CHAPTER 2

LITERLATURE REVIEW

The review of literature can be organized into three sections. The first section reviews methodology to analyze welfare effects from pollution or undesirable facilities. Methodology Discussion is also provide in this section in order to provide the rationale for selecting the model. The second section reviews the theoretical issues of the Hedonic Price Model (HPM), which is selected as the methodology of the study. Thirdly, the policy implication of HPM's implicit price is reviewed.

2.1 Methodology for Measuring the Effects of Pollution and Undesirable Facilities on Health Effects

To quantify the effect of the Phuket MSW incinerator, there are two main methodologies. That is non-market and market techniques. The former is typically a series of contingent valuation (CV) methodology. The latter is the method in that the effects are valued mostly through the property market. The methodology survey is categorized into Contingent valuation method (CVM) and the market techniques. Those market techniques are the Hedonic Price Model (HPM), Random bidding model (RBM), and Discrete choice model.

2.1.1 Contingent Valuation Method (CVM)

In principle, CV is a very direct method of obtaining valuation information when the real situation is muddled by lack of information or confounding variables (Farber (1998)). It is useful, because it can value a particular effect. **Smith and Desvousges (1986)** used questionnaires to formulate demand function to describe households' WTP for distance from facilities with hazardous waste sites. In this case, distance is represented by both the disamenity associated with living near sites, and the risks of hazardous waste. Their survey questions asked each individual to consider the situation in which he could select the distance from facilities. When they were

asked to choose between two identical homes, one could be preferred depending on the distance from a house to hazardous waste sites. As such, house prices can also be different. The study revealed that respondents would be willing to pay in lump-sum amount between $2472 and $3199 more for a home located a mile further from hazardous waste sites.

Alberini et al. (1997) also conducted a CV survey to value air pollution in Taiwan to elicit willingness to pay (WTP) to avoid a recurrence of the most recently acute respiratory illness of the respondent. Their paper provided information that could be used to value the benefits of air pollution control programs and other health programs in Taiwan. The study asked respondents to value an illness that people had actually experienced, rather than a synthetic illness that the interviewer describes to them, the standard approach in CVM of acute illness.

Their model of WTP depended on the attributes of the illness (duration and number of symptoms, and nature of the illness) and on respondent characteristics (such as income and health history), and allow mitigating behavior to be endogenously determined with WTP.

Since they are interested in acute illness, Alberini et al. (1997) utilized 4 steps for eliciting WTP, consisting of

Step 1. Define the symptoms of last time acute respiratory illness such as cold, headache.

Step 2. Indicate a time as to how long each symptom lasted.

Step 3. Capture the severity of illness by describing the episode caused them to miss working, to stay in bed, or to interrupt their normal activities.

Step 4. After describing their illness episode in details, the respondent was asked if he would experience a recurrence of the illness, and, in turn, how much he would pay for avoiding the illness episode entirely.

The results suggest that WTP to avoid illness were internally valid. WTP to avoid illness increased with duration of illness, with the number of symptoms experienced, and with education and income.

This study has an advantage due to the accuracy of the data because people were asked what they were prepared to do to avoid another bout of acute illness. This framework makes it easy for the respondents to form WTP, so CVM is also an

appropriate one. However, they did not solicit sufficient data on air pollution in Taiwan due to the fact that they elicited responses for avoiding illness, but not as to what constituted better air conditions.

Brookshire et al. (1982) argued that in the case of remote recreation sites, CVM is more appropriate than market technique because there is lack of information in terms of a reference market, which is needed for the market method, such as the housing market. They would like to compare the performance of CVM and HPM in assessing WTP of people living in the Los Angeles metropolitan area, where the air pollution problem was well defined, and a detailed property value data existed. Twelve census tracts were chosen for sampling in the framework of HPM while 290 households interviews were conducted during March 1978 at the same twelve communities used for CVM. To avoid multicollinearity in HPM, they used two HPM for each air pollution such as NO2 and TSP (total suspended particulate matter). The WTP from the survey method above was bounded above by the result from HPM.

2.1.2 Hedonic Price Model (HPM)

Many times, CVM can be subjected to strategic bias and inconsistent survey data, so the HPM can be an alternative method. HPM is the most popular market technique to value pollution and undesirable facilities, especially when a reference market for the environment exists and market data is quite complete, economists usually use HPM. The revealed preference method seeks to observe what individuals implicitly really pay with adverse effects of pollution or undesirable land uses.

