การประเมินมูลค่าคุณภาพอากาศในกรุงเทพมหานครด้วยวิธีราคาเฮโดนิค

Valuing Air Quality in Bangkok with Hedonic Price Method

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บทคัดย่อ

การศึกษาครั้งนี้มีวัตถุประสงค์ 3 ข้อ คือ เพื่อทดสอบการใช้งานของวิธีราคาเฮโดนิคในประเทศไทย เพื่อศึกษาถึงผลกระทบของมลพิษอากาศต่อราคาบ้านในพื้นที่กรุงเทพมหานคร และเพื่อประเมินมูลค่าของคุณภาพอากาศในกรุงเทพมหานคร ในการศึกษาได้รวบรวมข้อมูลคุณภาพอากาศจากสถานีตรวจวัดคุณภาพอากาศจำนวน 3 สถานีซึ่งเป็นตัวแทนของพื้นที่ที่มีดัชนีคุณภาพอากาศ (AQI) สูง ปานกลาง และต่ำ ส่วนราคาบ้านและข้อมูลต่างๆของบ้านได้จากแบบสอบถาม

จากผลการศึกษาวิธีราคาเฮโดนิคด้วยข้อมูลกรุงเทพมหานคร พบว่าได้สมการที่น่าเชื่อถือทางสถิติที่จะนำไปใช้ประเมินมูลค่าของคุณภาพอากาศในกรุงเทพมหานคร โดยสมการในแบบจำลองสุดท้าย ประกอบด้วยตัวแปรอิสระ 5 ตัว ซึ่งตัวแปรอิสระเหล่านี้ได้แก่ ขนาดที่ดิน พื้นที่ใช้สอย อายุบ้าน จำนวนห้องน้ำ และค่าเฉลี่ยรายปีของดัชนีคุณภาพอากาศ ตัวแปรอิสระทั้งหมดในสมการมีนัยสำคัญทางสถิติที่ระดับความเชื่อมั่นร้อยละ 99 เครื่องหมายของค่าสัมประสิทธิ์ของค่าเฉลี่ยรายปีของดัชนีคุณภาพอากาศเป็นเครื่องหมายลบอย่างที่ควรจะเป็น แสดงว่าหากคุณภาพอากาศ (ค่าเฉลี่ยรายปีของดัชนีคุณภาพอากาศ) มีค่าลดลงหนึ่งหน่วยจะส่งผลให้ราคาบ้านเพิ่มขึ้นประมาณ 47,135 บาท การปรับปรุงคุณภาพอากาศในกรุงเทพมหานคร เพื่อไม่ให้มีผลกระทบต่อสุขภาพ โดยการลดไม่ให้มีวันที่มีค่าดัชนีคุณภาพอากาศเกิน 100 พบว่าราคาของบ้านใน 7 พื้นที่ (เขตธนบุรี เขตลาดพร้าว เขตดินแดง เขตบางกะปิ เขตห้วยขวาง เขตยานนาวา และเขตบางขุนเทียน) จะเพิ่มขึ้น 6,819 ล้านบาท

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ABSTRACT

This study had three objectives. The first aim was to test the performance of the hedonic price method in Thailand. The second one was to study effect of air pollution on house price in Bangkok and finally the study wanted to value air quality in Bangkok. The study collected air quality data from 3 monitoring stations which represented high, moderate and low air quality index (AQI) area in year 2007 while house price and other characteristics of house were collected by questionnaire survey.

The hedonic price method with Bangkok data provided a statistical equation which could be confidently used to value air quality in Bangkok. The equation showed only 5 independent variables

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remained in the final model, namely land size, utility area, house age, number of bathrooms and annual mean AQI. These independent variables were all statistically significant at 99 percent confident level. The sign of the coefficient of annual mean AQI was negative as it should be. Each unit-reduction of air quality (annual mean AQI) would result in house price increase by 47,135 bahts. An improvement of air quality in Bangkok to the level with no impact on health by reducing total day which had AQI over 100 to zero would increase property value in 7 districts (Thonburi, Lad Phrao, Din Deang, Bang Kapi, Hui Khwang, Yannawa and Bang Khun Thien district) by 6,819 million bahts.

