Willingness to Pay for Change

The use of Contingent Valuation and Choice Experiments in the Trinidad and Tobago Water Services Sector

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ABSTRACT

Financing water infrastructure has been increasingly identified as a constraint to reaching the Millennium Development Goals for developing countries' water sectors and a significant area in which potential exists to develop sustainable financing is through the design of appropriate tariff policies.

This thesis examines in detail the demand for water service improvements by analysing the willingness to pay for such improvements in Trinidad and Tobago. The basis for the work is a household sample survey conducted in 2003 which assessed the current quality of service and attitudes towards changing the status quo situation. The survey of 1419 households showed that services are poorer than officially stated, and that in response many households have opted for private coping solutions to mitigate the poor service levels of the utility.

Choice experiments, which have only limited previous application in the sector, are employed to develop attribute based utility models describing the welfare effects of service level changes, in addition to the more commonly used contingent valuation method. A rigorous comparison of the two methods is developed. It provides evidence that the choice experiment methodology has benefits for policy analysis around the willingness to pay for service changes in the water sector.

An analysis of proposed marginal cost based tariffs in Trinidad, as a part of wider sector reforms, is used as a case study for the policy applications of the choice experiment based willingness to pay data. Consumers are willing to pay for investments in water infrastructure, provided that they impact upon the actual service received. Marginal cost based tariffs might be socially unacceptable given that whilst significant, the willingness to pay, given likely service changes associated with planned investments by the Trinidadian water utility, for service changes is not sufficient to cover this economically efficient level of tariff.

RESUME

Le financement des infrastuctures liées à l'eau a été identifié de manière croissante comme un but essentiel des Objectifs du Millénaire dans les secteurs de l'eau des pays en développement et comme un élément essentiel pour développer un financement viable passant par l'établissement de politiques tarifaires appropriées.

Cette thèse examine en détail la demande pour l'amélioration des services liés à l'eau en analysant l'adhesion au fait de payer pour de telles améliorations à Trinité et Tobago. Cette analyse se base sur une etude réalisée en 2003 auprès de foyers, qui a évaluée la qualité des services délivrés et les réactions face à tout changement de la situation actuelle. L'étude emtreprise auprès de 1419 foyers a démontré que les services étaient de plus mauvaise qualité qu'officiellement admis, et que par réaction face à cette situation la plupart des foyers avaient opté pour des solutions similaires developees a leur niveau afin d'atténuer la mauvaise qualité des services délivrés par le prestataire.

Les choix expérimentés sur le terrain, dont on ne trouve que peu d'exemples antérieurs dans le secteur, ont pour but de développer des modèles spécifiques d'analyse des services du prestataire décrivant les benefices des changements operes sur la qualité des services, en plus de la méthode d'évaluation qui est plus communément utilisée. Une analyse detaillee des deux methodes a ete effectuee. Elle a mis en évidence le fait que la méthodologie des choix experimentes a permis d'analyser l'adhesion de payer pour des réformes touchant les services dans le secteur de l'eau.

Une analyse des coûts marginaux des tarifs de base à La Trinité , constituant une partie de réformes plus larges touchant le secteur, est utilisée comme une étude de cas d'une politique appliquée sur les choix experimentes et relevant de l'adhesion de payer. Les consomateurs sont prêts à payer pour des investissements dans les infrastructures du secteur de l'eau, ayant un impact concret sur la qualité du service actuellement délivré. Un coût marginal sur les tarifs de base pratiqués n'est pas socialement accepté, car bien qu'il existe une adhesion au principe de payer, en relation avec l'amelioration attendue des services delivres grace aux investissements planifiés par le prestataire trinidadien de l'eau, cette adhesion n'est pas suffisante pour accepter le niveau des tarifs.

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Contributions to Knowledge

1. **Unique national level service standards large sample survey in Trinidad and Tobago**
   This thesis conducted one of the largest household surveys to assess the quality water supply services, which was done in Trinidad and Tobago. As well, this work is unique in its analysis of coping strategies associated with poor utility service.

2. **Detailed demand analysis for water supply service changes in Trinidad and Tobago as a regulatory input**
   A detailed analysis of demand for changes to water supply services was conducted in Trinidad and Tobago and provides a unique baseline assessment for regulatory policy setting in the water sector.

