Economic Perspectives on the Siting of a Municipal Solid Waste Facility

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ABSTRACT

LULU (Locally Unwanted Land Use) and NIMBY (Never In My Back Yard) are often cited as two major hurdles to overcome for successful siting of a noxious facility. Among various types of waste in Korea, food waste has been posing a serious problem for its high rate of moisture and salt component (MOE 2001). This has necessitated siting of large scale composting facilities around the country. Although there has been an increasing number of studies on NIMBY towards siting of noxious facilities, one can hardly find a study on NIMBY attitudes toward a composting facility from an economic perspective. To analyze NIMBY attitude of residents in Cheju City, Korea toward hosting a composting facility, we base our theoretical analysis on the expected utility theory and subsequently use a MNLM (multinomial logit model) for empirical analysis.

This study consists of four major parts: theoretical analysis, data management, MNLM estimations, and interpretation. A theoretical model is constructed by maximizing expected utility: first, a two-choice model, then extending it to a three-choice model to incorporate residents' uncertain attitudes toward a composting facility, providing a theoretical basis for using MNLM model. Our empirical results show with statistical significance that the higher the income, the stronger the NIMBY attitude towards siting a composting facility. Further, it shows that the negative effect of economic benefits on NIMBY attitude is (marginally) stronger than the positive effect of environmental concern, which contrast with what is usually observed in US where the effect of environmental concern dominates over that of economic benefits. Socio-demographic

variables included to have the economic variables controlled for are mostly insignificant. Further, from our empirical results is deduced that the residents gave uncertain responses are tilted towards accepting the composting facility.

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CHAPTER I

INTRODUCTION

1.1 Background

Human activity generates waste in one form or another. Virtually no economic activity without a negative externality in the form of waste exists. Therefore, as an economy grows, the waste disposal poses an enormous challenge which defies an easy solution. Waste can be either simply dumped or disposed of through different modes of disposal. Each mode, however, necessitates or requires so-called noxious facilities that can be harmful to the local communities and their environments. Whatever mode is chosen for waste disposal, it adversely affects the community in one way or another. For example, landfilling with waste not only take away pieces of land from their alternative uses but also may contaminate water sources through leachate. Dioxin, a chemical residue of waste incineration, is a lethal component of air pollution. Composting, though considered to be safe compared to other disposal modes, is likely to spill out foul smell, cause heavy traffic, and lower the property value in the vicinity of the facility. These negative effects result in the tendency for people to oppose the construction of noxious facilities. Popular phrases such as "LULU (Locally Unwanted Land Use)" and "NIMBY (Never In My Backyard)" reflect the community resistance to having noxious facilities in the neighboring area.

In Korea, the disposal of food waste which contains a high degree of saturation and salt, and landfilling with or incinerating food waste causes an environmental problem (MOE 1999). For a number of years, the issue of food waste disposal in Korea has been a major issue which concerns the public as well as local and central governments. So far the most widely used mode of waste disposal is through large - scale composting facilities (MOE 2000). Composting facility does have some advantages: it recycles food waste into compost, and is relatively safer as compared with other waste disposal modes. Nonetheless, due to the NIMBY attitude, communities are reluctant to host a composting facility regardless of its advantage over other modes.

A great deal of research has been conducted on the siting problems associated with waste disposal facilities. These studies are mostly in disciplines such as political science, sociology, and psychology rather than economics. A few studies from economic perspective exist but none of them is with a theoretical rigor. Furthermore, the focus of those has been rarely on composting facilities.

This study analyzes NIMBY attitude towards siting of the composting facilities from an economic perspective. The target area selected is Cheju City, Korea. Compared to other places in Korea, Cheju is one of the most popular tourist destinations in Korea where natural and environmental resources have greater economic values than elsewhere in Korea, hence the opportunity costs of siting a waste disposal facility is expected to be significantly higher than elsewhere in Korea.

1.2 Purpose of the Study

NIMBY has been traditionally described as the behavior of people driven by collective self-interest (O'Hare 1977). Though a significant number of NIMBY related studies exist, they are mostly from non-economic perspectives. From an economic perspective, NIMBY can be viewed as a rational behavior based on economic principles. In the same vein, this research attempts to identify the major determinants of NIMBY attitude when a noxious facility is built around a residential area.

In view of lack of theoretical rigor in the previous NIMBY related studies, the first objective of this study is to provide a theoretical framework prior to empirical analysis. The second objective is to estimate the effects of various variables on NIMBY attitude toward the hosting a large - scale composting facility using a survey data and multinomial logit model. The final objective is to analyze the estimation results to draw policy implications.

1.3 Outline of the Study

Reviewed in Chapter II are various waste disposal modes, NIMBY syndrome, and some eclectics on waste in Korea. Chapter III reviews existing literature on the expected utility theory, and also provides empirical findings in previous siting studies. The theoretical foundation for empirical analysis is laid out in Chapter IV. Chapter V provides a brief background description of the survey data collection and management. In Chapter VI we analyze estimated multinomial logit models: general interpretation of estimation results, discussion of new findings, and the hypothesis test results. Finally, Chapter VII concludes this study by providing a brief summary, policy implications, and suggestions for future research.

CHAPTER II

ECLECTICS ON WASTE DISPOSAL AND THE CASE OF KOREA

2.1 Overview

As stated in the introduction, this research explores a local resident's attitude towards the siting of a noxious facility. The object facility in our study is a large - scale composting facility planned for Cheju City, Korea. Since there are several other waste disposal modes other than composting, the next section provides a brief overview of waste disposal modes. The general nature of NIMBY phenomenon is elaborated in Section 2.3. While many countries are common in having to deal with the waste disposal problem, the degree of urgency varies from country to country. Since the target area for this study is in Korea, an overview of Korea with regard to waste disposal is also provided in Section 2.4.

2.2 Economics of Waste Disposal and Disposal Modes

Production and consumption of goods generate solid waste, which in turn entails environmental issues. Collection of solid waste generated from economic activity can be through either legal (paying a fixed fee or user fee) or illegal channel. The legal channel creates demand for WDS (waste disposal services), while the illegal channel is simply through illegal dumping in an area. The collected waste can be separated by type into recyclables and non-recyclables. The recyclable waste is transformed through the MRF (Material Recycling Facility) in the case of non-organic waste and turned into compost in a composting facility in the case of organic waste (food or yard waste). As for the non-recyclables, the waste can be dumped into the designated landfill area or burned in an incinerating facility. Since waste is an output of economic activity, its continuous outflow creates negative externalities to the environment.

The potential contributions that can be made by economists in this field are quite extensive, encompassing subjects ranging from waste generation to disposal. Most of studies on waste so far have focused on waste collection rather than disposal, and examines the effectiveness of user fee as opposed to fixed fee to pay for WDS. A common argument in these studies is that the user fee is more effective in reducing waste generated at the firm and household levels than the fixed fee (Jenkins 1993), but the argument is valid only if there is no illegal dumping as a result of imposing a user fee. However, Fullerton and Kinnaman (1996) find significant evidence of illegal dumping under the user fee system, which calls for economic studies on waste disposal. Tammemagi (1999) sets policy priorities in the order of source reduction, reuse and recycling (3Rs)[1]. This hierarchical approach suggests that if policies aimed at source reduction and reuse are not effective through a user fee due to the increased illegal dumping, then recycling assumes an important role in waste management. However, US statistics shows that waste disposal through recycling accounts for no more than 50% of the total waste output (EPA 1996), leaving more than half of the total disposal through other modes of waste disposal such as composting[2].

The major modes of waste disposal may be listed as incinerating, landfilling, recycling, and composting. Incineration is a mode which requires large-scale burning

[1] Some authors use the term "4Rs" to include incineration.
[2] There are many of studies on recycling, but not on composting in economics.

furnaces that could generate and maintain heat of high temperatures.[3] Since the incinerator generates energy in the process of burning the waste, it is called a 'waste-energy facility'.

In the past, incinerating facilities in Korea incurred high operating costs, and were blamed for a great deal of environmental deterioration (MOE 2001). Technological improvement has made the incineration process safer and more efficient, thus generating more energy and substantially reducing the hazardous residue from incineration as well as saving landfill space. Incineration facility, however, requires high fixed cost compared with other modes of waste disposal facilities. The technology for controlling the side effects of incinerators has been improved, but a large fixed cost of the facility poses a challenge in adopting new technologies, which in turn slows down the application of new technology. In particular, the dioxin emission remains a serious problem.

Landfilling, another mode of waste disposal, requires large waste collecting areas, specifically designed large depressions in the ground lined with a protective material (Carless 1992). While modern landfills are operated safely, still several environmental problems such as water contamination, air pollution, and methane gas emission could emerge as a consequence of continuous use of unsafe equipment (Tammemagi 1999). A study on 43 landfill areas in Korea shows that the average levels of 3,743mg/L in BOD (Biological Oxygen Demand) and 5,023 mg/L in COD (Chemical Oxygen Demand) in groundwater around urban areas are higher than those (BOD: 278mg/L, COD: 488mg/L) in rural areas due to poor handling of leachate (MOE, 1999).

There are other problems associated with the use of the landfills such as decreasing landfill space available and the rising cost of landfilling. Several states in US

[3]For more detailed features of incinerators, see Tammemagi (1999)

are running out of permitted landfill areas, and in a matter of few years, according to previous studies, US will be hard pressed for landfill space (Tammemagi 1999). The rising costs of landfilling will be an added issue. Waste tipping and transportation costs in certain landfill areas have been increasing rather rapidly. This problem has become more serious in urban than rural areas due to shortage of available landfill space (Tammemagi 1999). Careless (1992) argues that tipping fees in New Jersey have been increasing continuously since the early eighties and concludes that the high tipping cost will force states to look for cheaper places, which results in substantial higher transportation costs for waste disposal.

The increasing costs of waste tipping and transportation makes recycling more attractive. Recycling is defined as the collection and separation of materials from MSW (Municipal Solid Waste) and the processing of these materials to produce marketable products (Tammemagi 1999). Two factors (i.e., the ever increasing solid waste and rising waste disposal costs) make recycling the best available alternative option in dealing with the waste problem. Statistics show that in Korea the recycling rate had been increasing since the introduction of user-fee system[4] introduced in early 90's, indicating that the system works. But there are some doubts about its effectiveness. When residents dispose of waste, they are required to separate waste into different types. However, there is no information on the final recycled products, their purchases by consumers, and their distributions. Hence, in view of the definition of recycling, the recycling rate as reported by MOE (2001) appears to be higher than the actual rate.

[4] Under this system residents are required to separate the waste into recyclables and non-recyclable, using standardized bags distributed by the government.

Finally, composting is a special recycling in which organic waste is biologically converted into a product that could be beneficial to land and friendly to environment (Tammemagi 1999). Once waste is collected and transferred to a composting facility, the waste is separated by types: inorganic waste (which is sent to a landfill or an incinerating facility) and organic waste such as food and yard waste (Miller and Golden 1992). The organic waste is processed into compost under special conditions. Through the natural process, the organic waste is changed into a soil-like substance. The recycled product, compost, is marketable after a certain curing period. Several environmental problems could arise during the composting process. A rather serious one is unpleasant odor which spills out from flawed composting facilities or flawed process. Nevertheless, the composting has long been familiar to Koreans. In the past, Koreans made compost for agricultural use by fermenting organic waste such as leaves, stems, and excretion from farm animals. Given the fact that food waste in Korea is substantial in quantity and toxic in nature causing an environmental concern, in addition to the traditional demand for compost, Koreans well appreciate the need of large - scale composting facilities.

2.3 NIMBY Syndrome

Waste disposal may cause serious health and environmental problems. Naturally, when a noxious facility is planned to be build, it is not uncommon to meet a vehement resistance from the residents near those facilities. This is known as LULU. The explanation for this phenomenon is that there are negative externalities in the vicinity of the noxious facility and unfair geographical distribution of costs of and benefits from the faculty. There are several approaches to explaining the LULU phenomenon. The most popular and extensively used approach is NIMBY, a terminology first used by O'Hare (1977) to describe individuals' opposition against having to reside around an unpopular facility.

While some views NIMBY as an irrational response from those residing close to the noxious facility (for example Reilly 1987[5]), there are others who view NIMBY as a rational and justifiable response on the premise that local residents understand the community matters better than the experts who are directly or indirectly associated with the siting plan. Thus, the concerns of local residents with regard to the risks to the environment and the community's well being are rational from economic perspective. Fiorino (1989) argues that local residents are the best judges of their own community matters. Without resistance from local residents, the allocation of the facility siting may not attain efficiency (Laws and Susskind 1991).

In developing or newly developed countries like Korea, a deep-rooted distrust has been built toward government and public officials in charge of siting unpopular facilities. Many environmentalists and local residents alike have argued that the government should listen to the residents and must compensate for their losses. Some people in developing countries assert that NIMBY should not be viewed solely as irrational.

NIMBY has been studied rather extensively cross-different disciplines. Most of these studies have been focused on siting facilities for toxic or hazardous waste disposal, including landfills and incineration facilities. However, very few studies are on composting facilities. If organic waste such as food or yard waste is substantial and its disposal through landfilling or incineration is costly, then the siting a composting facility

[5] "Almost everyone seems to agree on the need for waste disposal facilities. Yet almost no one seems to want one of them anywhere near his or her residence."

may be the economic alternative. Nevertheless, no disposal facility is completely free of negative externalities, thus some degree of NIMBY opposition is unavoidable regardless of waste disposal mode.

2.4 Some Eclectics on Waste in Korea

Each type of waste has a different time period required for decomposition as reported in Table 2.1. For example, waste such as leather shoes takes decades to decompose, whereas waste such as paper takes a relatively short time period.

Table 2.1: The Required Time Period for Decomposition of Waste

Kinds of Waste	Required Time for Waste to Decompose	Types of Waste	Required Time for Waste to Decompose
Paper	2-5 months	Orange Peel	6 months
Milk Carton	5 years	Cigarette Filter	10 – 12 years
Plastic	10 – 20 years	Plastic bowl	50 – 80 years
Cloth*	30 – 40 years	Leather Shoes	25 – 40 years

Source: MOE (2000). *Made from Nylon

2.4.1 Waste in Korea[6]

In general, the types and quantities of solid waste generated depend on the industrial structure, GDP, recycling cost, and lifestyles of the residents. In many a developing country, industrialization has led to massive rural-to-urban migration. A considerable number of countries experienced rapid urbanization since World War II. In urban areas, unlike rural areas, the limited land supply has created a daunting challenge of waste management. Korea followed a similar path: a rapid industrialization

[6] Ministry of Environment (MOE) (2000), Environmental Statistics Year Book. Seoul.

accompanied by a dramatic increase in urban population during the 1960's. Most of the solid waste in Korea was produced in large cities such as Seoul, Pusan and Daegu.[7] This can be attributed to growing consumption of non-reusable products by growing urban population. The increase in demand for non-reusable products not only accelerates depletion of the resources but also creates the problem of waste disposal.[8]

The annual growth rate of solid waste from the industrial sector has also been outpacing the growth of Korean economy. The growth rate of solid waste from the industrial sector had been hovering over 10% in the late 1980's, which contrasts with over 20% of hazardous waste during the same period, creating an added problem of waste toxicity. During 1960's, around 80% of solid waste in Korea was accounted for by briquette - ash while food waste accounted for a relatively small proportion. In the past the mixture of briquette - ash with good aeration and food waste turned into a good compost, and when used for landfilling, the landfills were converted back into fertile farmland after a certain period of time for decomposition of food waste.

Since the 1970's, however, there has been an increase in organic solid waste such as yard or food waste. There has also been a substantial increase in the use of goods that produce toxic waste such as batteries, light bulbs, and household appliances. Concomitantly, new types of waste such as plastics, glass, textiles, and aluminum came into the picture.

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[7] However, other regions in Korea are not free of waste problem. Though relatively less serious, for the rest of Korea the waste problem is expected to be increasingly more serious into the future.

[8] Current increasing demand for fast food has led to a concomitant increase in demand for non-reusable products.

2.4.2 Food Waste and NIMBY in Korea

Economic conditions vary from country to country, and so does the urgency of the waste disposal problem. Initially, food waste problem in Korea was virtually nonexistent. As Korea economy grew at a rapid pace, the waste management issue became increasingly urgent. More and more residents were involved in public debates and hearings about landfilling and incineration between 1980–1993. During 1994–1995 the user fee system was introduced. Since 1996, the food waste disposal has been emerging rapidly as an urgent issue. Prior to that, food waste was simply incinerated or landfilled with other types of waste. Food waste in Korea contains high moisture contents which decay rather quickly, hence the process of its collection, transportation, and disposal is much more costly and complex than those for other types of waste.

These problems forced the Seoul municipal government to stop using food waste for landfilling in and around the city. The similar action was taken for the incinerating facilities in the capital (OWM 1994c). Currently, the generally held public view on the issue is that each producer of food waste should be responsible for its disposal. It is also a public consensus that food waste should be treated as a toxic and hazardous waste. The total output of food waste in 1998, for instance, is 11,798 ton/day which representing 26% of the total solid waste output of the year.

As Table 2.2 shows, the output of food waste has been steadily decreasing from 26,311 tons/day in 1991 to 11,798 ton/day in 1998. Comparing the rates of change of FW (Food Waste) and MSW, one can notice similar patterns of change over the period in the table with one exception of 1996: MSW increased by 4.5% whereas FW decreased by 3.6%.

Table 2.2: Trend of Food Waste Output in Korea (unit: ton per day)

Year	Total Amount of Municipal Solid Waste (A)	Amount of Food Waste (B)	Ratio of Food Waste To Total MSW (B/A)	Growth Rate of MSW (%)	Growth Rate of Food Waste (%)
1991	92,246	26,311	0.28	9.9	14.4
1992	75,096	21,807	0.29	– 18.6	– 17.1
1993	62,940	19,764	0.31	– 16.2	– 9.4
1994	58,118	18,055	0.31	– 7.7	– 8.6
1995	47,774	15,075	0.32	– 17.8	– 16.5
1996	49,925	14,532	0.29	4.5	– 3.6
1997	47,895	13,063	0.27	– 4.1	– 10.1
1998	44,583	11,798	0.26	– 6.9	– 9.7

Source: MOE (1999).

The annual output of food waste in US for 1991/98 period is shown in Table 2.3. Comparison of Tables 2.2 and 2.3 shows that the average annual ratio of food waste to total MSW in Korea is approximately three times as high as in US. The annual growth rate of food waste in Korea in comparison with US appears to indicate an effective food waste management in Korea in light of the fact that the growth rate of food waste in Korea has been negative from the year 1992 to 1998 while that of food waste in USA mostly has been positive.

Table 2.3: Trend of Food Waste Output in the US (unit: ton per day)

Year	Output of Municipal Solid Waste (A)	Output of Food Waste (B)	Ratio of Food Waste to Total MSW (B/A)	Growth Rate of MSW (%)	Growth Rate of Food Waste (%)
1991	204,550	20,910	0.10	– 0.32	0.53
1992	208,930	21,000	0.10	2.14	0.43
1993	211,820	20,910	0.10	1.38	– 0.43
1994	214,170	21,500	0.10	1.11	2.82
1995	211,460	21,800	0.10	– 1.27	1.40
1996	209,660	21,900	0.10	– 0.85	0.46
1997	218,180	22,730	0.10	4.06	3.79
1998	223,360	24,910	0.11	2.37	9.60

Source: EPA (2000)

In Korea, the cost of food waste disposal through composting is higher than through landfilling and lower than through incineration: landfilling with food waste cost 24,879-26,384 won/ton as opposed to 75,711-86,339 won/ton for incineration in 1996. Based on these costs, the estimated cost of recycling food waste would be 30,000 to 60,000 won/ton (MOE, 2001). However, the composting cost would be much lower if one takes into account the environmental costs associated with land filling/incineration and the opportunity cost of landfills. It would be even lower if one considers the revenue generated from sales of the compost.

Table 2.4: The Composting Facilities in Korea

City and Province	The Number of Existing Facilities	Composting Size*	The Number of Planned Facilities	Planned Composting Size
Seoul	15	290	1	30
Pusan	10	210	1	120
Taegu	0	0	1	20
Inchon	0	0	0	0
Kwangju	2	46	0	0
Taejon	1	10	1	10
Ulsan	0	0	1	60
Kyunggi	14	423	3	300
Kangwon	2	30	1	10
Chungbuk	0	0	0	0
Chungnam	4	28	1	30
Chonbuk	0	0	1	20
Chonnam	2	27	1	30
Kyungbuk	1	4	1	20
Kyungnam	3	70	0	0
Cheju	0	0	1	19
Total	54	1138	14	669

Source: MOE (1999), *: unit (ton per day)

To deal with the problem of food waste disposal, large-scale composting facilities have been constructed throughout Korea. As of 1999 in Korea, a total of 54 public composting facilities were in operation. Detailed information on the number and the sizes of respective composting facilities are summarized in Table 2.4. Table 2.4 shows that Seoul, the capital city of Korea, has the largest number of composting facilities. Fourteen more composting facilities are planned for construction across Korea in the near future.

Currently, there are regions still without composting facilities including Cheju Island. However, as Table 2.4 shows, one is slated for construction in Cheju. Hence, an *ex ante* analysis of NIMBY attitudes of Cheju residents towards the composting facility will be not only timely but also give insights to the policy makers in Cheju and elsewhere in Korea.

The NIMBY syndrome is a common phenomenon observed in many a developed economy (Rabe 1991; Malone 1991). It is quite strong even among developing and newly developed economies. In the case of Korea, the incidences of NIMBY syndrome has increased considerably in number. The most notable one in Korea was in connection with the Anmyon Island (Moon 1994). Since the mid-eighties, the degree of NIMBY attitude in Korea has grown in terms of scale and intensity. A number of noxious facilities planned could not survive the NIMBY syndrome, which includes a low-level radioactive waste repository (Kim et al. 1994) as well as 34 large regional landfills throughout the country (Park 1992). Several studies show that the NIMBY attitudes in Korea are expected to be even stronger in the future. This may be attributed to two major factors: first, more decentralized Korean political system; second, the residents in Korea increasingly more concerned with environment quality rather than higher income.[9] Taking these factors into account, the NIMBY attitude is expected to be a major hurdle to overcome for successful siting of a noxious facility. Therefore, it may well be a valuable source of reference for policy makers to identify the major determinants of NIMBY syndrome, which is the intended purpose of this study.

[9]Central Daily News [Choong Ang Ilbo]. March 28, 1996.

CHAPTER III

LITERATURE REVIEW

3.1 Testing Expected Utility Theory

Since Alfred Marshall laid out the foundation for modern economic theory, one of the greatest achievements in economics is in incorporating uncertainty into economic analysis. Pioneered by Neumann and Morgenstern (1947), the expected utility (EU) theory is built on four axioms that are assumed to rule consumer behavior: continuity, complete ordering, independence, and unequal probability. The key premise of EU theory is that each individual maximizes the expected utility in the context of uncertainty.

There are two main challenges to EU theory by Baumol (1951). One relates to the consistency of EU theory within the general economic theory of consumer preferences, the other to measurability of utility. Friedman and Savage (1952) address these two issues. By making several postulates about expected utility, they draw the conclusion that utility is consistent with the usual preference system and can be measured within EU theory framework. However, their theoretical argument prompts a fundamental question: Can EU theory predict or describe actual behavior under uncertain state? The answer to the question is in the empirical test for its validity.

There are empirical studies that test for EU model's applicability in predicting an economic agent's rational response under uncertain conditions (e.g., Rapoport and Wallstern 1972; Becker and McClintock 1967; Edwards 1961). A comprehensive critical review of the applicability of EU theory is given in Schoemaker (1982) who himself made a significant contribution to both theory and practice in this regard. He states "It has been used prescriptively in management science (especially decision analysis), predictively in finance and economics, descriptively by psychologists, and has played a central role in theories of measurable utility," but in the end he argues that EU theory is fragile in its applicability. However, there are a number of empirical studies which counter Schoemaker's argument. For example, Gould (1969) shows that EU hypothesis cannot be ruled out as a description of behavior for a consumer's purchase of auto insurance.

There are several studies based on EU theory using either of two different approaches. One is the hedonic pricing approach (Brookshire et al. 1985) and the other is the risk perception approach (Halstead et al. 1999; Kunreuther and Easterling 1990). Brookshire et al. (1985), using the data on property values, in the context of two states of event *earthquake* and *no earthquake*, they derive the "hedonic price gradient for safety" for two areas: Los Angeles and San Francisco. Their study shows that people tend to pay less for houses located in an earthquake-prone area, *ceteris paribus*. Paying more for safer houses is a form of "self-insurance". Their empirical results show that price gradient is consistent with their theoretical expectation, hence extending an empirical support for EU theory. Based on the data on land and housing prices, Brookshire et al. also show how the value of economic goods are affected by expected environmental damage. Though the same rationale can be applied to siting of a hazardous waste facility, their study falls short of analyzing the local residents' detailed NIMBY attitudes towards the facility. The determinants of NIMBY behavior can also be found in residents' attitudes as well as the environmental impacts in the area of hosting a noxious facility.

The risk perception approach primarily uses survey data gathered from residents. The major focus of this approach is on identifying the effects on NIMBY attitude of such variables as the proximity to a facility and the residents' socio - economic idiosyncrasies. Siting studies using the risk perception approach are found in Kunreuther and Easterling (1990), and Halstead et al. (1999).

With their model built on the EU, Kunreuther and Easterling (1990) explain several relevant factors which include compensation and the level of public trust. They specified a two-period additive utility is a function of WTA (willingness to accept amount). In their model, the compensation is a return to the local residents for hosting a nuclear waste repository near the community. The model predicts a positive relationship between acceptance of the hazardous waste facility and the level of compensation. In the empirical part of their analysis, they use two sets of telephone survey data in early 1987; one is a national data (1,201 U.S. households), and the other is a Nevada data (1,001 households). In specifying their logit model, they add an attitude variable (trust) to see how personal attitude affects an individual's siting decision. The main conclusion of the study is twofold. First, local residents do not respond to any level of compensation under the situation without adequate environmental safeguards. Second, the residents' attitudes are important in mitigating risk perception.

Kunreuther and Easterling (1990) find an empirical evidence on relationships between risk perception and a set of independent variables including attitude variables. Their theoretical analysis, however, is not based on maximizing expected utility though it is relevant. Moreover, in their theoretical analysis "trust" is the only attitude variable considered.

Using the same theory of expected utility as Brookshire et al. (1985), Halstead et al. (1999) examines the local resident's behavior towards the siting of a composting facility. The two states of event in the theoretical model are assumed: one in which the composting facility is built and operated without any negative externalities and the other in which an environmental externality occurs. Following Kline et al. (1993), this study uses subjective (perceived) probability rather than the actual probability. Of the nine regressors used in estimating a logit model, eight of them show the statistical significance at 5% or less.

The contribution made by Halstead et al. (1999) includes discussion of NIMBY determinants based on economic theory and also consideration of uncertainty by including "*Maybe*" choice as a choice for dependent variable in their empirical model. In the case of Brookshire et al. (1985) the theoretical derivation of the FOCs (First Order Conditions) is consistent with their empirical model. However, in Halstead et al. (1999), the linkage is not clear. They assume two states (hazardous and safe) in their theoretical model whereas the dependent variable has three choices in their empirical model. Though they explicitly assume uncertainty, they do not derive any implication of the uncertainty in their model.

3.2 Siting Studies in Korea[10]

There have been several siting studies in Korea based on two approaches: hedonic pricing approach and risk perception one. Based on the hedonic pricing are studies by Cho (1998), Cheong (1995), Im and Chun (1993), and Yi (1996). Cho (1998) investigates the impact of a noxious facility on land price of the surrounding area. The area covered

[10] To our knowledge, there are no siting studies in Korea that adopt EU theory.

by the research is within three kilometers from the incineration facility located in Mokdong, Seoul, Korea. He finds that the noxious facility affects land price negatively at 1 % significance level. Cheong (1995) finds that the effect of the incineration facility on the property value in the same area is not as influential as in Cho. Im and Chun (1993), and Yi (1996) find that air pollution has a significant negative impact on housing prices. Overall, the results of these studies, with the exception of Cheong (1995), show that the environmental factors have significant negative effects on the property value in the host area; thus extending empirical evidences in support of the residents' NIMBY attitudes.

Based on the risk perception approach, Lee and An (1999) treat NIMBY as a function of the socio-psychological characteristics of residents. For instance, if a resident has a strong altruistic view, his attitude is likely to be more permissive of the facility. They estimated a binomial logit model to capture NIMBY attitude with a purpose of making a policy proposal to effectively mitigate the residents' NIMBY attitudes towards the siting large - scale incinerating facilities. Their analysis based on the survey data in Chungju City, Korea shows that the socio-demographic variables are important determinants of NIMBY attitudes as well as the residents' degree of trust in mass media and knowledge of the noxious facility. They emphasize the importance of residents' participation in decision making process and information dissemination which promotes the public knowledge with regard to the safety of the facilities.

As discussed in Chapter Two, a solution to food waste disposal in Korea may be to use composting facilities. Nearly all of the siting studies in Korea, however, focus on other waste disposal modes such as landfilling and incineration which are more hazardous than composting facilities. Most of these studies either implicitly or explicitly assume away uncertainty.

3.3 Empirical Findings

In this section, we review the determinants of NIMBY phenomenon in the siting noxious facilities found in previous empirical studies. Except for a few, the studies on NIMBY attitudes are based on risk perception approach. Since our study is basically a risk perception approach based on expected utility theory, we review empirical evidence in studies based on risk perception approach.