By the HPM standard model of Rosen (1974), environment attribute is one attribute in the housing price. The implicit price can be elicited by differentiating housing price with environment attribute of interest. Thus, HPM is the method that can elicit impact of pollution or the effect of facilities on house prices.

The past empirical studies of HPM can be categorized by undesirable facilities into 4 groups; namely, the incinerator, dumping waste sites, nuclear sites, and others.

Incinerator

Kiel and McClain (1995a, 1995b) tried to correct the measure of social cost of incinerator by including the time effect through appreciation rate. They conducted HPM comparing with repeated time sales model and income capitalization model using 2593 single-family home sales in North Andover, Massachusetts, from January 1974 through May 1992. They predicted that the appreciation rates in five siting stages were not constant overtime, so they concluded that the study that was conducted in two points of time was not appropriate. The five siting stages for this study was defined as

Pre-rumor	1974-1978
Rumor	1979-1980
Construction	1981-1984
Online	1985-1988
Ongoing Operation	1989-1992.

They estimated effects for different stages of the siting process, from rumor to operation stages. Although there were no observable effects prior to construction, adverse effects were evident during construction, and during initial on-line and operations phases. An additional mile from the site raised residential property values by $2,671, $9,497 and $7,746 per mile for each of these three phases, respectively. Thus, the contribution of the study is confirming time segmentation on housing market to identify demand function. The detail of identification problem is in section 2.2

Dumping waste sites

Michaels and Smith (1990) used HPM to value amenities associated with hazardous waste sites in Boston. Their analysis is based on a sample of sales prices for 2,182 single-family homes between November 1977 and March 1981, collected by the Society of Real Estate Appraisers for suburban Boston. They concerned the identification problem, as discussed in detail later, so they used realtor-defined submarkets.

Table 2.1

Description of Submarket in Boston Housing Market

Submarket	Description
Premier	Exclusive housing, single family homes
Above average	Primarily single-family homes
Average	Single-family intermixed with multiple-family
Below average	Virtually all lots are less than an acre

Source: Michaels and Smith (1990)

They argued that a single hedonic price function unlikely provides an adequate description of the relationship between the equilibrium prices and the structural and site characteristics of the homes in a large, complex market. The results from an adaptation of the Browm-Durbin-Evans test supported this observation. The null hypothesis of a single hedonic price function was clearly rejected.

After that they applied the hedonic price function (HPF) as demand function for the environment by using distance variable to capture disamenity and perceived risk from hazardous waste sites. The mean willingness to pay for removing hazardous waste sites are $ 1,799 for premier market, $ 362 for above average market, $ 38 for average market. As they expected, the largest gains are realized for the premier market (both total and on a per-mile basis). Thus, the contribution of the study is confirming multiple market segmentation to identify demand function.

Kohlhase (1991) studied toxic dump in Houston in 1976, 1980, and 1986. The year 1976 was that the site was in operation before environment protection agency (EPA) announcement about its safety. In 1980, EPA announced that other sites to be hazardous waste sites and might be unsafe, and the last 1986, after the EPA had announced about the site itself. The study separated periods to test whether new information from EPA had an effect on neighboring people. It was found that distance from the dump displayed the correct sign and statistically significant only in 1986 after the EPA had announced that the sites were toxic. Moreover, the asset value of an average house would increase $ 2,360 if the same house were located 1 mile farther from a site. On a flow basis, this result corresponded to about $310 per mile per year

at a 10% interest rate and 15-year time horizon. The contribution of the study is that the data had to be scoped in the period after the emergence of the risk perception of an undesirable facility.

Nelson (1992) used a sample size of 700 single family homes near Ramsey Landfill, Minnesota, to formulate HPF. There was debate on the extent to which landfills impact on nearby single family houses. This article contributed to that debate. Nelson used distance variable to capture the impact of landfill, like other literatures. His contribution is how to design a study area. He found the HPF for half mile and add half- mile area until distance variable was not significant and his study area was in 2 miles around landfill. Empirical results indicate that the landfill adversely affected home values at the rate of 12 % of housing price at the landfill boundary and 6 % at about 1 mile.

