings. The granting of green labels certifying that buildings are green is limited to certain large-scale buildings. There are many cases in which the quality and so on of such large-scale buildings is higher than that of other buildings due to their having extensive common areas. Further, many of them are developed by major developers, and it is typical for construction to be performed by companies with strong technological capabilities.

In such a case, the question has been raised as to whether green label certification is not just a proxy variable for factors such as condominium size, developer and construction company quality, etc.

The second problem relates to econometrics. Empirical analysis of green buildings' economic value is performed with the method known as the hedonic approach. In estimating a hedonic function, if important variables in determining property values are not taken into account, the problem of the estimated value being unreliable occurs (this is known as the

[6] I have referred to discussion by the Economic Value Working Group at the Ministry of Land, Infrastructure, Transport, and Tourism Land and Water Bureau's "Conference on the 'Green' Value of Buildings."

"omitted variable bias" problem[7]).

In this analysis, these problems have been addressed as follows. With regard to the first problem, condominium size-related characteristics have been eliminated to the extent possible, while price differentials due to differences in developer and construction company have been considered. Moreover, through questionnaire survey, factors differentiating housing performance – such as whether or not there are housing performance evaluation documents – have been gathered to the extent possible. With respect to the second problem, environmental differences were examined with detailed geographic units (a grid of 500 meter squares), using the GIS (Geographic Information System), and via questionnaire survey, factors such as buyer age, income, occupation, and household size were incorporated as variables. Considering in particular the possibility that evaluation of buildings' environmental performance changes in accordance with buyer characteristics, and in view of consistency with hedonic theory, it is extremely important to take buyer characteristics into account.

Based on these measures, the aforementioned problems pointed out in relation to estimating green buildings' economic value have been resolved.

As a result, the outcomes of this empirical analysis are of considerable significance.

At the present time, while strong environmental regulations do not necessarily exist, efforts are being made by developers to attach a high premium to buildings with superior environmental performance when trying to sell them, and this premium is being accepted by buyers. This fact suggests it is possible that an even higher premium would be accepted by the market depending on future environmental regulation trends.

4 Green Building-Related Environmental Regulation Trends

4.1 Environmental Regulation Trends

When considering the investment value of green buildings, future trends in environmental regulations will have a significant effect, as has been explained in this paper's analysis. Here, I shall discuss recent trends, taking Takagi and Shimizu's (2010) explanation as a starting point.

In terms of international trends surrounding environmental regulations for property, the publication of the Principles for Responsible Investment (PRI) by the UNEP FI[8] set up within the U.N. could be described as a major turning point.[9] These principles follow on from the previously formulated Global Compact.

The Global Compact is a concept that was called for by former Secretary-General Kofi Annan – just like the Principles for Responsible Investment – at the 1999 World Economic

[7]This is the problem of bias occurring in estimate values due to the existence of variables that fundamentally have to be considered. In this case, the problem is that a bias may exist in the coefficient calculated as the effect of green certification due to the absence of variables that should be incorporated into the model.

[8]In 2006, at the urging of Kofi Annan, then Secretary-General of the U.N., the Principles were formulated with the UNEP FI (United Nations Environment Programme Finance Initiative: http://www.unepfi.org/) serving as the head office.

[9]As of October 2011, 915 institutional investors have signed. http://www.unpri.org/

Forum (Davos Forum).[10] This concept encourages companies to contribute to sustainable globalized economic development by supporting ten principles relating to "human rights," "labor standards," "the environment," and "anti-corruption" and incorporating them into their corporate activities.[11]

In the wake of this development, attempts have been made to encourage proactive acknowledgement and evaluation of principles and company efforts in the area of responsible corporate activities on the part of "operators (investors)," who are important stakeholders for companies. The Principles for Responsible Investment were aimed at encouraging this kind of behavior.

The Principles for Responsible Investment positioned "Environmental," "Social," and "Corporate Governance." as the three key factors.[12]

The Principles for Responsible Investment begin by stating: "As institutional investors, we have a duty to act in the long-term best interests of our beneficiaries. In this fiduciary role, we believe that environmental, social, and corporate governance (ESG) issues can affect the performance of investment portfolios (to varying degrees across companies, sectors, regions, asset classes and through time). We also recognize that applying these Principles may better align investors with broader objectives of society." Six principles were stipulated focusing on Environmental, Social, and Corporate Governance (ESG) issues.[13]

Following these Principles, a Property Working Group was organized as a subsidiary organization of the UNEP FI, which has attempted to adapt the Principles to property investment.[14]

However, while many Japanese companies have signed the Global Compact or Principles

---

[10] At the current time (January 2012), over 6,000 companies in approximately 135 countries worldwide (including 148 Japanese companies) have signed. http://www.unglobalcompact.org/

[11] The ten Global Compact principles:
Human rights Businesses should:
Principle 1: support and respect the protection of internationally proclaimed human rights; and
Principle 2: make sure that they are not complicit in human rights abuses.
Labor standards Businesses should uphold:
Principle 3: the freedom of association and the effective recognition of the right to collective bargaining;
Principle 4: the elimination of all forms of forced and compulsory labor;
Principle 5: the effective abolition of child labor; and
Principle 6: the elimination of discrimination in respect of employment and occupation.
The environment Businesses should:
Principle 7: support a precautionary approach to environmental challenges;
Principle 8: undertake initiatives to promote greater environmental responsibility; and
Principle 9: encourage the development and diffusion of environmentally friendly technologies.
Anti-corruption Businesses should:
Principle 10: work against corruption in all its forms, including extortion and bribery.

[12] Taken together, these three issues are known as ESG issues. As well, the Principles for Responsible Investment declared that efforts would be undertaken by investors to contribute to sustainable development by incorporating the principles into all investment activity processes, from decision-making through monitoring.

[13] 1. We will incorporate ESG issues into investment analysis and decision-making processes.
2. We will be active owners and incorporate ESG issues into our ownership policies and practices.
3. We will seek appropriate disclosure on ESG issues by the entities in which we invest.
4. We will promote acceptance and implementation of the Principles within the investment industry.
5. We will work together to enhance our effectiveness in implementing the Principles.
6. We will each report on our activities and progress towards implementing the Principles.

[14] The outcome of this was published as the June 2008 report "Building Responsible Property Portfolios," and the following month, "Responsible Property Investment: What the Leaders Are Doing" (hereafter referred to as the RPI report) was published.

for Responsible Investment, in fact it appears at the present time that this has not led to concrete actions being taken.

Here, I shall focus on trends related to green buildings in Japan.

In Japan, it may be said environmental regulations surrounding property are being moved forward mainly by local governments. Methods of implementing specific environmental policies can be divided into "information disclosure policies" expected to have an indirect effect on the market and "direct regulations." The latter include public burdens such as environmental tax, subsidies, and so forth.

Taking Tokyo Metropolitan Government as an example in terms of information disclosure policies, a "Green Building Program" was introduced in June 2002. This program obliged owners planning new construction or expansion of large-scale buildings exceeding 10,000m^2 to submit an environmental plan at the time of planning and a completion notice. This was to evaluate buildings' environmental performance from the perspective of "streamlining of energy use," "proper use of resources," and "conservation of the natural environment." Moreover, based on revisions to the Green Building Program in June 2005, "heat island measures" were added to these three evaluation categories.