3.3.1 Distance

One of the key determinants of NIMBY is the proximity of a residence from a noxious facility. Many studies show a significant correlation between the proximity and a local resident's attitude with regard to the siting a noxious facility (Halstead et al. 1999; Lober 1993; Furseth and Johnson 1988): the closer to the facility, the greater the costs to the resident. NIMBY attitude is triggered when the costs outweigh the benefits from the facility. Therefore, the probability of residents' accepting a noxious facility depends upon the distance to the proposed facility. Kraft and Clay (1991) find that the effects of distance may be caused by a "shadow effect" from the past experience with a similar hazardous facility. A similar conclusion is made by Mushkatel et al. (1993) who argue that there is a positive relationship between the shadow effect and the resident's perceived risk concerning a new proposed facility, particularly regarding nuclear and radioactive waste facilities.

3.3.2 Participation

Participation in waste management is considered an important attitude variable in the siting study. One form of participation is an individual's waste management activity in one's daily life (Halstead et al. 1999). Halstead et al. (1999) combine seven variables on the local resident's waste management activity to create the measurement variable, "WIM (Waste Involvement Measure)". In calculating WIM, they use survey questions on household trash handling or recycling activity. The estimation result on WIM shows that a local resident's active involvement in waste management plays a significant role in determining one's siting decision.

Another form of participation is the public involvement in the decision making process. In many developing countries, studies show that the opportunities of participating in the decision making process (public policy) available to the local residents are very limited (Yun 1997). The limited participation in turn limits the information available to the residents and their knowledge. In natural resource management, public participation is crucial for its success (Blahna and Yonts 1990) though conflicts of interests are inevitable. Heberlin (1976) suggests that offering each group equal opportunity to be heard and participate in the decision making process would decrease the potential conflict. A significant number of studies find that the limited public participation diminishes the chance of success of hosting a facility (Bogdonoff 1995; Matheny and Williams 1988; Davis 1986).

3.3.3 Environmental Impact and Economic Opportunity

A noxious facility almost certainly causes some damage on the environment. The degree and kind of damage depend on the type of the facility. The environmental problems include air pollution from incinerating facilities (e.g., dioxin), contamination of water sources from landfilling, and odor from composting facilities. A number of previous studies provide empirical evidence that residents' environmental concern has a negative effect on their attitudes toward a noxious facility (e.g., Lober 1994).

Counterbalancing the negative effect are the economic benefits from the facilities such as jobs created, lower property taxes, and local economic growth (Bacot et al. 1993). Which effect is relatively stronger than or dominates the other depends on the various factors specific to the region. Halstead et al (1999) find that in the case of three New England cities (Keene, Rochester, and New Hampshire) the residents' environmental concern overrides their economic benefits expected from a large–scale composting facility in their neighboring area. That is, the income effect on their demand for safer environment overrides the substitution effect of economic benefits for safer environment.

3.3.4 Trust

The distrust of waste management agencies or institutions is also considered to be important factors in the siting studies. Lack of trust of government appears to be a strong source of persistent resistance to siting of a facility (Morell and Magorian 1982). This may be due to the fact that residents tend to take their distrust of the government as identical with its inability to safeguard the residents against the negative environmental impact from a noxious facility.

Rising public distrust has made a solution to the siting problem even more difficult and complicated, especially for extremely hazardous facilities such as a nuclear repository. A negative relationship between the level of trust of local residents and the level of their potential risk perception is found in many studies where public's trust in the government is a key factor in siting decision (Desvousges et al. 1993; Mushkatel et al. 1993). Kunreuther et al. (1993) find that the resident's level of trust is a significant determinant of NIMBY attitude and is something for which the monetary compensation is not an easy solution.

3.3.5 Knowledge

Knowledge on the part of residents also plays an important role in siting of a noxious facility.[11] Lack of knowledge on the facility's potential benefits and risk may cause a great deal of anxiety among the residents, therefore more likely to show a negative response to the proposed siting plan. Knowledge with every respect to the proposed facility may have a significant bearing on the residents' propensity to respond to a proposed or planned a noxious facility (Dunlap et al. 1993; Matheny and Williams 1985). Kraft and Clay (1991) argue that residents' resistance to siting a nuclear power station near their residential area is largely due to their lack of knowledge.

However, the effect of knowledge on residents' NIMBY attitudes could be either way. For instance, even if actual risk is quite low, more in-depth knowledge on a hazardous facility could raise, instead of lower, concerns about potential risk (Brody and

[11] O'Hare et al. (1983) cite three important aspects of knowledge. First, knowledge varies by both the quantity and quality. Second, knowledge can be both subjective and objective. Third, the value of knowledge varies from person to person depending on individual interests.

Fleishman 1993; Rosa and Freundenberg 1993). This reaction may stems from the local residents' higher level concern about higher technology application such as nuclear power generation than with traditional one.

Kunreuther et al. (1993) argues that, though it is unclear whether in-depth knowledge raises or lowers the public's level of concern, enhanced knowledge of noxious facilities overall increases the probability of the final decision in favor of a planned facility. Even if the waste disposal facility is operated with an extreme safety precautions, a lack of knowledge on the part of residents are likely to trigger residents' over-action against a proposed facility (Kraft and Clary 1991).

3.3.6 Compensation and Information Source

Kunreuther and Easterling (1990) suggest that "compensation in the form of a rebate is unlikely to have positive effects on siting a facility unless the risk is perceived to be sufficiently low to an individual and to others, including future generations", which reverses the common belief that a positive reaction to a facility siting is a positive linear function of the monetary compensation offered. Rather, they argue that a more significant determinant of the residents' acceptance of the siting proposal is the level of trust in the siting institution.

According to Peele and Ellis (1987), a threshold level of safety for residents in a host area should be made prior to a compensation offer. The key observation in the past empirical findings with regard to the compensation may be summarized as follows: without adequate environmental safety measures, the compensation offered does not alter the residents' NIMBY position. That is, the compensation offer is conditionally effective.

In addition to "compensation," the availability of information sources on waste management is also critical. Slovic (1987) argues that the residents in the host area may be overly concerned with the noxious facility's negative externalities in the absence of the information sources or the channels on the facility. In short, a limited information availability has a greater chance of leading to a groundless negative rumor on the facility planned. Hence, the more information dissemination and the resulting higher transparency may mitigate local residents' fear towards the siting of a noxious facility.

3.3.7 Socio-economic Variables[12]

Empirical findings with regard to the effects of socio-economic variables on NIMBY attitude fail to show any stylized fact. Mushkatel et al. (1993) conclude in their research that the effects of various socio-economic characteristics are not consistent in terms of statistical significance and direction. That is, the effects of socio-economic variables are specific to regional idiosyncrasies. Table 3.1 briefly summarizes the findings in the previous studies where socio-economic variables include gender, the number of children, age, education, and income.

[12] Socio-economic variables are also referred to as socio-demographic variables (Halstead et al. 1999).

Table 3.1: Previous Estimation Results of Socio-economic Variables

Variables	*Significant*	*Insignificant*
Gender	Lee and An (1999): Female[1] Dunlap et al. (1993): Male Brody and Fleishman (1993): Female Portney(1991): Female Blocker and Eckberg (1989): Male Hamilton (1985): Female	Lober (1993) Kunreuther et al. (1993)
Children[2]	Brody and Fleishman (1993) Piller (1991)	Halstead et al. (1999) Dunlap et .al (1993) Lober (1993) Kunreuther et al (1993)
Age	Lee and An (1999): Young[3] Dunlap et al. (1993): Young	Mushatel et al. (1993) Lober (1993) Kunreuther et al (1993)
Education	Blocker and Eckberg (1989): Lower education[4] Wrigley. (1998): Higher education	Lee and An (1999) Lober (1993) Brody and Fleishman (1993) Kunreuther et al. (1993) Zeiss and Atwater (1987) Madisso (1985)
Income	Halstead et al. (1999): Higher income[5] Brody and Fleishman (1993): Lower income	Lee and An (1999) Lober (1993) Kunreuther et al. (1993)

1: Females respond to risk more sensitively than males.
2: Households with more children respond to risk more sensitively.
3: Younger residents respond to risk more sensitively.
4: Residents with lower education backgrounds show more sensitivity to risk.
5: Higher income earners respond to risk more sensitively.

3.4 Summary of Literature Review

Economic analysis of NIMBY may be characterized as based on the expected utility theory. Under expected utility theory, there are two major approaches: the hedonic price approach and the risk perception approach. The hedonic price approach is the one where NIMBY attitude is explained indirectly by way of measuring the impacts on property values of a noxious facility in the host area. However, a major limitation of this approach is that attitudes on the part of residents are completely ignored. On the other hand, risk perception model incorporates both residents' attitudes and the environmental impact of a sited facility but without a clear theoretical basis.

The regression analyses show that attitude and other variables have significant bearings on the siting decision of local residents. However, there is no clear linkage between theory and empirical analysis in the study of NIMBY, leaving a gap for further analysis. Our study is intended to fill the existing gap by developing a theoretical justification for subsequent empirical analysis.

CHAPTER IV

THEORETICAL MODEL FOR SITING OF THE COMPOSTING FACILITY

4.1 Overview

In this Chapter, we derive a theoretical model describing the representative resident's attitude towards the siting of a large - scale composting facility in the vicinity of his residential area.[13] Section 4.2 presents a two-choice model as a theoretical basis in general for using the simple logit model in siting studies. In section 4.3, we extend the two-choice model to three-choice one which provides the theoretical basis for our empirical model (i.e., MNLM).

4.2 Two-choice Model

As stated earlier, our approach for developing a theoretical model is based on the expected utility theory.[14] The siting of a MSW composting facility generates both expected wealth equivalent and expected costs.[15] Wealth equivalent (w) may be specified as a function of a vector of positive wealth attributes ($\boldsymbol{a}$), which is continuous and twice differentiable.

$$w = w(\boldsymbol{a}) \tag{1}$$

where

[13] To our knowledge, there is no siting study that provides a rigorous theoretical basis for empirical application of the logit model.
[14] For example, see Brookshire et al. (1985).
[15] Hereafter, "expected" will be omitted for convenience.

$w_{a_i} > 0$; $w_{a_i a_i} < 0$; $\boldsymbol{a}_{n\times 1} = [a_1 \ a_2 \ .... \ a_n]'$.

Subscript a_i denotes derivative of the subscripted function with respect to a_i. The vector of major positive wealth attributes contains compensation, the local residents' positive attitudes (such as active waste management behavior and trust in the siting institutions), and economic benefits from hosting the facility.[16] The wealth equivalent to be generated by the siting of the MSW composting facility can be considered as an increasing function of each positive wealth attribute. For example, for a resident with a strong tendency to dispose of yard and food waste regardless of the existence of the composting facility, the composting facility sited close to his property would save him a great deal of effort and time. Therefore, the closer to his residence is the facility, the greater is his expected wealth equivalent. The proximity of the facility to his residence would also generate other wealth effects through economic benefits offered by siting authorities (local or central government) to the residents in host area.

The costs (h)[17] associated with the MSW composting facility also may be stated as a function of both positive and negative wealth attributes, and assumed to be continuous and twice differentiable with respect to each argument.

$$h = h\,(\boldsymbol{a}, \boldsymbol{s}) \qquad (2)$$

where

[16] For example, enhanced school quality and economic opportunity such as new jobs, lower property taxes, and economic growth (Halstead et al. 1999)

[17] Brookshire et al. (1985) used consumer's house payment as the hedonic price function under the two states of event; *earthquake* or *no earthquake* state. In the context of the siting of a composting facility, the hedonic price is considered as the purchasing price of various estates and real estate. Since the role of the hedonic price is the cost to the buyers of estates, for convenience the hedonic price function will be referred to as cost function.

$h_{a_i} > 0;\ h_{a_i a_i} > 0; -1 < h_{s_j} < 0;\ h_{s_j s_j} > 0;\ h_{a_i s_j} = h_{s_j a_i} < 0;\ h_{a_i a_i}\ h_{s_j s_j} > h_{s_j}{}^2;$

$s_{l\times 1} = [s_1\ s_2\ \dots\ s_l]'$.

Subscript s_j denotes derivative of the subscribed function with respect to s_j. The cost is an increasing function with respect to each positive wealth attribute. A resident with an active waste management trait may have a higher reservation price for a property closer to the composting facility.[18] Note that s as an argument in the cost function is a vector of negative wealth attributes in terms of monetary loss as a self-insurance. It also includes the indirect monetary costs the representative resident perceives in connection with the existing negative environmental impact. A greater monetary loss would incur if the property were within the perimeters subject to significant environmental impact, thus reducing the market value of the property ($-1 < h_{s_j} < 0$).[19] The cost function is assumed to be convex in both attributes.[20]

[18] The positive attitude variables are normally referred to simply as "attitude variables" in siting studies. According to Sears et al. (1980), there is a close linkage between one's attitude and pursuit of wealth. Hence attitude variables positively affect the wealth equivalent as well as the cost functions. As stated in the literature review in Section 3.2, attitude variables include such variables as trust in institutions, public participation in the decision making process, general knowledge on facilities and the available information sources on the noxious facilities. While previous siting studies attach importance to the attitude variables, none of studies treats them from an economic perspective.

[19] The marginal cost of safety ($-1 < h_{s_j} < 0$) implies that 'one additional dollar spent on safety more than offsets the cost' (Brookshire et al. 1985). More specifically, if a resident spends one dollar for safety of his estate, the price of the estate increases by more than a dollar.

[20] The Hessian for the cost function is,

$\mathrm{H} = \begin{bmatrix} h_{a_i a_i} & h_{a_i s_j} \\ h_{s_j a_i} & h_{s_j s_j} \end{bmatrix}$. By the assumptions of $h_{a_i a_i} > 0$, $h_{a_i s_j} = h_{s_j a_i} < 0$, $h_{s_j s_j} > 0$, and $h_{a_i a_i} h_{s_j s_j} - h_{a_i s_j}{}^2 > 0$ in Equation (2) the Hessian is positive definite, which implies the cost function is convex.

The net wealth equivalent (q^* or q) of the representative resident varies depending on each state of the event,

$$q^* = w(\boldsymbol{a}) - h(\boldsymbol{a}, \boldsymbol{s}) - \boldsymbol{l}'\boldsymbol{s} \tag{3}$$

if the composting facility is sited;

$$q = w(\boldsymbol{a}) - h(\boldsymbol{a}, \boldsymbol{s}) \tag{4}$$

if the composting facility is not sited[21]

where

$\boldsymbol{l}_{t \times 1} = [\,1\,1 \ldots 1]'$

The right-most term in Equation (3) is the monetary loss due to safety measures taken to safeguard against potential adverse environmental impacts such as groundwater contamination when the composting facility is sited. In this case, the monetary loss incurred varies depending on the resident's proximity to the facility and the degree of negative environmental impact of the composting facility. Siting a composting facility *vis-à-vis* the status quo adds to the monetary loss (e.g., an increase in noise level, foul smells, pollution, health, and safety risks to children). In the absence of the composting facility, monetary loss (s) is limited only to the cost function.[22] The utility of the representative local resident is a function of the net wealth equivalent which depends on

[21] The wealth equivalent and the cost are still relevant even when the composting facility is not sited.
[22] We assume that in the absence of the composting facility there is still a minimal environmental impact from other sources, hence s still remains in q.

whether the composting facility is sited or not. Utility functions in both cases may be expressed as:

$$U(q^*) = U[w(\boldsymbol{a}) - h(\boldsymbol{a},\boldsymbol{s}) - \boldsymbol{l}'\boldsymbol{s}] \tag{5}$$

if the composting facility is sited

$$U(q) = U[w(\boldsymbol{a}) - h(\boldsymbol{a},\boldsymbol{s})] \tag{6}$$

if the composting facility is not sited

where

$U_{q^*} > 0;\ U_{q^*q^*} < 0;\ U_q > 0;\ U_{qq} < 0.$

Functions subscripted with q^* and q denote their derivatives with respect to q^* and q, respectively. Each utility function is assumed to be concave in the net wealth equivalent. The subjective probabilities that the local resident accepts or rejects siting the composting facility are denoted by p and $(1 - p)$, respectively. The representative local resident's expected utility[23] may be written as

$$EU(q) = p\,U(q^*) + (1-p)\,U(q) \tag{7}$$

---

[23] The siting of a large-scale waste facility is an important public issue of social optimal allocation. For its unique nature of non-rivalry and non-excludability, however, public goods do not have markets which determine their prices. CVM(Contingent Valuation Method) is a practical approach to valuing the public goods. In CVM, the value of a public good is measured based on the compensation value or public's "willingness to accept or pay". Unlike CVM, our approach is based on expected utility where the probability is endogenously determined by positive and negative wealth attributes. Therefore, the "compensation" variable in CVM is only a component in the vector of wealth attributes in our model.

Equating to zero the partial derivatives with respect to a_i and s_j yields Equations (8) and (9) as the FOC.[24]

$$p\,U_{q^*}(w_{a_i} - h_{a_i}) + (1-p)\,U_q(w_{a_i} - h_{a_i}) = 0 \tag{8}$$

$$-\frac{(1-p)h_{s_j}}{p(1+h_{s_j})} = \frac{U_{q^*}}{U_q} \tag{9}$$

where

$i = 1, 2, \ldots, n;\ j = 1, 2, \ldots, l.$

Equation (8) states that at the optimum the marginal (net wealth) benefit and the marginal cost of the *i-th* wealth attribute are balanced ($w_{a_i} = h_{a_i}$). Equation (9) shows that at the optimum the ratio of marginal utilities in two states (of siting and no siting) equals the ratio of marginal costs weighted by the corresponding probabilities. It also describes the willingness to bear a higher cost for a greater safety.

The final objective of this section is to analyze the effects of positive and negative wealth attributes (a_i and s_j) on the subjective probability of the representative local resident's attitude toward siting of the composting facility in terms of *Yes* (accepting) or *No* (rejecting). To show the relationship between these attributes and the resident's

[24] Formal proof of second order condition is available in the appendix A.

subjective probability, first we rearrange Equation (9) for the ratio of the probabilities or odds (γ).

$$\gamma = -\frac{U_q}{U_{q^*}} \frac{h_{s_j}}{(1+h_{s_j})} \tag{10}$$

where

$$\gamma = \frac{p}{1-p}$$

Under the optimal condition ($w_{a_i} = h_{a_i}$), taking partial derivatives of Equation (10) with respect to both positive (a_i) and negative (s_j) wealth attributes yields Equations (11) and (12).

$$\gamma_{a_i} = -\frac{U_q}{U_{q^*}} \frac{h_{s_j a_i}}{(1+h_{s_j})^2} > 0 \tag{11}$$

$$\gamma_{s_j} = \frac{1}{U_{q^*}(1+h_{s_j})^2} A < 0 \tag{12}$$

where

$$A = -[\,(-U_{qq}h_{s_j}^{\;2} + U_q h_{s_j s_j})\,U_{q^*}(1+h_{s_j}) + \{U_{q^* q^*}(1+h_{s_j})^2 - U_{q^*}h_{s_j s_j}\}\,U_q h_{s_j}\,] < 0$$

Equations (11) and (12) indicate that the positive wealth attribute increases the probability that the resident accepts the facility, while the negative wealth attribute decreases the probability. By Equations (11) and (12), we find that the odds γ is a positive function of the vector of positive wealth attributes (***a***) and the negative function of the vector of negative wealth attributes (***s***). In short, γ can be expressed as the function of ***a*** and ***s*** as:[25]

$$\gamma = f\,(\boldsymbol{a}, \boldsymbol{s}) \tag{13}$$

where

$f_{a_i} > 0; \; f_{s_j} < 0.$

Equation (13) is a two-choice theoretical model which renders itself as a sound theoretical basis for applications of a binomial logit model. It also explains NIMBY attitude as an outcome of rational behavior on the part of residents.

There are two principal reasons for Equation (13) being a sound theoretical basis for empirical application of the simple logit model. First, the subjective probability in our theoretical model is endogenously determined. Previous siting studies have modeled the resident's subjective probability as the main indicator of risk perception; such a probability is given exogenously (Kunreuther and Easterling 1990; Halstead et al. 1999). Second, our model is a theoretical counterpart of the simple logit model. Since the

[25] When γ is redefined as its reciprocal, then the signs of γ_{a_i} and γ_{s_j} are reversed.

dependent variable in the logit model is the log of odds ratio, this model's endogenously determined odds ratio can be recast as a simple logit model:

$$\ln \gamma = \ln \frac{p}{1-p} = x\Phi + \varepsilon \tag{14}$$

where

$x_{1\times k} = [\ x_1\ x_2 \dots\ x_k\ ]$; $\Phi_{k\times 1} = [\ \phi_1\ \phi_2 \dots\ \phi_k\ ]'$; ε = residual vector.

Suppose x_i and x_j are proxies for a_i and s_j respectively. That is, $x_i = x_i(a_i)$ and $x_j = x_j(s_j)$, for which $(x_i)_{a_i} > 0$ and $(x_j)_{s_j} > 0$. Differentiating Equation (14) with respect to a_i, and rearranging for ϕ_i,

$$\phi_i = \left[\frac{1}{\gamma}\frac{1}{(x_i)_{a_i}}\right] \gamma_{a_i} > 0 \tag{15}$$

Noting that the positivity of ϕ_i is due to $\gamma > 0$, $(x_i)_{a_i} > 0$, and $\gamma_{a_i} > 0$, and ϕ_i measures the impact of a_i on the *Yes* odds (γ_{a_i}).

Similarly,

$$\phi_j = \left[\frac{1}{\gamma} \frac{1}{(x_j)_{s_j}} \right] \gamma_{s_j} < 0 \qquad (16)$$

Noting the negativity of ϕ_j due to $\gamma > 0$ and $(x_j)_{s_j} > 0$, and $\gamma_{s_j} < 0$. Therefore, the two-choice model lends itself as a theoretical justification for applying the simple logit model.

4.3 Three-choice Model

Equation (13) is derived under the assumptions of two states of event, therefore unsuitable as a theoretical basis for MNLM applied in our empirical analysis, where survey respondents have three choices to questions: *Yes*, *No*, and *Maybe*.[26] Therefore, in this section we extend the two-choice model to a three-choice one under the same assumptions as the previous section.[27]

Suppose that respondents have three choices with regard to siting the composting facility: p_1 for choice *Yes*, p_2 for choice *No*, and p_3 for choice *Maybe* which reflects respondents' reservation on whether the facility should or should not be sited. The expected utility function in the context of these three choices is:

$$EU(q) = p_1 U(q_1) + p_2 U(q_2) + p_3 U(q_3) \qquad (17)$$

---

[26] See question 40 in Appendix B. Detailed explanation is given in Chapter 5.

[27] Assumptions on the wealth equivalent, cost, and utility functions remain the same as the previous section, unless otherwise stated.

where

$q_1 = \mathrm{w}(\boldsymbol{a}) - \mathrm{h}(\boldsymbol{a}, \boldsymbol{s}) - \boldsymbol{l's}$ if the composting facility is sited;

$q_2 = \mathrm{w}(\boldsymbol{a}) - \mathrm{h}(\boldsymbol{a}, \boldsymbol{s})$ if the composting facility is not sited;

$q_3 = \lambda[w(\boldsymbol{a}) - h(\boldsymbol{a}, \boldsymbol{s}) - \boldsymbol{l'S}] + (1-\lambda)[\mathrm{w}(\boldsymbol{a}) - \mathrm{h}(\boldsymbol{a}, \boldsymbol{s})]$

$= [w(\boldsymbol{a}) - h(\boldsymbol{a}, \boldsymbol{s}) - \lambda \boldsymbol{l's}]$ if the siting of a composting facility is uncertain;

$0 < \lambda < 1$ risk orientation factor;

$\sum_{i=1}^{3} p_i = 1.$

The value of resident's risk orientation factor (λ) is assumed to range from 0 to 1. If λ is close to 1, the resident tends towards in favor of siting of the composting. If λ is close to 0, the resident tends towards against the composting facility. Therefore, if λ is between 0 and 1, this represents an intermediate case between the two choices; accepting the composting facility and rejecting the composting facility. As in the previous two - choice case, FOCs are obtained by taking partial derivatives of Equation (17) with respect to a_i and s_j respectively.

$$p_1 U_{q_1}(w_{a_i} - h_{a_i}) + p_2 U_{q_2}(w_{a_i} - h_{a_i}) + p_3 U_{q_3}(w_{a_i} - h_{a_i}) = 0 \tag{18}$$

$$-p_1 U_{q_1}(1 + h_{s_j}) - p_2 U_{q_2} h_{s_j} - p_3 U_{q_3}(1 - \lambda + h_{s_j}) = 0 \tag{19}$$

The value of marginal cost of safety h_{s_j} in Equation (19) is between –1 and 0. The greater absolute value of the marginal cost of safety implies that one dollar spent on the safety measure has a smaller positive impact on the property value.

To investigate the effect of positive and negative wealth attributes on the representative local resident's siting decision, we divide through Equation (19) by $p_1 = (1 - p_2 - p_3)$.

$$U_{q_1}(1 + h_{s_j}) + \gamma_{21}\, U_{q_2}\, h_{s_j} + \gamma_{31}\, U_{q_3}(\,\lambda + h_{s_j}\,) \;=\; 0 \tag{20}$$

where

$$\gamma_{21} = \frac{p_2}{(1 - p_2 - p_3)}\,;\; \gamma_{31} = \frac{p_3}{(1 - p_2 - p_3)}\,.$$

By taking partial derivatives of Equation (20) with respect to a_i, holding γ_{31} constant, we have,

$$U_{q_1} h_{s_j a_i} + (\gamma_{21})_{a_i}\, U_{q_2}\, h_{s_j} + \gamma_{21} U_{q_2} h_{s_j a_i} + \gamma_{31} U_{q_3} h_{s_j a_i} \;=\; 0 \tag{21}$$

Rearranging Equation (21) for $(\gamma_{21})_{a_i}$,

$$(\gamma_{21})_{a_i} = -\frac{h_{s_j a_i}}{U_{q_2} h_{s_j}}(U_{q_1} + \gamma_{21} U_{q_2} + \gamma_{31} U_{q_3}) < 0 \tag{22}$$

Partially differentiating Equation (20) with respect to s_j, holding γ_{31} constant,

$$\begin{aligned} &-U_{q_1 q_1}(1+h_{s_j})^2 + U_{q_1} h_{s_j s_j} + (\gamma_{21})_{s_j} U_{q_2} h_{s_j} + \gamma_{21}(-U_{q_2 q_2} h_{s_j}{}^2 + U_{q_2} h_{s_j s_j}) \\ &+ \gamma_{31}[-U_{q_3 q_3}(\lambda + h_{s_j})^2 + U_{q_3} h_{s_j s_j}] = 0 \end{aligned} \tag{23}$$

Rewriting Equation (23) for $(\gamma_{21})_{s_j}$,

$$\begin{aligned} (\gamma_{21})_{s_j} = \frac{1}{U_{q_2} h_{s_j}} [&U_{q_1 q_1}(1+h_{s_j})^2 - U_{q_1} h_{s_j s_j} + \gamma_{21}(U_{q_2 q_2} h_{s_j}{}^2 - U_{q_2} h_{s_j s_j}) \\ &+ \gamma_{31}\{U_{q_3 q_3}(\lambda + h_{s_j})^2 - U_{q_3} h_{s_j s_j}\}] > 0 \end{aligned} \tag{24}$$

By taking partial derivatives of Equation (20) with respect to a_i, holding γ_{21} constant,

$$U_{q_1} h_{s_j a_i} + \gamma_{21} U_{q_2} h_{s_j a_i} + (\gamma_{31})_{a_i} U_{q_3}(\lambda + h_{s_j}) + \gamma_{31} U_{q_3} h_{s_j a_i} = 0 \tag{25}$$

Rearranging Equation (25) for $(\gamma_{31})_{a_i}$,

$$(\gamma_{31})_{a_i} = -\frac{h_{s_j a_i}}{U_{q_3}(\lambda + h_{s_j})}(U_{q_1} + \gamma_{21}U_{q_2} + \gamma_{31}U_{q_3}) \tag{26}$$

where

$(\gamma_{31})_{a_i} > 0$, if $\lambda + h_{s_j} > 0$ $(\lambda > |h_{s_j}|)$;

$(\gamma_{31})_{a_i} < 0$, if $\lambda + h_{s_j} < 0$ $(\lambda < |h_{s_j}|)$.

The absolute value of the marginal cost of safety ($|h_{s_j}|$) could be lower or higher than that of the risk orientation factor (λ), determining the sign of $(\gamma_{31})_{a_i}$.

Now, partially differentiating Equation (20) with respect to s_j, holding γ_{21} constant,

$$\begin{aligned} &-U_{q_1q_1}(1+h_{s_j})^2 + U_{q_1}h_{s_js_j} + \gamma_{21}(-U_{q_2q_2}h_{s_j}{}^2 + U_{q_2}h_{s_js_j}) \\ &+(\gamma_{31})_{s_j}U_{q_3}(\lambda + h_{s_j}) + \gamma_{31}[-U_{q_3q_3}(\lambda + h_{s_j})^2 + U_{q_3}h_{s_js_j}] = 0 \end{aligned} \tag{27}$$

Rewriting Equation (27) for $(\gamma_{31})_{s_j}$,

$$\begin{aligned} (\gamma_{31})_{s_j} = \frac{1}{U_{q_3}(\lambda + h_{s_j})}&[U_{q_1q_1}(1+h_{s_j})^2 - U_{q_1}h_{s_js_j} + \gamma_{21}(U_{q_2q_2}h_{s_j}{}^2 - U_{q_2}h_{s_js_j}) \\ &+\gamma_{31}\{U_{q_3q_3}(\lambda + h_{s_j})^2 - U_{q_3}h_{s_js_j}\}] \end{aligned} \tag{28}$$

where

$(\gamma_{31})_{s_j} < 0$, if $\lambda + h_{s_j} > 0$ ($\lambda > |h_{s_j}|$); $(\gamma_{31})_{s_j} > 0$, if $\lambda + h_{s_j} < 0$ ($\lambda < |h_{s_j}|$).

