



Willingness-to-pay for a bus fare reform: A contingent valuation approach with multiple bound dichotomous choices



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ABSTRACT

The aims of this study are twofold: to measure travelers' willingness to pay (WTP) for bus travel under various travel distance for performing a bus fare reform, and to evaluate the reliability and validity of contingent valuation approach of dichotomous choice with multiple follow-up questions (DC_m). To achieve so, this study designs triple-bound dichotomous choice contingent valuation scenarios, and employs multilevel interval regression to capture possible endogeneity within individuals. The estimated models using data with all three bounds, with the first two bounds, and with any specific single bound mostly gave consistent parameter significances and effect directions. However, the WTP estimated using the single third bound model demonstrated a different pattern from the other models, suggesting possible weariness effects. The analysis results also revealed yea-saying and free-riding effects, implying that respondents tended to say yes if their first two responses were yeses, and say no if their first two responses were noes. The yea-sayers had high income and low frequency in using public transit. On the other hand, the free riders significantly less supported the bus fare reform. Under well control of bound and path effects, WTP estimated by the proposed models was consistent with the WTP estimated with actual mode choice data, implying an anchor effect of current stage-based bus fares on travelers' WTP for future distance-based bus fare scheme. This study suggests that researchers who use DC_m to evaluate WTP should investigate internally inconsistent responses caused by psychological and technical factors; DC_m provides robust WTP estimates if the survey has been carefully designed with potential bound and path effects well controlled. More importantly, those internally inconsistent responses also provide information that is useful to fare reform.

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1. Introduction

In city transportation, bus fare schemes can considerably affect how travelers use public transit. In order to improve the quality and accessibility of public transport network and to increase the ridership of public transport, fare policy may change, as being part of a larger reform. For example, Seoul transformed its city bus fare scheme from flat fare to distance-based fare in 2004; this reform combined with other system changes such as bus network reform significantly changed travelers' behaviors and elevated the development density in urban centers of Seoul (Allen, 2013; Jun, 2012). Israel also changed their bus fare policies in Haifa, Jerusalem, and Tel-Aviv metropolitan areas respectively in 2008, 2010, and 2011; the aim was to

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provide a simple, integrated, user-friendly fare system, coherent with a multi-modal transfer-based system (Sharaby and Shiftan, 2012). Obviously, a successful bus fare reform mainly relies upon the degree of acceptability of passengers. Without knowing their possible responses, achieving successful fare reform is impossible.

Measuring willingness to pay (WTP) for fare policy changes and understanding potentially heterogeneous WTP traveler groups are helpful to a fare scheme reform. Changing to an overly high bus fare would force bus travelers switching to other modes, and to an overly low fare would jeopardize the profits of bus companies or results into a heavy financial burden of government subsidy. Travelers with different socioeconomic background and trip characteristics may also have different WTPs. A clear understanding of the causes of these differences can help implement a new bus fare scheme, particularly if a low estimated WTP is found in specific groups such as underprivileged travelers.

Contingent valuation (CV) is widely used to measure WTP for nonexistent transportation service. Of various CV approaches proposed in the literature, dichotomous choice CV with follow-up questions (or DC_m) is considered a convenient and effective approach. Ruiz and Bernabé (2014), for instance, used a series of dichotomous questions to investigate how drivers and transit users value non-motorized improvements. Jou (2014) used a DC3 (i.e., triple bound dichotomous choice) approach to evaluate the WTP of road accident perpetrators for victims. Lu and Shon (2012) used a DC2 approach to evaluate WTP for carbon offsets in airline passengers.

Despite its popularity, there have been some debates about the DC_m approach. McFadden (1994) questioned the reliability of the CV approach based on a series of experiments on the value of preserving wilderness areas in the western United States. Bateman et al. (2001) discovered internally inconsistent response patterns of DC2 and DC3 approaches in a dataset containing the results of a survey of tourists regarding their opinions about protecting a wetland area in England. The DC_m approach may suffer from hypothetical bias, i.e. a deviation from real market evidence, if the study was conducted in hypothetical situations with no consumption consequences for the participants (Ding et al., 2005). On the other hand, Hanemann et al. (1991) suggested DC2 as an efficient approach to obtaining contingent valuation estimates. Carson et al. (2003) indicated that a careful contingent valuation survey design and development could reduce the concern of biased estimates of DC_m, especially when a large-scale survey was employed rather than a small size experiment. The above literature review highlights the still inconclusive justification of using DC_m for measuring WTP, and motivates the present study.

This study aims to contribute the literature in two aspects. First, city traveler WTP is investigated in the context of the reform of bus fare scheme, which should be useful to cities who are considering transforming their fare scheme. The reported case is Taipei and New Taipei Cities (or, in short, Taipei Cities) of Taiwan; in this case, Taipei City governments were attempting to change their bus fare scheme from stage- to distance-based. Second, possible biases that may be introduced in DC_m are examined using a representative sample collected in a survey with careful design and development in Taipei Cities. An analysis considering possible endogeneity due to multiple responses from same individuals is conducted. Factors that may cause internally inconsistent response patterns are identified, and their implications for reforming bus fare scheme are discussed too. Additionally, hypothetical WTP, i.e., the estimated WTP under the hypothetical distance-based bus fare scheme, is compared with the actual WTP under current stage-based bus fare scheme. The result of the present study should be able to shed more lights on the reliability and validity issues of adopting DC_m to contingent valuation especially in transportation.

The remainder of this paper is organized as follows. Section 2 briefly introduces the public transit system and their operations in Taipei Cities. Section 3 reviews debates on DC_m in contingent valuation. Section 4 presents the methodology, including the analysis method as well as the design and development of the survey. Section 5 provides the analysis results, followed by a discussion in Sections 6. Section 7 describes the limitations of the study and proposes future research directions.

2. Bus fare scheme reform in Taipei Cities

2.1. Reasons for changing from stage- to distance-based bus fare scheme

The current bus fare scheme in Taipei Cities is stage-based; that is, the fare depends on the number of stage boundaries bus travelers cross during a trip. Each stage costs a traveler NT\$15; crossing one additional stage costs a traveler an additional NT\$15. Whereas stage boundaries may differ among routes, the average distance of a stage is 8.5 km, which is approximately 20 bus stops.

The stage-based fare scheme is easily implemented; however, it has several shortcomings. Bus passengers who went onboard prior to a stage boundary would have to pay a two-stage fare even with a short trip distance; in contrast, passengers who board immediately after stage boundaries would pay merely a one-stage fare if they went off the bus before moving to next stage. Equity is an obvious problem in a stage-based fare scheme, but it could be resolved if a distance-based bus fare scheme were applied.

2.2. Bus operations in Taipei Cities

In 2015, fourteen bus companies operated 387 bus routes in Taipei and New Taipei Cities. Some buses traveled within the cities while other buses traveled between these two cities to satisfy commute and daily life needs for residents of these two cities. The average route distance was 28.61 km with a standard deviation of 12.62 km. The average bus travel distance was

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