Next, let us consider direct regulations. At Tokyo Metropolitan Government, a "CO_2 Emission Reduction and Cap-and-Trade Program" was implemented in April 2010. This program mandated a reduction of CO_2 by offices whose 2009 energy use was over 1,500kL in crude oil equivalents. As a general rule, the reduction obligation lies with owners, but securitized buildings and the like also have a considerable degree of responsibility in greenhouse gas emission reduction, and those registered in Tokyo have reduction obligations. Furthermore, tenants with a used floor space of 5,000m^2 or more or whose electricity usage in the previous year was 6 million kWh or more are also obliged to prepare and submit a measure planning document and then proceed with measures based on it.[15] The most distinctive feature of this program is that it has established what is popularly known as a cap-and-trade system, whereby it is possible for individual companies to fulfill their reduction obligation not only by reducing their own emission amounts but also by trading emissions.

4.2 Environmental Regulations and Property Values

What kind of effect do these trends in environmental policies/regulations have on property investment values?

First, let us consider information disclosure policies. If information is widely disseminated in the market and the behavior of market participants who are aware of this information changes as a result, this will be reflected in market values (Shimizu, 2010). Providing/disclosing information alone does not lead to a change in market values. Only once a change in behavior occurs will a change in market values occur. This is the same whether in

[15] Mandatory reduction is to be implemented over a five-year target period. The mandatory reduction rate is set at 8% for office buildings and the like belonging to the business sector, 6% for buildings in said category that use 20% or more of all their energy for local heating and cooling, and 6% for factories, water treatment facilities, etc.

the case of households investing in a home or in the case of companies investing in a large office building.

Next, let us consider direct regulations. Direct regulations change market behavior in accordance with how strict/soft the regulation is. Interest subsidies and other subsidies also cause changes in behavior corresponding to their amount.

If a change in market behavior occurs, an "income variation effect" and "discount rate/liquidity risk variation effect" are generated as indicated in the previous section, and investment values are also significantly affected, not just at the current time but also in future. As a result, it should be recognized environment-related regulations have emerged as one of the risk factors that must be scrutinized the most when investing in property.

Therefore, with regard to these regulatory trends, what kinds of issues do property investors need to be concerned about?

First, there is the "income variation effect." Since there will be an increase in parties actively seeking locations in green buildings if environmental regulations are enforced, there will be an increase in tenants willing to pay relatively high rents and buyers willing to purchase property at high prices compared to non-green buildings.

Moreover, since the costs related to using property will decrease, an "expense reduction effect" is to be expected. As a result, income will increase considerably when costs are factored in.

Conversely, in the case of ownership, the initial investment will become greater. In cases where the facilities are not only higher-performing but also more complicated and with higher added value, it is also possible that investment in maintenance/repairs will increase. Both positive and negative effects must be considered.

What has the strongest effect is the "discount rate/liquidity risk variation effect." Considering the long-term nature of property investment, it is possible the liquidity of green buildings will increase considerably in comparison to non-green buildings. To put it another way, it is necessary to anticipate the possibility that properties not outfitted with certain environmental features will lose liquidity.

5 The Sustainability of Property Value: Conclusion

Environmental issues in property investment should become a focus of risk management in the near future. However, when it comes to the maximization of property investment values and maintaining property values, it is necessary to view environmental issues more broadly.

The objective of property investment is to maximize the return on investment. Furthermore, considering the durable nature of property, it is necessary to maximize the return on investment into the future. At that point, the information which is needed is the "sustainability" of investment value.

Since existing green label systems such as CASBEE simply indicate a building's performance at a specific point in time, they are not expressly related to investment value. Here, a useful reference is the IPD Environment Code, published in the U.K. in 2007. In contrast to BREEAM, CASBEE, and LEED, which focus on evaluating buildings' inherent functions, the IPD Environment Code is distinctive in that it focuses on actual usage conditions and seeks to measure environmental loads. With its objective being to comprehend usage conditions, the significance of the IPD Environment Code is considerable: if usage condition-based environmental loads enabling the environmental status to be captured as it changes over time can be understood – rather than just points of time providing isolated snapshots of properties under development – then it will be possible to adopt measures based on those conditions.

This kind of information makes it possible to not only increase buildings' performance in a "hard" sense, but also to implement measures through introducing or changing usage methods.

The objective of green building policy is to contribute toward the achievement of a low-carbon society, not to develop buildings with superior environmental performance. Even if buildings with superior environmental performance are developed, whether or not their energy-efficiency increases varies considerably depending on their usage. As a result, it is important to capture their actual usage conditions.

What, then, is required of property investment managers? One measure to consider is disclosing actual environmental loads for each investment property or fund label. As stated previously, once investors' behavior changes through the disclosure of such information, green buildings' investment value will come to be evaluated on the market. In order to achieve this, it will likely be necessary to create common information disclosure rules in future.

Moreover, IPD Environment Code evaluation areas require taking into account not only environmental features such as 1), energy efficiency, 2) water usage efficiency, 3) waste disposal efficiency, 4) transportation access, 5) facilities, and 6) indoor environment, but also addressing future risks, i.e., 7) adaptation to global environmental changes. Specifically, this refers to how risk is managed with respect to the effects of climate change and rising sea levels accompanying global warming. For example, as the risk of flooding rises, risk management in this area is required. The IPD Environment Code is distinctive in that it is not created by building-related engineers but primarily by investors. In other words, it does not simply measure a building's performance at a specific point from a "hard" perspective, but places the emphasis on measuring its environmental load over an investment period.

The European Union formulated a directive related to flood measures in 2007 and resolved to create flood hazard maps and flood risk maps by 2013. As of 2009, 29 countries had completed preparation of flood maps. Completion of basic flood risk evaluation by 2011 and creation of flood risk management plans by 2015 has been requested.

Many Japanese cities, including the Tokyo metropolitan area, adjoin the sea, and given that, historically, cities were formed around rivers, it goes without saying that addressing flooding risks should be proactively incorporated as a focus of risk management.

When the sustainability of property investment values is considered, there are even more issues that must be focused on in risk management: measures addressing environmental regulations; measures addressing rising sea levels accompanying global warming/climate change, heavy localized rainfall, and the like; ; measures addressing earthquakes; measures addressing tsunamis; etc. In future, as society as a whole matures, it is to be expected that the Principles of Responsible Investment approach will also be a major factor in the sustainability of investment values.

In other words, it is to be expected that not just the "hard" features of a building but also its "soft" features (such as the management approach and management principles of the relevant property) will have a major impact on the sustainability of its investment value. In this context, it is easy to predict that measures addressing the environment will become a key focus of risk management.

Today, property investment managers are required to maximize property values from a long-term perspective suitable to the 21st century "green era" and to realize the sustainability of those values. In order to achieve this, there is likely a real need for market infrastructure development, information disclosure, and investment strategy from an actual investor perspective.

References

[1] Banfi, S., Farsi, M., Filippini, M., and Jakob, M. (2005), "Willingness to Pay for Energy-Saving Measures in Residential Buildings," *CEPE Working Paper*, No. 41.

[2] Dian, T.M., and Miranowski, J. (1989), "Estimating the Implicit Price of Energy Efficiency Improvements in the Residential Housing Market—A Hedonic Approach," *Journal of Urban Economics*, 25, pp. 52-67.

[3] Eichholtz, P., Kok, N., and Quigley, J.M. (2009a), "Doing Well by Doing Good? Green Office Buildings," *Berkeley Program on Housing and Urban Policy Working Papers*, W08-001.

[4] Eichholtz, P., Kok, N., and Quigley, J.M. (2009b), "Why Do Companies Rent Green? Real Property and Corporate Social Responsibility," *Berkeley Program on Housing and Urban Policy Working Papers*, W09-004.

[5] Galema, R., Plantinga, A., and Scholtens, B. (2008), "The stocks at stake: Return and risk in socially responsible investment," *Journal of Banking & Finance*, 32, pp. 2646-2654.