Equations (22) and (24) show that the odds of *No* to *Yes* is a decreasing function of the positive wealth attributes and an increasing function of the negative wealth attributes.[28] Equations (26) and (28) show that the signs of partial derivatives of *Maybe* odds depend on the sign of the difference between λ and h_{s_j}. When the value of the risk orientation factor is greater (smaller) than the absolute value of the marginal safety cost, the signs of partial derivatives of *Maybe* odds are the same as those of the partial derivatives of *Yes* (*No*) odds.

The odds ratios γ_{m1} ($= \frac{p_m}{p_1}$, $m = 2, 3$) in Equation (20) change into γ_{m2} ($= \frac{p_m}{p_2}$, $m = 1, 3$) if Equation (19) is divided by P_2 as shown in Equation (29).

$$\gamma_{12} U_{q_1} (1 + h_{s_j}) + U_{q_2} h_{s_j} + \gamma_{32} U_{q_3} (\lambda + h_{s_j}) = 0 \qquad (29)$$

where

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[28] Having three choices available to respondents is exactly the case in our survey form (see Appendix B). In our empirical model (MNLM) in Chapter VI, the dependent variables are the log of odds which corresponds to the odds functions in three-choice model. The direction of change in the odds ratio is the same as that of log of odds ratio: when the odds ratio of *No* to *Yes* choice ($\gamma_{21} = P_2/P_1$) increases (decreases), the log of odds ratio ($\ln(P_2/P_1)$) also increases (decreases). Hence, for consistency in both theoretical and empirical analyses, we use the same terminology " odds of *m* to *b* choice " for both γ_{mb} and $\ln(P_m/P_b)$ ($m = 1,2,3$, $b = 1,2,3$, and $m \neq b$). Further, by "*Yes* odds (ratio)" we refer to $\gamma_{1b} = \ln(P_1/P_b)$, $b = 2$ or 3), and by "*No* odds (ratio) " to $\gamma_{2b} = \ln(P_2/P_b)$, $b = 1$or 3, and by "*Maybe* odds (ratio)" to $\gamma_{3b} = \ln(P_3/P_b)$, $b = 1$ or 2.

$$\gamma_{12} = \frac{p_1}{(1 - p_1 - p_3)},\ \gamma_{32} = \frac{p_3}{(1 - p_1 - p_3)}$$

Taking partial derivatives of Equation (29) with respect to a_i and s_j respectively, holding γ_{32} constant,

$$(\gamma_{12})_{a_i} U_{q_1}(1 + h_{s_j}) + \gamma_{12}(U_{q_1} h_{s_j a_i} + U_{q_2} h_{s_j a_i}) + \gamma_{32} U_{q_3} h_{s_j a_i} = 0 \tag{30}$$

$$\begin{aligned}(\gamma_{12})_{s_j} U_{q_1}(1 + h_{s_j}) + \gamma_{12}[-U_{q_1q_1}(1 + h_{s_j})^2 + U_{q_1} h_{s_j s_j}] \\ - U_{q_2q_2} h_{s_j}{}^2 + U_{q_2} h_{s_j}{}^2 + \gamma_{32}[-U_{q_3q_3}(h_{s_j} + \lambda)^2 + U_{q_3} h_{s_j s_j}] = 0\end{aligned} \tag{31}$$

Rewriting Equation (30) for $(\gamma_{12})_{a_i}$ and Equation (31) for $(\gamma_{12})_{s_j}$,

$$(\gamma_{12})_{a_i} = -\frac{h_{s_j a_i}}{U_{q_1}(1 + h_s)}(\gamma_{12} U_{q_1} + U_{q_2} + \gamma_{32} U_{q_3}) > 0 \tag{32}$$

$$\begin{aligned}(\gamma_{12})_{s_j} = \frac{1}{U_{q_1}(1 + h_s)}[(\gamma_{12}\{U_{q_1q_1}(1 + h_{s_j})^2 - U_{q_1} h_{s_j s_j}\} + U_{q_2q_2} h_{s_j}{}^2 \\ - U_{q_2} h_{s_j s_j} + \gamma_{32}\{U_{q_3q_3}(\lambda + h_{s_j})^2 - U_{q_3} h_{s_j s_j}\}] < 0\end{aligned} \tag{33}$$

Equations (32) and (33) have the same implication as Equations (22) and (24). The partial derivatives of two odds (γ_{12}, γ_{21}) show that they are symmetric as expected: for example, $(\gamma_{12})_{a_i} > 0$ and $(\gamma_{21})_{a_i} < 0$. The positive sign of $(\gamma_{12})_{a_i}$ indicates that the odds of *Yes* to *No* choice increases as a positive wealth attribute increases. Which, in turn, implies that the odds of *No* to *Yes* choice decrease as a positive wealth attribute increases. The same implication also holds for $(\gamma_{12})_{s_j}$ and $(\gamma_{21})_{s_j}$.

Now, holding γ_{12} constant, partially differentiating (29) with respect to a_i and s_j, and rearranging for $(\gamma_{32})_{a_i}$, $(\gamma_{32})_{s_j}$, the following equations are obtained:

$$(\gamma_{32})_{a_i} = -\frac{h_{s_j a_i}}{U_{q_3}(\lambda + h_{s_j})}(\gamma_{12}U_{q_1} + U_{q_2} + \gamma_{32}U_{q_3}) \tag{34}$$

where

$(\gamma_{32})_{a_i} > 0$, if $\lambda + h_{s_j} > 0$ $(\lambda > |h_{s_j}|)$; $(\gamma_{32})_{a_i} < 0$, if $\lambda + h_{s_j} < 0$ $(\lambda < |h_{s_j}|)$.

$$(\gamma_{32})_{s_j} = \frac{1}{U_{q_3}(\lambda + h_{s_j})}[(\gamma_{12}\{U_{q_1q_1}(1 + h_{s_j})^2 - U_{q_1}h_{s_js_j}\} + U_{q_2q_2}h_{s_j}{}^2 - U_{q_2}h_{s_js_j} + \gamma_{32}\{U_{q_3q_3}(\lambda + h_{s_j})^2 - U_{q_3}h_{s_js_j}\}] \tag{35}$$

where

$(\gamma_{32})_{s_j} < 0$, if $\lambda + h_{s_j} > 0$ $(\lambda > |h_{s_j}|)$; $(\gamma_{32})_{s_j} > 0$, if $\lambda + h_{s_j} < 0$ $(\lambda < |h_{s_j}|)$.

The signs of $(\gamma_{32})_{a_i}$ and $(\gamma_{32})_{s_j}$ in Equations (34) and (35) are determined by the size of λ relative to $|h_{s_j}|$ as $(\gamma_{31})_{a_i}$ and $(\gamma_{31})_{s_j}$ in Equations (26) and (28).

Finally, dividing through (19) by $p_3 = 1 - p_1 - p_2$:

$$\gamma_{13} U_{q_1} (1 + h_{s_j}) + \gamma_{23} U_{q_2} h_{s_j} + U_{q_3} (\lambda + h_{s_j}) = 0 \tag{36}$$

where

$$\gamma_{13} = \frac{p_1}{(1 - p_1 - p_2)}; \ \gamma_{23} = \frac{p_2}{(1 - p_1 - p_2)}.$$

Differentiating γ_{13} and γ_{23} with respect to each argument a_i and s_j, we obtain the following partial derivatives:

$$(\gamma_{13})_{a_i} = -\frac{h_{s_j a_i}}{U_{q_1}(1 + h_{s_j})} (\gamma_{13} U_{q_1} + \gamma_{23} U_{q_2} + U_{q_3}) > 0 \tag{37}$$

$$(\gamma_{13})_{s_j} = \frac{1}{U_{q_1}(1 + h_{s_j})} [\gamma_{13} \{U_{q_1 q_1} (1 + h_{s_j})^2 - U_{q_1} h_{s_j s_j}\} + \gamma_{23} \{U_{q_2 q_2} h_{s_j}{}^2 - U_{q_2} h_{s_j s_j}\} + U_{q_3 q_3} (\lambda + h_{s_j})^2 - U_{q_3} h_{s_j s_j}] < 0 \tag{38}$$

$$(\gamma_{23})_{a_i} = -\frac{h_{s_j a_i}}{U_{q_2} h_{s_j}} (\gamma_{13} U_{q_1} + \gamma_{23} U_{q_2} + U_{q_3}) < 0 \tag{39}$$

$$(\gamma_{23})_{s_j} = \frac{1}{U_{q_2} h_{s_j}} [\gamma_{13}\{U_{q_1q_1}(1+h_{s_j})^2 - U_{q_1} h_{s_js_j}\} + \gamma_{23}(U_{q_2q_2} h_{s_j}{}^2 - U_{q_2} h_{s_js_j})$$
$$+ U_{q_3q_3}(\lambda + h_{s_j})^2 - U_{q_3} h_{s_js_j}] > 0 \qquad (40)$$

The sign for each of $(\gamma_{12})_{a_i}$, $(\gamma_{12})_{s_j}$, $(\gamma_{21})_{a_i}$, and $(\gamma_{21})_{s_j}$ in Equations (22), (24), (32), and (33) indicates the direction of the relationship between a non-base choice and a wealth attribute. The signs of partial derivatives of the *Yes* and *No* odds are invariant with respect to the base choice as Equations (37) through (40) show.

Our three-choice model can be expressed as Equation (41), summing up the previous 12 equations: (22), (24), (26), (28), (32) through (35), and (37) through (40).

$$\gamma_{mb} = f_{mb}(\boldsymbol{a}, \boldsymbol{s}) \qquad (41)$$

where

$\gamma_{mb} = \dfrac{p_m}{p_b}$, $(m = 1, 2, 3;\ b = 1, 2, 3;\ m \neq b)$;

$(f_{mb})_{a_i} > 0$ and $(f_{mb})_{s_j} < 0$, if the non - base choice is *Yes* $(m = 1)$;

$(f_{mb})_{a_i} < 0$ and $(f_{mb})_{s_j} > 0$, if the non - base choice is *No* $(m = 2)$;

$(f_{mb})_{a_i} > 0$ and $(f_{mb})_{s_j} < 0$, if the non - base choice is *Maybe* $(m = 3)$ and $\lambda > |h_{s_j}|$;

$(f_{mb})_{a_i} < 0$ and $(f_{mb})_{s_j} > 0$, if the non – base choice is *Maybe* $(m = 3)$ and $\lambda < |h_{s_j}|$.

The signs of partial derivatives of each odds are summarized in Table 4.1. The signs in Table 4.1 imply that a resident's response on the siting is contingent upon wealth attributes (positive or negative) and the magnitude of the risk orientation factor relative to that of the marginal safety cost. The signs of partial derivative of *Yes* and *No* odds ($\gamma_{12}, \gamma_{13}, \gamma_{21}$, and γ_{23}) depend upon whether the wealth attribute is positive or negative. More specifically, residents have more tendency to vote against (for) the noxious facility when their positive wealth attributes are lower (greater), which is exactly the opposite for negative wealth attributes.

With respect to the signs of *Maybe* odds' partial derivatives, if one's risk orientation factor is relatively high ($\lambda > |h_{s_j}|$), then the signs of $(\gamma_{31})_{a_i}$ and $(\gamma_{32})_{a_i}$ (or, $(\gamma_{31})_{s_j}$ and $(\gamma_{32})_{s_j}$) are the same as those of the *Yes* odds' partial derivatives: $(\gamma_{12})_{a_i}$ and $(\gamma_{13})_{a_i}$ (or, $(\gamma_{12})_{s_j}$ and $(\gamma_{13})_{s_j}$). When the risk orientation factor is relatively small ($\lambda < |h_{s_j}|$), then the signs of $(\gamma_{31})_{a_i}$ and $(\gamma_{32})_{a_i}$ (or, $(\gamma_{31})_{s_j}$ and $(\gamma_{32})_{s_j}$) are the same as those of the *No* odds' partial derivatives: $(\gamma_{21})_{a_i}$ and $(\gamma_{23})_{a_i}$ (or, $(\gamma_{21})_{s_j}$ and $(\gamma_{23})_{s_j}$. Therefore, the risk orientation factor can be identified simply by referring to the signs of *Maybe* odds' partial derivatives. That is, if the signs of both $(\gamma_{31})_{a_i}$ and $(\gamma_{32})_{a_i}$ are negative, then the signs are the same as those of *No* odds' partial derivatives ($(\gamma_{21})_{a_i}$ and $(\gamma_{23})_{a_i}$), which indicates that the risk orientation factor is less than that of the absolute value of the marginal safety cost, thus implying a relatively weak orientation towards the siting. The opposite (a stronger orientation towards *Yes*) will be the case if the sign of both $(\gamma_{31})_{a_i}$ and $(\gamma_{32})_{a_i}$ are positive. Our model with the risk orientation factor incorporated has a greater applicability to empirical analysis of the siting problem associated with any other unpopular facilities where the local resident's level of risk perception matters.

In short, the three-choice model has identified the impacts of wealth attributes on the residents' responses to the planned siting of an obnoxious facility, and also the relevance of the risk orientation factor latent in *Maybe* choice. Compared to the two-choice model, the three-choice model's implications are more amenable to reality with more detailed information regarding *Maybe* choice incorporated into the model.

Table 4.1: Impacts of Wealth Attributes on Odds

<table>
<tr><td>Yes odds</td><td colspan="2">Sign</td></tr>
<tr><td>$(\gamma_{12})_{a_i}$, $(\gamma_{13})_{a_i}$</td><td colspan="2">+</td></tr>
<tr><td>$(\gamma_{12})_{s_j}$, $(\gamma_{13})_{s_j}$</td><td colspan="2">–</td></tr>
<tr><td>No odds</td><td colspan="2">Sign</td></tr>
<tr><td>$(\gamma_{21})_{a_i}$, $(\gamma_{23})_{a_i}$</td><td colspan="2">–</td></tr>
<tr><td>$(\gamma_{21})_{s_j}$, $(\gamma_{23})_{s_j}$</td><td colspan="2">+</td></tr>
<tr><td>Maybe odds</td><td>Sign</td><td>Sign Condition</td></tr>
<tr><td rowspan="2">$(\gamma_{31})_{a_i}$, $(\gamma_{32})_{a_i}$</td><td>+</td><td>if $\lambda > |h_{s_j}|$</td></tr>
<tr><td>–</td><td>if $\lambda < |h_{s_j}|$</td></tr>
<tr><td rowspan="2">$(\gamma_{31})_{s_j}$, $(\gamma_{32})_{s_j}$</td><td>–</td><td>if $\lambda > |h_{s_j}|$</td></tr>
<tr><td>+</td><td>if $\lambda < |h_{s_j}|$</td></tr>
</table>

CHAPTER V
SURVEY AND DATA MANAGEMENT

5.1 Variable Selection

In specifying the logit model, we have chosen mostly the variables employed in previous siting studies. As mentioned in the previous chapter, there are a number of explanatory variables that have been previously used. The three-choice model indicates that the subjective probability of rejecting (accepting) the facility is a decreasing (increasing) function of positive wealth attributes and an increasing (decreasing) function of negative wealth attributes. The variables chosen, therefore, may be classified into two categories: positive wealth attribute variables and negative wealth attribute variables.

Five variables (*IPWM*, *PPDSP*, *TRUST*, *KNOW*, *ACCESS*) of the positive attribute variables employed may be called 'the positive attitude variables'. Past studies show that a local resident's active participation in waste management leads to a fairly high probability of accepting the facility (Halstead et al. 1999). Involvement in the decision making process regarding the siting plan is also an important factor (Bogdonoff 1995; Blahna and Yonts 1990). *IPWM* (individual's participation in waste management) and *PPDSP* (public participation in decision making for siting plan) are meant to capture the permissiveness. *IPWM* is intended to measure how the residents remain active in managing waste disposal and their attitudes towards recycling. By *PPDSP* we measure the extent of the residents' participation in the decision making process. *TRUST* measures the individual's perceived dependability of various waste management related institutions; such as the central and local government, universities, etc. Hence, the higher the residents' trust of the institutions considerably, their responses would reveal a higher probability of accepting the unpopular facility (Kunreuther et al. 1993; Desvousges et al. 1993).

Several studies also argue that the general knowledge of a noxious facility may reduce risk perception induced by such a facility. Residents with correct knowledge of the environmental impacts of facilities tend to reveal a lower probability of rejecting the noxious facility as opposed to residents who do not have knowledge (Dunlap et al. 1993; Kraft and the Clay 1991; Rosa and Freundenberg 1993). The level of general knowledge is measured by *KNOW*.

COMP (monetary compensation) and *RELCOM* (relative monetary compensation) are selected as the compensation variables. As stated in previous studies, monetary compensation is found to be effective in encouraging local residents to accept the noxious facility; assuming sufficient environmental safeguards are strictly enforced (Bacot et al. 1993; Kunreuther and Easterling 1990; Peele and Ellis 1987). In managing a composting facility, it is unlikely that any hazardous incident will occur with normal efforts to protect the environment in place. In our analysis, we anticipate that a resident demanding a high monetary compensation has a stronger NIMBY attitude, hence a monetary compensation will have a positive effect on the residents' attitudes toward a composting facility siting. In addition, we have *RELCOM* which is obtained through dividing *COMP* by the individual's income. Hence, the amount of compensation chosen by each respondent is expected to vary according as his or her income level.[29]

A resident's siting decision also depends on the number of information sources one has access to on a facility (GAO 1996; Slovic 1987). By *ACCESS* (the availability of information sources on waste management) we measure the information sources available

[29] The issue related to data bias is discussed in Section 5.2.3.

to the public. Variable *ACCESS* is used to investigate whether the availability of information sources matters in Korea as observed elsewhere in previous studies. *ECO* measures the economic opportunity that local residents in a host area can anticipate from hosting a composting facility. Examples include lower property tax, lower waste disposal cost and an increase in employment. *ECO* is generated through factor analysis to represent the multiple aspects of a community's local economic situation that may vary by the hosting of a noxious facility.

We have three negative wealth attribute variables: *DIST* (proximity), *ENV* (environmental impact), and *INCOME* (monthly disposable income). [30] There is significant amount of evidence of a positive relationship between a resident's proximity to a noxious facility and a resident's negative attitude towards siting decision. Thus, we have chosen proximity as one of the negative wealth attribute variables for our empirical analysis. The positive effect of an economic opportunity available to a local economy is weighed against the environmental impact of hosting a noxious facility (Halstead et al. 1999; Cho 1998; Wirth and Heinz 1991). Like *ECO*, *ENV* is generated through factor analysis to measure the various degrees of environmental impact that stems from hosting the composting facility.

Previous empirical evidence does not support an unambiguous prediction of the resident's income level's effect on siting attitude. However, compared to other countries, the price of real estate in Korea has been unstable and extremely high relative to other assets. Consequently, many Koreans earning high incomes are likely to allocate a

[30] Often in the siting literature 'socio-economic variable' and 'socio-demographic variable' are used interchangeably. However, since technically *INCOME* is classified as one of the negative wealth attribute variables, we will refer to the previous socio-economic variables as socio-demographic variables if income is excluded. Otherwise, the variables will be referred to as socio-economic variables for convenience.

significant portion of their wealth to real estate or land. The presence of a noxious facility would, therefore, make high income residents have a keener risk perception relative to low income residents. Thus, we expect a positive relationship between the residents' negative siting decision and their income level.

Socio-demographic variables are included in many siting studies along with attitude variables, because they are considered very much relevant in explaining the siting decision of residents in local context. Though the socio-demographic variables are not explicitly mentioned in our theoretical discussion in Chapter IV, they are included in our empirical model to see how they are important in the local resident's siting decision in Korea. The socio-demographic variables used in our empirical model are *CHILD* (number of children in household), *EDU* (level of education), *GENDER* (a resident's gender), *AGE* (a resident's age), *NHMBR* (household size), *YRSTAY* (number of years a resident has lived in their home), and *HSFORM* (a resident's house type).

In anticipating the result of our empirical estimation, we leave the effects of two socio-demographic variables (*CHILD EDU*) to a siting decision as unknown due to contrasting results from previous studies. Following Lee and An (1999), we expect that women and young people are more likely to perceive high risk, and therefore more sensitive to the siting of a composting facility. In addition to *CHILD NHMBR* is added to reflect the long tradition of respecting the elderly in the Korean culture. If residents have more family members, including elders, they are likely to respond more negatively to the composting facility than otherwise.

There are two additional socio-demographic variables; *YRSTAY* and *HSFORM*. For *YRSTAY* we expect that as people live longer in one place they will display a more rigid attitude towards a facility siting. A longer period of residence may be a good indicator of a weaker incentive to move to another place, causing residents to feel more sensitive to environmental impacts than otherwise.

HSFORM may also be related to a resident's siting decision. Apartment complexes in Korea are usually located in the central area of a city. The composting facility is considered to have a greater impact on the average market value of apartment units rather than houses. Hence, residents living in apartment units may feel more susceptible to a composting facility sited in their neighborhood.

5.2 Survey and Data

5.2.1 Sampling and Survey Procedure

We chose Cheju City, Korea as target area for our survey for the reason that Cheju Province is one of the most attractive tourist destinations in Korea for its cleaner environment and mild temperature, therefore the opportunity cost of the composting facility would be much higher than the rest of Korea. Further, we are unaware of any previous study with respect to siting a noxious facility in Cheju Province. Our *ex-ante* study will provide insights for future plans to site noxious facilities in Cheju Province and other parts of Korea.

The population of Cheju City is 279,087, and the number of households is 90,562 as of December 2000 (Cheju City Hall 2001). Cheju City is composed of 19 dongs. To minimize the sampling bias, the random sampling was used. Table 5.1 shows the distribution of the total sample size in proportion to the population distribution. Following the sample distribution, we used the telephone directory to randomly select

2,500 respondents. A total of 2,500 survey forms were distributed randomly to the respondents. Of the 2,500 forms, 650 were classified as 'incomplete' and excluded from our analysis. The remaining 1,850 forms only were used, which is approximately 2.04 % of the total households in Cheju City.

Table 5.1: Sample Distribution

Dong	Number of Households in each Dong =A	B=(A/90,562)× 100	C	D	E=D/1,850
Il do II dong	1,775	2.0	49	31	1.7
Il do I dong	12,289	13.6	339	256	13.9
I do II dong	2,761	3.0	76	59	3.2
I do I dong	12,791	14.1	353	302	16.3
Samdo II dong	4,871	5.4	134	111	6.0
Samdo I dong	3,763	4.2	104	92	5.0
Yongdam II dong	3,417	3.8	94	73	4.0
Yongdam I dong	5,943	6.6	164	98	5.3
Gunip dong	4,128	4.6	114	71	3.8
Hoabuk dong	6,222	6.9	172	111	6.0
Sam Yang dong	2,541	2.8	70	41	2.2
Bongaedong	885	1.0	24	12	0.7
Ara dong	3,920	4.3	108	63	3.4
Ora dong	1,723	1.9	48	39	2.1
Yeon dong	11,391	12.6	314	233	12.6
Nohyung dong	7,480	8.3	206	158	8.6
Oido dong	2,708	3.0	75	62	3.3
I ho dong	1,301	1.4	36	24	1.3
Do du dong	653	0.7	18	12	0.7
Total	90,562	100.0	2,500	1,850	100.0

Source: Cheju City hall, 2001

B: The percentage of the number of households in each dong out of the total number of households in Cheju City

C: The total number of distributed survey forms

D: The total number of available survey forms taken from C

E: The percentage of the number of finally used survey forms out of 1,850

The survey forms were divided into 5 groups based on the distance between respondent's home and the hypothetically proposed composting facility, i.e., 100 m, 300 m, 700 m, 1 km, and 3 km. The survey was conducted by individual visits to 2,500 households asking the residents to fill out the questionnaires. The whole data collection process took approximately eight months.[31]

5.2.2 Survey Data and Bias Problems

The survey data is usually susceptible to biases in conducting CVM. The bias problem in survey data relates to the primary goal of CVM: measuring one's WTP (willingness to pay) (Dixon et al. 1986). However, our study's main objective is not to produce any specific numerical value but to find the relationship between the local resident's siting decision and the various factors (independent variables) based on economic principles. Therefore, there is a low probability of our data being affected by the same type of biases found in CVM. Since we opted to use surveys for collecting data, however, we endeavored to minimize the biases by implementing our survey based on a planned and conducted survey questionnaire (Dixon et al. 1986) as explained below.

Information Bias Problem

The information bias can be caused by misleading survey questions or insufficient information presented in questionnaires (Dixon et al. 1986). To avoid this type of biases, the survey contents should be as clear and objective as possible. Many telephone or mail survey involves a great deal of miscommunication between interviewers and interviewees, consequently leading to information bias (Kwak and Chun 1995). In order to minimize the problem, we conducted personal interviews instead of relying on telephone or mail

[31] From May 2001 to December 2001.

survey. Surveyors were given a specific guideline on how to explain survey questions with a maximum clarity.

Instrument Bias Problem

The instrument bias emerges from the choice of inappropriate payment means (Dixion et al. 1986). Generally, instrument bias occurs when the willingness to pay vary depending on the different payment vehicles in CVM (i.e., tax or entrance fee). Instrument bias also occurs from choosing 0 (no money), which indicates strong support by the respondent towards hosting the facility. Following Douglas (1989), we used tax as a proxy variable for the monetary compensation *COMP*. We designed the options for question 43 corresponding to *COMP* to vary between 3,000 and 50,000[32] to alleviate this bias. Having taken this precaution, an instrument bias is unlikely to occur in our study.

Inappropriate Measure Bias Problem

Inappropriate measure bias is associated with respondents having different income levels. To avoid this bias, we divided *COMP* by each respondent's income level so that the level of compensation can be differentiated among different income groups.

5.2.3 Survey Content

We reviewed several previous survey forms for format as well as content to create our survey questionnaire. While drafting the survey questionnaire, we found that most previous studies were on the siting of hazardous waste facilities, and that there were only a few studies related to the siting of composting facilities. This is the primary reason why

[32] This approximately corresponds to US$ 2.50 – 45.00.

we relied on Halstead et al. (1999).[33] Through interviews with waste management personnel in Korea, we were able to omit non-relevant questions from their survey. In addition, waste management personnel in Korea provided valuable insights resulting in some additional questions. We referred to the survey forms conducted by Kunreuther and Easterling (1990), and Douglas (1989) to add questions on compensation and socio-economic variables. Since our study involves Korea, we also referred to several survey forms implemented in Korea to reflect the germane feature of Korea. Prior to the survey implementation, an experimental survey was conducted for a selected number of residents with a purpose of improving initial draft.

The final version of our survey questionnaire consists of 52 questions. Question 40 relates to the dependent variable, asking the respondent to select one of three choices, i.e., *Yes, No* or *Maybe*. The survey has three major sections. The first section is concerning solid waste management practices and attitudes, which consists of 14 questions. Questions 1 through 6 measure the resident's willingness to be involved in waste management, which are used for *IPWM*. Questions 7 to 14 are used to gauge the level of trust (*TRUST*) that residents place in institutions (e.g., local government, environmental groups). The second section begins with the sentence "What if a composting facility is built around your residence?" There are questions about how local residents perceive negative environmental effects and what kind of economic opportunity they expect from the composting facility (questions 15 to 28). Based on these survey questions, we implement factor analysis to generate two new variables: *ENV* and *ECO*.

[33] In formulating survey questionnaire, they also referred to several previous works such as Lober (1993), Portney (1991) and Hamilton (1985).

Question 41 is intended to measure the resident's general knowledge of the composting facility compared to that of other waste disposal facilities. In this question we try to measure whether residents have a general knowledge of a composting facility's safety relative to other waste disposal methods (*KNOW*). Respondents have five options to choose from "very low" to "very high".

Question 42 is designed to capture the degree of public participation (*PPDSP*). Question 42 asks how residents feel about their involvement in the decision making process in relation to their previous experiences. As in the question 41, this question also provides five options; 1 (not at all) to 5 (yes). Question 43 relates to compensation in return for hosting a facility (*COMP*). The respondents are asked to choose from among 9 options. Question 44 is to find the number of information sources regarding waste management (*ACCESS*).

The third section of the survey consists of eight questions: questions 45 through 52. These questions are intended to find the information on the socio-economic traits of the residents; the number of children in respondent's home (*CHILD*), a respondent's education level (*EDU*), a respondent's gender (*GENDER*), a respondent's age (*AGE*), a respondent's household size (*NHMBR*)[34], the number of years at the current residence (*YRSTAY*), a resident's house type (*HSFORM*), and a household's average monthly disposable income (*INCOME*).[35]

[34] *NHMBR* is calculated through [1+ 'number of children in one's household'+ 'number of adults in one's household'].

[35] As stated in section 5.1, *INCOME* is used as a negative wealth attribute variable. Since Section III in the survey questionnaire includes income, we refer to this set of questions as socio-economic questions.