Keywords : Hedonic Price Method, Valuing, Air Quality
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INTRODUCTION

Bangkok, the capital of Thailand with nearly 6 million peoples (Department of Provincial Administration, 2007) had been through a process of rapid development and urbanization. The process has created many environmental problems in Bangkok. One of these environmental problems is air pollution which is serious and tends to worsen. Pollution Control Department (PCD)'s air pollution monitoring data of Bangkok showed the PM10 has been exceeded national ambient air quality standard since 1995 and it has been found ozone concentration sometimes exceeded ambient air standard as well (Pollution Control Department, 2007). People living in Bangkok are exposed to high level of air pollutants that seriously affects their health. Air quality can be improved by many measures such as electrical train construction to reduce individual vehicles usage, and fuel quality adjustment. From an economic point of view costly measures can be implemented if the benefit is out-weighted the costs. However, a common problem when dealing with this type of issue is how to obtain a monetary value for a “good” which is intangible and does not have a market price. The increasing importance given to intangible goods during the last decades has given rise to the development of several valuation methods.

Health cost method valuates environment from direct costs for treating symptoms caused by air pollution which is classified as revealed preference method. Another commonly used valuation method for air pollution is contingent valuation method. This method is a stated preference method. The stated preference method elicits value by directly asking people to specify the value. Hedonic price method, which is also a revealed preference method, is another candidate to value air quality. To illustrate the approach, considering a consumer searching for a certain commodity such as housing, if consumer lives in a city with air and noise pollution of varying levels depending on location, it makes sense to believe that the consumer will preferably locate in areas with lower levels of pollution. With this method, the value of air quality is reflected through house price. In Thailand, there have been some valuations of air quality by health cost and contingent valuation method but rarely by hedonic price method. Researcher is interested in valuing air quality in Bangkok by hedonic price method.

METHODOLOGY

Population and samples

Population in this study were the number of house in 3 selected areas of Bangkok which represent high, moderate and low air quality index (AQI) area and been area with PCD's emission monitoring data. Each selected area was within one kilometer radius of the PCD's monitoring station. According to PCD's monitoring data of 7 stations which monitored 5 parameters that needed for calculation of AQI in 2005 – 2007, it was found there were the day which had AQI over 100 (having impacts on health) in all stations(Pollution Control Department, 2008). According to the average of number of day which had AQI over 100 from PCD's monitoring data in 2005 – 2007, in this study Din Deang district represented the high AQI area, Bang Khun Thien district represented the moderate AQI area and Lad Phrao district represented the low AQI area.

The size of sample was calculated from the formula of Taro Yamane (Taro Yamane, 1973). It was 399 samples and these were further stratified proportionally to population of house in each area. Sampling survey was done only on house, townhouse and condominium.

Data Collection

Data for this study were;

1. Air quality data (A) were collected from PCD's monitoring data of 3 stations in year 2007. The air quality were daily average concentration of PM10, hourly average concentrations of NO_x, SO_2, CO and O_3, annual mean concentrations of PM10, NO_x, SO_2, CO and O_3, air quality index, air pollutant concentration trends and number of days exceeded ambient air standard
2. Crime rate data (N_3) were collected from National Statistical Office.
3. House price (P) and other data were collected by questionnaire survey. They were as follows;
   3.1 House characteristics; house type (H_1), house age (H_2), numbers of bedrooms (H_3), numbers of bathroom (H_4), utility area (H_5), land size (H_6),
   3.2 House location characteristics; main road location (L_1), distance to expressway (L_2), distance to sky train/subway (L_3), distance to hospital (L_4), distance to school (L_5)
   3.3 Neighborhood characteristics; distance to public park (N_1), distance to police station (N_2)

Data analysis

All analysis used SPSS for windows. The multiple linear regression was used for study effect of independent variables (characteristics of house and air quality) on dependent variable which was house price. The multiple regression model in this study used ordinary least squares technique (OLS) to find the coefficient of independent variables.