[6] Ministry of Land, Infrastructure, Transport, and Tourism Land and Water Bureau (2010), *Conference on the "Green" Value of Buildings Research Report*, Ministry of Land, Infrastructure, Transport, and Tourism.(in Japanese)

[7] Ministry of Land, Infrastructure, Transport, and Tourism Land and Water Bureau (2011), *Conference on the "Green" Value of Buildings Research Report*, Ministry of Land, Infrastructure, Transport, and Tourism.(in Japanese)

[8] Renneboog, L., Horst, J.T., and Zhang, C. (2008), "Socially responsible investments: Institutional aspects, performance, and investor behavior, *Journal of Banking & Finance*, 32, pp. 1723-1742.

[9] Shimizu, C. (2010), "Will green buildings be appropriately valued by the market?," RIPESS (Reitaku Institute of Political Economics and Social Studies) Working Paper, No.40.

[10] Shimizu, C. (2010), "Green buildings and property values," Fudosan Kantei (Property Appraisal), July 2010, pp. 28-36.(in Japanese)

[11] Shimizu, C. (2012), "Green buildings and property appraisals: Green values, ideal values, and actual values," Fudosan Kantei (Property Appraisal), April 2012, pp. 24-38.(in Japanese)

[12] Sugata, O., Kawamura, Y., and Shimizu, C. (2011), "Study regarding the effect of rental office building environmental performance on rental prices in the Tokyo metropolitan area," Japan Association for Real Estate Sciences Fall 2011 National Conference, pp. 131-138.(in Japanese)

[13] Takagi, Y. and Shimizu, C. (2010), "The Environment and Real-Estate Investment: Responsible property investing," Business Ethics and Compliance Research Center Working Paper (Reitaku University), No. 6.

[14] Tokyo Association of Real Estate Appraisers (2010), *Property environmental friendliness and asset prices: Empirical evidence based on Tokyo condominiums.*(in Japanese)

[15] Yoshida, J. and Shimizu, C. (2012), "The impact of environmentally friendly buildings on property values: The case of new Japanese condominiums, Jutaku Tochi Keizai (The Quarterly Journal of Housing and Land Economics), No. 83, pp. 20-32.(in Japanese)

A Measurement of the Economic Value of Green Buildings

A.1 The Added Economic Value of Green Buildings

Much research has been published in recent years surrounding whether or not added economic value exists for green buildings. Specifically, questions such as whether added economic value exists for green-certified buildings have been analyzed using the hedonic approach.

Eichholtz et al. (2009a), for example, in an empirical study focusing on the U.S. office market, confirmed that attaching a green label indicating a building is environmentally friendly increases rents by almost 3% and showed that effective rents taking occupancy rates into account increase by approximately 6%. Eichholtz et al. (2009b) analyzed the corporate location behavior underlying this kind of rental increase. Fuerst et al. (2009, 2010), similarly focusing on the U.S. property market, showed results indicating that occupancy rates become 3% to 8% higher.

Furthermore, in the housing market, there is previous research by Dian and Miranowski (1989) which showed that increasing energy efficiency increases housing prices. Banfi et al. (2005) have published research findings indicating that rental housing tenants are prepared to pay up to 13% higher rent for buildings that have adopted energy-saving measures.

In contrast to the research by Dian and Miranowski (1989) and Banfi et al. (2005), which focused only on energy-saving performance, what is distinctive about the other studies is that they examine the effect of the green labels that have been developed in recent years.

In Japan as well, research by governments (Ministry of Land, Infrastructure, Transport, and Tourism, 2010) and scholars has been undertaken in recent years. However, when one looks at Japanese research, there are still a number of issues that should be improved.

The first problem relates to data. The Tokyo Association of Real Estate Appraisers (2010) has conducted analysis by pooling transaction prices for new condominiums and used condominiums. However, in the present system, no green labeling system exists for used condominiums. There are differences between the used condominium market and new condominium market in consumers' housing selection behavior, and it is to be expected that there will be discontinuity between these markets. Calculating estimates by pooling the two markets in this way may cause bias to occur in the estimation results.

Yoshida and Shimizu (2010) and Shimizu (2010) have conducted analysis focusing on the new condominium market using asking prices and transaction prices. However, the number of transaction price data samples was extremely small, and the results did not ensure a sufficient level of statistical reliability.

The second problem is one of consistency with economic theory models. The hedonic model proposed by Rosen (1974) led to the development of market equilibrium theory for products differentiated according to the proposition by Tinbergen (1959), and it shows how differentiated assets such as housing can be analyzed, both from an economic theory and econometric model perspective. Specifically, it carefully scrutinizes the relationship between the product supplier's offer, product consumer's bid function, and hedonic price function structure, and defines the product's market price based on consumer and producer behavior. Although actual empirical analysis is not performed, it also outlines the econometric estimation procedure.

In the estimation of many hedonic functions, however, due to strong data limitations, it is not possible to gather all the variables designated as important by the theory. As indicated by Ekeland, Heckman, and Nesheim (2004) and Shimizu (2009), one faces the problem known as omitted variable bias, which occurs if important variables are left out of the function estimation; the estimated regression coefficient lacks impartiality and is biased.[16]

The objective of this study is to examine whether or not added economic value exists for green buildings with superior environmental performance, using the hedonic approach and focusing on the Tokyo new condominium market. In estimating the hedonic function, the following improvements were implemented.

First, with regard to the data, by means of questionnaire survey, as many variables as possible were gathered that were not previously able to be observed. Specifically, in terms of housing price information, both the asking price (which is the producer's offer price) and the transaction price (which is linked to the bid price) were gathered. Further, in order to ensure consistency with the hedonic theory model, data relating to buyer characteristics such as income, household size, etc., was gathered by means of questionnaire survey. Based on this improved data, the study aimed to clarify whether an added economic value exists for green buildings with superior environmental performance, and if it does, to what extent it occurs.

A.2 Empirical Model and Data

A.2.1 Estimation Model

In order to measure the economic value of green buildings, estimates were made based on the hedonic approach.

With the hedonic model proposed by Rosen (1974), even in simplified cases (cases in which producers are treated as homogeneous), extremely complex analysis is needed in order to distinguish preferences and technical structures based on hedonic price functions. Epple (1987) formulated an econometric model developed from Rosen's theory, assuming that there are large numbers of consumers and producers. The problem with Rosen's theory is that in the structural equation formed by supply and demand, it is not possible to eliminate the

[16] In estimating using the hedonic model, the following must be presumed: a) the utility function type is homogeneous for all consumers, but preference parameters follow a normal distribution (covariance is a diagonal matrix in which the non-diagonal elements are 0); b) for the consumer utility function, attribute variables are additively separable and in quadratic form; and c) the supply of differentiated products is provided exogenously. These are determinant hypotheses which assume that there is no reciprocal influence between the economic parties and that it is a feasible function type that the hedonic price function can represent during market equilibrium.

following scenario: specifically, important attributes are not observed and if the important attributes are correlated with observed attributes, the problem of simultaneity bias – in which there is neither impartiality nor consistency – will occur in the coefficient estimation of hedonic price function observed attributes in equilibrium (Ekeland, Heckman, and Nesheim, 2004).

With regard to this point, Epple's model is an approach that proposes a hedonic price function which is able to properly handle observation errors. However, this approach performs estimation by making an a priori assumption for the utility function and deriving a hedonic price function for closed market equilibrium in which exogenous variables are not required.