5.3 Measurement Variables and Factor Analysis

5.3.1 Measurement Variables[36]

There are two measurement variables; *IPWM* and *TRUST*. *IPWM* is measured as a composite of responses to questions 1 through 6 in our survey. These questions have binary options coded "0" or "1". For example, question 1 is to see whether the respondent is actively involved in waste management. The yes option indicates that the respondent has a high tendency to recycle whereas the no option indicates the opposite. Yes and no options are coded "1" or "0" respectively. Unlike questions 1 and 2, there are four options to answer questions 3 to 6:1 (never), 2 (sometimes), 3 (very often), and 4 (always). These questions are to measure how much effort a respondent exerts to reduce the waste output in daily life. Among 4 options, "0" codes the choice of 1 or 2. Similarly, "1" codes the option of 3 or 4. The binary measurements for *IPWM* are summarized in Table 5.2. The summation of the binary codes for question 1 through 6 generates the measurement variable *IPWM*. The range of *IPWM* is from "0" through "6". Tables 5.3 and 5.4 respectively present the frequency distribution and summary statistics of *IPWM*.

Table 5.2: Binary Codes for Measurement Variable *IPWM*

Question number	Response 1	Code 1	Response2	Code 2
1. Recycle	Yes	1	No	0
2. Compost	Yes	1	No	0
3. Less package	1 or 2	0	3 or 4	1
4. Using reusables	1 or 2	0	3 or 4	1
5. Borrow/rent	1 or 2	0	3 or 4	1
6. Sell/donate	1 or 2	0	3 or 4	1

[36]Measurement variable herein is defined as a variable generated by combining more than one variable in survey data.

Table 5.3: Frequency Distribution of *IPWM*

IPWM	Frequency	Percentage	Cumulative Percentage
0	87	4.74	4.74
1	416	22.65	27.38
2	404	21.99	49.37
3	300	16.33	65.70
4	242	13.1 7	78.88
5	281	15.30	94.18
6	107	5.82	100.00
Total	1,837	100.00	100.00

Table 5.4: Summary Statistics of *IPWM*

Variable	Obs	Mean	Std. Dev	Min	Max
IPWM	1,837	2.80	1.67	0	6

Table 5.5: Codes for Measurement Variable *TRUST*

Question Number	Response 1	Code 1	Response2	Code 2	Response3	Code 3
7	1 or 2	0	3	1	4	2
8	1 or 2	0	3	1	4	2
9	1 or 2	0	3	1	4	2
10	1 or 2	0	3	1	4	2
11	1 or 2	0	3	1	4	2
12	1 or 2	0	3	1	4	2
13	1 or 2	0	3	1	4	2
14	1 or 2	0	3	1	4	2

Table 5.6: Frequency Distribution of *TRUST*

TRUST	Frequency	Percentage	Cumulative Percentage
0	85	4.63	4.63
1	47	2.56	7.19
2	65	3.54	10.72
3	114	6.21	16.93
4	151	8.22	25.15
5	145	7.89	33.04
6	157	8.55	41.59
7	184	10.02	51.61
8	315	17.15	68.75
9	145	7.89	76.65
10	146	7.95	84.59
11	118	6.42	91.02
12	72	3.92	94.94
13	42	2.29	97.22
14	17	0.93	98.15
15	17	0.93	99.07
16	17	0.93	100.00
Total	1,837	100.00	100.00

Table 5.7: Summary Statistics of *TRUST*

Variable	Obs	Mean	Std. Dev.	Min	Max
TRUST	1,837	6.99	3.47	0	16

TRUST is measured through questions 7 to 14. The eight questions ask whether people trust the institution, and if so, how much. As in questions 3 to 6, there are 4 options ranging from 1 (never trust) to 4 (absolutely trust). For theses questions, we assigned three different codes, i.e., "0" to options 1 and 2, "1" to 3, and "2" to 4. Table 5.5 shows the code for each question. The summation of codes for questions 7 through 14 generates *TRUST*. The range of *TRUST* is from "0" to "16". Table 5.6 summarizes the frequency of the measurement range (0 - 16) of *TRUST*. Table 5.7 presents the summary statistics of *TRUST*.

5.3.2 Factor Analysis

The purpose of the factor analysis is to first extract out unobserved orthogonal factors latent in observable data. These factors then are added to other regressors in estimation. The procedure for the factor analysis is as follows: 1) Extract factors, 2) Rotate the extracted factors, and 3) Generate factor scores for each factor (Kachigan 1991).

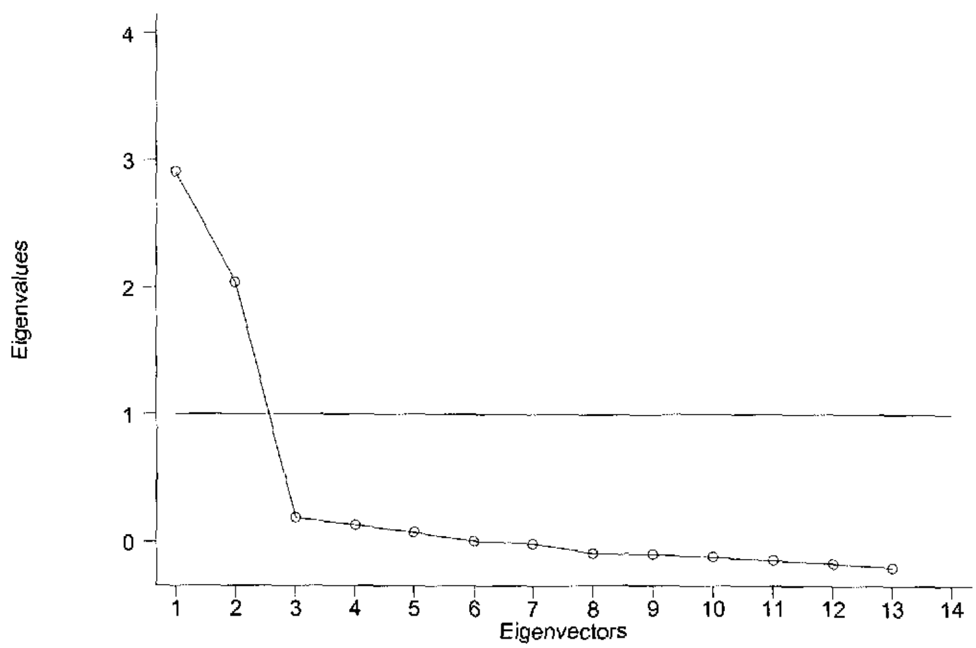

Figure 5.1: The Eigenvalues

Questions 15 through 28 relate to environmental and economic impacts on the community. Presence of the composting facility incurs both wealth equivalence and costs, neither of which can be fully captured by one or two questions. By asking as many questions as needed, we attempt to capture the information which reveals the respondents' attitudes towards the hypothetically proposed facility. The factor analysis converted 14 questions into two factors; negative environmental externality and economic opportunity respectively.[37] Each variable's eigenvalue can be checked. Figure 5.1 shows that two eigenvalues exceed 1, which is the usual threshold value as significant.

Table 5.8: Factor Loadings

Question Number	Factor Loading 1	Factor Loading 2
15	0.32	0.47
16	0.57	− 0.27
17	0.36	0.43
18	0.48	− 0.41
19	0.39	0.36
20	0.50	− 0.39
21	0.40	0.32
22	0.59	− 0.33
23	0.36	0.47
24	0.50	− 0.28
25	0.41	0.48
26	0.51	− 0.27
27	0.36	0.51
28	0.54	− 0.22

[37] Here each question is referred to as a variable. Variables *ECO* and *ENV* are composite variables generated from the 14 variables

Table 5.8 reports "factor loadings" which are obtained through extracting factors. By comparing two factor values for each variable, we can tell which variable is more of which factor. For instance, for question 15 "stimulate economic growth", the factor loading values are 0.32 for factor 1 and 0.47 for factor 2. This implies that question 15 is more related to the second factor since the value of the second factor (0.47) is greater than that of the first factor (0.32).

Table 5.9: Rotated Factor Loadings

Question Number	Rotated Factor Loading 1	Rotated Factor Loading 2
15	− 0.004	0.57
16	0.61	0.10
17	0.04	0.56
18	0.62	− 0.06
19	0.12	0.52
20	0.63	− 0.03
21	0.14	0.49
22	0.67	0.07
23	0.03	0.60
24	0.57	0.05
25	0.06	0.62
26	0.57	0.07
27	0.005	0.62
28	0.56	0.13

For question 28 "increase noise pollution," the relationship is reversed with the value of factor loading 1 (0.54) being greater than that of factor loading 2 (-0.22). By comparing the values of factor loadings for each variable,[38] one can judge whether the

[38] In factor analysis, each question is treated as a variable. The resulting factors, composed of questions, become independent variables (Kachigan 1991).

question is more of the adverse environmental impact or economic opportunities according as factor 1 value is greater or less than factor 2 value.

Next, we rotated the factor loadings by using varimax. The results are reported in Table 5.9. Table 5.9 indicates that differences between rotated factor loadings become more conspicuous. The rotated factor loadings for question 15, for example, give less weight to the first factor and more weight to the second factor. Next, to generate the composite variables, factor loadings are converted into scoring coefficients, following the formula:

$$\boldsymbol{s} = \boldsymbol{A}^{-1}\, \boldsymbol{b}\, (\boldsymbol{C}'\boldsymbol{C})^{-1} \qquad (1)$$

where

$\boldsymbol{s}_{k\times j}$ = A matrix of scoring coefficients;

$\boldsymbol{A}_{k\times k}$ = The correlation matrix of variables (k is a number of variables);

$\boldsymbol{b}_{k\times j}$ = Unrotated factor loading matrix (j is a number of factors);

$\boldsymbol{C}_{j\times j}$ = Varimax rotated factor loading matrix.

In our study, k = 14 and j = 2. The scoring coefficients are reported in Table 5.10.

Table 5.10: Scoring Coefficients

Variable	Scoring Coefficients 1	Scoring Coefficients 2
Q15	− 0.02	0.19
Q16	0.19	0.01
Q17	− 0.01	0.18
Q18	0.19	− 0.05
Q19	0.01	0.16
Q20	0.20	− 0.04
Q21	0.02	0.14
Q22	0.23	− 0.003
Q23	− 0.02	0.20
Q24	0.17	− 0.01
Q25	− 0.01	0.22
Q26	0.16	0.002
Q27	− 0.02	0.22
Q28	0.16	0.02

Finally, multiplying the vector of variables by its vector of scoring coefficients produces a vector of factor scores. This is shown as Equation (2).

$$\bar{f} = \boldsymbol{ds} \tag{2}$$

where

$\bar{f}_{1\times j}$ = Vector of factor scores;

$\boldsymbol{d}_{l\times k}$ = Vector of variables;

$\boldsymbol{s}_{k\times j}$ = Matrix of scoring coefficients.

The vector of factor scores, which are the two composite variables *ENV* and *ECO*, are used as independent variables. Table 5.11 reports the summary statistics of these two variables.

Table 5.11: Summary Statistics of *ENV* and *ECO*

Variable	No. of obs	Mean	Std. Dev.	Min	Max
ENV	1,809	0.004	0.89	− 2.81	1.93
ECO	1,809	0.008	0.87	− 3.02	1.84

CHAPTER VI

MULTINOMIAL LOGIT ESTIMATION

6.1 Overview

Our empirical model is specified in accordance with the implications of our theoretical model. Our three-choice model sheds two key theoretical implications. The first one is that the positive and negative wealth attributes affect a resident's siting decision accordingly. The second one is that the level of risk orientation can be identified by the signs of partial derivative of *Maybe* odds ratios.

One of our empirical focal points is whether or not our empirical finding on the relationships between a resident's siting decision and the wealth attributes are consistent with what is implied by our theoretical model and what is observed in the previous siting studies. Previous studies suggest that specific regional factors (socio-demographic variables) are relevant to a resident's attitude toward the siting. Though socio-demographic variables are not dealt with explicitly in our theoretical model, these variables are also included in our empirical model to avoid possible estimation biases without them. Second focal point is to identify risk orientation level indirectly through the signs of estimated coefficients.

The chapter is organized as follows. Section 6.2 discusses and specifies the empirical counterpart of our theoretical model in Chapter IV. The section also presents the expected signs of coefficients. Section 6.3 presents the results of *Yes* base estimation. The analytical interpretation is provided in Section 6.4. Section 6.5 discusses the level of risk orientation as implied by the estimated coefficients. Section 6.6 carry out the significance test for *Yes* base estimation[39] and for risk orientation. Section 6.7 examines the policy implication of our empirical findings.

6.2 Empirical Model

We established theoretically in Chapter IV that the logit model is indeed the empirical counterpart of our theoretical model: Equation (41) in Chapter IV. Specifically, we use the MNLM following Luce and Suppes (1965)[40] for our analysis. Due to the paucity of published data suitable for our study, we obtained the data we need through a carefully designed survey. In our survey form, the respondents had three choices (*Yes*, *No*, or *Maybe*) for their answer to each of the questions with regard to hosting the composting facility. These choices are related to the dependent variable in our empirical model. *Maybe* choice reflects the uncertainty of respondent's perception regarding the impact of the composting facility on the local community (Halstead et al. 1999). With the *Maybe* choice available to the respondents, the *Yes* and *No* choices are expected to be less likely biased.

For our empirical model specification, first, we take the natural logarithm of Equation (41) and use proxies x_i for positive wealth attributes (a_i) and x_j for negative wealth attributes (s_j):

[39] Unlike the simple logit model, MNLM involves multiple choices which are normalized by a particular choice. For convenience, we refer to the normalizing choice as base choice.

[40] They found that a logit model is matched well with expected utility theory under the normality assumption, i.e., disturbance term is iid (independently and identically distributed).

$$\ln(\gamma_{mb}) = \ln\left(\frac{p_m}{p_b}\right) = \phi_{o_{mb}} + \sum_{i=1}^{k_1} \phi_{i_{mb}} x_i + \sum_{j=k_1+1}^{k} \phi_{j_{mb}} x_j$$

$$= \phi_{o_{mb}} + (\phi_{1_{mb}}\ \phi_{2_{mb}}\ \phi_{3_{mb}} \ldots\ \phi_{k_{mb}})(x_1\ x_2\ x_3 \ldots x_k)' = (1\ \ x)\mathbf{\Phi}_{mb} \tag{1}$$

where

$m =$ Choice m;

$b =$ Base choice;

$P_m =$ Probability of choice m;

$P_b =$ Probability of choice b;

$\ln\left(\frac{p_m}{p_b}\right) =$ Odds of m to b choice;[41]

$x_{1\times k} =$ $[x_1\ x_2\ x_3 \ldots x_k]$: Vector of independent variables as proxies for a_i and s_j;

$\phi_{o_{mb}} =$ Intercept term;

$\mathbf{\Phi}_{mb, k\times 1} = [\phi_1\ \ \phi_2\ \ \phi_3\ \ \ldots\ \ \phi_k]$: Vector of logit coefficients;

$k =$ Number of independent variables;

$k_1 =$ Number of positive wealth attribute variables.

In addition to the wealth attributes as regressors of the logit model in Equation (1), we include socio-demographic variables, which are important as well. Even if our primary focus is on estimating the effects of the wealth attributes on the resident's attitudes toward the siting, exclusion of relevant variables may well bias the estimated

[41] As stated in footnote 28 in Chapter IV, we use the term "odds of m to b choice" for $\ln(P_b/P_m)$ as an alternative to using "logarithm of the odds of m to b choice".

effects of wealth attributes. To avoid the bias problem, it is necessary to include the socio-demographic variables in the model. With the socio-demographic variables included, the logit model specified for our empirical analysis contains a total of eighteen variables: eight for positive wealth attributes, three for negative wealth attributes, and seven for socio-demographic variables.

$$
\begin{aligned}
\ln(\gamma_{mb}) &= \ln\left(\frac{p_m}{p_b}\right) \\
&= \phi_{0_{mb}} + \phi_{1_{mb}} IPWM + \phi_{2_{mb}} PPDSP + \phi_{3_{mb}} TRUST + \phi_{4_{mb}} KNOW + \phi_{5_{mb}} ACESS \\
&+ \phi_{6_{mb}} COMP + \phi_{7_{mb}} RELCOM + \phi_{8_{mb}} ECO + \phi_{9_{mb}} DIST + \phi_{10_{mb}} ENV \\
&+ \phi_{11_{mb}} INCOME + \phi_{12_{mb}} CHILD + \phi_{13_{mb}} EDU + \phi_{14_{mb}} GENDER + \phi_{15_{mb}} AGE \\
&+ \phi_{16_{mb}} NHMBR + \phi_{17_{mb}} YRSTAY + \phi_{18_{mb}} HSFORM + \varepsilon \qquad (2)
\end{aligned}
$$

where

PWA# =	**Positive Wealth Attribute Variables:**
IPWM =	Individual's participation in waste management (PWA1);
PPDSP =	Public participation in decision making for siting plan (PWA2);
TRUST =	Individual's trust in the institution related to waste management (PWA3);
KNOW =	General knowledge of the large - scale composting facility's environmental impact (PWA4);
ACCESS =	Number of information sources on waste management (PWA5);
COMP =	Amount of monetary compensation in terms of a tax (PWA6);

RELCOM = Relative amount of monetary compensation. The value of *COMP* deflated by *INCOME* (PWA7);

ECO = Economic benefit which any local resident living near the composting facility expects to gain (PWA8).

NWA# = Negative Wealth Attribute Variables:

DIST = Distance between the composting facility and the home of the residents (NWA1);

ENV = Environmental impact of the composting facility (NWA2);

INCOME = Household's average monthly disposable income (NWA3).

SD# = Socio-demographic Variables:

CHILD = Number of children in respondent's home (SD1);

EDU = Respondent's education level (SD2);

GENDER = Respondent's gender (SD3);

AGE = Respondent's age (SD4);

NHMBR = Respondent's household size (SD5);

YRSTAY = Number of years at the current residence (SD6);

HSFORM = Resident's house type (SD7).

ε = Error term which is assumed to be *iid*.

Though the signs of the coefficients switch with the selection of the base choice, the implication of the coefficient for each independent variable is in essence invariant.

Therefore, we choose *Yes* base estimation for our first analysis. Table 6.1 summarizes the expected signs of coefficients for independent variables in *Yes* based logit model.

Table 6.1: Expected Signs of Coefficients (*Yes* Base Estimation)

Variable	Dependent Variable		
	$\ln(P_2/P_1)$	$\ln(P_3/P_1)$	
IPWM	–	(+), if $\lambda > \lvert h_{s_j} \rvert$	(–), if $\lambda < \lvert h_{s_j} \rvert$
PPDSP	–	(+), if $\lambda > \lvert h_{s_j} \rvert$	(–), if $\lambda < \lvert h_{s_j} \rvert$
TRUST	–	(+), if $\lambda > \lvert h_{s_j} \rvert$	(–), if $\lambda < \lvert h_{s_j} \rvert$
KNOW	+	(–), if $\lambda > \lvert h_{s_j} \rvert$	(+), if $\lambda < \lvert h_{s_j} \rvert$
ACCESS	–	(+), if $\lambda > \lvert h_{s_j} \rvert$	(–), if $\lambda < \lvert h_{s_j} \rvert$
COMP	+	(–), if $\lambda > \lvert h_{s_j} \rvert$	(+), if $\lambda < \lvert h_{s_j} \rvert$
RELCOM	+	(–), if $\lambda > \lvert h_{s_j} \rvert$	(+), if $\lambda < \lvert h_{s_j} \rvert$
ECO	–	(+), if $\lambda > \lvert h_{s_j} \rvert$	(–), if $\lambda < \lvert h_{s_j} \rvert$
DIST	–	(+), if $\lambda > \lvert h_{s_j} \rvert$	(–), if $\lambda < \lvert h_{s_j} \rvert$
ENV	+	(–), if $\lambda > \lvert h_{s_j} \rvert$	(+), if $\lambda < \lvert h_{s_j} \rvert$
INCOME	+	(–), if $\lambda > \lvert h_{s_j} \rvert$	(+), if $\lambda < \lvert h_{s_j} \rvert$
CHILD	?	(?), if $\lambda > \lvert h_{s_j} \rvert$	(?), if $\lambda < \lvert h_{s_j} \rvert$
EDU	?	(?), if $\lambda > \lvert h_{s_j} \rvert$	(?), if $\lambda < \lvert h_{s_j} \rvert$
GENDER	–	(+), if $\lambda > \lvert h_{s_j} \rvert$	(–), if $\lambda < \lvert h_{s_j} \rvert$
AGE	–	(+), if $\lambda > \lvert h_{s_j} \rvert$	(–), if $\lambda < \lvert h_{s_j} \rvert$
NHMBR	+	(–), if $\lambda > \lvert h_{s_j} \rvert$	(+), if $\lambda < \lvert h_{s_j} \rvert$
YRSTAY	+	(–), if $\lambda > \lvert h_{s_j} \rvert$	(+), if $\lambda < \lvert h_{s_j} \rvert$
HSFORM	–	(+), if $\lambda > \lvert h_{s_j} \rvert$	(–), if $\lambda < \lvert h_{s_j} \rvert$

P_1: Probability of choice *Yes*
P_2: Probability of choice *No*
P_3: Probability of choice *Maybe*
$\ln(P_2/P_1)$: Odds of *No* to *Yes* choice
$\ln(P_3/P_1)$: Odds of *Maybe* to *Yes* choice

The expected signs are based on the theoretical expectation in our model as well as previous empirical evidence. For PWA variables, signs of coefficients are expected to be negative for the odds of *No* to *Yes* choice $\ln(P_2/P_1)$ as a dependent variable. However, three PWA variables (*KNOW*, *COMP*, *RELCOM*) have positive signs since they are scaled in the reverse of the usual order. NWA variables are expected to be positive in their signs. Of the three NWA variables (*DIST*, *ENV*, *INCOME*), only *DIST* is expected to be negative in sign for the same reason as in the case of *KNOW*, *COMP*, and *RELCOM*.

Of SD variables, the coefficients for *CHILD* and *EDU* are sign indefinite. A) For other SD variables, the expected signs were based on either what is observed in previous studies in Korea (*GENDER* and AGE) or on specific rationales (*NHMBR*, *YRSTAY*, and *HSFORM*).[42]

6.3 Estimation Results

Using the survey data, we estimated our MNLM as specified Section 6.3. For our analysis we used the *Yes* base estimation. The results are summarized in Table 6.2. Two dependent variables for the *Yes* base estimation are the odds of *No* to *Yes* choice $\ln(P_2/P_1)$ and *Maybe* to *Yes* choice $\ln(P_3/P_1)$. The estimated McFadden's pseudo R^2 is 0.3076, which is within the usual range of estimated fits for cross-sectional data. The slope coefficients in the logit model measure the changes of the odds of *No* or *Maybe* to *Yes* choice for one unit change in the independent variables.

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[42] The elaborate discussion on these variables is given in Section 5.1.

Table 6.2: Summary of the *Yes* Base Estimation (n = 1531)

Independent Variable (Expected Sign for ln (P_2/P_1))	$\ln(P_2/P_1)$	$\ln(P_3/P_1)$
IPWM (–)	– 0.171 (0.003)	– 0.202 (0.000)
PPDSP (–)	– 0.733 (0.000)	– 0.325 (0.000)
TRUST (–)	– 0.055 (0.050)	0.006 (0.809)
KNOW (+)	0.49 (0.000)	0.291 (0.000)
ACCESS (–)	– 0.343 (0.000)	– 0.154 (0.004)
COMP (+)	0.160 (0.027)	– 0.018 (0.817)
RELCOM (+)	0.411 (0.006)	0.199 (0.193)
ECO (–)	– 0.887 (0.000)	– 0.596 (0.000)
DIST (–)	– 0.0009 (0.000)	– 0.00014 (0.077)
ENV (+)	0.790 (0.000)	0.199 (0.030)
INCOME (+)	0.451 (0.000)	0.151 (0.014)
CHILD (?)	– 0.140 (0.186)	0.067 (0.498)
EDU (?)	– 0.013 (0.820)	0.013 (0.806)
GENDER (–)	– 0.278 (0.102)	– 0.654 (0.000)
AGE (–)	0.001 (0.885)	– 0.0002 (0.981)
NHMBR (+)	0.252 (0.001)	0.052 (0.445)
YRSTAY (+)	0.0004 (0.948)	0.005 (0.418)
HSFORM (–)	0.067 (0.477)	– 0.075 (0.397)
Constant	– 0.977 (0.182)	– 0.091 (0.892)

P_1: Probability of choice *Yes*
P_2: Probability of choice *No*
P_3: Probability of choice *Maybe*

Absolute p - values are in parentheses
Dependent variable: $\ln(P_2/P_1)$); $\ln(P_3/P_1)$.
Pseudo R^2: 0.3076

In Table 6.2, a positive coefficient indicates that the percentage change in probability of choice *No* or choice *Maybe* is higher than that of choice *Yes* by the amount of the coefficient for one unit increase in the independent variable. The effect is exactly the opposite if the coefficient's sign is negative. For instance, – 0.055 as the estimated coefficient for independent variable *TRUST* in the model for $\ln(P_2/P_1)$ implies that the percentage change in probability of choice *No* is lower than that of choice *Yes* by as much as 0.055 for one unit increase in *TRUST*. Coefficients for 12 variables out of 18 are significant at less than or equal to the 5% significance level for $\ln(P_2/P_1)$ whereas 9 variables are significant for $\ln(P_3/P_1)$.[43] These results are mostly consistent with those observed in the previous siting studies.[44] The signs of estimated coefficients in $\ln(P_2/P_1)$ are all consistent with the expected ones, except for four variables (*CHILD*, *EDU*, *AGE*, *HSFORM*).

These empirical results are consistent with the theoretically expected in our three-choice model: the subjective probability of accepting (rejecting) the facility is an increasing (decreasing) function of PWA variables (*IPWM*, *PPDSP*, *TRUST*, *KNOW*, *ACCESS*, *COMP*, *RELCOM*, *ECO*), and a decreasing (increasing) function of NWA variables (*DIST*, *ENV*, *INCOME*).

Out of four variables (*CHILD*, *EDU*, *AGE*, *HSFORM*), the signs of *CHILD* and *EDU* are found to be negative. This implies that as the resident's concern with the negative impact on children's health (*CHILD*) and the resident's level of education (*EDU*) are higher, the probability of choice *No* is lower. However, the results are not statistically significant. Negative signs of the other two variables (*AGE*, *HSFORM*)

[43] The coefficient of *DIST* for $\ln(P_3/P_1)$ is significant at the 10 % level.

[44] The previous empirical findings are summarized in Chapter III.

indicate that if the resident is young (*AGE*) or lives in an apartment complex (*HSFORM*), the resident tends to reject the composting facility. The impact of these two variables on the siting decision, however, is not statistically significant either. Overall, we find that the logit model specified well describes the data in terms of pseudo R^2, statistical significance of estimated coefficients, and the expected signs.[45]

6.4 Normalizing Logit Coefficients

To facilitate an easier comparison of estimated impacts of regressors, we normalize the estimated logit coefficients ($\phi_{k_{mb}}$) by following the procedure. First, we take anti-log of the estimated MNLM in (2). That is:

$$\gamma_{mb} = \frac{P_m}{P_b} = \exp(\mathbf{X}'\Phi_{mb}) \tag{3}$$

Then we can rewrite Equation (3),

$$\begin{aligned} \exp(\mathbf{X}'\Phi_{mb}) &= \exp(\phi_{0_{mb}} + \phi_{1_{mb}} x_1 + \ldots + \phi_{k_{mb}} x_k) \\ &= \exp(\phi_{0_{mb}}) \exp(\phi_{1_{mb}} x_1) \ldots \exp(\phi_{k_{mb}} x_k) \\ &= \gamma_{mb}(z, x_k) \end{aligned} \tag{4}$$

where

[45] The coefficient's sign and its statistical significance in $\ln(P_3/P_1)$ model are discussed in Section 6.5 in relation to the level of risk orientation.

$z = [\, x_1 \; x_2 \; .... \; x_{k-1} \,]$, Vector of independent variables excluding x_k.

Rewriting Equation (4) for x_k to $x_k + \Delta x_k$ as

$$\gamma_{mb}\ (\, z, x_k + \Delta x_k \,) = \exp\,(\, \phi_{0_{mb}} \,) \exp\,(\, \phi_{1_{mb}} x_1 \,) \ldots \exp\,(\, \phi_{k_{mb}} (x_k + \Delta x_k \,) \,)\ . \qquad (5)$$

Dividing Equation (5) by Equation (4),

$$\frac{\gamma_{mb}\ (\, z, x_k + \Delta x_k \,)}{\gamma_{mb}\ (\, z, x_k \,)} = \frac{\exp\,(\, \phi_{0_{mb}} \,) \exp\,(\, \phi_{1_{mb}} x_1 \,) \ldots \exp\,(\, \phi_{k_{mb}} x_k \,) \exp\,(\, \phi_{k_{mb}} \Delta x_k \,)}{\exp\,(\, \phi_{0_{mb}} \,) \exp\,(\, \phi_{1_{mb}} x_1 \,) \ldots \exp\,(\, \phi_{k_{mb}} x_k \,)}$$

$$= \exp\,(\, \phi_{k_{mb}}\ \Delta x_k \,). \qquad (6)$$

The last equality in Equation (6) measures a percentage change of the odds of choice m to base choice b corresponding to a change in a regressor. For further simplification, we consider the percentage change of the odds in response to one unit change in each regressor ($\Delta x_k = 1$). Hence, the normalized coefficients for each choice are: exp ($\phi_{k_{11}}$) for base choice *Yes*, exp ($\phi_{k_{21}}$) for choice *No*, and exp ($\phi_{k_{31}}$) for choice

Maybe. Note that normalized coefficients for base choice (*Yes*) is $\exp(\phi_{k_{11}}) = 1$.[46] If a normalized coefficient is less than 1, the corresponding variable has a negative coefficient in the logit model. If it is greater than one, the corresponding variable has a positive coefficient. The magnitude of impact of each independent variable becomes greater as the value of the normalized coefficient departs father from unity.