Gayer et al. (2000) conducted HPM to assess learning about the risk associated with hazardous waste sites in the greater Grand Rapids, Michigan. This paper incorporated a Bayesian learning model into a hedonic framework to estimate the value that residents placed on avoiding cancer risk from hazardous waste. People would update this risk when they were informed with new information. The study defined disamenity from hazardous waste by the distance variable. They formed the subjective risk variable from several factors including the area of the closest Superfund site which is hazardous waste site in the clean-up project, the National Priorities List (NPL) ranking of hazardous waste sites in clean-up project, the number of months since hazardous waste was placed on NPL, and the type of hazardous waste sites. Moreover, the number of words printed in the Grand Rapids Press was a proxy of information provided by media. The results for three variables; disamenity, information from EPA, and information from media, are similar. They showed that residents were willing to pay (WTP) to avoid cancer risk before the announcement of the clean-up project, but willingness to pay decreased after the announcement of that project. It means that the information of risk or action in the site has an impact on the WTP of respondents. Thus, the action or the different information can be used as criteria to segment market as well.

Kiel and Zabel (2001) made a cost benefit analysis of a hazardous waste cleanup project using HPM. They applied HPM to the two hazardous waste sites in

Woburn, Massachusetts. Both were announced as superfund sites in the early 1980s, and the cleanup is currently underway. They used distance variable as disamenity and risk perception variable to measure the benefits of the cleanup project. The benefits are in the range of $72 -$122 million (1992 dollars) that outweighed the cost $30 million. Thus it appears that the cleanup of the Woburn superfund site results in a positive net benefit to society.

Hile et al. (2001) apply HPM to value the impact of landfills on the nearby property value. Well-defined study areas around each of four landfills in Franklin Country, Ohio, were chosen and the housing data in 1990 were collected. The four landfills were chosen because of the difference in life expectancy being 20 and 2 years, repectively. Obetz and Alum Greek landfill were closed in 6 and 11 years ago. The reason for chosing operated and closed landfills is to test whether there are impacts of time associated with landfill. Furthermore, the result confirmed the hypothesis that a closed one can have an impact lower than an operated one, and even it was closed, the impact still was exist.

Nuclear sites

Unlike the incinerator and dumping site, there is positive effect, such as the employment impact, to offset the negative effect of nuclear site. **Nelson (1981)** analyzed housing prices in two communities near the Three Mile Island (TMI) nuclear power plant accident, and found no statistically significant effect of proximity to the plant on housing prices. Gamble and Downing (1982) using a large data set and longer time span than Nelson, similarly found no impact. However, Nelson noted that any negative effects of nuclear power effect have been offset by government assurance programs and employment opportunity from costly facility cleanup.

The positive effects demonstrated by the nuclear power plant are negligible in the Phuket incinerator due to no further employment opportunity. The incinerator required only some people to control the burning and other equipment. However, when the study can be designed to capture positive effect such as a higher employment rate, the welfare change experienced by the nuclear site can still be shown.

Gawandee and Smith (2001) used HPM to measure the impact of nuclear waste transportation on the residential property value through their perceived risk. Moreover they used the distance from house to the route of nuclear waste transportation as premium in housing price.

Spent nuclear fuel shipments have raised concerns about property values due to the real or perceived risks from the shipments. The initiations of radioactive waste shipments to New Mexico, and the prospect of shipments of high-level nuclear waste from across the U.S. to Nevada, make consideration of possible property value impacts of substantial concern for federal policymakers. The study employs data on 9432 real estate transactions in South Carolina to model the effects of a series of highly publicized shipments of spent nuclear fuel to a storage facility at the Department of Energy's Savannah River Site.

In this study they focus on the possible effects of highly publicized shipments of spent nuclear fuel on residential property values in three countries in South Carolina; Aiken, Berkley, and Charleston.

The study is the one that concerns timing of impact. The primary focus of analytical interest is on DISTANCE and its interactions with timings of foreign spent nuclear fuel (FSNF) shipments. If perceptions of risk from the transportation of spent fuel indeed lead to lower property values, they hypothesize that such effects will dissipate with distance from the source of the risk. They obtain results with important implications for the kinds of effects that nuclear waste shipments may have on property values. In Aiken, the area with lower risk perception and more experience with nuclear materials management, we find that the shipments did not affect property values. In Chaleston, with more populous urban areas, property values appear to have been lowered in value. In Berkeley results are ambiguous because shipments ceased after the second shipment and people perceived the risk to be very low.