Therefore, after taking into account buyer characteristics, which are limiting conditions for the bid price function, the following model was set.

$$P_{(i,j,t)} = f(G_i, X_{(i,j)}, NE_k, HH_{(i,j)}) \quad (3)$$

$P_{(i,j,t)}$: New condominium price of condominium i and dwelling j at time t (1: asking price, 2: transaction price)

G_i : Green label of condominium i

$X_{(i,j)}$: Building characteristics of condominium i and dwelling j

NE_k : Location characteristics of region k

$HH_{(i,j)}$: Buyer characteristics of condominium i and dwelling j

In estimating the hedonic function, there were many cases where variables that should normally be incorporated are not considered due to data restrictions. Specifically, since information relating to the town/living environment in the vicinity of housing, which is not indicated in housing advertisements and the like, could not be obtained or was difficult to convert into a variable, it was often not incorporated. Moreover, information relating to housing buyers that determines the bid price function was not taken into account in most cases. However, when such variables are not considered, from an econometric perspective, one faces the problem known as omitted variable bias.

In this study, there are a number of improvements in comparison to previously estimated hedonic functions.

First, with regard to the price ($P_{(i,j,t)}$), both the asking price (which is the producer's offer price) and the market price (which is formed in connection to the buyer's bid price) were used. For these prices, what kind of effect each condominium green label (G_i) had was examined. Second, with regard to housing prices, in general, a price differential is generated ($X_{(i,j)}$) based on differences in condominium (i) features such as "building structure" and the size of the lot area, as well as features related to the dwelling (j), such as the "floor space," the unit's position ("whether or not it is a corner unit"), etc. In terms of the condominium building's features (i), it has increasingly been pointed out that a price differential is generated by the condominium developer or the developer's brand (the developer's reliability and quality assurance, which is difficult to observe visually) and by the construction company. With regard to these variables, developer and construction company information was also gathered and incorporated.

Further to these kinds of building and dwelling characteristics, the characteristics of the surrounding environment, such as the streetscape of the area (k), the commercial density, etc., have a major effect on housing prices. This is known as the "neighborhood effect" (NE_k). The neighborhood effect includes not only the living environment but also the ease of commuting to work or school and the ease of shopping, which are represented by transportation convenience ("accessibility of nearest station," "time to central business district," etc.).

Moreover, as shown in hedonic theory, it is also to be expected that a price differential will be generated via changes in the bid price function based on buyer characteristics ($HH_{(i,j)}$). The required floor space and housing features change in accordance with the buyer's annual income and household size, and if they are not linear, these characteristics have to be taken into account. In particular, since it is to be expected that factors such as a building's environmental performance will change considerably according to housing buyers' preferences, it may be too much to assume that there is a homogenous utility function (Shimizu, Nishimura, and Karato, 2007).

Based on this kind of model analysis, the following three estimation models were set.

Here, factoring in the time element, the hedonic price function is estimated focusing on the condominium price ($P_{(i,j,t)}$) at time t.

First, as a standard model, the following model was taken as a starting point (Model 1).

$$\begin{aligned} \log P_{(i,j,t)} = a_0 + a_1 T_{(i,j)} + a_2 G_i + a_3 G_i T_{(i,j)} + \sum_m a_4^m X_{(i,j)}^m \\ + \sum_n a_5^n NE_k^n + \sum_t a_6^t D_t + \epsilon_{(i,j)} \end{aligned} \tag{4}$$

$T_{(i,j)}$ is a transaction dummy (1 in the case of the transaction price; 0 in the case of the asking price), while D_t ($t = 2001$ to 2011) is a time dummy. With regard to the green label effect (G_i), it is to be expected the degree to which the effect appears will change depending on the asking price (which is the producer's offer price) or the transaction price (which is linked to the bid price). Accordingly, the difference between the two has been differentiated by inserting a cross-term ($G_i \times T_j$) with the transaction price dummy (T_j), which is 1 for the transaction price and 0 for the asking price.

Next, it was expanded into a hedonic function factoring in buyer characteristics, which in theoretical terms should normally be considered, but which were difficult to incorporate into the model due to data limitations (Model 2).

$$\log P_{(i,j,t)} = a_0 + a_1 T_{(i,j)} + a_2 G_i + a_3 G_i T_{(i,j)} + \sum_m a_3^m X_{(i,j)}^m \\ + \sum_n a_4^n NE_k^n + \sum_s a_5^s HH_{(i,j)}^s + \sum_t a_6^t D_t + \epsilon_{(i,j)} \tag{5}$$

Moreover, how the green label effect (G_i) changed in accordance with the passage of time was analyzed (Model 3).

$$\log P_{(i,j,t)} = a_0 + a_1 T_{(i,j)} + a_2 G_i + a_3 G_i T_{(i,j)} + \sum_m a_3^m X_{(i,j)}^m \\ + \sum_n a_4^n NE_k^n + \sum_s a_5^s HH_{(i,j)}^s + \sum_t a_6^t D_t + \epsilon_{(i,j)} + \sum_t a_7^t G_i D_t + \epsilon_{(i,j)} \tag{6}$$

A.2.2 Data

Housing Price Data ($P_{(i,j,t)}$), Building Characteristics ($X_{(i,j)}^m$), and Market Characteristics (MK) Empirical analysis was conducted, focusing on the new condominium market in the Tokyo metropolitan area. The main variables used in the analysis are outlined in Table1.

Housing price-related information and building characteristics were gathered via questionnaire survey,[17] and in addition, the Real Estate Economic Institute's database was used. As well as the producer's asking price, the following are present in the Real Estate Economic Institute's database: the development company, development overview (development scale), location characteristics (coordinates, address, nearest station, distance to nearest station), and building characteristics (building area, land area, building structure). This data was matched to transaction prices (contract data), building characteristics, and buyer characteristics (buyer's annual income, size of family, etc.) gathered by the Recruit Housing Institute.

In this manner, for the 10-year period from 2001 to 2011, two types of condominium price data ($P_{(i,j,k)}$) were constructed for offered and transacted asking prices and selling prices.

As well, based on questionnaire survey, whether the form of land leasehold was ownership, general leasehold, or fixed-term leasehold was added. In addition, the form of management was also investigated via questionnaire survey —i.e., is the building managed through visits (no permanent presence in the building either during day- or night-time), through day shifts (a manager works in the administrative office during the day time only), or through having a permanent residence on site (a manager works in the administrative office and is present on a 24-hour basis). It was thought that these kinds of differences would also be expressed as condominium price differentials. As well, the total number of condominium units, lot area, and overall building area were also considered as size characteristics. Moreover, with respect to condominium characteristics, it is known price differentials also arise based on the

[17]The questionnaire survey was conducted by Recruit, starting in November 2011. Surveys were conducted in writing, via submissions from home buyers. Also, it was possible to gather accurate transaction prices by collecting contract data. As of March 2012, the research was still ongoing.

developer's brand power, since this varies by developer. In addition, construction company differences based on what company built the condominium were also considered.[18]

Moreover, in terms of market characteristics (MK), the first-month contract rate was incorporated. The first-month contract rate examines how many housing units were able to be sold in the one-month period after going on sale. It is thought that the higher the first-month contract rate, the more affordable the housing unit prices are in relation to the condominium's features.

Environmental Performance Evaluation Data(G_i) With regard to environmental performance evaluation labels, data for labeling based on Tokyo Metropolitan Government's Green Labeling System for Condominiums was used.

At Tokyo Metropolitan Government, a Green Building Program was implemented in June 2002, which obliged owners planning new construction or expansion of large-scale buildings exceeding 10,000m^2 to submit an environmental plan document at the time of planning and a completion notice. As well, in October 2005, the Green Labeling System for Condominiums was begun, which made it mandatory to organize and publish information based on four evaluation items. The four evaluation items are: a) building insulation, which addresses reduction in the building's heat load; b) facility energy-saving performance, which addresses energy-saving systems; and c) lifespan extension and d) greening of the building, which address lifespan extension, etc., and greening. The evaluation results for the respective items are expressed as a number of star (★) symbols, with the evaluation having three levels. In addition, in order to increase recognition among consumers, condominium buildings which submitted an environmental plan document were obliged to indicate all of the evaluation items in advertising displaying floor plans (including newspaper inserts, direct mail, and the Internet). Moreover, from January 2010 onward, the system was changed so that it covered not only regular condominium buildings but also rental condominium buildings, the floor space for which notification is required was lowered to 5,000m^2, and it became possible for buildings from 2,000m^2 to 5,000m^2 to provide notification at their own discretion.