3. **The application of novel methods in the valuation of water sector service changes**
   The detailed use of choice experiments as a valuation technique for water supply improvements at a national level is unique. Previous studies have focussed on small sample regional studies. As well, the application of the method within a real regulatory context in a developing country is a singularity.

4. **Validation of choice experiments as an alternative to contingent valuation in the water sector**
   The comparison of choice experiments and the contingent valuation method has been only limited in the literature and this study provides a first example of such a comparison in the water supply sector.

5. **Demonstration of the policy application, in a water tariff setting context, of willingness to pay data**
   The use of willingness to pay data for the analysis of proposed tariffs has not been fully documented in the literature and this study provides such an example.

Contribution to Authorship

All data collection, including the design of survey instruments an experimental design was conducted by me. Input to the data collection process was received from the Regulated Industries Commission in Trinidad, Staff at the University of the West Indies and Susan Gaskin at McGill University. The data was also analysed, and policy implications developed, by me. Advice was received from Susan Gaskin on some of the policy implications of the research. She also reviewed the thesis for use of language. The paper in Appendix D is a revised version of a paper presented at the XI World Water Congress, International Water Resources Association, Madrid, Spain in 2003.

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Acronyms

ASC – Alternative Specific Constant
CE – Choice experiments
CSO – Central Statistical Office
CSSP – Continuous Survey Sample of Population
CV – Contingent Valuation
FSE – Full service equivalent
GORTT – Government of the Republic of Trinidad and Tobago
IIA – Independence from irrelevant alternatives
IOA – Interim Operating Agreement
LTA – Long Term Arrangement
NHA – National Housing Authority
PNM – People's National Movement
PSP – Private sector participation
PUC – Public Utilities Commission
RIC – Regulated Industries Commission
RUM – Random Utility Maximization
ST/W – Severn Trent/ Wimpy
TTWS – Trinidad and Tobago Water Services
UNC – United National Congress
VSEP – Voluntary Separation Program
WASA – Water and Sewerage Authority
WSS – Water supply and sanitation
WTP – Willingness to pay

Exchange Rate

1 US$ = 6.12 TT$
1 CAN$ = 4.71 TT$

December (2003)

1 Introduction

Water supply is a basic service. Access to water supply has at a society level considerable public health benefit and at the household level, in addition to contributing to health, additional economic values. The time spent collecting water can be otherwise spent in earning income for adults and in education for children. Developing countries are particularly plagued by poor water services and so correspondingly suffer the economic costs of poor water access.

Water supply access is normally defined as access to water that is potable and does not burden the household with too much effort in collecting it. The Joint Monitoring Program, the global program charged with monitoring the progress of towards the attainment of water and sanitation Millennium Development Goals (MDGs) by the United Nations, defines improved water supplies by a series of 'improved' sources which are protected from contamination or rely upon deep groundwater for water quality (JMP, 2005)

Numerous types of water supply are normally considered within this definition as improved; from borehole or hand dug well water supplies which provide a basic service level to in-house piped connections which deliver potable water on demand. Within this wide range of definitions the quality of service varies considerably and different countries define improved access differently.

Within the context of the Millennium Development Goals (MDGs), financing issues regarding water supply and sanitation (WSS) have become increasingly highlighted in international debates (Mehta et al., 2005). One focus area of the MDGs is increased access to water supply and sanitation services, with the target set at reducing the un-served by half by 2015. The increasing relevance of financing issues in the WSS sector led to the development of a high level panel report investigating issues and options. This Camdessus report (Winpenny, 2003) presented its results at the 3rd World Water Forum in Kyoto in 2002. One of its recommendations emphasized sustainable cost recovery in the sector. Its

recommendation that promotion of local capital finance markets as potential financing source also rests on the assumption of financial viability of water utilities and hence cost recovery from tariffs and sustainable fiscal transfers. This explicit focus on increased access and finance linked issues in the WSS sector arises from the persistent observation that the WSS sector has under-performed, and left coverage levels low. Access to WSS services impacts upon health outcomes (e.g. Briscoe and Garn, 1994) as well as affecting economic growth at a macro level (e.g. SIWI, 2005).

Efforts to improve water access have been numerous. The water supply and sanitation decade (Cairncross, 1992) focussed international efforts on reducing the number of people without access to basic services. The trend of private sector participation (PSP) in the sector during the 1990s (e.g. Briscoe, 1999) was also in response to lack of performance associated with the status quo. More recently, the debate about changing the sector has evolved more generally to discuss elements of reform.