Others

In addition to waste sites and nuclear plants, HPM is applied in other undesirable facilities as well. **Hamilton and Schwann (1995)** analyzed the impact of high voltage (defined as 69,000 volts or greater) electric transmission lines on the prices of nearby single detached houses. They predicted that the disamenity and

perceived risks of nearby resident can be measured through the depressed housing market. However, the offsets on property values are restricted to a narrow band and are primarily due to the transmission towers being visual.

Palmquist et al. (1997) conducted HPM of rural residential house sales in southeastern North Carolina to determine the effect of large scale hog operations on surrounding property values. An index of hog manure production at differences distance from the houses was developed as a proxy for the environment variable. It was found that proximity caused a statistically significant reduction in house prices of up to 9 percent depending on the number of hogs and their distance from the house.

2.1.3 Random Bidding Model and Discrete Choice Models

To investigate the reliability of HPM, other market techniques conducted by **Chaltopadhyay (1998)** used random bidding model (RBM) as a cross-check on the reliability of the standard HPM. RBM seeks to predict the type of household that will have the winning bid for a particular house, and involves direct specification and estimation of the bid-rent function, while HPM tries to elicit the willingness to pay function from the equilibrium of bid and offer function. He conducted the RBM and hedonic on the air quality valuation of Chicago and on the same housing data.

The paper shows that the benefit estimates obtained using two methods are very close in marginal and non-marginal changes in air quality. Moreover, **Chattopadyay (2000)** used McFaddens's nested logit model with the same data set with a previous paper to cross-check HPM. McFadden's model is one of the discrete choice models. McFadden improved the choice model by conceptualizing the respondent choice decision of a consumer as a nested hierarchical process. For example, they have to select the city first and neighborhood later, and so on. A comparison of the model with the standard HPM reveals that the benefit of air quality improvement is consistently lower in the case of RBM.

Palmquist and Israngkura (1999) conducted a discrete choice model to compare with HPM as well. They used the data of thirteen city housing data to measure the benefit improvement air quality in four pollutions (TSP, NO_2, O_3, and SO_2). While HPM was successful in deriving demand function for air pollution

attribute, the discrete choice model was less successful, even important variables such as living space, year built, and number of bath rooms were insignificant at the 95 % level.

2.1.4 Methodology Discussion

After reviewing the methodology, both CV and market technique can be used to quantify the effects of undesirable facilities. However, **Freeman (1993)** pointed out that when people believe the CV survey can be used to estimate actual compensation, or if the respondent believed that the policy to locate a nuclear power plant would depend on response, they may act strategically by increasing the WTP higher than their original figure. It is called the strategic bias.

Moreover, the limitation of CVM results from the fact that data are based on a specific survey. When other researchers do the same survey to elicit the effects, it may be inconsistent with other surveys due to different environment in perform surveys. The market technique has an advantage in this sense because it requires the secondary data to yield consistent results.

Kenkel (1994), and Fabian and Tolley (1994) discuss the issues involved with using surveys in order to value health risk. Contingent valuation is especially useful when reliable market data are not available. However, constructing surveys to yield reliable benefit estimates is often a non-trivial task. They may not always replicate decisions that would be made in a hypothesized market. When reliable market data are available, use of such data to analyze individual valuations of risk is usually preferable. Thus, when the problem is to value use-value for the market or activity that the reference market for that attribute exists, market technique is more preferable.

The case study of Phuket incinerator concerns the strategic bias, non-trivial task of forming CV in risk perception, and inconsistent result as described above. Moreover, the housing market data of risk perception and disamenity of the the Phuket incineration exists, so the study uses the market technique.

When comparing performance of different market oriented techniques, the Hedonic Price Model (HPM) was mostly utilized, which the Random Bidding Model

(RBM) and Discrete Chioce Model are utilized to cross check the HPM. However, the result of the discrete choice model (Palmquist and Israngkura (1999) was less successful, even important variables such as living space, year built, and number of bath rooms were insignificant at the 95 % level. Thus, the methodology in the case study of Phuket incinerator is HPM.