This study used data relating to these environmental performance evaluations. Specifically, a dummy variable was created which was 1 for buildings with two or more stars (★) for either a) building insulation (covering reduction in the building's heat load) or b) facility energy-saving performance (covering energy-saving systems) and which was 0 otherwise. The dummy variable was not applied to buildings which had only one star (★) under the Green Labeling System for Condominiums for either a) building insulation or b) facility energy-saving performance and buildings which were not covered by this system (i.e., the dummy was 0).

Next, in order to precisely recognize the effects of this kind of green label, it is necessary to

[18] A dummy variable was created to distinguish: leading construction companies (1) Takenaka Corporation, (2) Obayashi Corporation, (2) Kajima Corporation, (4) Shimizu Corporation, and (5) Taisei Corporation; second-tier construction companies (6) Kumagai Gumi, (7) Toda Corporation, (8) Penta-Ocean Construction, (9) Konoike Construction, (10) Sato Kogyo, (11) Mitsui Construction, (12) Mitsubishi Construction, (13) Sumitomo Construction, (14) Nishimatsu Construction, and (15) Haseko Corporation; and (16) other.

take into account differences in condominium building performance. First, since whether or not it is necessary to obtain a green label is determined based on the condominium building's total floor space, sufficient consideration must be given to size characteristics.

As a result, total floor space was added as a variable. Moreover, with regard to building performance evaluation, whether or not there is a "Housing Design Performance Evaluation Document" and "Housing Construction Performance Evaluation Document" based on the Housing Quality Assurance Act was also considered. In other words, this study analyzed the extent to which a green label effect exists independently of the effect of whether or not there are conventional Housing Performance Evaluation Documents.

Neighboring Environment Variables (NE_k^n) With respect to neighboring environment characteristics, a neighboring environment index was created using the 500m x 500m mesh block in which the condominium is located as a unit. Specifically, the characteristics are the degree to which the area is built up (number of buildings), average floor space, standard deviation of the floor space, average number of floors for each building, and the standard deviation for the number of floors. Next, based on census mesh block statistics, the proportion of the population aged 65 and over and the proportion of office workers (professionals in specialized and technical occupations) were added.

Moreover, in order to account for characteristics unable to be assimilated with these variables, differences in administrative services were considered as an "administrative district dummy." In addition, in order to account for environmental differences by train line, a "railway dummy" was created, and a variable relating to the "time required to Tokyo Station from the nearest station" was also created.

Buyer Characteristics ($H_{(i,j)}^s$) Next, condominium buyer characteristics were gathered via questionnaire survey. Specifically, the following variables were considered: home buyers' annual income, age, occupation, household size, whether or not they had children, and whether or not they were new home-buyers (whether it was their first purchase). With regard to occupation in particular, differences by employment status,[19] work category,[20] and industry category[21] were examined.

The number of samples for which analysis data was gathered/organized in this way was 23,908, which, in statistical terms, may be considered as a number which ensures that a certain level of reliability can be obtained.

[19]With regard to employment status, the survey was conducted using the following classification: 01. permanent employee, 02. contract employee, 03. civil servant/public organization employee, 04. self-employed, 05. physician/lawyer/tax accountant/accountant/etc., 06. part-time/casual, 07. homemaker, 08. student, and 09. unemployed. There were no samples corresponding to contract worker, part-time worker, homemaker, or student.

[20]The survey was conducted using the following classification for employment category: 01. clerical job, 02. sales job, 03. technical job, 04. service/retail job, 05. construction/manufacturing job, 06. specialized job, 07. management job, and 08. company executive.

[21]The following items were surveyed as industry categories: 01. agriculture, forestry, and fishing, 02. construction, 03. manufacturing, 04. transportation/warehousing, 05. finance/securities/insurance, 06. advertising/publishing/broadcasting, 07. printing/typesetting, 08. fashion-related, 09. travel/hotel/leisure, 10. restaurant/bar, 11. housing/real estate, 12. trading/wholesaling, 13. retail, 14. software/information services, 15. beauty, 16. medical/welfare, 17. education, 18. creative professions, and 19. other.

The summary statistics are outlined in Table2. In comparison to the average asking price value of ¥45.49 million, the average value for the actual transaction price was approximately ¥1.5 million lower, at ¥43.91 million. The floor space ranged from 10m^2 studio condominiums to large-scale condominiums exceeding 200m^2. The time to the nearest station was 7 minutes, on average, while the average time to Tokyo Station was 23 minutes, which shows that these condominiums were located in extremely accessible areas when it comes to transportation.

Looking at housing buyer characteristics, the average age of buyers was 37 and the average number of people in the household was 2.3, meaning that they are typical Japanese households and could also be described as representative Japanese home buyers. However, the household head's average income was ¥8.51 million, which is at a level that considerably exceeds the Japanese average income.[22]

A.3 Estimation Results

Estimation was performed using the three models below. A model with only the building characteristics used in estimating a standard hedonic model (Model 1) was taken as the starting point and expanded into a model that also takes buyer characteristics into account (Model 2). Moreover, in order to look at temporal changes in the effect of green labels, a model was estimated that factors in a cross-term of the time dummy and green labels (Model 3).

The estimation results for the three models are outlined in Table 3, and the effects of green labels are outlined in Table 4.

Model 1: Standard Model Let us evaluate the overall model. First, there is a strong possibility that green labels are strongly linked to buildings' performance. Specifically, in cases where the existence of a Housing Performance Evaluation Document[23] and the existence of a green label overlap, only the effect of green labels has been considered in previous analyses. However, there is a possibility that an effect occurs based on the presence of a Housing Performance Evaluation Document. Accordingly, the green label effect has been distinguished from the Housing Performance Evaluation Document effect using a dummy variable. Looking at the results shows that buildings with a Housing Design Performance Evaluation Document are only evaluated 0.7% higher than those without one, and that the figure is 1.3% (0.7% + 0.6%) higher for those which have not only a Housing Design Performance Evaluation Document but also a Housing Construction Performance Evaluation Document. Next, similarly distinguishing buildings based on management costs,

[22] According to a survey by the National Tax Agency, the average income of salaried workers in 2010 was ¥4.12 million.

[23] The Housing Performance Indication System is based on the Housing Quality Assurance Act that was enacted on April 1, 2000. It evaluates housing performance based on fixed standards, such as complying with the obligatory 10-year defects liability period for basic structural areas of new housing. Under this system, Housing Performance Evaluation Documents are issued, which are divided into Housing Design Performance Evaluation Documents and Housing Construction Performance Evaluation Documents.