The next three subsections discuss the impacts of three groups of variables in terms of normalized coefficients.

6.4.1 Positive Wealth Attribute Variables

Figure 6.1 shows normalized coefficients for eight PWA variables (*IPWM, PPDSP, TRUST, KNOW, ACCESS, COMP, RELCOM, ECO*). Each bar in Figure 6.1 represents the corresponding choice; *Yes* (base choice), *No*, and *Maybe*. The height of each bar indicates the value of the normalized coefficient. For instance, the values of the three bars of *IPWM* are $\exp(\phi_{k_{21}}) = 0.843$ for choice *No*, $\exp(\phi_{k_{11}}) = 1$ for base choice *Yes*, and $\exp(\phi_{k_{31}}) = 0.817$ for choice *Maybe*. The values in parentheses are statistical

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[46] By the characteristic of MNLM, logit coefficient $\phi_{k_{mb}}$ equals $\phi_{k_m} - \phi_{k_b}$ (Long 1997; Long and Freese 2001). Probability P_q (q is choice m or b) in MNLM can be expressed as $P_q = \frac{\exp(x_k \phi_{k_q})}{\sum_{j=1}^{J} \exp(x_k \phi_{k_j})}$, where $j = 1, \ldots, J$ choices. By taking the ratio of P_m to P_b, we get:

$$\frac{P_m}{P_b} = \frac{\exp(x_k \phi_{k_m})}{\sum_{j=1}^{J} \exp(x_k \phi_{k_j})} \Bigg/ \frac{\exp(x_k \phi_{k_b})}{\sum_{j=1}^{J} \exp(x_k \phi_{k_j})} = \exp(x_k(\phi_{k_m} - \phi_{k_b})) = \exp(x_k \phi_{k_{mb}})$$

. Therefore, if non-base choice m is the same as the base choice b, then $\phi_{k_{mb}} = \phi_{k_{bb}} = \phi_{k_{11}} = \phi_{k_1} - \phi_{k_1} = 0$ and $\exp(\phi_{k_{mb}}) = \exp(\phi_{k_{bb}}) = \exp(\phi_{k_{11}}) = 1$.

significance levels; 1 % level (***), 5 % level (**), and 10 % level (*). In the section, we mainly discuss the independent variable's effect on choice *No*, i.e., the odds of *No* to *Yes* by the normalized coefficient. The reason for selecting choice *No* is that there is no previous empirical analysis of choice *Maybe* that can be compared with our estimation results.[47]

Five out of eight PWA variables are positive attitude variables (*IPWM, PPDSP, TRUST, KNOW, ACCESS*) in our empirical model. *IPWM* measures the resident's degree of involvement in waste management activity. *IPWM* in Figure 6.1 shows that the values of normalized coefficients corresponding to choices *No* and *Maybe* are 0.843 and 0.817 respectively. This implies that the probabilities of selecting choice *No* and *Maybe* are less than that of selecting choice *Yes*. Both normalized coefficients of *IPWM* are statistically significant at the 1 % level. The value of the normalized coefficient for *IPWM* indicates that as the residents become more involved in waste management activities such as recycling, the resident shows a less negative response. This result is consistent with the previous empirical evidence that a local resident's waste management activity is positively related to one's positive siting attitude (Halstead et at. 1999).

PPDSP measures public participation in decision making for the siting plan. The estimated normalized coefficients of *PPDSP* corresponding to choices *No* and *Maybe* are 0.480 and 0.723 respectively. Both coefficients are statistically significant at the 1 % level. The normalized coefficient for choice *No* indicates that the odds of *No* to *Yes* choice are almost half (0.480) for the local residents believing that the siting institutions have sufficiently considered a local resident's economic loss in a hosting area. The

[47] The discussion on choice *Maybe* (or *Maybe* odds) is done separately in the section 6.5 in regards to the risk orientation factor.

normalized coefficients for choice *No* of *PPDSP* imply that as the siting institutions convince the residents in a hosting area, the resident shows a less negative response. This result supports the previous empirical evidence that the source of strong NIMBY lies in the siting institution's improper consideration of the local resident's opinion (Bogdonoff 1995).

TRUST measures the resident's degree of trust in the institutions in charge of waste management. According to previous studies, *TRUST* is also found to be an important factor affecting a resident's siting behavior (Kunreuther and Easterling 1990). *TRUST* in Figure 6.1 shows that the effect of the resident's level of trust in institutions is statistically significant at the 5 % level for choice *No* while the effect of *TRUST* for choice *Maybe* is insignificant. Compared to the other PWA variables, the normalized coefficients of *TRUST* are not much different from that of base choice *Yes* (=1). The normalized coefficient for choice *No* is found to be close to 1 (0.946) implying that the probability of selecting choice *No* is very close to that of selecting choice *Yes*. Hence, our result moderately supports the previous empirical results.

KNOW measures the extent to which the residents can distinguish the differences in adverse environmental effects among the various waste disposal facilities. Showing statistical significance at the 1 % level for the two choices *No* and *Maybe*, the values of the two normalized coefficients of this variable are found to be 1.632 for choice *No* and 1.338 for choice *Maybe*. The normalized coefficient for choice *No* implies that the odds of *No* to *Yes* choice is slightly more than one and a half for residents who do not know common facts on waste disposal methods. This indicates that the lack of common knowledge on waste disposal methods tends to cause the residents to respond negatively.

This also implies that a resident's knowledge of the noxious facility's hazardousness has a significant impact on siting decisions.

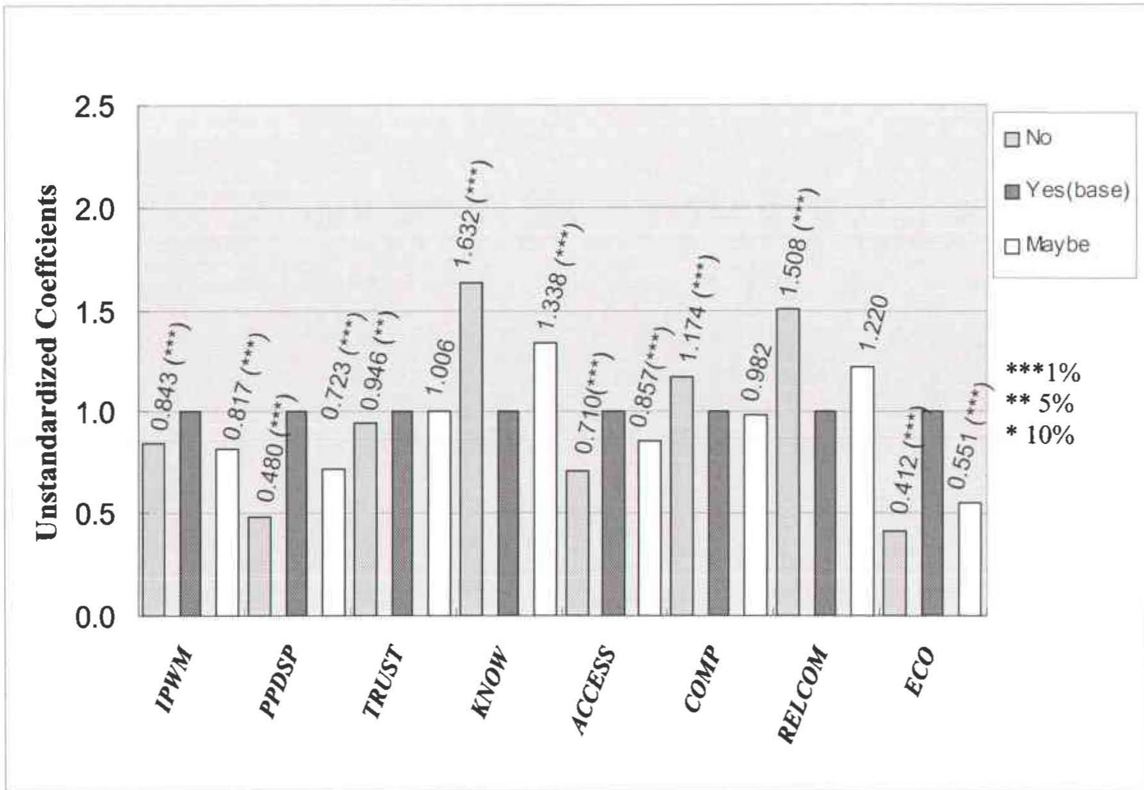

Figure 6.1: Positive Wealth Attribute Variables

ACCESS measures the information sources available to residents. Compared to the effects of the other positive attitude variables, its impact appears to be intermediate: stronger than *IPWM* and *TRUST* yet weaker than *PPDSP* and *KNOW*. The normalized coefficient for *ACCESS* (0.710) in *No* choice model is far less than that of base choice (=1), as compared to those for *IPWM* (0.843 in *NO* choice model) and *TRUST* (0.946 in *No* choice model). The impact of *ACCESS* is weaker than *PPDSP* and *KNOW* as its normalized coefficient (0.710) in *No* choice model is closer to 1 which compares with 0.480 for *PPDSP* and 1.632 for *KNOW*. As shown in Figure 6.1, the normalized coefficient for *ACCESS* in *No* choice models has negative effect on rejecting a composting facility (or equivalently it has a positive effect on siting the facility) with a statistical significance at 1% level. The positive attitude variables' effects on the siting are statistically significant and substantial in magnitude.

Of the two compensation variables (*COMP*, *RELCOM*), *COMP* measures the monetary compensation: the maximum tax the residents are willing to pay to prevent the siting of the composting facility. *RELCOM* is the *INCOME* deflated *COMP*. A higher *COMP* and *RELCOM* mean a greater monetary compensation demanded for siting the facility.[48] The normalized coefficients for choice *No* and choice *Maybe* are 1.174 and 0.982 for *COMP*, while the corresponding coefficients for *RELCOM* are 1.508 and 1.220 respectively. *COMP* and *RELCOM* differ in the magnitude of their respective effects but share the statistical significance. Both normalized coefficients for the *No* choice indicates that choice against siting the composting facility increases as the maximum amount residents are willing to pay to have the siting plan cancelled increases. This result is on condition that the sufficient environmental protection measures are taken when and if the facility is sited.

ECO measures the economic opportunity that residents expect to gain from hosting a composting facility. As seen in Figure 6.1, the normalized coefficients corresponding to choice *No* and choice *Maybe* in *ECO* are statistically significant at the 1% level. The normalized coefficient for *No* choice model is 0.412 which indicates that

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[48] Monetary compensation is the one form of various compensations. Other kinds of compensations include conditional compensation, in – kind compensation, protection, and impact mitigation (O'Hare et al. 1983).

the probability that a resident is against the siting is less than the probability he is for. Hence, our estimation result from *ECO* is consistent with the previous empirical studies (Halstead et al. 1999, for example) which shows that the probability of rejecting the facility declines as a resident expects more economic benefits from the composting facility.

6.4.2 Negative Wealth Attribute Variables

The effects of NWA variables on the resident's siting decision are presented in Figure 6.2. *DIST* measures the hypothetical distance from a resident's home to the composting facility. As seen in Figure 6.2, the normalized coefficients for *DIST* in *No* and *Maybe* choice models are very close to 1. Figure 6.2 also shows their statistical significance at 1% and 10% level respectively. This implies that a local resident's attitude against siting a composing facility weakens as his residence is farther away from the composting facility, demonstrating NIMBY attitude. This finding is consistent with a number of siting studies (Halstead et al. 1999; Lober 1993; Furseth and Johnson 1988).

ENV measures the degree of concern that the residents have about the environmental impact of the composting facility. Both *ENV* and *ECO* are generated through factor analysis. The normalized coefficients for *ENV* (2.203) and *ECO* (0.412) in *No* choice model shows that the probability of choosing *No* as opposed to *Yes* is positively affected by the residents' environmental concern whereas it is negatively affected by the economic benefits. In other words, the environmental concern has a negative impact on residents' willingness to accept the facility whereas the economic benefits have a positive effect.

The estimated impacts of *ECO* and *ENV* on NIMBY attitude in our study are in a clear contrast with those of Halstead et al. (1999). In a US study by Halstead et al. (1999), the estimated coefficients for *ENV* and *ECO* are found to be 2.0803 and – 0.6078 respectively as opposed to *ENV* (0.789) and *ECO* (-0.887) in out study. This clearly indicates that for residents in Cheju City environmental concern has almost as strong an impact as economic benefits on making their siting decision, whereas the environmental concern in Halstead et al. (1999) dominates over the economic benefits from the facility.

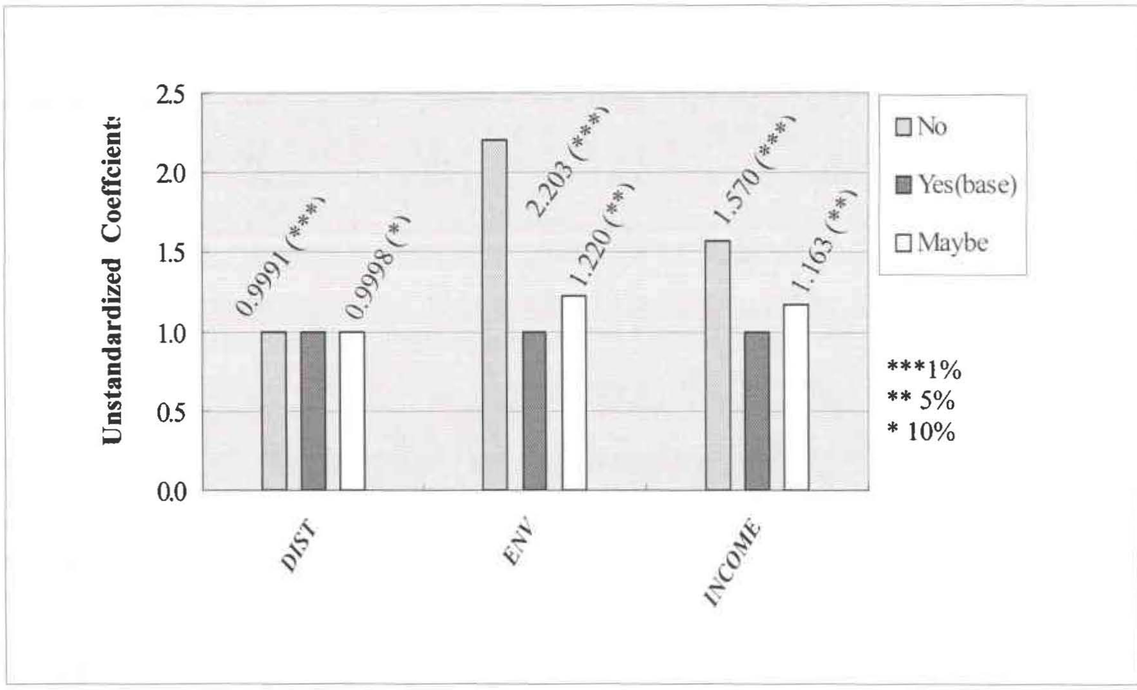

Figure 6.2: Negative Wealth Attribute Variables

Figure 6.2 also shows that the normalized coefficient for *INCOME* in *No* choice model is 1.570, which means that the greater a resident's income, the higher the probability of rejecting (as opposed to accepting). In contrast to Lee and An (1999), the coefficients of *INCOME* in our estimation results are statistically significant at 1% level or less. This extends supporting evidence that the NIMBY attitudes are stronger and prevalent amongst high income earners than lower ones as previously found (Hankyeoreh Daily News May 5 2002).

6.4.3 Socio-demographic Variables

Figure 6.3 shows the effects of SD variables on the resident's siting decision. The main feature of Figure 6.3 is that many of SD variables are insignificant. Of the seven variables (*CHILD, EDU, GENDER, AGE, NHMBR, YRSTAY, HSFORM*), the coefficients of six variables (*CHILD, EDU, GENDER, AGE, YRSTAY, HSFORM*) are insignificant for choice *No*.

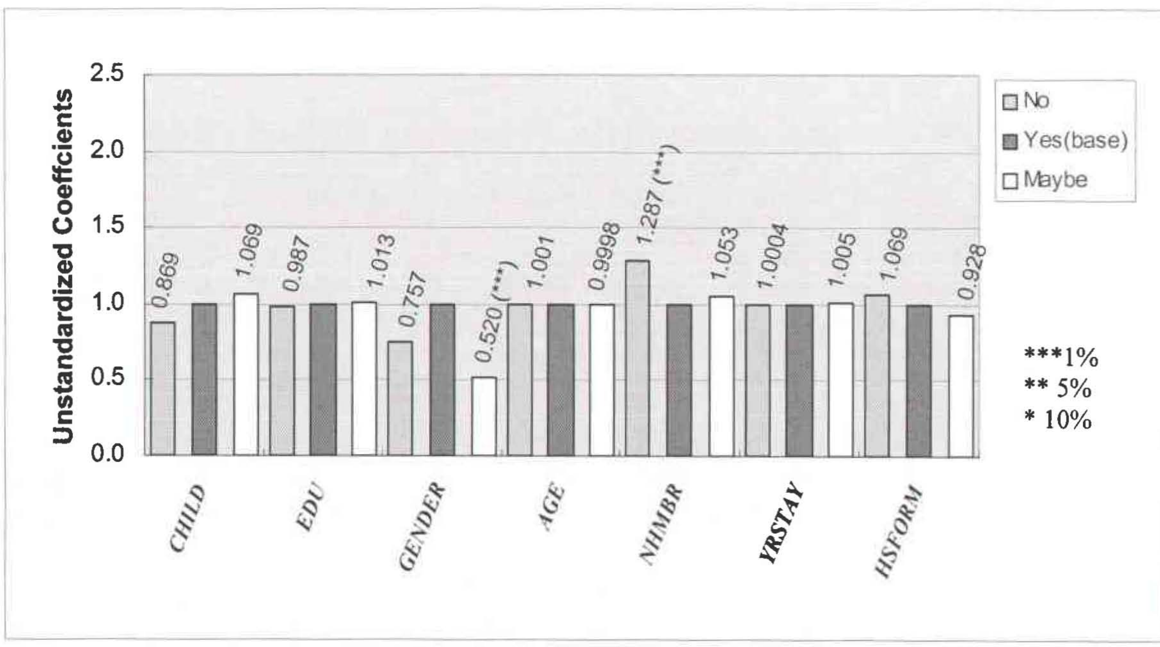

Figure 6.3: Socio-demographic Variables

Empirical results in some of the previous siting studies show the negative relationship between the number of children and willingness to accept a noxious facility (Piller 1991). Figure 6.3 indicates that the normalized estimated coefficient for *CHILD* is statistically insignificant while *NHMBR* is significant. The normalized coefficient for *NHMBR* in *No* choice model is 1.287. The results show that the Cheju City residents with a larger household size show a stronger NIMBY towards the composting facility.

While in Lee and An (1999) *GENDER* and *AGE* are statistically significant in their *No* choice model, they are insignificant in our study as shown in Figure 6.3. The normalized coefficient for *GENDER* in *Maybe* choice model (0.520) shows that a male resident's *Maybe* response relative to *Yes* weaker than a female. That is, female residents are more uncertain about the composting facility than males. Figure 6.3 also shows no statistical significance for each of the variables: *EDU, YRSTAY, HSFORM.* That is, the education level, the number of years at the current residence, and housing type have no significant bearings on the residents' NIMBY attitudes towards the composting facility.

6.5 Discussion on the Level of Risk Orientation

In our three-choice model, the level of risk orientation λ is determined by comparing the signs of the partial derivatives of two Maybe odds (the odds of *Maybe* to *Yes* choice and the odds of *Maybe* to *No* choice). As shown in Table 4.1, the partial derivative sign of the *Maybe* odds ($(\gamma_{31})_{a_i}, (\gamma_{32})_{a_i}, (\gamma_{31})_{s_j}, (\gamma_{32})_{s_j}$) depends upon the relative level of the risk orientation factor and the magnitude of the marginal safety cost. If the former (latter) is greater than the latter (former), the partial derivative sign of the *Maybe* odds is the same as that of the *Yes* (*No*) odds. In estimation results, the decision on the level of risk orientation is made by comparing the coefficients' signs of independent variables corresponding to two dependent variables ($\ln(P_3/P_1)$ and $\ln(P_3/P_2)$). The estimation result of the odds of *Maybe* to *Yes* choice ($\ln(P_3/P_1)$) is reported in Table 6.2. The estimated coefficient signs of odds of *Maybe* to *No* choice ($\ln(P_3/P_2)$) are reported in Table 6.3, which summarizes the results of *No* base estimation.

By comparing both of the estimation results (Tables 6.2 and 6.3), one can infer that residents' risk orientation is relatively low (high) if the sign of the coefficients of independent variables corresponding to the *Maybe* odds is the same as that of the *No* (*Yes*) odds. For *IPWM*, for instance, the sign of the *Maybe* odds is the same as that of the *No* odds for both estimation results, indicating the resident's relatively small risk orientation towards the composting facility. The level of risk orientation is reversed for *COMP*, showing a relatively high level of risk orientation. Comparing the sign of the *Maybe* odds of *INCOME* from both tables, we find that the sign of the *Maybe* odds equals that of the *Yes* odds for the *No* base estimation, and is equal to that of the *No* odds for the *Yes* base estimation. Since this is contradictory, we do not know whether the level of risk orientation is relatively high or low, so the result is inconclusive.

The level of risk orientation is summarized in Table 6.4. Out of 18 variables three variables (*IPWM, GENDER, YRSTAY*) reveal a relatively moderate risk orientation. Six variables (*TRUST, COMP, CHILD, EDU, AGE, HSFROM*) show a relatively high level of risk orientation.

Table 6.3: Summary of the *No* Base Estimation (n = 1531)

Independent Variables Expected sign for $\ln(P_1/P_2)$	$\ln(P_1/P_2)$	$\ln(P_3/P_2)$
IPWM (+)	0.171 (0.003)	− 0.031 (0.603)
PPDSP (+)	0.733 (0.000)	0.408 (0.000)
TRUST (+)	0.055 (0.050)	0.061 (0.029)
KNOW (−)	− 0.490 (0.000)	− 0.199 (0.006)
ACCESS (+)	0.343 (0.000)	0.190 (0.003)
COMP (−)	− 0.160 (0.027)	− 0.178 (0.011)
RELCOM (−)	− 0.411 (0.006)	− 0.212 (0.160)
ECO (+)	0.887 (0.000)	0.291 (0.007)
DIST (+)	0.0009 (0.000)	0.0007 (0.000)
ENV (−)	− 0.790 (0.000)	− 0.590 (0.000)
INCOME (−)	− 0.451 (0.000)	− 0.299 (0.000)
CHILD (?)	0.140 (0.186)	0.207 (0.050)
EDU (?)	0.013 (0.82)	0.026 (0.647)
GENDER (+)	0.278 (0.102)	− 0.376 (0.027)
AGE (+)	− 0.001 (0.885)	− 0.001 (0.871)
NHMBR (−)	− 0.252 (0.001)	− 0.200 (0.005)
YRSTAY (−)	− 0.0004 (0.948)	0.005 (0.494)
HSFORM (+)	− 0.067 (0.477)	− 0.142 (0.133)
Constant	0.977 (0.182)	0.886 (0.228)

Table 6.4: Resident's Risk Orientation

Independent Variables	Sign of Independent Variable in the *Yes* Base Estimation			Sign of Independent Variable in the *No* Base Estimation			Orientation of *Maybe*
	$\ln(p_2/p_1)$	$\ln(p_3/p_1)$	λ vs. $\lvert h_{s_j} \rvert$	$\ln(p_1/p_2)$	$\ln(p_3/p_2)$	λ vs. $\lvert h_{s_j} \rvert$	
IPWM	–	–	$\lambda < \lvert h_{s_j} \rvert$	+	–	$\lambda < \lvert h_{s_j} \rvert$	*No*
PPDSP	–	–	$\lambda < \lvert h_{s_j} \rvert$	+	+	$\lambda > \lvert h_{s_j} \rvert$	Inconclusive
TRUST	–	+	$\lambda > \lvert h_{s_j} \rvert$	+	+	$\lambda > \lvert h_{s_j} \rvert$	*Yes*
KNOW	+	+	$\lambda < \lvert h_{s_j} \rvert$	–	–	$\lambda > \lvert h_{s_j} \rvert$	Inconclusive
ACCESS	–	–	$\lambda < \lvert h_{s_j} \rvert$	+	+	$\lambda > \lvert h_{s_j} \rvert$	Inconclusive
COMP	+	–	$\lambda > \lvert h_{s_j} \rvert$	–	–	$\lambda > \lvert h_{s_j} \rvert$	*Yes*
RELCOM	+	+	$\lambda < \lvert h_{s_j} \rvert$	–	–	$\lambda > \lvert h_{s_j} \rvert$	Inconclusive
ECO	–	–	$\lambda < \lvert h_{s_j} \rvert$	+	+	$\lambda > \lvert h_{s_j} \rvert$	Inconclusive
DIST	–	–	$\lambda < \lvert h_{s_j} \rvert$	+	+	$\lambda > \lvert h_{s_j} \rvert$	Inconclusive
ENV	+	+	$\lambda < \lvert h_{s_j} \rvert$	–	–	$\lambda > \lvert h_{s_j} \rvert$	Inconclusive
INCOME	+	+	$\lambda < \lvert h_{s_j} \rvert$	–	–	$\lambda > \lvert h_{s_j} \rvert$	Inconclusive
CHILD	–	+	$\lambda > \lvert h_{s_j} \rvert$	+	+	$\lambda > \lvert h_{s_j} \rvert$	*Yes*
EDU	–	+	$\lambda > \lvert h_{s_j} \rvert$	+	+	$\lambda > \lvert h_{s_j} \rvert$	*Yes*
GENDER	–	–	$\lambda < \lvert h_{s_j} \rvert$	+	–	$\lambda < \lvert h_{s_j} \rvert$	*No*
AGE	+	–	$\lambda > \lvert h_{s_j} \rvert$	–	–	$\lambda > \lvert h_{s_j} \rvert$	*Yes*
NHMBR	+	+	$\lambda < \lvert h_{s_j} \rvert$	–	–	$\lambda > \lvert h_{s_j} \rvert$	Inconclusive
YRSTAY	+	+	$\lambda < \lvert h_{s_j} \rvert$	–	+	$\lambda < \lvert h_{s_j} \rvert$	*No*
HSFORM	+	–	$\lambda > \lvert h_{s_j} \rvert$	–	–	$\lambda > \lvert h_{s_j} \rvert$	*Yes*

Nine variables (*PPDSP, KNOW, RELCOM, ACCESS, DIST, ECO, ENV, INCOME, NHMBR*) are found to be the inconclusive for the level of risk orientation toward the composting facility. The inferences on the risk orientation as listed in the last column in table are based on the test statistics calculated under the null hypotheses discussed in the following section.

6.6 Hypothesis Test

We have carried out significance tests on our empirical results. The statistical significance of each coefficient of our empirical result is reported in tables 6.2 and 6.3. Although *p*-value indicates the statistical significance of each estimated coefficient, it does not test whether a pair of coefficients for each regressor is simultaneously significant. Hence, we also carry out the significance test for each pair of coefficients. Then we carry out a simultaneous significance test for the estimated coefficients as a whole. Finally, we discuss the statistical significance of the level of risk orientation.

Since there are three choices in our model, each independent variable has two coefficients. Hence we need to test whether both coefficients are simultaneously different from "0" with a statistical significance. The null hypothesis can be stated as:

$$H_0: \phi_{k_{NY}} = \phi_{k_{MY}} = 0 \qquad (7)$$

where,

ϕ_k = Coefficient for *k-th* regressor (k =1,2,3,...,18);

"*NY*", "*MY*" = *No* choice,*Maybe* choice with *Yes* choice as base.

Table 6.5: Wald Test

df = 2

Variable	χ^2	p – value
IPWM	16.069	0.000
PPDSP	108.518	0.000
TRUST	5.541	0.063
KNOW	46.983	0.000
ACCESS	31.131	0.000
COMP	8.056	0.018
RELCOM	7.534	0.023
ECO	62.651	0.000
DIST	67.824	0.000
ENV	60.931	0.000
INCOME	53.065	0.000
CHILD	3.897	0.142
EDU	0.211	0.900
GENDER	17.009	0.000
AGE	0.031	0.985
NHMBR	13.026	0.001
YRSTAY	0.778	0.678
HSFORM	2.281	0.320

Table 6.6: LR Test

df = 2

Variable	χ^2	p – value
IPWM	16.168	0.000
PPDSP	121.848	0.000
TRUST	5.558	0.062
KNOW	49.056	0.000
ACCESS	33.228	0.000
COMP	8.202	0.017
RELCOM	7.794	0.020
ECO	69.496	0.000
DIST	81.827	0.000
ENV	66.165	0.000
INCOME	56.691	0.000
CHILD	3.915	0.141
EDU	0.211	0.900
GENDER	17.277	0.000
AGE	0.031	0.985
NHMBR	13.206	0.001
YRSTAY	0.773	0.679
HSFORM	2.308	0.315

The Wald test statistic is,

$$W_k = \hat{\Phi}'_k \hat{var}(\hat{\Phi}_k)^{-1} \hat{\Phi}_k \sim \chi^2(2) \quad (8)$$

where

$\hat{\Phi}'_{k,2\times1} = (\phi_{k_{NY}} \ \ \phi_{k_{MY}})'$: Vector of the maximum likelihood estimates for variable x_k ;

$\hat{var}(\hat{\Phi}'_k)_{2\times2} =$ Estimated covariance matrix.