2.2 Review of Hedonic Price Model Theory

Firstly, HPM is introduced by Rosen (1974), and was developed over 30 years to be the standard model now. The method is to elicit implicit price of attributes by regressing hedonic price function P(Z) by housing attributes, neighborhood attributes, and environment attributes. Then, differentiate hedonic price function by the variable of interest. However, there are many issues that must be addressed in estimating HPM.

First, it is functional form. Because it is costly or nearly impossible to repackage the attributes of houses, the hedonic price function need not be linear (see appendix A). Rosen (1974) and Freeman (1993) stated that economic theory did not suggest an appropriate functional form. The finding of appropriate functional form is of concern.

Second, to elicit disamenity and risk perception, it required an appropriate environmental variable. To form a direct variable is nearly impossible because this relates to asking respondents subjectively value disamenity and risk perception, and if survey is applied, contingent valuation method will be more appropriate. Hence, in the HPM approach the choice of suitable variable is necessary.

Third, the identification problem is of concern. The hedonic price function is formulated from the tangency of demand and supply function, so lack of data to identify the demand function is a problem.

Functional form

Halvorsen and Pollakowski (1981) and Graves et al. (1988) conducted detailed investigation of functional form and found that the predicted hedonic price varied significantly across various functional forms. They recommended the Box-Cox

flexible functional form, which has been adopted in hedonic studies, such as Goodman (1978), Linneman (1980), Blomquist and Worley (1981), Cheshire and Sheppard (1995), Hamilton and Schwann (1995), Palmquist and Israngura (1999), and Gawandee and Jenkins-Smith (2001).

However, **Cassel and Mandelsohn (1985)** suggested that the best fitting functional form was not the objective of the hedonic price analysis. More inportanly the form that producing the best fit of the data might not generate accurate estimates of the hedonic prices of the important attributes. In certain circumstances, the simple functional form might be more appropriate. First, the large numbers of coefficient estimated with Box-Cox reduces the accuracy of any single coefficient, which could lead to poorer estimates of specific prices. Second, the traditional Box-Cox is not suited to any data set containing negative number. Third, the Box-Cox may be inappropriate for prediction. Forth, the nonlinear transformation results in complex estimates of slopes and elasticity which are often too cumbersome to implement properly. For example, suppose one estimates the Box-Cox and obtains:

$$(V^{\alpha}-1)/\alpha = b_0 + b_1(\frac{Z_1^{\beta}-1}{\beta}) + b_2(\frac{Z_2^{\beta}-1}{\beta}) + b_3(\frac{Z_1^{\beta}-1}{\beta})(\frac{Z_2^{\beta}-1}{\beta}) \qquad (2.1)$$

where V is a dependent variable, α is a Box-Cox parameter, and Z is an independent variable.

For instance, the partial derivative of V with respect to Z_1 represents an implicit price function (P_{Z_1}).

$$P_{Z_1} = \frac{\partial V}{\partial Z_1} = V^{(1-\alpha)} Z_1^{(\beta-1)} (b_1 + b_3(\frac{Z_2^{\beta}-1}{\beta})) \qquad (2.2)$$

From equation 2.2, the partial derivative or the implicit price in HPM is too cumbersome to calculate the accurate implicit price due to a lot of coefficients estimated in the Box-Cox functional form.

Moreover, **Cropper et al. (1988)** found that when some of the independent variables are omitted or measured with proxy variables, simpler forms (linear, semi-log, log-log, linear Box-Cox) outperform quadratic models. The linear and log models have been used by many economists, such as Nelson (1981), Gamble and Downing (1982), Brookshire et al. (1982), Michaels and Smith (1990), Kohlhare (1991), Nelson

et al. (1992), Kiel and McClain (1995), Grayer et al. (2000), and Kiel and Zabel (2001).

Besides using Box-Cox as a functional form for nonlinear hedonic price function, it can be used to determine which simple functional form provides the best fit of the data. Dougherty (1992) suggested that examining sum squares residual (SSR) of each functional form can determine the appropriate functional form. In case of different dependent variable, the Box-Cox transformation is used, so the study can examine four of simple functional form, linear, double-log, semi-log, and inverse semi-log functional form. Thus, the case study of Phuket incinerator uses the Dougherty's Box-Cox method to determine the appropriate functional form.