Table 1: List of variables

Symbol	Variable	Content	Unit
G	Green label dummy	Buildings with two or more stars (★) for either a) building insulation or b) facility energy-saving performance = 1. Other = 0	(0,1)
T	Transaction price dummy	Transaction price=1. Asking price=0.	(0,1)
S	Floor space of building	Floor space of building/square meters	m^2
TS	Distance to the nearest station	Time distance to the nearest station (Time by Walk or Bus).	meters
Bus	Bus area dummy	Whether the time distance includes riding time of bus 1, Not including bus time including bus time 0.	(0,1)
TT	Travel Time to central business district*	Minimum of railway riding time in daytime to Tokyo central station.	minite
TU	Total units	Total number of the condominium units number in building.	unit
Land	Total site area	Site area in building.	m^2
TA	Total construction area	Total construction area in building.	m^2
ISP1	Housing Design Performance Evaluation Document dummy	With Housing Design Performance Evaluation Document = 1. Other = 0.	(0,1)
ISP2	Housing Construction Performance Evaluation Document dummy	With Housing Construction Performance Evaluation Document = 1. Other = 0.	(0,1)
MGC	Management cost	Management cost + Maintenance cost.	JYN
MG1	Building managed dummy1: Visiting type**	A manager works in the administrative office during the day time only=1. Other magement type=0.	(0,1)
MG2	Building managed dummy2: 24-hour's type**	A manager works in the administrative office and is present on a 24-hour basis= 1. Other magement type=0.	(0,1)
CN	Corner dummy.	The unit located on the corner of floor = 1. Other location = 0.	(0,1)
SRC	Steel reinforced concrete dummy	Steel reinforced concrete frame structure = 1. Other structure = 0.	(0,1)
RL1	General leasehold dummy	General leasehold = 1. Other leasehold = 0.	(0,1)
RL2	Fixed-term leasehold dummy	Fixed-term leasehold = 1. Other leasehold = 0.	(0,1)
TR	Transaction completed rate in first month	Transaction completed rate in first month.	(%)
LU_g $(g=0,\ldots,G)$	City Planning Use dummy***	*g*-th City planning use = 1. Other land use = 0.	(0,1)
HD_h $(h=0,\ldots,H)$	Employment status dummy	*h*-th employment status =1, Other employment status = 0.	(0,1)
WD_i $(i=0,\ldots,I)$	Work category dummy	*i*-th work category =1, Other work category = 0.	(0,1)
YD_j $(j=0,\ldots,J)$	Industry category dummy	*j*-th industry category =1, Other industry category = 0.	(0,1)
LD_k $(k=0,\ldots,K)$	Location (ward) dummy	*k*-th administrative district =1, Other district =0.	(0,1)
RD_l $(l=0,\ldots,L)$	Railway line dummy	*l*-th railway line =1 Other railway line = 0.	(0,1)
D_m $(m=0,\ldots,M)$	Time dummy (yearly)	*m*-th year =1 Other year =0.	(0,1)

*Calculating with the average from the nearest station to Tokyo central station in day time.

**There is one more different management type; Patrol type.

***We summarized 12 city planning land use for three categories: Residential, Commercial and Industrial.

Table 2: Summary statistics of main variables

	Average	Standard deviation	Minimum	Maximum
*P*1: Asking price: 10,000 JYN	4,549.36	1,451.48	1,190.00	20,600.00
*P*2: Transaction price: 10,000 JYN	4,391.79	1,383.86	276.00	18,567.00
S: Floor space: ㎡	69.64	14.75	10.00	266.00
TS: Time to the Nearest station : minute	7.51	4.23	1.00	36.00
TT : Time to the Tokyo Station: minute	23.43	11.21	0.00	80.00
Age of Buyer: Age	37.49	8.49	22.00	80.00
Number of household	2.37	1.05	0.00	8.00
Total income in household: 10,000 JYN	851.25	420.98	0.00	3,000.00
TU: Total units : unit	164.42	191.20	9.00	970.00
Land: Site area / ㎡	4,882.02	7,017.30	138.55	60,843.96
TA: Total building area / ㎡	15,970.57	25,662.47	229.97	191,160.10

Number of observations= 23,908

maintenance/renovation investments, etc., shows that the higher these are, the higher the transaction price is. With regard to the management form, in comparison to "visit-type" management,[24] although no difference was observed for "daily-type" management,[25] the price was 2.2% higher for "permanent-type" management.[26]

Furthermore, the price was 1.1% lower when the type of land ownership was "general leasehold" and 8.8% lower when it was "fixed-term leasehold." The price was 2.2% higher when the dwelling was a "corner unit."

Besides these, when it comes to market characteristics (MK), the first-month contract rate did not have any effect on price.

Next, with regard to the urban planning usage area dummy in neighboring environment characteristics (NE), compared to housing-related usage, prices were 0.7% lower for commercial areas and 4% lower for industrial areas. In terms of the average number of building floors viewed by 500m^2 mesh block unit, prices were higher in areas with a greater average number of floors and more high-rise buildings, but if there was considerable variation (high standard deviation), it had a downward effect on prices. It is presumed that the reason for this is that in areas where high-rise and low-rise buildings are mixed together, the possibility of the scenery being negatively impacted increases. As well, the results showed that in areas with many elderly people and high rental rates, condominium prices were lower. On the

[24] "Visit-type" management indicates that a manager visits the condominium building for the purpose of performing management tasks only at fixed times on a daily or weekly basis.

[25] "Daily-type" management indicates that a manager is present in the condominium building to perform management tasks only for a fixed period of time each day, without residing there.

[26] "Permanent-type" management indicates that a manager resides in the condominium building and performs management tasks.

other hand, in areas with many "professionals in specialized/technical occupations," prices were relatively high. It is known that when the professional classifications used for the census are examined, the income level for "professionals in specialized/technical occupations" is relatively high. This variable may be a proxy variable for the area's income level.

Looking at the effect of green labels under the model estimated in this manner, compared to condominiums without green labels, the base asking price for condominiums with green labels was 5.8% higher. In other words, producers attempted to sell condominiums with superior environmental performance at a higher price. However, the base transaction price dropped to 4.7% (5.8% - 1.1%). Despite producers' efforts to sell at a price approximately 5.8% higher, the actual market evaluation went no more than 4.7% higher.

Model 2: Model Taking Buyer Characteristics into Account Let us examine the results when buyer characteristics are added to Model 1. Looking at the estimation results for Model 2, buyers purchased more expensive condominiums if the household head's income was higher and he/she was older and if the family size was larger. Given the Japanese employment system in which the higher one's age, the higher one's income is (seniority system), it is to be expected that there would be a fixed correlation between income and age. As well, when it comes to age, since higher age means a longer asset-building period, it also has a correlation with size of assets. As a result, one may presume that age reflects the effect of not only current income level but also past accumulation of assets.

On the other hand, in the case of new home buyers (those making their first housing purchase), the price was 1.4% lower. With regard to this estimate value, if one considers that the first-time buyer segment's age and income are relatively low, one might assume that this is a proxy variable for age and income. However, even if one controls for the household head's income and age (the higher the income or age, the higher the price becomes), an effect still remains.

A price differential also occurs based on occupation. Independent of current income and age, it is possible that on an underlying level, this is a variable acting as a proxy for future income or the certainty (stability) of that income.

For example, with respect to employment form, taking typical salaried workers as a baseline, civil servants/public organization employees signed contracts for condominiums that were priced approximately 0.5% higher, and for physicians/lawyers/accountants/tax accountants the price was 7.2% higher. In terms of occupation type, prices were 1.1% higher for those in specialized jobs, 2.5% higher for those in management jobs, and 3.0% higher for company executives. Also, all industry types were examined by inserting a dummy variable, but the results showed that the prices were approximately 1.6% higher for the finance/securities/insurance industry only.

The fact that these kinds of price distinctions based on annual income and employment form generate differences in housing prices supports the economy theory background outlined in the preceding section. In other words, as hedonic economic theory indicates, this shows that price differences cannot be explained by general building features alone, such as "floor space" size, "distance to nearest station," and "time to central business district."

Looking at the effect of green labels with this improved hedonic function, the asking price effect is almost unchanged at 5.78%, while an effect of 4.6% (5.7% - 1.1%) also exists for the transaction price base.