The number of total choices (= 3) minus 1 is the degrees of freedom. The null hypothesis in this test is "no effect of the independent variable on the resident's decision towards the hosting the facility". The null hypothesis stated above is tested for each of 18 regressors. The test results are reported in both Tables 6.5 (Wald test) and 6.6 (LR test), and both results are very close, although the p-values for both Wald and LR tests are different.[49] Out of 18 variables, 13 variables show a statistical significance at 10 % level or less.

The null hypothesis for simultaneous significance test for entire coefficients is:

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[49] LR test statistic is, $LR_k = 2\ln L(M_F) - 2\ln L(M_R) \sim \chi^2(2)$
where
$L(M_F)$ = The value of the likelihood function evaluated at the maximum likelihood estimates for the full (unconstrained) model;
$L(M_R)$ = The value of the likelihood function evaluated at the maximum likelihood estimates for the restricted (constrained) model.

Both of Wald and LR tests follow χ^2 distribution whose total restrictions are the number of variables multiplied by J-1 (J is the total number of choices).

H$_0$: $\phi_{1_{NY}} = \phi_{1_{MY}} = 0$

$\phi_{2_{NY}} = \phi_{2_{MY}} = 0$

......

$$\phi_{18_{NY}} = \phi_{18_{MY}} = 0 \quad (9)$$

The test statistics used for testing the null hypothesis in (9) are:

$$W = \hat{\Phi}' \hat{\text{var}}(\hat{\Phi})^{-1} \hat{\Phi} \sim \chi^2(36) \quad (10)$$

where

$\hat{\Phi}'_{36\times1} = (\hat{\phi}_{1_{NY}}\ \hat{\phi}_{1_{MY}}\ \hat{\phi}_{2_{NY}}\ \hat{\phi}_{2_{MY}} \ldots \hat{\phi}_{18_{NY}}\ \hat{\phi}_{18_{MY}})'$: Vector of the maximum likelihood estimates

for variables $x_1, \ldots, x_{18}$;

$\hat{\text{var}}(\hat{\Phi})_{36\times36} =$ The estimated covariance matrix.

$$\text{LR} = 2\ln L(M_F) - 2\ln L(M_R) \sim \chi^2(36) \quad (11)$$

Since there are 18 variables and 3 choices, the degrees of freedom are equal to 36 for both tests. The test statistics as reported in Table 6.7 reject the null at 1 % significance level.

Table 6.7: Wald Test and LR Test for Independent Variables as a Whole

Accept	χ^2	df	*p*-value
Wald	466.818	36	0.000
LR	983.768	36	0.000

The final section in this Chapter relates to testing for the risk orientation latent in *Maybe* responses. Based on the empirical results reported in Table 6.8, we can draw a conclusion with regard to the residents' risk orientation (λ) in our three-choice model theoretically analyzed in Chapter 4. The analysis therein suggests that if the resident's net wealth equivalent function (or utility function) becomes closer to the case of the composting facility not sited, the level of risk orientation factor λ becomes closer to "0". This means that as λ approaches to "0" the estimated coefficients in the *Yes* based MNLMs ($\ln(P_2/P_1)$ and $\ln(P_3/P_1)$ as reported in Table 6.2 converge to each other with their differences vanishing. Hence, the non-zero difference between $\ln(P_2/P_1)$ and $\ln(P_3/P_1)$ implies the existence of a certain level of risk orientation as presented in Table 6.8. In Table 6.8, $\ln(P_2/P_1)$ and $\ln(P_3/P_1)$ are the dependent variables for the *Yes* base estimations: i.e., the odds of *No* to *Yes* choice and the odds of *Maybe* to *Yes* choice.

$\ln(P_2/P_3)$, in the fourth column in Table 6.8, is the difference between the two dependent variables corresponding to two (log of) odds, which are shown in Equation (12).

$$\ln(\frac{P_2}{P_1}) - \ln(\frac{P_3}{P_1}) = \ln P_2 - \ln P_1 - \ln P_3 + \ln P_1 = \ln P_2 - \ln P_3 = \ln(\frac{P_2}{P_3}) \qquad (12)$$

Table 6.8: Identification of the Level of Risk Orientation Factor

Independent Variables	$\ln(P_2/P_1)$	$\ln(P_3/P_1)$	$\ln(P_2/P_3)$
IPWM	– 0.171 (0.003)	– 0.202 (0.000)	0.031
PPDSP	– 0.733 (0.000)	– 0.325 (0.000)	– 0.408
TRUST	– 0.055 (0.050)	0.006 (0.809)	– 0.061
KNOW	0.49 (0.000)	0.291 (0.000)	0.199
ACCESS	– 0.343 (0.000)	– 0.154 (0.004)	– 0.190
COMP	0.160 (0.027)	– 0.018 (0.817)	0.178
RELCOM	0.411 (0.006)	0.199 (0.193)	0.212
ECO	– 0.887 (0.000)	– 0.596 (0.000)	– 0.291
DIST	– 0.0009 (0.000)	– 0.00014 (0.077)	– 0.0007
ENV	0.790 (0.000)	0.199 (0.030)	0.590
INCOME	0.451 (0.000)	0.151 (0.014)	0.299
CHILD	– 0.140 (0.186)	0.067 (0.498)	– 0.207
EDU	– 0.013 (0.820)	0.013 (0.806)	– 0.026
GENDER	– 0.278 (0.102)	– 0.654 (0.000)	0.376
AGE	0.001 (0.885)	– 0.0002 (0.981)	0.001
NHMBR	0.252 (0.001)	0.052 (0.445)	0.200
YRSTAY	0.0004 (0.948)	0.005 (0.418)	– 0.005
HSFORM	0.067 (0.477)	– 0.075 (0.397)	0.142
Constant	– 0.977 (0.182)	– 0.091 (0.892)	– 0.886

As seen in Equation (12), the numerical values in the fourth column indicate the difference between the coefficients of the two independent variables corresponding to $\ln(P_2/P_1)$ and $\ln(P_3/P_1)$. For example, the coefficients of *IPWM* corresponding to $\ln(P_2/P_1)$ and $\ln(P_3/P_1)$ are – 0.171 and – 0.202. Subtracting the coefficient of *IPWM* in $\ln(P_3/P_1)$ from that of *IPWM* in $\ln(P_2/P_1)$ produces 0.031. Column 4 in Table 6.8 lists the differences between columns 2 and 3 which are identical with the estimated coefficients for MNLM with $\ln(P_2/P_3)$ as dependent variable.

As previously discussed, in three-choice model the non-zero coefficients of the fourth column imply the existence of a level of risk orientation. However, these non-zero coefficients need to be subject to the statistical significance test. To test the significance of a coefficient, *z*-test is used to confirm whether uncertain residents in Cheju City have a significant level of risk orientation toward siting of a composting facility. The null hypothesis for this test is,

$$H_0:\ \phi_{k_{NM}} = 0 \tag{13}$$

The null hypothesis (13) states that *k-th* regressor in MNLM (x_k) does not have an impact on odds of *No* to *Maybe*. The test statistic used in this test is,

$$z = \frac{\hat{\phi}_{k_{NM}}}{\hat{\sigma}_{k_{NM}}} \tag{14}$$

where

$\hat{\sigma}_{k_{NM}}$ = The estimated standard deviation for variable x_k in *No/Maybe* model.

Table 6.9 summarizes the test results of the level of risk orientation. The Table shows the statistical significance of the risk orientations inferred from pairwise comparisons of signs for estimated coefficients as reported in Table 6.4.

Table 6.9: Test Result of Resident's Risk Orientation

Variable	$\lvert z \rvert$	*p*-value	Orientation of *Maybe*
IPWM	0.52	0.603	*No*
PPDSP	5.91	0.000	Inconclusive*
TRUST	2.19	0.029	*Yes**
KNOW	2.75	0.006	Inconclusive*
ACCESS	2.96	0.003	Inconclusive*
COMP	2.54	0.011	*Yes**
RELCOM	1.41	0.160	Inconclusive
ECO	2.70	0.007	Inconclusive*
DIST	6.98	0.000	Inconclusive*
ENV	5.87	0.000	Inconclusive*
INCOME	4.90	0.000	Inconclusive*
CHILD	1.96	0.050	*Yes**
EDU	0.46	0.647	*Yes*
GENDER	2.22	0.027	*No**
AGE	0.16	0.871	*Yes*
NHMBR	2.78	0.005	Inconclusive*
YRSTAY	0.68	0.494	*No*
HSFORM	1.50	0.133	*Yes*

*: significant at or less than 5% level

In Table 6.4 three variables (*IPWM, GENDER, YRSTAY*) out of 18 regressors show a relatively weak risk orientation. Among the three variables, only *GENDER* is statistically significant. Six variables show a higher risk orientation, out of which three (*TRUST,* *COMP, CHILD*) show a statistical significance and the remaining three (*EDU, AGE, HSFORM*) are insignificant. Nine variables (*KNOW, ACCESS, DIST, ECO ENV, INCOME, PPDSP, NHMBR, RELCOM*) show the inconclusiveness with regard to the risk orientation of *Maybe* responsiveness, and all but *RELCOM* show statistical insignificance.

Among the four variables which are a statistically significant risk orientation, the higher risk orientation cases outnumber the lower cases. Therefore we may conclude that uncertain respondents in Cheju City are more oriented towards accepting the facility.

6.7 Policy Implication

In this section we examine the policy implications of our empirical findings. The estimated impacts of PWA and NWA variables in *Yes* base model may be relevant to the policy formulation. In mid 1990's in Korea a user fee system was instituted for municipal solid waste disposal where the residents are required to separate the waste by type, recycle, and pack the waste with bags provided by the municipal government. This policy has been reported as effectively motivating residents in waste management (MOE 2000). The estimated coefficients for *IPWM* are consistent with the report. In many instances, a strong NIMBY attitude is an outcome of improper procedures followed on the part of the central or local government (Bogdonoff 1995). Hence, the local residents' opinions should be accommodated through a public hearing or debate (Hankyeore Daily News May 20, 2001). The estimated impact of *PPDSP* suggests that the awareness on the part of residents that their opinions are reflected could soften their NIMBY attitudes towards sting a composting facility.

It appears that the residents have different degrees of trust (*TRUST*) in the institutions related to waste management. Our survey shows that the local residents have different degrees of trust for different institutions in the order of: environmental organizations, local public officials, civil organizations, local recycling/solid waste managers, universities, central government, mass media, and private businesses. Therefore, it appears to be desirable that officials from highly trusted institutions be included in the policy making body. Our estimation results indicate that the residents' knowledge of the hazardousness of waste facilities is an important factor in the siting decision. Out of 1,850 observations, 12.11 % of respondents believe that a composting facility would result in more serious environmental damage than other facilities. A substantial number of residents of the 12.11 % do not want the composting facility to be sited near their residences. This implies that the more misinformed, the more misguided views the residents may have on siting a noxious facility. Transfer of knowledge on the environmental impacts can be achieved through various educational programs or campaign initiated by local governments or educational institutions. In addition, the estimated impact of *ACCESS* suggests that a wide spectrum of information on waste management may contribute to a substantial mitigation of NIMBY attitudes. That is, provision of as many information sources as possible may work.

In our survey, the siting of a hypothetical composting facility is on condition that a minimum environmental safety measures are in place. The estimated coefficients for *COMP* and *RELCOM* show that the NIMBY attitude bears a positive relationship with the amount of monetary compensation and the NIMBY attitude holds on condition that the resident's risk perception is sufficiently low (Kunreuther and Easterling 1990).

Further, this implies that the use of pure monetary compensation as a policy instrument may be effective only when necessary environmental safety measures are in place.

The result of *ECO* implies that the local or the central government can motivate the local residents to host the composting facility by either offering lower taxes or employing local people to operate the facility. These policies will be highly effective when the resident's expectation of the economic benefit increases. The results of *ECO* and *ENV* indicate that people in Korea, as opposed to people in the USA, do not perceive a high environmental threat. This is due to the fact that Koreans are more familiar with the environmental safety of the composting facilities. Rather, Koreans are more concerned about the availability of economic opportunity that arises from hosting the facility.

As with several previous empirical studies (Kraft and Clay 1991; Lindel and Earle 1983), our result of *DIST* also shows a high level of significance. The difference in proximity to a noxious facility incurs different cost burdens to local residents while benefits are evenly distributed. The significance of *DIST* reflects the imbalance of benefit and cost distribution by siting the noxious facility. Hence, close proximity to the facility motivates the residents to reveal the NIMBY attitude. Accordingly, to mitigate the NIMBY attitudes, the effective policy may require offering differentiated compensation that varies by each resident's level of proximity to the facility. However, one shortcoming is that our estimation result of *DIST* does not provide any information on the critical distance where the residents may feel safe. One way to find the critical distance is to use the response elasticity analysis, where we find that the value of elasticity becomes almost constant beyond a certain distance.

The level of income (*INCOME*) is found to be significant. Hence, the high income earner in Cheju City is likely to oppose any noxious facility in their neighborhood. This result contradicts Brody and Fleishman (1993) and supports Halstead et al. (1999). One of the most serious problems of siting noxious facilities in Korea is the strong opposition from the high income earners as opposed to lower income households (Hankyoreh Daily News January 15, 2002). High income residents in Korea own lopsidedly more properties relative to low income residents. This fact combined with high land value due to scarcity of land in Korea makes high income residents quite sensitive to the adverse environmental impact of the sited facility near their properties. The statistical significance of *INCOME* in our study indicates that policy makers may need to persuade high income residents in Korea of the importance of the facility in terms of economic benefits for all residents. Overall, the results of *Yes* base estimation suggest that relevant policy should consider 'the perception of need' for a facility rather than concentrating solely on compensation and risk alleviation as policy instruments.

As shown in the previous section, the results of the SD variables from *Yes* base estimation convey specific regional information for different countries or regions. The resident's education level (*EDU*)'s insignificant effect on one's siting decision may indicate that although environmental concerns are sounded throughout the Korean educational system, post-education endeavors are less focused on the natural environment. In regards to the significance of *NHMBR*, there are two possible explanations. The first explanation may be found in centuries-old Confucian Culture in Korea. As a consequence, the respondents show a greater concern for their elderly and children than in other cultures. The second explanation is that a resident living with a greater number of family members may have a greater sensitivity to any kind of nuisances including the environmental one. The impacts of *GENDER* and *AGE* as estimated in our study are different from those of Lee and An (1999). This implies that socio-demographic variables may have a significantly different set of impacts depending on the region-specific factors, which suggests that policy makers may have to assign a different set of weights to the same set of socio - demographic variables in formulating their policies related to siting the noxious facilities.

We compared estimated coefficients for *Yes* and *No* choice models and carried out the significance test for each pair of coefficients to draw a conclusion with regard to the level of risk orientation latent in *Maybe* responses. Three variables: *TRUST*, *COMP*, and *CHILD* show a more risk orientation with a statistical significance. Only *GENDER* variable showed a statistically significant less risk orientation. The risk orientation based on estimated coefficients for other variables are mostly inconclusive with a statistical significance. Therefore, on balance, we may conclude that *Maybe* responses tend towards *Yes* responses with regard to hosting the composting facility, which may be received as a favorable sign by the policy makers who may have to sway the residents' attitudes into accepting the composting facility planned.

CHAPTER VII

CONCLUSION

7.1 Summary of the Study

Expected utility theory was applied to derive a theoretical basis for our empirical model employed to analyze the residents' attitudes in Cheju City, Korea towards siting of a large - scale composting facility. As a preliminary step, we worked out a two-choice model by optimizing expected utility which provides a theoretical basis for applying the two-choice logit model. Then, we extended it to a three-choice model to address the nature of uncertain responses of the residents towards siting a composting facility.

Out of the 2,500 survey forms collected, only 1,850 completed ones were entered as the database we analyzed. Responses to several questions were transformed to generate two measurement variables: one is intended to measure the individual resident's degree of participation in waste management, and the other to measure the resident's degree of trust of waste management institutions. We also generated additional two variables through a factor analysis of fourteen variables: one as a measure of environmental impact, and the other of economic opportunity. A total of eighteen regressors were used for regression. As a reference for assessment of our estimation results, we produced a list of expected signs for estimated coefficients based on our theoretical analysis, findings in previous empirical studies, and observed facts in Korea except two variables: the number of children in a household and the respondent's level of education. *Yes* base estimation produced the results, which are largely consistent with the expected signs and robust in terms of statistical significance of estimated coefficients. Comparison of estimated coefficients for both *Yes* and *No* base MNLMs indicates that there is a high level of risk orientation latent in *Maybe* responses to the proposed composting facility.

7.2 Summary of Empirical Findings and Policy Implications

As in the previous siting studies, all of the five positive attitude variables have significant impact on the resident's siting decision. Local residents' active participation in both waste management and decision making process, access to information on waste management, public trust of the waste management institutions, and knowledge on environmental impact on the composting faculty have a significant positive impact on siting of a compost facility. The public trust, though statistically significant, has a notably small impact relative to the rest of the positive attitude variables on the residents' permissive attitudes on siting the facility.

Both absolute and relative monetary compensations are found to have positive impact on the residents' siting decision on condition that appropriate environmental protection measures are taken. This indicates that a policy of monetary compensation without being accompanied by environmental safety measures will be ineffective. Expected economic benefits from the facility also have a favorable impact on the siting decision. Therefore, to successfully induce the residents to accept siting of the composting facility, government may need to consider providing the economic benefits to the residents in hosting area.

Variables of environmental impact, proximity to the facility, and resident's income all have significant negative impacts on the siting, revealing the typical NIMBY attitudes as seen elsewhere. Somewhat interestingly, the positive economic benefits of the facility appear to slightly override the negative environmental impact, which contrasts with a US study by Halstead et al (1999) where the negative impact of environmental concern is more than three times the positive impact of the economic benefits on the siting decision in terms of the estimated coefficients in the logit model. This reveals that the income effect on demand for safer environment is much weaker in Korea than in US, which may be a useful piece of information to policy makers.

Socio-demographic variables may be summarized as mostly statistically insignificant. As in Lee and An (1999), the effect of resident's education level is statistically insignificant.Unlike Lee and An (1999), the resident's age and gender have no statistically significant bearing on the probability of accepting the composting facility. It is interesting to note, though, that females show a significantly stronger reservation than males to respond either way to siting an obnoxious facility. Only statistically significant socio-demographic variable is the size of household, and it did show a negative impact as expected. Overall, it appears to be the case for Cheju City that socio-demographic variables are insignificant. This observation appears to indicate a weak inter-regional consistency with regard to impact of the socio-demographic variables, which implies that policy makers may have to take into consideration their region-specific socio-demographic factors instead of simply emulating the policies successful elsewhere.

We made pairwise sign comparisons of corresponding estimated coefficients from *Yes* and *No* based MNLMs estimated for *Maybe* responses to identify the risk orientation level for *Maybe* responses. The level of risk orientation based on the pairwise sign comparisons for the variables: public participation in decision making, resident's general knowledge, a number of information sources, proximity, economic benefit, environmental impact, level of income, public participation, and household size are inconclusive. However, the pairwise comparisons for trust, monetary compensation, number of children, and resident's gender showed a relatively high or low risk orientation with a statistical significance. Only gender variable shows a low risk orientation level while three others show a high risk orientation. The implication is that *Maybe* responses in our study tend towards *Yes* responses rather than toward *No*, which may prove to be useful information for policy makers.

7.3 Contributions and Future Research Suggestion

The theoretical contribution of this study is in having provided a theoretical basis for empirical application of the logit model, establishing a clearer linkage between the theory and empirical model. In our study, unlike others, the probability is endogenously determined. Further, we incorporate a third choice, without which there may be serious biases in estimating probabilities.

At empirical level, the contribution of this study may be described as having provided an *ex-ante* analysis of the attitudes of Cheju City residents towards a composting facility which may prove to be very useful as a reference for policy makers not only in Cheju City but also in other regions in Korea which are potential candidates for siting a noxious facility, particularly in view of the fact that most existing siting studies in Korea have focused solely on more hazardous waste disposals such as land filling or incineration.

Our study opens a venue for further research in the future. At theory level, it is possible to generalize our model by incorporating any number of choices though its practical value may diminish as the number increases. At empirical level, since *Maybe* choice in the logit model is relevant to virtually all circumstances, it may prove to be fruitful to repeat our approach in siting studies in general. In addition, our study is an *ex-ante* rather than *ex-post* analysis. If and when the facility is actually sited, our *ex-ante* study may prove to be a valuable reference for any *ex-post* impact analysis of the facility.

APPENDIX A: PROOF OF SECOND ORDER CONDITIONS

AI. Two-choice Model

$$\text{Max} \quad EU(q) = p\,U(q^*) + (1-p)\,U(q) \tag{AI-1}$$

where

$q^* = w(\boldsymbol{a}) - h(\boldsymbol{a}, \boldsymbol{s}) - \boldsymbol{1}'\boldsymbol{s}$;

$q = w(\boldsymbol{a}) - h(\boldsymbol{a}, \boldsymbol{s})$.

$\boldsymbol{1}_{l\times 1} = [\,1\ 1 \ldots 1]'$; $i = 1, 2, \ldots, n$; $j = 1, 2, \ldots, l$.

$$\frac{\partial\, EU}{\partial\, a_i} = p\,U_{q^*}(w_{a_i} - h_{a_i}) + (1-p)\,U_q(w_{a_i} - h_{a_i}) = 0 \tag{AI-2}$$

$$\frac{\partial\, EU}{\partial\, s_j} = -\,p\,U_{q^*}(1 + h_{s_j}) - (1-p)\,U_q h_{s_j} = 0 \tag{AI-3}$$

$$\frac{\partial^2 EU}{\partial\, a_i^{\,2}} = [p\,U_{q^*} + (1-p)\,U_q](w_{a_i a_i} - h_{a_i a_i}) < 0 \tag{AI-4}$$

$$\frac{\partial^2 EU}{\partial\, a_i s_j}\left(= \frac{\partial^2 EU}{\partial\, s_j a_i}\right) = -h_{a_i s_j}[p\,U_{q^*} + (1-p)\,U_q] > 0 \tag{AI-5}$$

$$\frac{\partial^2 EU}{\partial s_j^{\,2}} = [p\,U_{q^*q^*}(1+h_{s_j})^2 + (1-p)\,U_{qq}h_{s_j}^{\,2}] - [p\,U_{q^*} + (1-p)\,U_q]\,h_{s_js_j} < 0 \qquad \text{(AI-6)}$$

The Hessian for the objective function is,

$$H = \begin{bmatrix} \dfrac{\partial^2 EU}{\partial a_i^{\,2}} & \dfrac{\partial^2 EU}{\partial a_i \partial s_j} \\ \dfrac{\partial^2 EU}{\partial s_j \partial a_i} & \dfrac{\partial^2 EU}{\partial s_j^{\,2}} \end{bmatrix} \qquad \text{(AI-7)}$$

By Equation (AI-4), the sign of the first order leading principal minor is,

$$|H_1| = \frac{\partial^2 EU}{\partial a_i^{\,2}} < 0 \qquad \text{(AI-8)}$$

The second order leading principal minor is,

$$|H_2| = \frac{\partial^2 EU}{\partial a_i^{\,2}}\frac{\partial^2 EU}{\partial s_j^{\,2}} - \left(\frac{\partial^2 EU}{\partial a_i \partial s_j}\right)^2 \qquad \text{(AI-9)}$$

RHS of Equation (AI-9) is

$$[\{p\,U_{q^*} + (1-p)\,U_q\}(w_{a_ia_i} - h_{a_ia_i})]\,[\{p\,U_{q^*q^*} + (1+h_{s_j})^2 + (1-p)\,U_{qq}h_{s_j}{}^2\}$$
$$-\{p\,U_{q^*} + (1-p)\,U_q\}\,h_{s_js_j}] - h_{a_is_j}{}^2[p\,U_{q^*} + (1-p)\,U_q]^2 \qquad (\text{AI}-9)'$$

Equation $(\text{AI}-9)'$ can be expressed as Equation (A10)

$$R(w_{a_ia_i} - h_{a_ia_i})T - R^2[(w_{a_ia_i} - h_{a_ia_i})h_{s_js_j} + h_{a_is_j}{}^2] > 0 \qquad (\text{AI-10})$$

where

$R = p\,U_{q^*} + (1-p) > 0;$

$T = p\,U_{q^*q^*}(1+h_{s_j})^2 + (1-p)\,U_{qq}h_{s_j}{}^2 < 0;$

$(w_{a_ia_i} - h_{a_ia_i}) < 0;$

$[(w_{a_ia_i} - h_{a_ia_i})\,h_{s_js_j} + h_{a_is_j}{}^2] = [w_{a_ia_i}h_{s_js_j} - (h_{a_ia_i}h_{s_js_j} - h_{a_is_j}{}^2)] < 0.$

Negative sign of $[w_{a_ia_i}h_{s_js_j} - (h_{a_ia_i}h_{s_js_j} - h_{a_is_j}{}^2)]$ holds by the assumptions of convex cost function. The positive sign of Equation $(\text{AI}-9)'$ indicates the positive second order leading principal minor ($|H_2| > 0$). Since the two leading principal minors duly alternate in sign, $|H_1|$ being negative, the two-choice model satisfies the second order condition under the given assumptions.

AII. Three-choice Model

$$\text{Max} \quad EU(q) = p_1 U(q_1) + p_2 U(q_2) + p_3 U(q_3) \tag{AII-1}$$

where

$q_1 = \mathrm{w}(\boldsymbol{a}) - \mathrm{h}(\boldsymbol{a}, \boldsymbol{s}) - \boldsymbol{l}'\boldsymbol{s}$;

$q_2 = \mathrm{w}(\boldsymbol{a}) - \mathrm{h}(\boldsymbol{a}, \boldsymbol{s})$;

$q_3 = \lambda[w(\boldsymbol{a}) - h(\boldsymbol{a}, \boldsymbol{s}) - \boldsymbol{l}'\boldsymbol{s}] + (1-\lambda)[w(\boldsymbol{a}) - h(\boldsymbol{a}, \boldsymbol{s})]$

$\quad = [w(\boldsymbol{a}) - h(\boldsymbol{a}, \boldsymbol{s}) - \lambda \boldsymbol{l}'\boldsymbol{s}]$;

$\boldsymbol{l}_{l \times l} = [1\ 1 \ldots 1]'$; $i = 1, 2, \ldots, n$; $j = 1, 2, \ldots, l$.

$$\frac{\partial EU}{\partial a_i} = p_1 U_{q_1}(w_{a_i} - h_{a_i}) + p_2 U_{q_2}(w_{a_i} - h_{a_i}) + p_3 U_{q_3}(w_{a_i} - h_{a_i}) = 0 \tag{AII-2}$$

$$\frac{\partial EU}{\partial s_j} = -p_1 U_{q_1}(1 + h_{s_j}) - p_2 U_{q_2} h_{s_j} - p_3 U_{q_3}(\lambda + h_{s_j}) = 0 \tag{AII-3}$$

$$\frac{\partial^2 EU}{\partial a_i^2} = (p_1 U_{q_1} + p_2 U_{q_2} + p_3 U_{q_3})(w_{a_i a_i} - h_{a_i a_i}) < 0 \tag{AII-4}$$

$$\frac{\partial^2 EU}{\partial a_i s_j} \left(= \frac{\partial^2 EU}{\partial s_j a_i}\right) = -h_{a_i s_j}(p_1 U_{q_1} + p_2 U_{q_2} + p_3 U_{q_3}) > 0 \tag{AII-5}$$

$$\frac{\partial^2 EU}{\partial s_j^{\,2}} = p_1 U_{q_1q_1}(1+h_{s_j})^2 + p_2 U_{q_2q_2} h_{s_j}^{\,2} + p_3 U_{q_3q_3}(\lambda + h_{s_j})^2$$
$$- h_{s_js_j}(p_1 U_{q_1} + p_2 U_{q_2} + p_3 U_{q_3}) < 0 \quad \text{(AII-6)}$$

The Hessian for the objective function is,

$$\mathrm{H} = \begin{bmatrix} \dfrac{\partial^2 EU}{\partial a_i^{\,2}} & \dfrac{\partial^2 EU}{\partial a_i \partial s_j} \\ \dfrac{\partial^2 EU}{\partial s_j \partial a_i} & \dfrac{\partial^2 EU}{\partial s_j^{\,2}} \end{bmatrix} \quad \text{(AII-7)}$$

By Equation (AII-4), the sign of the first order leading principal minor is,

$$|\mathrm{H}_1| = \frac{\partial^2 EU}{\partial a_i^{\,2}} < 0 \quad \text{(AII-8)}$$

The second order leading principal minor is,

$$|\mathrm{H}_2| = \frac{\partial^2 EU}{\partial a_i^{\,2}} \frac{\partial^2 EU}{\partial s_j^{\,2}} - \left(\frac{\partial^2 EU}{\partial a_i \partial s_j} \right)^2 \quad \text{(AII-9)}$$

RHS of Equation (AII-9) is

$$[(p_1 U_{q_1} + p_2 U_{q_2} + p_3 U_{q_3})(w_{a_i a_i} - h_{a_i a_i})][p_1 U_{q_1 q_1}(1 + h_{s_j})^2 + p_2 U_{q_2 q_2} h_{s_j}{}^2 + p_3 U_{q_3 q_3}(\lambda + h_{s_j})^2 - h_{s_j s_j}(p_1 U_{q_1} + p_2 U_{q_2} + p_3 U_{q_3})] - [h_{a_i s_j}(p_1 U_{q_1} + p_2 U_{q_2} + p_3 U_{q_3})]^2 \qquad \text{(AII} - 9)'$$

Equation $(\text{AII}-9)'$ can be expressed as Equation (AII-10).

$$\widetilde{R}\,(w_{a_i a_i} - h_{a_i a_i})\,\widetilde{T} - \widetilde{R}^2[(w_{a_i a_i} - h_{a_i a_i})h_{s_j s_j} + h_{a_i s_j}{}^2] > 0 \qquad \text{(AII-10)}$$

where

$\widetilde{R} = p_1 U_{q_1} + p_2 U_{q_2} + p_3 U_{q_3} > 0;$

$T = p_1 U_{q_1 q_1}(1 + h_{s_j})^2 + p_2 U_{q_2 q_2} h_{s_j}{}^2 + p_3 U_{q_3 q_3}(\lambda + h_{s_i})^2 < 0;$

$[(w_{a_i a_i} - h_{a_i a_i})\, h_{s_j s_j} + h_{a_i s_j}{}^2] = [w_{a_i a_i} h_{s_j s_j} - (h_{a_i a_i} h_{s_j s_j} - h_{a_i s_j}{}^2)] < 0.$

Negative sign of $[w_{a_i a_i} h_{s_j s_j} - (h_{a_i a_i} h_{s_j s_j} - h_{a_i s_j}{}^2)]$ holds by the assumptions of convex cost function. The positive sign of Equation $(\text{AII}-9)'$ indicates the positive second order leading principal minor ($|H_2| > 0$). Since the two leading principal minors duly alternate in sign, $|H_1|$ being negative, the three-choice model satisfies the second order condition under the given assumptions.