Environmental variables

Gamble and Downing (1982) chose distance variable and explained the theoretical background of using distance variable as an environmental variable. Housing attribute and location attribute served as surrogates for the flow of benefit in the future. If people value relief from disamenity and potential risk, the housing market should reveal these preference. Moreover, in the Rosen' model, the market is in the equilibrium. It implies that for consumer equilibrium, price differentials must arise among various locations that compensate consumers for the differences in benefit associated with specific locations. Because of mobility and the ability to buy and sell in the housing market, consumer equilibrium requires that there are price difference for identical housing in all respects at two different locations. One is near undesirable facility, and the another, in location 2, is not. The price of housing in location 1 must be less than that at location 2 by an amount that compensates buyers for the additional disamenity and risk they perceive at location 1. Otherwise, the consumer would be better off at location 2, and it will contradict the consumer equilibrium assumption.

Practically, **Farber (1998)** provided the survey of the literature on the impact of undesirable facilities on disamenity and risk perception to nearby respondents. Most economists applied distance variable. He found that the results of information about risk of hazardous waste sites are consistent with distance variable. Pre-announcement effects of the site to be hazard were found to be considerable

smaller than post-announcement effect per mile. The latter effects decreased after the cleanup project has been completed. Furthermore, **Gawandee and Jenkins-Smith (2001)** did the survey for public opinion on nuclear waste transport through Charleston Country and Aiken Country. The result was that Aiken people perceived a smaller risk than Chaleston people. They selected distance variables as a proxy for risk perception as well. They predicted that if risk perception was responsible for market effects, the effects of living near the route of nuclear waste transport would be different in two countries with difference in public opinion. The results showed that smaller effects in Aiken Country was consistent with the smaller risk perception as indicates in public surveys, and the higher effects in Charleston County was consistent with the same survey. Further, **McClelland et al. (1990)** combined psychological and economic analyses for estimating the impacts of hazardous waste sites on property values. This study found that health risk beliefs declined with distance from HW site. They also found the perceived odor from the landfill strongly influencing the subjective risks, and used odor as environmental variable. They noted that distance to the site and the perceived odor were not statistically significant when added to the hedonic price regression at the same time. They claimed that the insignificance was due to the high correlation between distance and risk variable. This is evidence that the distance to the undesirable site is a good proxy for the risk perception, rather than only disamenity, associated with the facilities.

However, there are some empirical studies that used other variable rather than distance. **Hamilton and Schwann (1995)** added the visible variable with distance variable to measure the impact of high voltage electric transmission lines. **Palmquist et al. (1997)** used the manure with 0.5 mile, 0.5-1 mile, and 1-2 mile to value the effect of hog operations. These two studies included the density that varied among the locations. In the case of hog operations, they are not a single facility like the incinerator, but they are scatteredly located in the city. Thus, to determine the whole effects the density of manure is more appropriate as a proxy. In the case of transmission line, Hamilton and Schwann expected that the visibility of transmission line would effects the nearby residents, and some could see long lines and some not, because visibility can be interrupted by buildings or other constructions unlike the case of incinerator. The major channel of incinerator exploded to residents through

the air. Again, visibility is not an appropriate variable in incinerator study. Furthermore, **Gayer et al. (2000)** formed the objective risk as a proxy for the cancer health effects of the sites. They noted that even though the cancer objective risk was utilized, the difficulty of indexing non-cancer health risks means that the distance variable may also reflect reactions to those health effects.

Overall, these findings suggest that the distance between a house and an undesirable facility can serve as a good proxy for two effects. One is typically disamenity associated with the incinerator, and one is the risk perception of nearby residents when the incinerator is located.

Hence, in step 1, there are two important issues. First is the functional form that no economic theory suggests the specific form, and second, that the environmental variables to capture risk perception and disamenity of the Phuket MSW incinerator. Furthermore, in the second step of Rosen's HPM, there are problems that have to be solved. Identification are problems when the demand system is determined in step 2. Identification arises when the demand function cannot be identified.

Identification problems

These are the empirical works to solve the identification problem. If there are distinct real estate markets over space or time or both, there will be a separated hedonic price function for each market. Then, the demand functions are identified by the different price schedules in the separated markets. Strazheim (1973), Goodman (1987), Schnare and Struyk (1976), and Sonstelie and Portney (1980) focused on locational and political boundaries or on the characteristics of households (such as race, and income) as the criteria for defining submarkets.