Even with a function that, as shown above, significantly improves on the variables adopted in most previous hedonic function estimations by also taking buyer characteristics into account, a price increase of approximately 4.6% based on the presence of a green label was found. This finding is consistent with Yoshida and Shimizu (2012).

Model 3: Analysis of Time Effect Next, let us examine how the added economic value of green buildings changed over time.

First, for the base asking price, the added value rose over time (5.8% in 2005, 4.1% in 2006, 4.5% in 2007, 8.5% in 2008, and 10.5% in 2009), but in 2010 an effect was no longer observed. As well, based on the cross-term with the transaction price dummy, in 2007 and 2010, no difference existed between the asking price and transaction price in terms of the effect of green labels on added economic value.

In 2005, when the added economic value was estimated at 5.8% for the base asking price, the figure went no higher than 0.9% for the base transaction price (5.8% - 4.9%), showing that green labels had almost no value. Subsequently, in 2006, there was an added value of 3.8% (4.1% - 0.34%); in 2007, the effect was the same as the asking price, at 4.5%; in 2007, it was 4.9% (8.5% - 3.6%), and in 2008, it increased to 7.5% (10.5% - 3.0%) in 2009.

A.4 Do Green Buildings Have Economic Value?: What Empirical Analysis Has Shown

Does an added economic value exist for green buildings? Focusing on the Tokyo new condominium market, this study answered this question in the same way as much previous research, by estimating a hedonic function. Here, with regard to the environmental value of green buildings, attention was focused on the extent to which a housing price differential occurs based on whether or not a condominium has a green label indicating that it is recognized as having a certain level of environmental performance under the Tokyo Green Labeling System for Condominiums.

In estimating a hedonic function, the starting point was a standard model (Model 1) using the variables employed in most previous research.

Then, this was expanded into a model that, in adherence with hedonic theory, took buyer characteristics into account (Model 2). Next, the change in the effect accompanying the passage of time was also analyzed (Model 3).

The hedonic model that considered standard building/location/area characteristics (Model 1) showed that, in comparison to condominiums which did not have green labels, a premium value exists for green labels: the effect was 5.8% for the base asking price and 4.7% for the base transaction price (5.8% - 1.1.%). The model was expanded to add in buyer character-

Table 3: Estimated result of Hedonic equation

	Model (1)		Model (2)		Model (3)	
	coefficient	t-value	coefficient	t-value	coefficient	t-value
X : Building Characteristics						
S : Floor space	0.015	74.13	0.014	61.25	0.014	61.04
TS : Distance to the nearest station	-0.010	-46.00	-0.009	-45.25	-0.009	-44.82
Bus : Bus area dummy	-0.202	-15.15	-0.195	-14.75	-0.200	-14.98
$TS \times Bus$	0.010	10.17	0.010	9.91	0.010	10.31
Total building area	0.000	0.99	0.000	1.13	0.000	1.60
Housing Design Performance Evaluation Document dummy	0.007	2.75	0.007	2.73	0.007	2.59
Housing Construction Performance Evaluation Document dummy	0.006	3.12	0.006	2.92	0.006	2.85
Management cost	0.007	10.63	0.007	10.83	0.007	10.77
Building managed dummy1: Visiting type	-0.003	-1.32	-0.005	-2.34	-0.004	-1.77
Building managed dummy2: 24-hour's type	0.022	7.82	0.018	6.59	0.019	6.60
General leasehold dummy	-0.011	-4.86	-0.008	-3.56	-0.007	-3.35
Fixed-term leasehold dummy	-0.038	-4.69	-0.037	-4.60	-0.037	-4.57
Corner dummy	0.022	12.25	0.020	11.71	0.020	11.81
SRC dummy	0.025	13025.00	0.020	11.60	0.025	13.15
MK : Market Characteristics						
Transaction completed rate in first month	0.004	0.99	0.003	0.85	0.003	0.87
NE : Neighboring Environment Variables						
TT : Travel Time to central business district	-0.002	-11.67	-0.002	-11.52	-0.002	-11.59
FAR : Floor Area Ratio	-0.001	-1.15	-0.001	-1.51	-0.002	-1.59
City planning use dummy: Commercial	-0.007	-2.79	-0.006	-2.58	-0.006	-2.59
City planning use dummy: Industrial	-0.040	-20.51	-0.039	-20.17	-0.039	-20.11
500m Mesh: Average building rank in mesh	0.029	15.35	0.027	14.72	0.027	14.72
500m Mesh: Standard deviation of building rank in mesh	-0.018	-15.36	-0.017	-14.43	-0.017	-14.38
500m Mesh: upper 65 age population	-0.016	-3.57	-0.015	-3.39	-0.015	-3.36
500m Mesh: Rental housing household	-0.050	-17.11	-0.048	-16.49	-0.048	-16.54
500m Mesh: Professional and technical workers	0.291	25.97	0.284	25.80	0.284	25.77
HH : Buyer Characteristics						
Household income: million JYN	-	-	0.023	5.14	0.023	5.24
Age of household head	-	-	0.001	7.04	0.001	7.07
Numbers of household	-	-	0.003	2.04	0.003	2.06
First buyer dummy	-	-	-0.014	-7.32	-0.014	-7.24
Investment purpose dummy	-	-	-0.085	-6.07	-0.086	-6.06
(Employment status dummy)						
Employment status: Public officials dummy	-	-	0.005	1.91	0.005	1.93
Employment status: Doctors, lawyers, tax accountants, accountants dummy	-	-	0.072	13.12	0.072	13.18
(Work category dummy)						
Work category:Profession	-	-	0.011	5.11	0.011	5.21
Work category:Manager	-	-	0.025	11.15	0.025	11.20
Work category:Exective	-	-	0.030	6.60	0.030	6.71
(Industry category dummy)						
Industry category: Insurance, securities and financial	-	-	0.016	7.50	0.016	7.60
D : Time dummy*	Yes		Yes		Yes	
Other dummy	Yes		Yes		Yes	
Railway dummy**	Yes		Yes		Yes	
Location (ward) dummy***	Yes		Yes		Yes	
Developer dummy****	Yes		Yes		Yes	
Construction company dummy*****	Yes		Yes		Yes	
Number of observations=	47,816		47,816		47,816	
Adjusted R-square	0.779		0.784		0.785	

*2001 year to 2011 year **66 railway dummies ***22 local (ward) dummies

****10 Developer's dummies *****14 construction company dummies

Table 4: Effect of the Green Label

	Model (1)		Model (2)		Model (3)	
	coefficient	t-value	coefficient	t-value	coefficient	t-value
G: Green Label Effect						
G: Green label dummy	0.0584	16.57	0.0578	16.58	-	-
$GT: G \times T$	-0.0111	-2.68	-0.0111	-2.71	-	-
$G \times$ 2005 year dummy	-	-	-	-	0.0578	2.92
$G \times$ 2006 year dummy	-	-	-	-	0.0414	4.76
$G \times$ 2007 year dummy	-	-	-	-	0.0448	4.98
$G \times$ 2008 year dummy	-	-	-	-	0.0848	10.64
$G \times$ 2009 year dummy	-	-	-	-	0.1048	14.16
$G \times$ 2010 year dummy	-	-	-	-	0.0372	6.59
$GT \times$ 2005 year dummy	-	-	-	-	-0.0490	-1.97
$GT \times$ 2006 year dummy	-	-	-	-	-0.0034	-0.30
$GT \times$ 2007 year dummy	-	-	-	-	0.0108	0.99
$GT \times$ 2008 year dummy	-	-	-	-	-0.0358	-2.86
$GT \times$ 2009 year dummy	-	-	-	-	-0.0294	-3.65
$GT \times$ 2010 year dummy	-	-	-	-	0.0073	1.17

istics as well (Model 2), but this did not significantly change the effect in Model 1. In other words, even when as many variables as could conceivably be gathered at the current time were inserted based on the assumptions of hedonic theory, the results showed that an added economic value exists for green labels. As a result, the findings obtained here may be said to have a certain level of reliability.

