



## Analysis

# Comparing Contingent Valuation and Averting Expenditure Estimates of the Costs of Irregular Water Supply



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## ABSTRACT

We compare two methods—contingent valuation and averting expenditures—to measure the demand for improved water reliability in urban Jordan. Traditionally, averting expenditures (a revealed preference measure) have been considered a lower bound for demand relative to contingent valuation (a stated preference measure) estimates. We develop a theoretical model to show that this relationship critically depends on household perceptions. In our setting, this insight is important, because households appear to have relatively low confidence in both the reliability and quality of existing water supplies, even though water quality tests suggest that utility water is safe to drink from a microbial perspective. Averting expenditures, which reach 4% of monthly expenditures on average, include substantial purchases of non-network water sourced from water shops or tankers, as well as costs in terms of water collection time, storage and in-home treatment. In contrast, the contingent valuation responses, while correlated with coping costs, reveal low willingness to pay for increases in water reliability from the utility network. We attribute this departure from the traditional relationship between averting expenditures and contingent valuation to the lack of household confidence in the quality of utility-provided water. Our study thus adds to previous evidence in the literature, which points to the importance of consumer perceptions in determining demand for environmental improvements.

## 1. Introduction

As global population increases and consumption of water continues to rise, concerns that humankind is entering a new age of global water scarcity are increasingly common (Postel, 1997; Vörösmarty et al., 2000). To some, rising water scarcity is uniquely worrisome because this resource is essential for myriad purposes – for drinking and critical domestic uses, as an input to food and industrial production processes, and for general human and ecological well-being – and yet is rarely allocated using mechanisms that effectively manage scarcity (Hanemann, 2005; Rijsberman, 2006; Whittington, 2016).<sup>1</sup> Because of the essentialness of this resource, many argue that growing scarcity creates a zero sum game that will inevitably lead to widespread social destabilization and environmental damage. And though many populations already face water availability problems and still find ways to manage complicated tradeoffs between uses, increasing scarcity is

fueling a need for methods that would support allocation of this non-market resource, as well as investment to support it.

Due to the general lack of market mechanisms to allocate water (and other similar environmental goods), the economic value of water is rarely directly observed. Thus, an economic perspective on the problem of managing complex water resource tradeoffs necessitates careful valuation work, to understand both the efficiency and distributional consequences of investments and institutional changes in the sector. Indeed, environmental economists have developed a sophisticated body of methods – both revealed and stated preference approaches – to measure the *ex ante* demand for such nonmarket environmental improvements. Stated preference (SP) methods include contingent valuation or choice experiments, and rely on survey responses from which the willingness to pay for specific changes can be derived. Revealed preference (RP) methods, on the other hand, examine individuals' existing choices in order to make inferences about the marginal benefits of similar improvements. Such RP

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<sup>1</sup> Besides essentialness, other features of water that challenge the use of markets for allocation include: high spatial and temporal variability; renewability and mobility; varying degree of non-rivalness (e.g., for non-rival recreation or spiritual aspects) and non-exclusivity; high fixed cost of transport and storage (which challenges reallocation across space and leads to natural monopoly); and pollutability. Others point out that people simply do not think about water as they do about other resources, see for example Whittington (2016).

approaches include the travel cost method (TCM), hedonic valuation and averting expenditure methods, among others.

Given the range of valuation methods that exist, it is natural to wonder whether they generate consistent measures of environmental benefits, and under what conditions. In fact, comparisons of stated and revealed preference methods have a long history in environmental economics (Carson et al., 1996; Haener et al., 2001; Whitehead, 2005; Whitehead et al., 2010). This literature has primarily focused on the estimation of recreational demand in higher income countries, yielding many comparisons of stated preference and travel cost measures of willingness to pay. Generally, the literature has concluded that stated preference estimates have convergent validity with those obtained from the TCM, and that the latter therefore often provides a meaningful measure of WTP even if it only reflects use values.

In this paper, we provide a different and much less common comparison that is perhaps more relevant to the problem of water scarcity and analysis of water allocation tradeoffs – that between averting expenditures (or coping costs) and contingent valuation. These methods are frequently used to estimate the economic benefits of improvements in water supply, but existing literature does not provide conclusive evidence on the nature of the relationship between them. Building on earlier insights in environmental economics (Freeman, 1979; Mäler, 1974), Wu and Huang (2001) provide a theoretical model suggesting that averting expenditures are a lower bound for WTP. Defensive expenditures in most settings cannot feasibly reduce the effects of inadequate environmental services to zero, i.e., they are not perfect substitutes for environmental improvements. Pattanayak et al. (2005) produce a similar result in an application to improved water supply in Kathmandu, Nepal, but Rosado et al. (2006) question whether contingent valuation and averting expenditures are measures arising from the same valuation process.