Michaels and Smith (1990) suggested that prior works are based on socio-economic submarkets, so they tried to find real submarkets which households perceived. They asked a realtor in Boston to segment market. After the process of expert defining housing submarkets, they concluded that there were four submarkets in Boston, premier, above average, average, and below average. They use distance variables to capture risk perception and risk amenity of hazardous waste sites. The result showed the most significant effect of distance in the premier market. These

supported expert-defining submarket method because they expected that households in premier market would concern the environment or had willingness to pay more than other markets. Moreover, **Bejranonda (1996)** used the legal constrains in horsepower (HP) of boats on lakes to segment markets. She separated markets into lakes, which allowed more than 10 HP boats, and not more than 10 HP boats. She recommended that households, who like entertainment, would sort themselves to live near lakes which allow sport activities and unlimited HP boats. Those who liked a calm environment would sort themselves in quiet lakes, and not allow more than 10 HP boats.

The above studies focus on segmented market in one city. **Palmquist and Israngkura (1999)** used multi-city market technique to estimate the demand for four air pollutants. They used data of thirteen markets, and separate hedonics were estimated for each market. However, probably since the cross-equation relationships were not considered, the results were mixed.

Many economists suggest that data based on multiple time-periods within a single market can accomplish the identification problem. **Kinzy (1992)** separated market according to time period. Four separated hedonic price functions were assigned to 4 years from 1986-1989. The estimation parameters for each time period were tested by the Chow test to ensure that each year's coefficient were structurally different from the pooled data. The null hypothesis, not different from the pooled data, was rejected with confidence. **Kiel and Zabel (2001), and Beron et al. (2001)** utilized the time-period market as well. Moreover, economists used multiple time-periods data in other purposes.

Michaels and Smith (1990), and Kohlhase (1991) separated periods to test whether an announcement of hazardous waste sites will effect asset prices. The results confirmed that there were distance effects observed after announcement. Kohlhase tested distance effect after clean-up sites as well. **Kiel and McClain (1995a,b)** also considered time-periods data. They estimated effects for different stages of the sitting process, from rumor to operation stages. Although there were no observable effects prior to construction, adverse effects were evident during construction, initial on-line, and operation phases. The study suggested that the timing of observations across

various phases of site use was important in estimating the magnitude of adverse effects.

Apart from using multiple market data, another solution is to impose a priori restrictions on the functional form. **Quigley (1982)** restricted the utility function to the generalized CES form. **Kanemoto and Nakamura (1986)** restricted the shape of the bid function to a certain quadratic form. Both of them applied Japanese housing data, but it was shown that they yielded considerably different results. The choice of functional form or method is very important, and thus, this limitation will be continuously developed.

However, some economists ignore identification and endogeneity. They neglect these problem by not estimating the demand system. **Yang (1996),** and **Kwak et al. (1996)** estimated implicit inverse demand function of the environmental attribute from hedonic price function. The price paid was explained not only by the quantity or quality of the environmental attribute but also by the socio-economic characteristics of households. The question is whether the curve hedonic price function can be interpreted as an inverse demand function. The only condition for the implicit price function to be equal to household demand functions is that all individuals have identical utility function, or in the situation of small changes of the environmental attribute. While the first case is unrealistic, in the second case, the steeper the individual demand curve, the lower is the quality of the approximation of the implicit price function. Under strong assumption, this method is only approximation of the demand function of environmental attribute.

2.3 Review of Policy Implication of Implicit Price of Environmental Variable

The final result of the Hedonic Price Model is implicit price. There is some implication of implicit price as the effects of the incinerator. **Nelson et al. (1992)** found that the landfill has effects in a two miles radius. Beyond that, they found a little effects. They suggested the area of the effects can be applied in siting a new landfill in order to reduce the effects on residents living near the incinerator. The undesired facilities should be sited far from housing area.

Gawandee and Jenkins- Smith (1995) argued the point of implicit price due to risk perception. They reviewed many cases in court. They found that this implicit price can be used in court no matter it is the only risk perception. The implicit price is used as the evident of the effect of undesired facilities. Then, residents can ask the court for more action in finding the exact environmental cost due from undesirable facilities.