In addition, if one looks at temporal changes in the premium, while the effect on the base transaction price was limited to 0.9% in 2005, it rose to 3.8% in 2006, 4.5% in 2007, 4.9% in 2008, and 7.5% in 2009, and then no value was found in 2010. Excluding the 2010 result, this shows that the effect of green labels became larger over time. In terms of the possible reasons for this, it may be that the awareness of green buildings is increasing in the Tokyo condominium market and, what's more, the buyer segment actively seeking to invest in their value is expanding.

However, more than a few problems remain. First, one could point out the problem of accuracy with regard to the green labels used as variables in order to distinguish the effect of green labels. The current labeling system is based on applications from developers, and it does no more than indicate buildings' anticipated environmental performance at the time of development. This means that the results will naturally change considerably depending on how green labels are defined.

In addition, unless the added economic value of green buildings estimated here is absorbed to what extent compared to the amount of added development costs, it cannot be used for future policy development. It is possible that the premium of 4.6% may still be too low in comparison to the added development expenses.

Moreover, when it comes to the development of green building policy, the problem remains of how it will be infused into the existing (used) housing market. Under the current system, green labels only cover newly developed buildings, but since it is expected that the existing housing market will expand in future, the application of labels to existing stocks will have to be considered. Notably, when it comes to a buyer's choice of home, the decision is often made under strong budget restrictions. With the rapid changes in demographic structure, the population of people in their 30s and 40s – which is the home-buyer segment that generates the greatest demand for housing – is decreasing significantly. Since, given this context, it is to be expected that budget restrictions will become increasingly more strict, it is likely necessary to keep monitoring whether there continues to be a fixed added value for green buildings. As well, the economic value of green buildings will also change considerably depending on what kind of environmental regulations are implemented in future (Takagi and Shimizu, 2010).

Application to the office market is also a major issue. As research by Sugata, Kawamura, and Shimizu (2011) indicates, only a limited green label effect can be found in the office market.

In order to develop green building policy, it is necessary to accurately estimate the extent of the economic value that may be anticipated. Along with these policy-related issues, the role that researchers must perform is also an issue of some importance.

References

[1] Banfi, S., Farsi, M., Filippini, M., and Jakob, M. (2005), "Willingness to Pay for Energy-Saving Measures in Residential Buildings," *CEPE Working Paper*, No. 41.

[2] Dian, T.M., and Miranowski, J. (1989), "Estimating the Implicit Price of Energy Efficiency Improvements in the Residential Housing Market—A Hedonic Approach," *Journal of Urban Economics*, 25, pp. 52-67.

[3] Eichholtz, P., Kok, N., and Quigley, J.M. (2009a), "Doing Well by Doing Good? Green Office Buildings," *Berkeley Program on Housing and Urban Policy Working Papers*, W08-001.

[4] Eichholtz, P., Kok, N., and Quigley, J.M. (2009b), "Why Do Companies Rent Green? Real Property and Corporate Social Responsibility," *Berkeley Program on Housing and Urban Policy Working Papers*, W09-004.

[5] Ekeland, I., J. J. Heckman and L. Nesheim, (2004), "Identification and Estimation of Hedonic Models", *Journal of Political Economy*, 112, pp.60-109.

[6] Epple, D., (1987), "Hedonic Prices and Implicit Markets: Estimating Demand and Supply Functions for Differentiated Products", *Journal of Political Economy*, 95, pp.58-80.

[7] Fuerst, F., and P. McAllister. (2009), " An Investigation of the Effect of Eco-Labeling on Office Occupancy Rates," *Working Papers in Real Estate & Planning* (University of Reading), No. 2009-08.

[8] Fuerst,F.,and P. McAlliste.(2010), "Green Noise or Green Value? Measuring the Effects of Environmental Certification on Office Values," *Real Estate Economics*, 39, pp. 45–69.

[9] Ministry of Land, Infrastructure, Transport, and Tourism Land and Water Bureau (2010), Conference on the "Green" Value of Buildings Research Report, Ministry of Land, Infrastructure, Transport, and Tourism.

[10] Rosen, S., (1974), "Hedonic Prices and Implicit Markets, Product Differentiation in Pure Competition", *Journal of Political Economy*, 82, pp.34-55.

[11] Shimizu, C. (2009), "Estimation of Hedonic Single-Family House Price Function Considering Neighborhood Effect Variables," CSIS (University of Tokyo) Discussion Paper, No. 93.

[12] Shimizu, C. (2010), "Will green buildings be appropriately valued by the market?,"*RIPESS* (*Reitaku Institute of Political Economics and Social Studies*) *Working Paper*,No.40.

[13] Shimizu, C., K.G.Nishimura, and K.Karato, (2007), "Nonlinearity of Housing Price Structure: the Secondhand Condominium Market in the Tokyo Metropolitan Area," *CSIS* (University of Tokyo) *Discussion Paper*, No. 86.

[14] Takagi,Y and C.Shimizu.(2010), "The Environment and Real-Estate Investment:Responsible property investing,"*Business Ethics and Compliance Research Center Working Paper(Reitaku University)*,No.6.

[15] Tinbergen, J., (1959), "On the theory of income distribution", in: L.M.K.L.H. Klaasen and H.J. Witteveen, eds, *Selected Paper of Jan Tinbergen* (North-Holland, Amsterdam).

[16] Tokyo Association of Real Estate Appraisers (2010), Property environmental friendliness and asset prices: Empirical evidence based on Tokyo condominiums.

[17] The impact of environmentally friendly buildings on property values: The case of new Japanese condominiums, Jutaku Tochi Keizai (The Quarterly Journal of Housing and Land Economics), No. 83, pp. 20-32.

企業倫理研究センター Working Paper 発行一覧

No.	発行年月日	題　名　／　執筆者
1	H18年7月	■ＣＳＲと利潤動機 ［ 永井　四郎 ］
2	H18年10月	■中国の企業統治と社会的責任　－会社法改正と外資企業への影響－ ［ 梶田　幸雄 ］
3	H21年6月	■容器・包装簡易化商品普及モデル　－「容器・包装簡易化推進プロジェクト」報告－ ［ 永井　四郎 ］
4	H21年7月	■産業界の視点から「排出権取引制度」を構想するNon-Cap　Approachの提唱 ［ 高　巖・小野　宏哉・倍　和博 ］
5	H22年3月	■中国における企業内部統制 ［ 梶田　幸雄・熊　琳・章　啓龍 ］
6	H22年7月	■The Environment and Real-Estate Investment:Responsible property investing ［ Yasuharu Takagi･Chihiro Shimizu ］
7	H23年3月	■環境配慮型経営　麗澤コンファレンス　－実施報告書－ ［ 永井　四郎 ］
8	H23年3月	■いかにＩＳＯ２６０００を個別組織に導入するか 『麗澤大学・ＩＳＯ２６０００管理一覧』を巡って ［ 高　巖 ］
9	H24年4月	■組織公正と従業員の倫理的行動に関する実証研究 ［ 横田　理宇・中野　千秋 ］

［問い合わせ先］
〒277-8686　千葉県柏市光ヶ丘２-１-１
麗澤大学企業倫理研究センター
Tel:04-7173-3761／Fax:04-7173-1100
http://r-bec.reitaku-u.ac.jp/