QED

APPENDIX B: SURVEY QUESTIONNAIRE (IN ENGLISH)

Dear Sir or Madame:

This survey is designed to collect residents' opinion on large - scale composting facility in Cheju-Province, South Korea. Around 2,500 copies of this questionnaire are being distributed. Your participation in this survey is on the voluntary basis only, and your candid and as precise as possible responses to the questionnaire will contribute to making right decisions with respect to establishing the waste disposal system in this area.

There is no definite right or wrong answer. Your thoughtful and honest response is important and will be greatly appreciated. The survey results will be used for the research purpose only. Accordingly, your privacy will be completely protected. If you have any questions or suggestions, please feel free to contact me at (808) 956-7561, (064) 746-2302 or the Committee on Human Studies ((808) 956-5007).

Thank you for your cooperation.

Hyuncheol Kim
Ph.D Candidate
Department of Economics
University of Hawaii at Manoa

[Questionnaire]

Part - waste disposal and attitude

1. Do you recycle part of your waste generated from your household?

Yes ( ) / No ( )

2. Do you compost part of your waste generated from your household?

Yes ( ) / No ( )

(Question 3-6) Please check one corresponding to how much effort you are making to lessen the generation of waste in your daily life.

	Never	Sometimes	Very often	Always
3. Purchase goods with less packaging. (Ex: Buy 1 big bottle instead of 2 smaller ones)	1	2	3	4
4. Purchase recyclable products. (Ex: Use coffee mug in the office instead of paper cups)	1	2	3	4
5. Borrow or share items. (Ex: share a lawnmower with neighbors or friends)	1	2	3	4
6. Sell or donate unused items to neighbors instead of throwing them away.	1	2	3	4

(Question 7-14) How much do you trust the following organizations to make decision about the waste management?

	Never trust	Trust a little	Trust a lot	Absolutely trust
7. Community organizations	1	2	3	4
8. Local recycling and waste administrator	1	2	3	4
9. Local public officials	1	2	3	4
10. Private businesses	1	2	3	4
11. Environmental organizations	1	2	3	4
12. Universities	1	2	3	4
13. Central government	1	2	3	4
14. Mass media (newspaper and broadcast media)	1	2	3	4

Part - If a new composting facility were built around your residence.

The following scenario is a hypothetical situation on the large - scale composting facility. Please read carefully prior to answering the questions 15 – 44.

[Suppose that public institution of your community has suggested building a large- scale composting facility in the neighborhood of your local residential area. The facility will be housed inside a building and produce compost by processing organic wastes (leaves, paper, diaper, food, etc.) of your and neighboring communities. Other wastes will be disposed at other places. Eight-meters-tall trees will be planted around the facility and the facility will be located 100m away from your house.]

(Question 15-28) Please read each question and answer on how it would affect your community.

	Never	To some degree	To much degree	Absolutely
15. Promote economic growth.	1	2	3	4
16. Pose serious risks to your children.	1	2	3	4
17. Create new job opportunities.	1	2	3	4
18. Generate bad odor.	1	2	3	4
19. Safety measures will decrease the risk.	1	2	3	4
20. Contaminate ground water.	1	2	3	4
21. Lower property tax.	1	2	3	4
22. Risk your neighbors' health and safety.	1	2	3	4
23. Lower the cost of waste disposal.	1	2	3	4
24. Lower the property value.	1	2	3	4
25. Provide a safe way for waste disposal.	1	2	3	4
26. Create a negative image on the community.	1	2	3	4
27. Will help improve the quality of the soil.	1	2	3	4
28. Increase the noise and pollution.	1	2	3	4

(Question 29-34) Under the hypothetical situation above on the composting facility, please read each question and answer on the importance of each issue can be.

	Don't know	Not important	*Important*	Very important
29. The supervising and governing power of the facility should be placed in the hands of both community and facility owner.	0	1	2	3
30. The waste should be sorted out into organic and inorganic types before reaching the facility.	0	1	2	3
31. The responsibility for the facility should be specified as a document before it is built.	0	1	2	3
32. In the event of accident or problems, your community should have the right to close the facility.	0	1	2	3
33. Markets for the compost should be guaranteed in documents before the facility is constructed.	0	1	2	3
34. More benefits should be given to your community hosting the facility than others using the facility. (e.g., free waste disposal, lower taxes, etc)	0	1	2	3

35. Which issue do you think is the most important among questions 29-34?

(1) Question 29 (Monitoring the facility)

(2) Question 30 (Sorting the waste by the type)

(3) Question 31 (The environmental responsibilities for the facility)

(4) Question 32 (Closing off the facility in the event of accident)

(5) Question 33 (Securing the market for the compost)

(6) Question 34 (More benefits to the facility hosting community)

36. In admitting the facility, what forms of benefits do you think should be given to your local community? Please select only 3 (   ) (   ) (   )

(1) Free waste disposal

(2) The grants for the building, parking lots, scholarship, etc.

(3) Reduce tax or guarantee property value for the landlords near the facility

(4) Hiring the local residents and purchasing the product from the facility

(5) Securing the fund for unexpected accidents or financial difficulties

(6) Providing local residents with free compost

(7) Maintaining water quality through ground water management

(8) Others

37. Suppose the facility has been approved and all relevant regulations and laws regulating environmental impacts (such as noise pollution, ground water pollution, etc.) are complied with, would you like to use the compost produced by the facility?
Yes ( )/ No ( )/ Maybe ( )

38. Suppose the composting facility has been approved and all the regulations and laws regulating environmental problems (such as noise pollution, water pollution, etc.) are complied with, are you willing to allow this compost produced by the facility to be used on your land 100m away from your house?
Yes ( )/ No ( )/ Maybe ( )

39. Do you think that recycling should be continued along with the new composting facility? Yes ( )/ No ( )/ Maybe ( )

40. If the facility is approved and the regulations and laws as related to environmental problems (such as noise pollution, water pollution, etc.) are complied with, are you willing to accept this composting facility if it is built 100m from your house?
Yes ( )/ No ( )/ Maybe ( )

41. Suppose a large-scale composting facility is being built. What would be your most concerned environmental impacts (ground water pollution, air pollution, etc.) as compared with those when a large - scale landfill or incineration facility is built?

1	2	3	4	5
low ←		similar to others		→ high

42. In your opinion, based on your past experience, when decisions were made to build new unwanted facilities, did the government office in charge bring the case to the public to reflect their views through appropriate channel (such as public hearings)?

1 2 3 4 5

Never ← → Certainly

43. How much tax are you willing to pay to call off the plan to build the composting facility in the vicinity of your residence? Choose one. (   )

(1) 3,000 won per month

(2) Over 3,000 and below 5,000 won per month

(3) Over 5,000 and below 10,000 won per month

(4) Over 10,000 and below 15,000 won per month

(5) Over 15,000 below 20,000 won per month

(6) Over 20,000 and below 30,000 won per month

(7) Over 30,000 and below 40,000 won per month

(8) Over 40,000 and below 50,000 won per month

(9) Over 50,000 won per month

44. Where do you get the information on the waste in your community? Choose all sources you use.

(1) Television ( )

(2) Radio ( )

(3) Local public officials ( )

(4) Newspapers ( )

(5) City hall ( )

(6) Neighbors ( )

(7) Local solid waste manager ( )

(8) Relatives or family members ( )

(9) Other sources ( )

Part III Socio-economic Questions

45. What is your age? (   )

46. What is your sex? female (   )/ male (   )

47. How many children under 18 are in your household? (   )

48. How many are older than 18 in your household? (   )

49. What is the level of your formal education? (   )

(1) Elementary school graduate or below

(2) Junior high school graduate

(3) Senior high school dropout

(4) Senior high school graduate

(5) Two year - college graduate

(6) University student

(7) University graduate

(8) Graduate work or above

50. Approximately how long have you been living in your current residence? (   ) years

51. What is the type of your current housing?

(1) an independent house (2) a tenement house (3) an apartment

52. Approximately how much is your monthly household income (monthly disposable income in 10,000 won)? (   )

(1) Less than 100 (2) 100 – 149 (3) 150 – 199 (4) 200 – 249

(5) 250 – 299 (6) 300 – 349 (7) 350 – 399 (8) 400 – 499

(9) Over 500

Closing: *Thank you for your time and cooperation.*

APPENDIX C: SURVEY QUESTIONNAIRE (IN KOREAN)

안녕하십니까?

이 설문은 제주도 쓰레기 시설에 관한 주민 여러분의 의견을 청취하기 위한 것입니다. 빼포될 총설문지 수량은 대략 2,500 부가 될 것입니다. 설문작성은 여러분의 자발적인 참여로 이루어집니다.여러분의 의견은 지역사회의 쓰레기 처리 개선에 큰 도움이 될 것입니다. 이 설문에는 정답이 있는 것이 아니므로 여러분이 생각하시는 그대로 대답해 주시면 됩니다. 진지하게 생각하신 후 솔직하게 적어 주십시오. 귀하의 응답 내용은 단지 본 연구를 위해서만 사용될 것이며, 절대 비밀이 보장됩니다. 만약 질문이 있을 시 에는 제 사무실 (808)956-7561 이나 자택(064)746-2302. office of Human study (808) 956-5007 로 문의 하시기 바랍니다.

감사합니다.

하와이 주립대 경제학과 박사과정

김 현철

[설문지]

설문 I - 쓰레기 처리와 태도

1. 귀하는 귀하의 집에서 나온 쓰레기의 일부를 재활용 (분리수거) 하십니까?
예 ( )/ 아니오 ( )

2. 귀하는 귀하의 쓰레기의 일부를 퇴비화(composting)하십니까?
예 ( )/ 아니오 ( )

● (질문 3-6) 다음 보기를 사용하여 쓰레기를 줄이는 노력을 얼마나 하고 계신지 체크하여 주십시오.

	전혀 안한다	가끔 한다	많이 한다	항상 한다
3. 포장이 덜 된 제품을 구입한다. (예: 2 개의 작은 병 대신 1 개의 큰 병 제품 구입)	1	2	3	4
4. 재사용 가능한 제품을 구입한다. (예: 사무실에서 개인의 커피잔을 사용한다.)	1	2	3	4
5. 일부 필요한 물건들을 빌리거나 함께 공유한다. (예: 벌초기계를 이웃이나 친구와 같이 쓴다)	1	2	3	4
6. 안 쓰는 물건들을 버리지 않고 이웃들에게 팔거나 기부한다.	1	2	3	4

● (질문 7-14) 귀하는 쓰레기 관리에 대한 올바른 의사결정을 하는데 있어서 아래의 기관들을 얼마만큼 신뢰하십니까?

	전혀 안함	약간 신뢰 함	많이 신뢰함	완전히 신뢰함
7. 시민단체	1	2	3	4
8. 재활용 및 폐기물 관리자	1	2	3	4
9. 시.도 공무원	1	2	3	4
10. 사기업 (일반개인기업포함)	1	2	3	4
11. 환경관련 단체	1	2	3	4
12. 대학	1	2	3	4
13. 정부	1	2	3	4
14. 언론 기관	1	2	3	4

설문 II - 만약에 귀하의 주변에 새로운 퇴비화 시설이 건립된다면?

아래의 내용은 실제 상황이 아니라 단지 귀하의 견해를 알기 위한 가상적인 상황일 뿐입니다. 다음 문장을 주의 깊게 읽고 아래 질문(15-44) 에 대답하여 주십시오. 이것은 오직 시험적 질문일 뿐입니다.

[귀하의 지역사회 공공기관이 지역사회 폐기물 쓰레기 퇴비화 시설을 건설하고자 주민들에게 건의를 하였습니다. 이 시설은 건물 내에 들어서며 귀하의 지역사회와 주변지역사회의 유기 쓰레기 (나뭇잎, 종이, 기저귀, 음식물 등)를 처리하여 비료(퇴비)를 생산할 것입니다. 그 밖의 쓰레기들은 다른 장소에서 처리될 것입니다. 그 시설 주위에는 8m 의 나무들이 조성될 것이며 귀하가 사는 장소로부터 100m 떨어진 곳에 위치하게 될 것입니다.]

● (질문 15-28) 귀하의 지역사회에 어떻게 영향을 미칠 지에 대해 아래 보기를 보고 답하여 주십시오.

	전혀 안 그렇다	약간 그렇다	꽤그렇다	아주그렇다
15. 경제적 성장을 촉진할 것이다.	1	2	3	4
16. 귀하의 자녀에게 심각한 위험을 초래할 것이다.	1	2	3	4
17. 새로운 직업 기회를 제공할 것이다.	1	2	3	4
18. 냄새가 심각할 것이다.	1	2	3	4
19. 안전조치 때문에 위험이 없을 것이다.	1	2	3	4
20. 지하수를 오염시킬 것이다.	1	2	3	4
21. 지역사회에 낮은 세금이 부과 될 것이다.	1	2	3	4
22. 이웃의 건강과 안전을 해칠 것이다.	1	2	3	4
23. 쓰레기 처리 비용을 감소시킬 것이다.	1	2	3	4
24. 시설인근 소유물의 가치를 떨어뜨릴 것이다.	1	2	3	4
25. 쓰레기 처리에 대한 안전한 방법을 제공할 것이다.	1	2	3	4
26. 지역사회에 좋지 않은 이미지를 줄 것이다.	1	2	3	4
27. 여유있고 안전한 토양 개선효과를 보일 것이다.	1	2	3	4
28. 소음공해를 증가시킬 것이다.	1	2	3	4

● (질문 29-34) 귀하의 주변에 새로운 퇴비화 시설 설립에 대한 위의 가상적 상황에서 다음 사항들에 대해 얼마나 중요하다고 생각하시는지 체크하여 주십시오.

	모른다	전혀 중요안함	중요함	아주 중요함
29. 시설감시 및 통제는 지역사회와 시설소유자가 해야 한다.	0	1	2	3
30. 쓰레기는 그 시설물에 들어오기 전에 유기물과 비유기물 물질로 구분되어야 한다.	0	1	2	3
31. 시설물에 대한 차후 책임소재는 건설 이전에 문서로 명기되어야 한다.	0	1	2	3
32. 문제가 발생했을 시에, 귀하의 지역사회가 그 시설을 철거할 수 있어야 한다.	0	1	2	3
33. 생산된 비료의 판로는 시설 건립 이전에 문서로 보장 되어야 한다.	0	1	2	3
34. 귀하의 지역사회는 그 시설을 사용하는 다른 지역사회 보다 더 많은 혜택을 받아야 한다. (예: 무료로 쓰레기 처리, 더 낮은 세금 등.)	0	1	2	3

35. 위의 질문 29-34 에서 가장 중요한 사항은 어떤 질문이라고 생각하십니까?

(1) 질문 29 (시설물에 대한 감시 및 통제)(2) 질문 30 (쓰레기의 분리)
(3) 질문 31 (시설물의 환경적 의무) (4) 질문 32 (문제발생시 시설물폐기)
(5) 질문 33 (비료의 판로 확보) (6) 질문 34 (시설물을 유치한 지역에 혜택 줌)

36. 그 시설을 받아들이기 위해 귀하께서 받아들일만한 수혜 중 가장 중요한 3가지만 체크하여 주십시오. ( ) ( ) ( )

(1) 쓰레기 처리 비용을 무료화
(2) 건물, 주차장, 장학금 등을 위한 특별보조금
(3) 인근 토지 소유자들에게 세금 인하 또는 소유권 가치 보장
(4) 그 지역사람을 우선적으로 고용하고 그 지역에서 생산되는 제품을 구입해야 함.
(5) 사고 또는 재정적인 문제 발생시를 대비한 자금확보
(6) 그 지역 주민들에게 무료로 퇴비화 해줌.
(7) 철저한 지하수 관리로 안전한 수질을 확보
(8) 기타

37. 위와 같은 시설이 허가가 되고 그 시설물 이 정부가 정한 모든 규제 및 법령(소음공해, 지하수 오염등에 관한 규제 등) 을 만족 한다면 귀하는 귀하의 소유물 위에 그 합성된 비료를 사용하시겠습니까?
예 ( )/ 아니오 ( )/ 아마 그럴것이다. ( )

38. 위와 같은 시설이 허가가 되고 정부가 정한 모든 규제 및 법령(소음공해,지하수 오염등에 관한 규제등)을 만족 한다면 귀하는 집에서 100m 정도 떨어진 땅에 이 비료가 사용되도록 허락하시겠습니까?
예 ( )/ 아니오 ( )/ 아마 그럴 것이다. ( )

39. 재활용이 새로운 퇴비화 시설과 더불어 계속적으로 이루어져야 한다고 생각하십니까?
예 ( )/ 아니오 ( )/ 아마 그럴것이다. ( )

40. 지역사회 폐기물 퇴비화 시설이 허가가 되고 정부가 정한 모든 규제 및 법령(소음공해, 지하수 오염등에 관한 규제등) 을 만족 하며 이시설이 귀하가 사시는 곳에서 100m 떨어진 곳에 설치된다면 그 시설물을 받아 들이시겠습니까?
예 ( )/ 아니오 ( )/ 아마 그럴것이다. ( )

41. 대규모 퇴비화 시설을 건립한다고 가정할 때, 매립이나 소각시설과 비교해서 퇴비화 시설이 환경에 끼칠 위험성 (지하수 오염, 대기오염 등) 은 얼마나 된다고 생각 하십니까?

1 2 3 4 5

매우 낮다← 비슷하다 →매우 높다

42. 본인 (설문지 작성자) 의 경험에 의거할 때 관련당국이 혐오시설을 특정지역에 유치할 때 해당지역주민들의 이해를 돕기위한 적법한 절차(예: 사안에 대한 공청회)를 통해 해당 지역 주민들의 의견을 수렴했다고 생각 하십니까?

1 2 3 4 5

전혀아니다← →그렇다

43. 귀하가 사는 지역 주변에 대규모 쓰레기 퇴비화 시설 설치계획을 취소 또는 저지시킬 수만 있다면 돈(세금)을 얼마까지 지불 할 수 있는지요? 다음 보기 중 하나를 선택하여 주십시오. ( )

(1) 월 3천원 미만 (2) 월 3천원 - 5천원 미만 (3) 월 5천원 - 1만원 미만
(4) 월 1만원 - 1만5천원 미만 (5) 월 1만5천원 - 2만원 미만
(6) 월 2만원 - 3만원 미만 (7) 월 3만원 - 4만원 미만

(8) 월 4만원 - 5만원 미만　　(9) 월 5만원 이상

44. 귀하의 지역사회 내 쓰레기에 대한 정보는 어디서 얻고 있습니까? 해당사항에 모두 표시하시오.

(1) 텔레비젼 (　　) (2) 라디오 (　) (3) 지역 공무원(　　)
(4) 신문 (　　) (5) 시청 (　　) (6) 이웃 혹은 교회 등(　　)
(7) 쓰레기 청소 담당자(　　) (8) 친지 혹은 가족(　　)
(9) 그 외의 다른 통로 (　　)

설문III- 설문응답자 사회경제적 정보 -- 귀하에 대한 내용입니다.

45. 귀하는 나이가 어떻게 되십니까? 만(　　)살

46. 귀하의 성별은? 여자 (　)/ 남자 (　)

47. 귀하의 가정에 만 18 세 이하의 자녀 수는 몇 명이십니까? (　　)명

48. 귀하의 집에 함께 거주하는 성인은 몇 명이십니까? (　　)명

49. 귀하의 학력은 다음 중 어디에 해당되십니까? (　)

(1) 국졸 이하 (2) 중졸 (3) 고등학교 중퇴 (4) 고등학교 졸업
(5) 전문대 졸업 (6) 대학교 재학 (7) 대학교 졸업 (9) 대학원 이상

50. 귀하는 몇 년 동안 현재 지역에 살고 계십니까? (　)년

51. 귀하께서 살고 있는 주거의 형태는 무엇입니까?

(1) 단독주택　　(2) 연립주택　　(3) 아파트

52. 귀하의 가족의 월 총 수입액 은 얼마입니까? (　　)

(1) 100 만원 미만　　(2) 100-149 만원　　(3) 150-199 만원
(4) 200-249 만원　　(5) 250-299 만원　　(6) 300-349 만원
(7) 350-399 만원　　(8)400-499 만원　　(9) 500 만원이상

☺ 설문지를 작성하시느라 귀한 시간 내주셔서 감사합니다. 귀하가 작성 하신 설문내용은 쓰레기 처리에 대한 연구에 아주 유용하게 사용되어 질것입니다. 감사합니다. ☺

APPENDIX D: STATISTICAL SUMMARY

DI. Survey Questions

Question 1. Do you recycle part of your waste generated from your household?

Table DI.1: Question 1

Response	Frequency	Percent	Cumulative Percent
Yes	1,646	88.97	88.97
No	203	10.97	99.95
No answer	1	0.05	100.00
Total	1,850	100.00	

Question 2. Do you compost part of your waste generated from your household?

Table DI.2: Question 2

Response	Frequency	Percent	Cumulative Percent
Yes	427	23.08	23.08
No	1,421	76.81	99.89
No answer	2	0.11	100.00
Total	1,850	100.00	

Question 3. Purchase goods with less packaging.

Table DI.3: Question 3

Response	Frequency	Percent	Cumulative Percent
Never	216	11.68	11.68
Sometimes	873	47.19	58.86
Very often	527	28.49	87.35
Always	232	12.54	99.89
No answer	2	0.11	100.00
Total	1,850	100.00	

Question 4. Purchase recyclable products.

Table DI.4: Question 4

Response	Frequency	Percent	Cumulative Percent
Never	239	12.92	12.92
Sometimes	717	38.76	51.68
Very often	566	30.59	82.27
Always	323	17.46	99.73
No answer	5	0.27	100.00
Total	1,850	100.00	

Question 5. Borrow or share items.

Table DI.5: Question 5

Response	Frequency	Percent	Cumulative Percent
Never	275	14.86	14.86
Sometimes	741	40.05	54.92
Very often	571	30.86	85.78
Always	256	13.84	99.62
No answer	7	0.38	100.00
Total	1,850	100.00	

Question 6. Sell or donate unused items to neighbors instead of throwing them away.

Table DI.6: Question 6

Response	Frequency	Percent	Cumulative Percent
Never	422	22.81	22.81
Sometimes	808	43.68	66.49
Very often	413	22.32	88.81
Always	201	10.86	99.68
No answer	6	0.32	100.00
Total	1,850	100.00	

Question 7. Community organizations

Table DI.7: Question 7

Response	Frequency	Percent	Cumulative Percent
Never trust	210	11.35	11.35
Trust a little	182	9.84	21.19
Trust a lot	1,041	56.27	77.46
Absolutely trust	414	22.38	99.84
No answer	3	0.16	100.00
Total	1,850	100.00	

Question 8. Local recycling and waste administrator

Table DI.8: Question 8

Response	Frequency	Percent	Cumulative Percent
Never trust	247	13.35	13.35
Trust a little	158	8.54	21.89
Trust a lot	1,046	56.54	78.43
Absolutely trust	393	21.24	99.68
No answer	6	0.32	100.00
Total	1,850	100.00	

Question 9. Local public officials

Table DI.9: Question 9

Response	Frequency	Percent	Cumulative Percent
Never trust	312	16.86	16.86
Trust a little	147	7.95	24.81
Trust a lot	964	52.11	76.92
Absolutely trust	423	22.86	99.78
No answer	4	0.22	100.00
Total	1,850	100.00	

Question 10. Private businesses

Table DI.10: Question 10

Response	Frequency	Percent	Cumulative Percent
Never trust	672	36.32	36.32
Trust a little	280	15.14	51.46
Trust a lot	785	42.43	93.89
Absolutely trust	107	5.78	99.68
No answer	6	0.32	100.00
Total	1,850	100.00	

Question 11. Environmental organizations

Table DI.11: Question 11

Response	Frequency	Percent	Cumulative Percent
Never trust	166	8.97	8.97
Trust a little	127	6.86	15.84
Trust a lot	896	48.43	64.27
Absolutely trust	658	35.57	99.84
No answer	3	0.16	100.00
Total	1,850	100.00	

Question 12. Universities

Table DI.12: Question 12

Response	Frequency	Percent	Cumulative Percent
Never trust	405	21.89	21.89
Trust a little	254	13.73	35.62
Trust a lot	926	50.05	85.68
Absolutely trust	260	14.05	99.73
No answer	5	0.27	100.00
Total	1,850	100.00	

Question 13. Central government

Table DI.13: Question 13

Response	Frequency	Percent	Cumulative Percent
Never trust	474	25.62	25.62
Trust a little	200	10.81	36.43
Trust a lot	956	51.68	88.11
Absolutely trust	215	11.62	99.73
No answer	5	0.27	100.00
Total	1,850	100.00	

Question 14. Mass media (newspaper and broadcast media)

Table DI.14: Question 14

Response	Frequency	Percent	Cumulative Percent
Never trust	462	24.97	24.97
Trust a little	227	12.27	37.24
Trust a lot	967	52.27	89.51
Absolutely trust	189	10.22	99.73
No answer	5	0.27	100.00
Total	1,850	100.00	

Question 15. Promote economic growth.

Table DI.15: Question 15

Response	Frequency	Percent	Cumulative Percent
Never	184	9.95	9.95
To some degree	442	23.89	33.84
To much degree	865	46.76	80.59
Absolutely	336	18.16	98.76
No answer	23	1.24	100.00
Total	1,850	100.00	

Question 16. Pose serious risks to your children.

Table DI.16: Question 16

Response	Frequency	Percent	Cumulative Percent
Never	156	8.43	8.43
To some degree	726	39.24	47.68
To much degree	727	39.30	86.97
Absolutely	218	11.78	98.76
No answer	23	1.24	100.00
Total	1,850	100.00	

Question 17. Create new job opportunities.

Table DI.17: Question 17

Response	Frequency	Percent	Cumulative Percent
Never	144	7.78	7.78
To some degree	341	18.43	26.22
To much degree	983	53.14	79.35
Absolutely	360	19.46	98.81
No answer	22	1.19	100.00
Total	1,850	100.00	

Question 18. Generate bad odor.

Table DI.18: Question 18

Response	Frequency	Percent	Cumulative Percent
Never	67	3.62	3.62
To some degree	244	13.19	16.81
To much degree	918	49.62	66.43
Absolutely	598	32.32	98.76
No answer	23	1.24	100.00
Total	1,850	100.00	

Question 19. Safety measures will decrease the risk.

Table DI.19: Question 19

Response	Frequency	Percent	Cumulative Percent
Never	224	12.11	12.11
To some degree	449	24.27	36.38
To much degree	895	48.38	84.76
Absolutely	259	14.00	98.76
No answer	23	1.24	100.00
Total	1,850	100.00	

Question 20. Contaminate ground water.

Table DI.20: Question 20

Response	Frequency	Percent	Cumulative Percent
Never	123	6.65	6.65
To some degree	318	17.19	23.84
To much degree	892	48.22	72.05
Absolutely	494	26.70	98.76
No answer	23	1.24	100.00
Total	1,850	100.00	

Question 21. Lower property tax.

Table DI.21: Question 21

Response	Frequency	Percent	Cumulative Percent
Never	203	10.97	10.97
To some degree	459	24.81	35.78
To much degree	818	44.22	80.00
Absolutely	347	18.76	98.76
No answer	23	1.24	100.00
Total	1,850	100.00	

Question 22. Risk your neighbors' health and safety.