RESULT

Multiple linear regression

A stepwise regression analysis for best model of samples used every variable except air quality variables. The air quality variable was used separated on stepwise regression run. The results of each air quality variable were shown in table 1.The R squares associated with different air quality parameters were, in fact, not that much different. The annual mean of AQI, however, yielded the highest R square.

Table 1 The results of each air quality on stepwise regression

Air quality variable	Air quality variable significant	R square
Maximum daily of PM10	No	-
Maximum hourly of SO_2	No	-
Maximum hourly of NO_2	Yes	0.598
Maximum hourly of CO	Yes	0.602
Maximum hourly of O_3	Yes	0.598
All Maximum pollution	Yes	0.602
Annual mean of PM10	Yes	0.598
Annual mean of SO_2	Yes	0.595
Annual mean of NO_2	Yes	0.595
Annual mean of CO	Yes	0.595
Annual mean of O_3	Yes	0.598
All annual mean pollution	Yes	0.598
Number of days exceed PM10 standard	Yes	0.598
Air quality index trend	No	-
Annual mean of air quality index	Yes	0.603
Maximum air quality index	Yes	0.598
Number of days have AQI exceed 100	Yes	0.598

The final model (Model 5) revealed quite a good fit ($R^2 = 0.614$) of the variance explained. The Analysis of Variance (ANOVA) showed that the overall model was significant (R=0.784) (F (5,388) = 123.69, p = 0.01). The regression equation was therefore,

$$P = 3{,}424{,}581 + 8{,}264\ H_5 - 47{,}135\ A + 30{,}780\ H_6 + 25{,}137\ H_2 + 223{,}138\ H_4$$

where P - House price

A - Annual mean AQI

H_2 - House age

H_4 - Number of bathrooms

H_5 - Utility area

H_6 - Land size

The independent variables remained in the final model were only 5 variables. These independent variables in the equation were all statistically significant at 99 percent confident level. The other variables such as house location characteristics, neighborhood characteristics and crime rate were excluded from model with stepwise method. Statistically, they were not significant.

The sign of the coefficient of annual mean AQI was negative as it should be or else the model estimated would be of no use for further analysis. The negative sign implied that higher annual mean AQI or worse air quality would reduce property value. It was, therefore, justified to use the model to value the benefit of improving air quality.

Performance of hedonic price method

The hedonic price method did provide an estimated equation to value air quality in Bangkok with R^2 of 0.614 which meant the independent variables included could explain 61.4 percent of house price. The study about "Measuring the benefit of air quality improvement: A spatial hedonic approach" also obtained an equation with R^2 equal to 0.612 (Kim, Philips, and Anselin, 1998).

Annual mean AQI was statistically most suitable as independent variable for air quality while PM10 was independent variable for the study about "An empirical investigation into the performance of Ellickson's random bidding Model, with an application to air quality valuation" (Chattopadhyay, 1998), "The value of improved air quality in Santiago de Chile" (Rogat, 1998) and "Estimating the demand for air quality: New evidence based on the Chicago housing market" (Chattopadhyay, 1999). The study about "Measuring the benefit of air quality improvement: A spatial hedonic approach" (Kim, Philips, and Anselin, 1998) and "Estimating the demand for air quality: New evidence based on the Chicago housing market" (Chattopadhyay, 1999) had SO_2 as variable for air quality.

It was found the number of independent variables of the other studies with hedonic price method for valuing air quality in others countries were more than this study such as property tax rate, percentage of white population, income of the census tract, distance to downtown (Chattopadhyay, 1998), operating expense per pupil and expenditure per capita by municipal government (Chattopadhyay, 1999), distance from slums, distance from industries (Murty, Gulati, and Banerjee, 2003), units with main windows facing south (Alsherfawi, 2005).

The sign of coefficients was turned out to be as expected especially the negative sign for the coefficient of annual mean AQI. As a result, it could be said that the hedonic price method could be satisfactorily used to value air quality in Bangkok.

