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## The monetary valuation of acute respiratory illness from air pollution in Turkey

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## ABSTRACT

A contingent valuation study is conducted in three locations in Turkey using a total of 1362 observations to elicit willingness to pay (WTP) to avoid the acute respiratory illness (three days of severe coughing and throat pain). This is the first research of this kind in Turkey, and also one of a few studies conducted in developing countries. Median WTPs are estimated as 65, 51, and 83 PPP-adjusted 2012 USD for Afsin-Elbistan, Kutahya-Tavsanli and Ankara, respectively. Income elasticities of WTP are derived as 0.8 for Afsin-Elbistan and tested statistically indifferent from 1.0 for Kutahya-Tavsanli, and Ankara, and are found to be greater than the cases in existing studies conducted both in developed and developing countries. We also find that 60 to 90 percent of WTP are devoted for avoiding pain and discomfort/restricted activity days, and much less weights are given for avoiding possible financial losses. As for the determinants of WTP, university graduates, those who have experienced coughing within one month, have spent out-of-pocket medical expenses and actually lost some part of their income due the last experienced minor symptoms are willing to pay more to avoid the future acute respiratory illness while women and the household using coal as the main source of home-heating are willing to pay less in one or more study areas. New air quality standard for PM10 (transition from 150  $\mu\text{g}/\text{m}^3$  to 40  $\mu\text{g}/\text{m}^3$  by 2019) causes the reductions in minor respiratory symptoms by 11, 8, and 4.4 per person, and the resulting welfare gains are calculated as 157 million, 123 million, and 1464 million PPP-adjusted 2012 USD for Afsin-Elbistan, Kutahya-Tavsanli and Ankara, respectively.

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## 1. Introduction

The ambient air quality standard in Turkey is in transition and the European Union standard will be fully adapted by 2019. Yet, there are some places where air quality is the major cause of health damages, especially acute and chronic respiratory illnesses in this country. Our initial hypothesis was that the major source of air pollution in the cities with high concentration of major pollutants is coal-fired electric power plants and the surrounding coal-mines nearby. Although we observed severe health issues due to a such power plant in Çoğulhan and Alemdar, that are located less than 1 km to an old Afsin-Elbistan coal-fired thermal power plant (A plant), the source of severe air quality problem especially in winter

are found to be mainly due to the low quality coal based house heating in the area. In Afsin-Elbistan, one of our study areas, the natural gas network has not reached the region, and the winter time air quality has been very bad. Our interviewers reported many encounters with families having multiple family members, including small children, with respiratory illnesses. In Kutahya-Tavsanli, people have been experiencing serious air pollution due to the same reason as in Afsin-Elbistan. However, after the introduction of natural gas in the region, many citizens witnessed the improvement of air quality. Therefore, Kutahya-Tavsanli is an interesting case going through a rapid improvement in air quality. In Ankara, most of the houses and apartments are equipped with central heating. However, due to the increase in the natural gas price and the distribution of free coal to low income houses by the municipality, the use of coal-fired heating at home has been increasing and contributing to the reduction in winter-time air quality.

Since the adoption of EU air quality standard requires necessary investments sufficient enough to lower air pollution, for example a

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reduction of the particulate matter less than 10  $\mu\text{m}$  in diameters (PM<sub>10</sub>) from 150  $\mu\text{g}/\text{m}^3$  to 40  $\mu\text{g}/\text{m}^3$  in 5 years, country/case specific benefit-cost analyses of such policy changes have to be conducted to observe the balance between various costs of pollution control and benefits of improved environmental quality and human health condition. Prior to our project which aimed to measure the value of statistical life (VSL), value of a life-year (VOLY) and welfare gain from reduced minor respiratory illness, there was no value of such measures available for Turkey. In this article, we attempt to estimate the welfare gain from the reduction of minor respiratory symptoms (3-days of severe coughing and throat pain) due to improved air quality in Turkey. We also attempt to decompose respondents' willingness to pay (WTP) into three categories, among which two of them are related to economic/financial concerns such as avoidance of (1) medical expenses and (2) lost-income, and the other is a health related quality of life consideration which is avoidance of (3) pain and discomfort. We found that the main component of WTP is to avoid pain and discomfort due to acute respiratory symptoms. In other words, purely market oriented economic valuations such as cost-of-illness approach merely provide the lower bound of WTP and is leaving out the potentially large fraction of welfare losses due to pain and discomfort suffered by individuals. Our finding confirms the results in earlier studies conducted in USA (Rowe and Chestnut, 1985; Harrington and Portney, 1987; Chestnut et al., 1988; Dickie and Gerking, 1991; Chestnut et al., 1997) and in Taiwan (Alberini and Krupnick, 2000). We also estimate the income elasticity of WTP for avoiding minor respiratory symptoms. The estimation of the elasticity is critical for two reasons. The first is to be used in benefit transfer and the second is to judge if the improvement in health condition is considered as either necessity or luxury in Turkey.