Trinidad and Tobago is a middle income two island country located in the southern Caribbean, with a population of 1.3 million inhabitants spread over the two islands. The responsibility for provision of water services in the country, both water supply and sewerage, belongs to the Water and Sewerage Authority (WASA), incorporated in 1965. A government appointed board of commissioners oversees the operations of the state owned utility.

WASA has traditionally been dependent upon government transfers to finance its operations and the availability of transfers has historically been tied to the international oil price, which constitutes the major source of public finance. With declining oil revenue in the 1980s and 1990s, public sector infrastructure declined. Capital expenditure accounted for only 8% of total government expenditure in 1989 (Mycoo, 1996).

The decline in capital spending reduced the available resources for utilities, such as WASA, to invest in service expansions. Decades of government support for balance sheet deficits had eroded the WASA's management efficiency, with billing collection efficiency at about 50%. Costs of operation were also inflated. Foremost on the list of cost inefficiencies has been inflated personnel costs. As WASA had been used as an outlet for political patronage (Ryan, 1992), the number of staff per connection was high as compared to a well run utility. In the early 1990s WASA had 16-18 staff per 1000 connections. This compares poorly with 4 per 1000 connections suggested as good practice in Yepes and Dianderas (1996). Salaries amounted to as much as 60% of operating costs (Atwal, 2002).

WASA's operations, since its incorporation, have been overseen by a notionally autonomous regulator, the Public Utilities Commission (PUC). A rate-of-return regulatory mechanism was used to provide for adequate tariffs to cover the operational costs of the utility. However, government policy focussed on subsidized service delivery which discouraged necessary tariff reviews to enable WASA to achieve adequate levels of cost recovery.

The reliance upon shrinking public finances for capital rehabilitation and extension had, by the early 1990s, forced a severe demand management program limiting twenty-four hour water supply to only 10% of the utility's customers. In 1997/98 it was estimated that the deficit in the availability of water was about 50Ml/day, out of a total production of 800Ml/day in 1997 (London Economics, 1998). Due to the inadequate investment in the aging capital stocks of the utility, system leakages rose to about 50% of the total water abstracted (Delcan International Corporation, 1992). Good practice levels of water losses in developed countries such as Canada, the United States of America, and France are between 10 and 15% of the total water abstracted (Yepes and Dianderas, 1996).

Thus the low revenues of the utility, insufficient budgetary support for capital expansion and maintenance, and general mismanagement led to the seeking of

innovative changes in the utility. In the early 1990s a team of local private sector management specialists were engaged to overhaul the management of the authority. Primary focus was given to the utility's inadequate billing collection however insufficient financial support for the necessary capital development, to increase service levels to customers, together with the eroded real tariff and outdated customer database, meant that the reform required was much deeper.

Due to the consistent under-performance of WASA, the government embarked upon a PSP led reform process in a phased approach and, because of inadequate information and the lack of a sufficient regulatory framework (Nankani, 1997), a private operator would first be engaged for a short management contract. This interim operating agreement (IOA) was envisaged as a preparatory stage in the move towards a full concession and took place from 1995-1999. During the IOA period a new national independent regulator, the Regulated Industries Commission (RIC) was created. The RIC was to be responsible for creating pricing policies along the lines that have been discussed, and to develop quality of service standards. However, by 2003, the RIC had not yet fully mobilized with only initial steps having been taken to consider the tariff issues that faced WASA.

Ultimately, the PSP reform failed in Trinidad and Tobago, primarily due to political forces, though poor execution, by seconding under-experienced staff, by the operator did not help. The reform process is on-going in Trinidad and Tobago, with the public utility, WASA, striving to increase the reliability of service and to increase its billing collection.

This thesis focuses on the issue of tariff linked utility reform in Trinidad and Tobago. Particularly, the problem the thesis aims to address is the question surrounding the possible levels of tariff which could be charged; that is the willingness to pay (WTP) for water supply changes in the country. The measurement of WTP is problematic. Normally, a market environment does not exist from which to infer users' choice preferences. The thesis also, therefore,

aims to analyse methods available for such WTP estimation. It examines, in addition to the conventionally used contingent valuation method, a method with a new and cursory history in the water sector; choice experiments and seeks to provide rigorous examination of the relative merits of the two methods together with a statistically relevant comparison. These two objectives of the thesis are discussed through a series of papers.