Effect of air pollution on house price

From the results of this study, the regression model showed the unstandardized coefficient of air quality variable (annual mean AQI from the best model) were - 47,135. The marginal price of air pollution was calculated by differentiating the hedonic price function with respect to air quality as

$$\frac{\partial P}{\partial A} = \frac{\partial(3,424,581 + 8,264 H_5 \;\; 47,135 A + 30,780 H_6 + 25,137 H_2 + 223,138 H_4)}{\partial A}$$

$$\frac{\partial P}{\partial A} = -47,135$$

Therefore, for a given household, each unit-reduction in air quality (annual mean AQI) would result in an estimated increase of 47,135 bahts in house price reflecting air quality effect on house price.

Value of air quality

The PCD had 17 air quality monitoring stations in Bangkok while only 7 stations in 7 districts(Thonburi, Lad Phrao, Din Deang, Bang Kapi, Hui Khwang, Yannawa and Bang Khun Thien district) which monitored 5 parameters that was required for calculating AQI. Improving air quality, in other words reducing the day which had AQI over 100 to zero in each district above could obtain benefit on house price. Improving the level of AQI by reducing total day which had AQI over 100 to zero and keeping the rest of the attributes constant, the benefit value or total increment in property value from improving air quality was obtained by:

$$\frac{\partial P}{\partial A} = -47,135 \text{ or}$$

$$\partial P = -47,135 \times \partial A \text{ for one house}$$

$$\Delta P = -47,135 \times (AQI_{existing} - AQI_{improving}) \times \text{Number of houses}$$

According to the total number of house of each district (Department of Provincial Administration, 2007), the benefit for air quality improvement was shown in table 2. The total benefit for air quality improvement of 7 districts was 6,819 million bahts and benefit at Din Deang district alone was 3,145 million bahts which was about a half of total benefit. Total benefit was calculated for only 7 districts which monitored 5 parameters that was required for calculating AQI. This amount represented the present value of all benefit flows which was reflected in property value.

With part of the benefits known from the hedonic price method, if the costs to improve the air quality in Bangkok were less than 6,819 million bahts, it would be economic worthwhile to undertake the air quality improvement project. It was obvious in this scenario that only one part of total benefits was already larger than the costs.

Table 2 The benefit for air quality improvement in 2007

District	Annual mean AQI (Existing)	Annual mean AQI (Improving)	Number of House	Benefit value (Million Bahts)
Thonburi district	52.79	52.69	44,092	208
Lad Phrao district	53.60	53.58	47,412	45
Din Deang district	71.00	69.64	49,062	3,145
Bang Kapi district	53.33	52.97	83,274	1,413
Hui Khwang district	57.68	57.52	40,510	306
Yannawa district	58.59	58.21	41,418	742
Bang Khun Thien district	56.56	56.21	58,268	961
Total benefit				**6,819**

CONCLUSION

The regression model with stepwise method was used in the study. Out of 15 house characteristic variables, only 5 variables remained in the final model. The independent variables with positive influence on dependent variable were land size, utility area, house age and number of bathrooms. The only variable with negative influence on dependent variable was Annual mean AQI. These independent variables in the equation were all statistically significant at 99 percent confident level. The sign of the coefficient of annual mean AQI was negative as expected. The negative sign implied that lower annual mean AQI or better air quality would increase property value.

The hedonic price method with Bangkok data provided a statistically significant equation and it could be confidently used to value air quality in Bangkok.

From the results of this study, for a given household, each unit-reduction in air quality (annual mean AQI) would result in an estimated increase of 47,135 bahts in house price reflecting air quality effect on house price.

Improving the level of AQI by reducing total day which had AQI over 100 to zero would increase property value in 7 districts (Thonburi, Lad Phrao, Din Deang, Bang Kapi, Hui Khwang, Yannawa and Bang Khun Thien district) by 6,819 million bahts.

The value of air quality in this study was only minimum value since there were other benefits as well such as other health improvements, reductions in property deterioration, increases in the availability of environmental amenities, improvements in visibility. Such additional information, if could be valued, shall be useful for air quality management.

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