Table DI.22: Question 22

Response	Frequency	Percent	Cumulative Percent
Never	167	9.03	9.03
To some degree	531	28.70	37.73
To much degree	898	48.54	86.27
Absolutely	231	12.49	98.76
No answer	23	1.24	100.00
Total	1,850	100.00	

Question 23. Lower the cost of waste disposal.

Table DI.23: Question 23

Response	Frequency	Percent	Cumulative Percent
Never	104	5.62	5.62
To some degree	265	14.32	19.95
To much degree	857	46.32	66.27
Absolutely	604	32.65	98.92
No answer	20	1.08	100.00
Total	1,850	100.00	

Question 24. Lower the property value.

Table DI.24: Question 24

Response	Frequency	Percent	Cumulative Percent
Never	106	5.73	5.73
To some degree	243	13.14	18.86
To much degree	912	49.30	68.16
Absolutely	566	30.59	98.76
No answer	23	1.24	100.00
Total	1,850	100.00	

Question 25. Provide a safe way for waste disposal.

Table DI.25: Question 25

Response	Frequency	Percent	Cumulative Percent
Never	151	8.16	8.16
To some degree	233	12.59	20.76
To much degree	950	51.35	72.11
Absolutely	495	26.76	98.86
No answer	21	1.14	100.00
Total	1,850	100.00	

Question 26. Create a negative image on the community.

Table DI.26: Question 26

Response	Frequency	Percent	Cumulative Percent
Never	115	6.22	6.22
To some degree	506	27.35	33.57
To much degree	847	45.78	79.35
Absolutely	361	19.51	98.86
No answer	21	1.14	100.00
Total	1,850	100.00	

Question 27. Will help improve the quality of the soil.

Table DI.27: Question 27

Response	Frequency	Percent	Cumulative Percent
Never	161	8.70	8.70
To some degree	348	18.81	27.51
To much degree	888	48.00	75.51
Absolutely	432	23.35	98.86
No answer	21	1.14	100.00
Total	1,850	100.00	

Question 28. Increase the noise and pollution.

Table DI.28: Question 28

Response	Frequency	Percent	Cumulative Percent
Never	161	8.70	8.70
To some degree	380	20.54	29.24
To much degree	917	49.57	78.81
Absolutely	372	20.11	98.92
No answer	20	1.08	100.00
Total	1,850	100.00	

Question 29. The supervising and governing power of the facility should be placed in the hands of both community and facility owner.

Table DI.29: Question 29

Response	Frequency	Percent	Cumulative Percent
Don't know	113	6.11	6.11
Not important	104	5.62	11.73
Important	679	36.70	48.43
Very important	946	51.14	99.57
No answer	8	0.43	100.00
Total	1,850	100.00	

Question 30. The waste should be sorted out into organic and inorganic types before reaching the facility.

Table DI.30: Question 30

Response	Frequency	Percent	Cumulative Percent
Don't know	44	2.38	2.38
Not important	69	3.73	6.11
Important	478	25.84	31.95
Very important	1,252	67.68	99.62
No answer	7	0.38	100.00
Total	1,850	100.00	

Question 31. The responsibility for the facility should be specified as a document before it is built.

Table DI.31: Question 31

Response	Frequency	Percent	Cumulative Percent
Don't know	86	4.65	4.65
Not important	101	5.46	10.11
Important	593	32.05	42.16
Very important	1,060	57.30	99.46
No answer	10	0.54	100.00
Total	1,850	100.00	

Question 32. In the event of accident or problems, your community should have the right to close the facility.

Table DI.32: Question 32

Response	Frequency	Percent	Cumulative Percent
Don't know	80	4.32	4.32
Not important	81	4.38	8.70
Important	526	28.43	37.14
Very important	1,153	62.32	99.46
No answer	10	0.54	100.00
Total	1,850	100.00	

Question 33. Markets for the compost should be guaranteed in documents before the facility is constructed.

Table DI.33: Question 33

Response	Frequency	Percent	Cumulative Percent
Don't know	110	5.95	5.95
Not important	108	5.84	11.78
Important	734	39.68	51.46
Very important	887	47.95	99.41
No answer	11	0.59	100.00
Total	1,850	100.00	

Question 34. More benefits should be given to your community hosting the facility than others using the facility. (e.g., free waste disposal, lower taxes, etc)

Table DI.34: Question 34

Response	Frequency	Percent	Cumulative Percent
Don't know	68	3.17	3.68
Not important	107	15.78	9.46
Important	634	314.27	43.73
Very important	1,030	515.68	991.41
No answer	11	10.59	100.00
Total	1,850	100.00	

Question 35. Which issue do you think is the most important among questions 29-34?

Table DI.35: Question 35

Response	Frequency	Percent	Cumulative Percent
Question 29	392	21.19	21.19
Question 30	405	21.89	43.08
Question 31	464	25.08	68.16
Question 32	328	17.73	85.89
Question 33	28	1.51	87.41
Question 34	205	11.08	98.49
No answer	28	1.51	100.00
Total	1,850	100.00	

Question 36. In admitting the facility, what forms of benefits do you think should be given to your local community? Please select only 3. ( ) ( ) ( )

Table DI.36: Question 36

Response	Frequency	Percent	Cumulative Percent
Free disposal	727	13.35	13.35
Grant	415	7.62	20.97
Reduce tax	891	16.36	37.32
Local benefit	742	13.62	50.95
Fund	824	15.13	66.07
Free composting	339	6.22	72.30
Good Environment	1,438	26.40	98.70
Others	71	1.30	100.00
Total	5,447	100.00	

Question 37. Suppose the facility has been approved and all relevant regulations and laws regulating environmental impacts (such as noise pollution, ground water pollution, etc.) are complied with, would you like to use the compost produced by the facility?

Table DI.37: Question 37

Response	Frequency	Percent	Cumulative Percent
Yes	1,089	58.86	58.86
No	206	11.14	70.00
Maybe	540	29.19	99.19
No answer	15	0.81	100.00
Total	1,850	100.00	

Question 38. Suppose the composting facility has been approved and all the regulations and laws regulating environmental problems (such as noise pollution, water pollution, etc.) are complied with, are you willing to allow this compost produced by the facility to be used on your land 100m away from your house?

Table DI.38: Question 38

Response	Frequency	Percent	Cumulative Percent
Yes	1,032	55.78	55.78
No	385	20.81	76.59
Maybe	417	22.54	99.14
No answer	16	0.86	.100.00
Total	1,850	100.00	

Question 39. Do you think that recycling should be continued along with the new composting facility?

Table DI.39: Question 39

Response	Frequency	Percent	Cumulative Percent
Yes	1,562	84.43	84.43
No	93	5.03	89.46
Maybe	162	8.76	98.22
No answer	33	1.78	100.00
Total	1,850	100.00	

Question 40. If the facility is approved and the regulations and laws as related to environmental problems (such as noise pollution, water pollution, etc.) are complied with, are you willing to accept this composting facility if it is built 100m from your house?

Table DI.40: Question 40

Response	Frequency	Percent	Cumulative Percent
Yes	854	46.16	46.16
No	571	30.86	77.03
Maybe	398	21.51	98.54
No answer	27	1.46	100.00
Total	1,850	100.00	

Question 41. Suppose a large-scale composting facility is being built. What would be your most concerned environmental impacts (ground water pollution, air pollution, etc.) as compared with those when a large - scale landfill or incineration facility is built?

Table DI.41: Question 41

Response	Frequency	Percent	Cumulative Percent
1(low)	322	17.41	17.41
2	421	22.76	40.16
3(similar to others)	552	29.84	70.00
4	287	15.51	85.51
5(high)	224	12.11	97.62
No answer	44	2.38	100.00
Total	1,850	100.00	

Question 42. In your opinion, based on your past experience, when decisions were made to build new unwanted facilities, did the government office in charge bring the case to the public to reflect their views through appropriate channel (such as public hearings)?

Table DI.42: Question 42

Response	Frequency	Percent	Cumulative Percent
1(never)	280	15.14	15.14
2	370	20.00	35.14
3	517	27.95	63.08
4	421	22.76	85.84
5(certainly)	241	13.03	98.86
No answer	21	1.14	100.00
Total	1,850	100.00	

Question 43. How much tax are you willing to pay to call off the plan to build the composting facility in the vicinity of your residence? Choose one.

Table DI.43: Question 43

Response	Frequency	Percent	Cumulative Percent
\3,000 *	674	36.43	36.43
\3,000 - \5,000	409	22.11	58.54
\5,000 -\10,000	285	15.41	73.95
\10,000 - \15,000	131	7.08	81.03
\15,000 - \20,000	78	4.22	85.24
\20,000 - \30,000	65	3.51	88.76
\30,000 - \40,000	47	2.54	91.30
\40,000 - \50,000	25	1.35	92.65
Over \50,000	35	1.89	94.54
No answer	101	5.46	100.00
Total	1,850	100.00	

* Unit: won

Question 44. Where do you get the information on the waste in your community? Choose all sources you use.

Table DI.44: Question 44

Response	Frequency	Percent	Cumulative Percent
Television	1,456	27.58	27.58
Radio	563	10.66	38.24
*LPO	551	10.44	48.68
Newspaper	1,205	22.82	71.50
City Hall	458	8.67	80.17
Neighbors	259	4.91	85.08
**LSWM	289	5.47	90.55
Relatives	258	4.89	95.44
Other sources	241	4.56	100.00
Total	5,280	100.00	

*Local public officials, **Local solid waste manager

Question 45. What is your age?

Table DI.45: Question 45

Response	Frequency	Percent	Cumulative Percent
20s	590	31.9	31.9
30s	658	35.6	67.5
40s	384	20.8	88.3
50s	94	5.1	93.4
Over 60s	37	2.0	95.4
No answer	87	4.7	100.00
Total	1,850	100.00	

Question 46. What is your sex?

Table DI.46: Question 46

Response	Frequency	Percent	Cumulative Percent
Female	875	47.30	47.30
Male	944	51.03	98.32
No answer	31	1.68	100.00
Total	1,850	100.00	

Question 47. How many children under 18 are staying in your household?

Table DI.47: Question 47

Response	Frequency	Percent	Cumulative Percent
0	601	32.49	32.49
1	337	18.22	50.70
2	579	31.30	82.00
3	166	8.97	90.97
4	26	1.41	92.38
5	9	0.49	92.86
6	2	0.11	92.97
7	4	0.22	93.19
No answer	126	6.81	100.00
Total	1,850	100.00	

Question 48. How many are older than 18 in your household?

Table DI.48: Question 48

Response	Frequency	Percent	Cumulative Percent
1	308	16.65	16.65
2	649	35.08	51.73
3	383	20.70	72.43
4	307	16.59	89.03
5	121	6.54	95.57
6	2	0.11	95.68
7	2	0.11	95.78
No answer	78	4.22	100.00
Total	1,850	100.00	

Question 49. What is the level of your formal education?

Table DI.49: Question 49

Response	Frequency	Percent	Cumulative Percent
Elementary	11	0.59	0.59
Junior high	38	2.05	2.65
Dropout of senior high	66	3.57	6.22
Senior high	537	29.03	35.24
Two year - college	405	21.89	57.14
University student	85	4.59	61.73
University graduate	615	33.24	94.97
Beyond post graduate	43	2.32	97.30
No answer	50	2.70	100.00
Total	1,850	100.00	

Question 50. Approximately how long have you been living in your current residence?

Table DI.50: Question 50

Response	Frequency	Percent	Cumulative Percent
Below 5 years	509	27.5	27.5
5 – 10 years	343	18.5	46.0
11 – 15 years	138	7.5	53.5
16 – 20 years	176	9.5	63.0
21 – 25 years	169	9.1	72.1
26 –30 years	199	10.8	82.9
31 – 35 years	97	5.2	88.1
Over 36 years	151	8.2	96.3
No answer	68	3.7	100.00
Total	1,850	100.00	

Question 51. What is the type of your current housing?

Table DI.51: Question 51

Response	Frequency	Percent	Cumulative Percent
Independent house	934	50.49	50.49
Tenement house	472	25.51	76.00
Apartment	395	21.35	97.35
No answer	49	2.65	100.00
Total	1,850	100.00	

Question 52. Approximately how much is your monthly household income (monthly disposable income in 10,000 won)?

Table DI.52: Question 52

Response	Frequency	Percent	Cumulative Percent
Less than 100 *	165	8.92	8.92
100 - 149	267	14.43	23.35
150 - 199	342	18.49	41.84
200 - 249	361	19.51	61.35
250 - 299	259	14.00	75.35
300 - 349	201	10.86	86.22
350 - 399	132	7.14	93.35
400 - 499	72	3.89	97.24
Over 500	28	1.51	98.76
No answer	23	1.24	100.00
Total	1,850	100.00	

* Unit:10,000 won

DII. Explanatory variables

DII-1 List of explanatory variables

1. ***IPWM***: **Individual's participation in waste management**

2. ***PPDSP***: **Public participation in decision making for siting plan**

3. ***TRUST***: **Individual's trust in the institution related to waste management**

4. ***KNOW***: **General knowledge of the large - scale composting facility's environmental impact**

5. ***ACCESS***: **Number of information sources on waste management**

6. ***COMP***: **Amount of monetary compensation in terms of a tax**

7. ***RELCOM***: **Relative amount of monetary compensation. The value of *COMP* deflated by *INCOME***

8. ***ECO***: **Economic benefit which any local resident living near the composting facility expects to gain**

9. ***DIST***: **Distance between the composting facility and the home of the residents**

10. ***ENV*****:** **Environmental impact of the composting facility**

11. ***INCOME*****:** **Household's average monthly disposable income**

12. ***CHILD*****:** **Number of children in respondent's home**

13. ***EDU*****:** **Respondent's education level**

14. ***GENDER*****:** **Gender of respondent**

15. ***AGE*****:** **Age of respondent**

16. ***NHMBR*****:** **Respondent's household size**

17. ***YRSTAY*****:** **Number of years at the current residence**

18. ***HSFORM*****:** **Respondent's house type**

DII-2 Statistical Summary of Explanatory Variables

Table DII.1: Statistical Summary of Explanatory Variables

Variable	Obs*	Mean	Std. Dev.**	Min	Max
IPWM	1,837	2.797	1.667	0	6
PPDSP	1,829	2.985	1.254	1	5
TRUST	1,837	6.987	3.470	0	16
KNOW	1,806	2.817	1.252	1	5
ACCESS	1,813	2.866	1.609	1	9
COMP	1,749	2.570	1.920	1	9
RELCOM	1,739	0.840	0.971	1	8
ECO	1,809	0.008	0.874	-3.023	1.842
DIST	1,850	1,020.865	1,052.498	100.000	3,000.000
ENV	1,809	0.004	0.891	-2.810	1.930
INCOME	1,827	4.062	1.957	1	9
CHILD	1,724	1.266	1.154	0	7
EDU	1,800	5.343	1.498	1	8
GENDER	1,819	0.520	0.500	0	1
AGE	1,802	34.173	10.100	19	79
NHMBR	1,695	4.805	1.613	1	12
YRSTAY	1,782	16.333	13.004	1	73
HSFORM	1,801	1.743	0.894	1	4

* number of observation, ** standard deviation

APPENDIX E: LIST OF SIGNIFICANT COEFFICIENTS

NOTE

sd: standard deviation, b: coefficients.

1. *IPWM*

Table E.1: *IPWM*

sd = 1.667

Odds of Base choice vs. Non-base choice		b	z	P > |z|	exp(b)	exp(b × sd)
Base choice	Non-base choice					
No	*Maybe*	0.031	0.521	0.603	1.031	1.053
No	*Yes*	– 0.171	– 2.926	0.003	0.843	0.752
Maybe	*No*	– 0.031	– 0.521	0.603	0.970	0.950
Maybe	*Yes*	– 0.202	– 3.752	0.000	0.817	0.714
Yes	*No*	0.171	2.926	0.003	1.187	1.330
Yes	*Maybe*	0.202	3.752	0.000	1.224	1.401

2. *PPDSP*

Table E.2: *PPDSP*

sd = 1.266

Odds of Base choice vs. Non-base choice		b	z	P > |z|	exp(b)	exp(b × sd)
Base choice	Non-base choice					
No	*Maybe*	– 0.408	– 5.914	0.000	0.665	0.597
No	*Yes*	– 0.733	– 10.417	0.000	0.481	0.395
Maybe	*No*	0.408	5.914	0.000	1.503	1.676
Maybe	*Yes*	– 0.325	– 5.074	0.000	0.722	0.663
Yes	*No*	0.733	10.417	0.000	2.081	2.529
Yes	*Maybe*	0.325	5.074	0.000	1.384	1.509

3. *TRUST*

Table E.3: *TRUST*

sd = 3.458

Odds of Base choice vs. Non-base choice		b	z	P > |z|	exp(b)	exp(b × sd)
Base choice	Non-base choice					
No	*Maybe*	− 0.061	− 2.188	0.029	0.941	0.811
No	*Yes*	− 0.055	− 1.960	0.050	0.947	0.828
Maybe	*No*	0.061	2.188	0.029	1.063	1.234
Maybe	*Yes*	0.006	0.241	0.809	1.006	1.022
Yes	*No*	0.055	1.960	0.050	1.056	1.208
Yes	*Maybe*	− 0.006	− 0.241	0.809	0.994	0.979

4. *KNOW*

Table E.4: *KNOW*

sd = 1.262

Odds of Base choice vs. Non-base choice		b	z	P > |z|	exp(b)	exp(b × sd)
Base choice	Non-base choice					
No	*Maybe*	0.199	2.753	0.006	1.220	1.286
No	*Yes*	0.491	6.734	0.000	1.633	1.857
Maybe	*No*	− 0.199	− 2.753	0.006	0.819	0.778
Maybe	*Yes*	0.291	4.306	0.000	1.338	1.444
Yes	*No*	− 0.491	− 6.734	0.000	0.612	0.539
Yes	*Maybe*	− 0.291	− 4.306	0.000	0.747	0.692

5. *ACCESS*

Table E.5: *ACCESS*

sd = 1.590

Odds of Base choice vs. Non-base choice		b	z	P > |z|	exp(b)	exp(b × sd)
Base choice	Non-base choice					
No	*Maybe*	− 0.190	− 2.961	0.003	0.827	0.740
No	*Yes*	− 0.343	− 5.517	0.000	0.709	0.579
Maybe	*No*	0.190	2.961	0.003	1.209	1.352
Maybe	*Yes*	− 0.154	− 2.912	0.004	0.858	0.783
Yes	*No*	0.343	5.517	0.000	1.410	1.726
Yes	*Maybe*	0.154	2.912	0.004	1.166	1.277

6. *COMP*

Table E.6: *COMP*

sd = 1.898

Odds of Base choice vs. Non-base choice		b	z	P > |z|	exp(b)	exp(b × sd)
Base choice	Non-base choice					
No	*Maybe*	0.178	2.536	0.011	1.195	1.402
No	*Yes*	0.160	2.213	0.027	1.174	1.356
Maybe	*No*	– 0.178	– 2.536	0.011	0.837	0.713
Maybe	*Yes*	– 0.018	– 0.231	0.817	0.982	0.967
Yes	*No*	– 0.160	– 2.213	0.027	0.852	0.738
Yes	*Maybe*	0.018	0.231	0.817	1.018	1.034

7. *RELCOM*

Table E.7: *RELCOM*

sd = .967

Odds of Base choice vs. Non-base choice		b	z	P > |z|	exp(b)	exp(b × sd)
Base choice	Non-base choice					
No	*Maybe*	0.212	1.405	0.160	1.236	1.227
No	*Yes*	0.411	2.743	0.006	1.509	1.488
Maybe	*No*	– 0.212	– 1.405	0.160	0.809	0.815
Maybe	*Yes*	0.200	1.302	0.193	1.221	1.213
Yes	*No*	– 0.411	– 2.743	0.006	0.663	0.672
Yes	*Maybe*	– 0.200	– 1.302	0.193	0.819	0.825

8. *ECO*

Table E.8: *ECO*

sd = .877

Odds of Base choice vs. Non-base choice		b	z	P > |z|	exp(b)	exp(b × sd)
Base choice	Non-base choice					
No	*Maybe*	– 0.291	– 2.698	0.007	0.748	0.775
No	*Yes*	– 0.887	– 7.685	0.000	0.412	0.460
Maybe	*No*	0.291	2.698	0.007	1.338	1.290
Maybe	*Yes*	– 0.596	– 5.657	0.000	0.551	0.593
Yes	*No*	0.887	7.685	0.000	2.428	2.176
Yes	*Maybe*	0.596	5.657	0.000	1.815	1.687

9. *DIST*

Table E.9: *DIST*

sd = 988.792

Odds of Base choice vs. Non-base choice		b	z	P > |z|	exp(b)	exp(b × sd)
Base choice	Non-base choice					
No	*Maybe*	– 0.00074	– 6.979	0.000	0.999	0.480
No	*Yes*	– 0.00089	– 8.051	0.000	0.999	0.417
Maybe	*No*	0.00074	6.979	0.000	1.001	2.082
Maybe	*Yes*	– 0.00014	– 1.769	0.077	1.000	0.867
Yes	*No*	0.00089	8.051	0.000	1.001	2.401
Yes	*Maybe*	0.00014	1.769	0.077	1.000	1.153

10. *ENV*

Table E.10: *ENV*

sd = .880

Odds of Base choice vs. Non-base choice		b	z	P > |z|	exp(b)	exp(b × sd)
Base choice	Non-base choice					
No	*Maybe*	0.590	5.867	0.000	1.804	1.681
No	*Yes*	0.790	7.625	0.000	2.203	2.004
Maybe	*No*	– 0.590	– 5.867	0.000	0.554	0.595
Maybe	*Yes*	0.200	2.170	0.030	1.221	1.192
Yes	*No*	– 0.790	– 7.625	0.000	0.454	0.499
Yes	*Maybe*	– 0.200	– 2.170	0.030	0.819	0.839

11. *INCOME*

Table E.11: *INCOME*

sd = 1.942

Odds of Base choice vs. Non-base choice		b	z	P > |z|	exp(b)	exp(b × sd)
Base choice	Non-base choice					
No	*Maybe*	0.299	4.904	0.000	1.349	1.788
No	*Yes*	0.451	7.131	0.000	1.569	2.399
Maybe	*No*	– 0.299	– 4.904	0.000	0.742	0.559
Maybe	*Yes*	0.152	2.459	0.014	1.164	1.342
Yes	*No*	– 0.451	– 7.131	0.000	0.637	0.417
Yes	*Maybe*	– 0.152	– 2.459	0.014	0.859	0.745

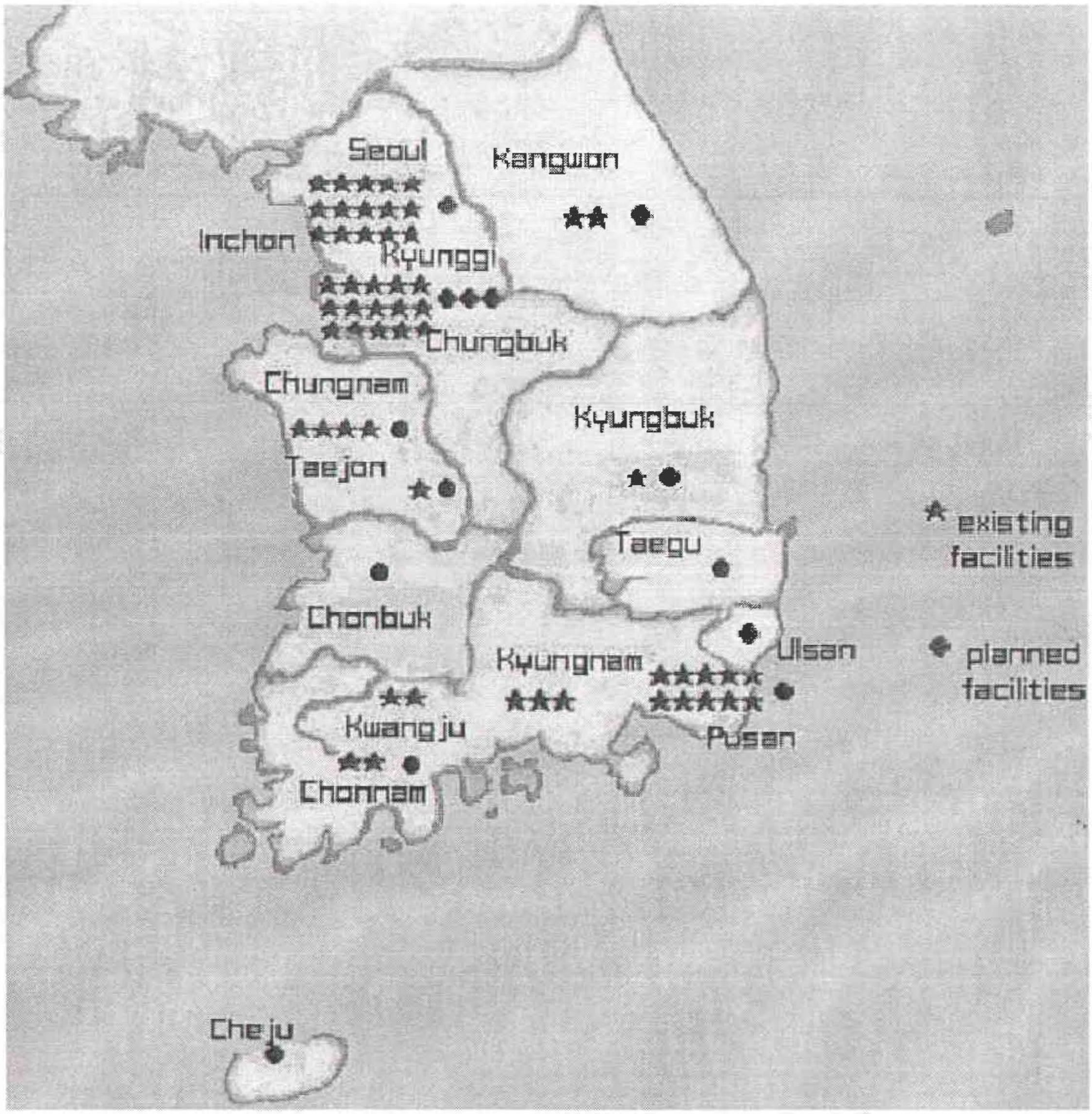
12. *NHMBR*

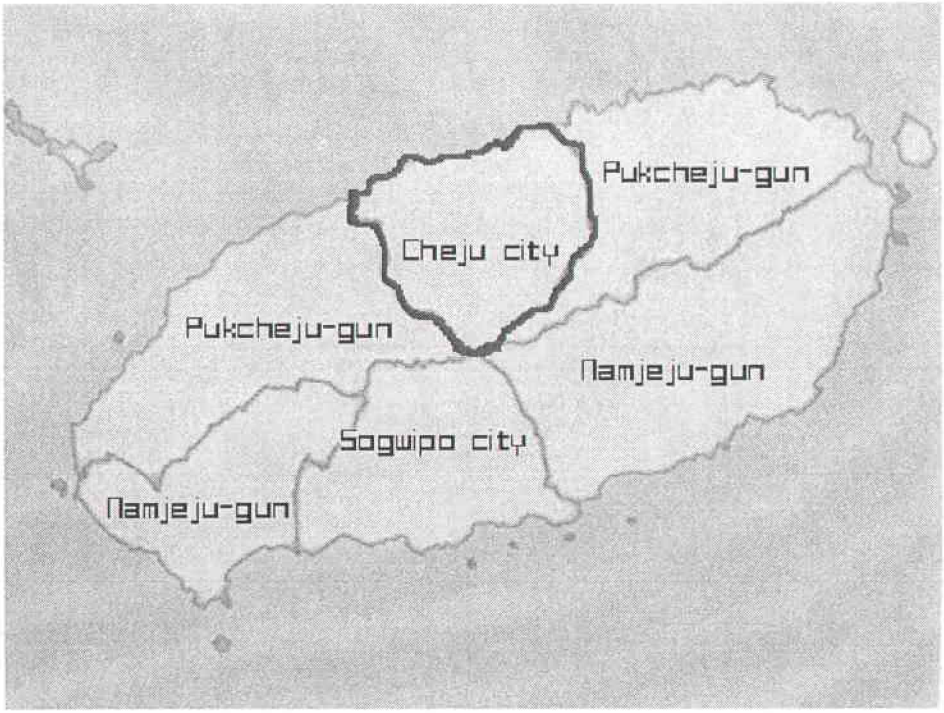
Table E.12: *NHMBR*

sd = 1.618

Odds of Base choice vs. Non-base choice		b	z	P > |z|	exp(b)	exp(b × sd)
Base choice	Non-base choice					
No	*Maybe*	0.200	2.782	0.005	1.222	1.382
No	*Yes*	0.252	3.459	0.001	1.287	1.504
Maybe	*No*	− 0.200	− 2.782	0.005	0.819	0.724
Maybe	*Yes*	0.052	0.764	0.445	1.054	1.088
Yes	*No*	− 0.252	− 3.459	0.001	0.777	0.665
Yes	*Maybe*	− 0.052	− 0.764	0.445	0.949	0.919

APPENDIX F: COMPOSTING FACILITIES IN KOREA




Pukcheju-gun
Cheju city
Pukcheju-gun
Namjeju-gun
Sogwipo city
Namjeju-gun

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