This paper adds to this limited existing literature by assessing the extent to which these two valuation methods are related, demonstrating that subjective perceptions of quality provide a key reason why they may be different, and discussing their relevance for thinking about the value of water service improvements. We also provide new evidence on the economic burden of unreliable water supplies in a particularly water-poor country in the Middle East. This evidence is timely because one of the Jordanian government's major current objectives is to improve water security for its urban population. This goal is being supported by numerous policy reforms and changes in the water sector, including corporatization of municipal water utilities, reallocation of water to higher value users, investment in improved infrastructure, and development of expensive alternative water sources (Royal Commission for Water, 2009). All of these changes are occurring in a complicated political economy context that strongly constrains opportunities for reform through more rational pricing of water, due to widespread popular opposition to higher water bills (Haddadin, 2006).<sup>2</sup>

In Section 2, we discuss the current literature on the measurement of social benefits from improved water supply, paying particular attention to averting expenditure or coping cost methods. Section 3 presents a theoretical model that considers more carefully the issue of substitutability across water sources. We describe the study setting and our data in Section 4. In Section 5, we provide an overview of our empirical methods. We present results in Section 6 and conclude in Section 7.

## 2. Background

### 2.1. The Benefits of Improved Water Supply: Empirical Evidence

There is a well-established public health and economic literature on the social benefits of investments in improved water services across

<sup>2</sup> Urban water tariffs in Jordan are higher than they are in many Middle Eastern countries, but most utilities nonetheless do not fully recover costs (Jordanian Ministry of Water and Irrigation, 2013; Sommaripa, 2011).

urban and rural environments. Households in many low-income settings compensate for unreliable and low-quality water supply by spending time and money seeking alternative sources or engaging in expensive private treatment (Whittington et al., 1990). Consequently, prior research has found that households gaining access to dependable water supply benefit from time savings, productivity, and positive changes in quality of life (Devoto et al., 2011). Galiani et al. (2009) show that expansions in the water supply network reduce household water expenditures by decreasing household reliance on more costly and distant water sources.

The literature also provides evidence of health benefits and better economic outcomes from investments in piped water supply. For example, the expansion of piped water supply has been found to significantly reduce childhood diarrhea and child and infant mortality rates (Galiani et al., 2005; Gamper-Rabindran et al., 2010). These changes may stem from utilities' ability to efficiently treat water and subsequently provide high quality water through piped networks (Alsana and Goldin, 2015; Cutler and Miller, 2005). In contrast, epidemiological meta-analyses fail to find convincing evidence that water supply improvements (in the absence of complementary water quality improvements) deliver reliable health gains (Fewtrell et al., 2005; Waddington and Snilstveit, 2009). Our study carefully considers how particular constraints – household perceptions – affect demand for such water supply improvements, which may impede the success of interventions (Jeuland et al., 2015).<sup>3</sup>

### 2.2. Evidence of Benefits From Ex Ante Averting Expenditure Studies

In the context of water supply and sanitation, averting expenditures, or coping costs, refer to monetized coping behaviors that households undertake when faced with intermittent water supply. Such behaviors can include purchases of alternative water sources, time spent seeking alternative sources of water (e.g., from water shops or tankers), and treatment costs to improve water quality. Multiple studies have documented the significance of such coping costs in settings with irregular or contaminated water supplies (Katuwal and Bohara, 2011; Pattanayak et al., 2005). Quantifying and monetizing these coping costs provides a potentially useful measure of the social benefits from improvements to municipal water networks, if such improvements eliminate the need for such behaviors. Environmental economists generally argue, however, that such measures represent a lower bound for benefits, since households may be willing to pay considerably more than what they can privately spend to improve water supplies, due to technological or institutional constraints (Freeman, 1979).

### 2.3. Contingent Valuation

An alternative way to measure the *ex ante* social benefits from water supply investments is to directly elicit the stated willingness to pay (WTP) for such improvements, using stated preference methods such as contingent valuation (CV) (Carson, 2000). To elicit demand using CV, survey enumerators present to respondents a detailed scenario of a hypothetical change (e.g., a discrete improvement in water reliability) coupled with a payment mechanism that is well suited to the specific context and characteristics of the improvement. Price levels that households would need to pay (using a credible payment vehicle such as an increased tariff) for the improvement are then randomized across respondents, who indicate during the interview whether or not they would pay the specified price for it.

The main critique of CV studies is that they suffer from hypothetical bias (Ajzen et al., 2004; Blumenschein et al., 1998; Murphy and

<sup>3</sup> It is important to note that we are defining the success of interventions from the perspective of benefits reaching households. There are other beneficiaries from water supply improvements, such as water utilities, which may reduce non-revenue water.

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