While a large amount of stated-preference based studies are conducted in developed countries, significantly smaller amount of studies can be found for developing countries. In most of developing countries, the monetary values of health end-points are largely missing, and they are usually borrowed from the studies conducted in developed countries as needed in benefit-cost analyses and environmental impact assessments. There are mainly two problems in doing so. Firstly, the levels of pollution are quite different between developed and developing countries. For example, the ambient air quality annual standard value of PM<sub>10</sub> prior to January, 2014 for Turkey was 150  $\mu\text{g}/\text{m}^3$  while it has been 40  $\mu\text{g}/\text{m}^3$  for EU countries. As discussed later in this article, the three-year (2009–2011) average in annual PM<sub>10</sub> level is 100  $\mu\text{g}/\text{m}^3$  for Afsin-Elbistan, for example. It is generally the case that PM<sub>10</sub> levels are higher for developing countries and significantly lower for the developed world. Observing the public perceptions given the existing “mid to high-end” of air pollution level add important contribution to the existing literature. Secondly, in developing countries, WTP is constrained more by “ability to pay” rather than “willingness to pay” comparing to the cases in developed countries where “willingness to pay” itself is the determinant. Our interviewees reported that some respondents stated that they were willing to pay, but could not afford and answered No–No to our double-bounded dichotomous choice contingent valuation question. Stated-preference studies conducted in the developing countries are valuable since they could provide additional perspective to the existing studies from the developed world.

The paper is organized as follows. The second section reviews existing literature on WTP estimation of acute respiratory symptoms. Section 3 contains the methodology, survey design, implementation and estimation models of our CVM study, followed by the data analysis in Section 4. In Section 5, we discuss the application of the found WTP to the new ambient air standard, and we conclude the article by conclusion.

## 2. Literature review

In this section, we review the existing studies on revealing WTP for avoiding minor respiratory symptoms conducted in USA (Tolley et al., 1986; Chestnut et al., 1997), Canada (Johnson et al., 2000), Taiwan (Alberini et al., 1997; Alberini and Krupnick, 1998; Liu et al., 2000), China (Hammit and Zhou, 2006) and Thailand (Chestnut et al., 1997).

Tolley et al. (1986) estimated WTP for seven minor symptoms including coughing spells and irritating throat separately in two cities in USA (Chicago and Denver) and found that mean WTP per month to eliminate 3 symptom days per month are \$8.87 for coughing spells and \$8.42 for irritating throat.

Chestnut et al. (1997) used three-month daily symptom diary study filled by 141 respondents in Bangkok, Thailand and estimated that median WTP for preventing a future day with respiratory symptoms with three different levels ((a) symptom day with no activity restriction, (b) reduced-activity day and (c) work loss day) were \$4, \$12 and \$24, respectively for Thailand. Given the reported median annual household income of \$8 000, each WTP corresponds to 0.6%, 1.2% and 3.6% of monthly household income. They concluded, in comparison to the WTP estimates in US, that the proportions of the income the respondents in Bangkok were willing to spend were equal to or higher than the estimates in US, and that the improvement of health condition was seen as a basic necessity in Thailand. They also confirmed that discomfort and the restricted activity on the days with symptoms bother respondents more than the financial losses such as medical expense or lost income.

Johnson et al. (2000) conducted choice experiments with four attributes (types of minor symptoms, duration, daily activity levels and annual costs) to estimate WTP for various symptoms for 1, 5 and 10 days time periods with different daily activity levels. For example, willingness to pay to avoid one-day coughing, wheezing or shortness of breath with the condition that one has to stay at home was estimated as CAN\$ 158 (1997 CAN\$), while it rose to CAN\$ 435 for five-day symptoms.

Alberini et al. (1997) conducted an in-person survey using CVM in Taiwan in 1992 to estimate WTP to avoid acute respiratory illness which respondents had experienced most recently. Average duration of the illness was 5.3 days and average number of symptoms experienced was 2.2 among 789 respondents. They found that WTP to avoid entire episode with 2.2 symptoms when the episode was a cold was \$20.45 (in 1992 USD) for 1-day episode, \$34.62 for 5-day episode, and if the illness was not a cold, WTP to avoid 1-day episode was \$30.73 while it was \$52.01 for 5-day episode. They found that among individual characteristics, monthly household income, educational attainment, the number of sick-leave days afforded by one's job, being married, and health history of serious respiratory illness or chronic illness positively affected WTP. The income elasticity of WTP was 0.45.

Alberini and Krupnick (1998) conducted CVM to estimate WTP for avoiding acute respiratory illness due to air pollution in Taiwan in 1991 and 1992 and found that WTP to avoid 1-day illness with 2.2 symptoms is \$26 and 2-day symptom is \$32.34. For the avoidance of 3-day symptoms which is used in our study, WTP is approximately \$37 in 1992 USD, which corresponds to about 1.5% of household income. The income elasticity of WTP estimated was 0.41, statistically different from 0.

Hammit and Zhou (2006) estimated WTP for preventing an episode of minor illness similar to each respondents' most recent cold as 3 to 6 dollars in Beijing, Anqing and rural areas in China. Durations of the recent cold are reported between 4.7 and 7.4 days on average, and the number of symptoms is on average 3.4. The number of days the respondents missed work are 1.2 in rural areas, 0.9 in Beijing and 0.2 in Anqing on average. The income elasticities were estimated as 0.01, 0.14 and 0.09 in the rural areas, Anqing

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