This thesis presents a series of papers which together present a picture of the current service levels provided by the utility and domestic customer demands for changes to the service. Contained within the analysis is a potential strategy for tariff reform, based on detailed analyses of users' willingness to pay, which could potentially revise the seemingly inevitable downward spiral WASA is currently facing. The analysis rests on the application of methods which are novel to the water services sector, in particular in developing country applications. A large and comprehensive survey was conducted in 2003, in Trinidad and Tobago to provide data for this analysis.

A detailed literature review is presented which discusses the role of demand measurement in planning water supply system investments in developing countries in general. A review of experience of such demand measurement then follows. This discussion also summarizes the technical details of methods used to measure demand for service changes and willingness to pay for such changes. The methodological details used in this study are presented in detail in chapter 3.

Paper 1 provides an overview of the service level currently being offered by the utility, and compares this with official estimates of performance. The paper also discusses consumer attitudes towards changing levels of water services and coping mechanisms employed to avoid the dis-benefits associated with poor water services. The contingent valuation (CV) method is employed to value users' willingness to pay (WTP) for service level changes.

Paper 2 introduces a new methodology for willingness to pay analysis in the water sector; the choice experiment (CE) method. Whist the method has had limited application in the water sector, it comes from a considerable history of successful applications in other sectors, transportation demand modelling and marketing. This paper demonstrates the analysis possible with this method using survey data collected in Trinidad and Tobago.

Paper 3 provides a comparison of the more often used continent valuation method (paper 1) and the choice experiment method (paper 2). In particular it analyses the results from the CE method for convergent validity with the CV method and demonstrates that users' WTP as estimated from CV data in Trinidad and Tobago may be subject to status quo bias associated with the chronic under performance of the utility. The CE method, capable of estimating the effect of such bias, presents possibly a better method for understanding the users' interest in service improvements. The paper also analyses the CE method in its ability to transfer benefits estimated from one population to another. This adds to the rather minimal literature on the topic.

Finally, paper 4 uses the analytic work in papers 1-3 and the contextual work in the paper in Appendix D, to discuss potential uses of WTP data in reforming the utility, with respect to tariff reforms. Proposed marginal cost based tariffs are analysed in relation to the social acceptability of such tariff increases using WTP data developed with the choice experiment data.

A summary of the findings and conclusions to be drawn are then presented.

Appendices are included, which give details of the field schedule followed for data collection (appendix A), the questionnaire used (appendix B) and flash cards used to support the questionnaire's application for the CEs (appendix C). Appendix D contains a paper presenting a detailed case study of the privatization

experience that WASA experienced in the mid-1990s. The details of utility performance before and after are reported and implications of the management contract, originally seen as the pre-cursor to a deeper form of private sector participation, discussed. This was presented at the IWRA XI World Congress in Madrid in 2003. Appendix E contains the ethics approvals for this work.

2 Understanding demand for water supply in Developing Countries – A review of the literature

2.1 Water supply design in developing countries

Historically, water supply systems were designed to ensure everyone had access to a 'full' level of service (Saunders and Warford, 1976). This implied that in designing such water systems, the public service had to cater to all expected demands of all the anticipated users over the system's design life. Often, this 'full' level of service imagined connections in each household using the system, which provided service continuously thorough the day at a full potable level. Indeed many developed country systems are so designed. Given the fact that the water service is being provided as a public good (in that the benefits of the service are mostly linked to everyone utilizing the service and the resultant benefits are shared across society) charges for the service have often been minimal, with financing of supply systems coming from government revenues (e.g. Webster, 1999).

This approach to water service provision, however, does require considerable finances to maintain, as systems often get designed for very large possible demands in the future, to reduce the probability of a shortage, given the often dire economic/political consequences of supply failures. Also, this approach to service provision does not have any inherent ability to relate the price paid for the service to the amount the service is accessed (i.e. the amount of water used), implying that the cost of providing the service is not necessarily spread equitably over the users of the service. Finally, given the large costs associated with designing systems in this manner, many countries are not able to afford such high levels of service provision (Menendez, 1991). The inequity of service provision, then, is exacerbated by the restricted access associated with fiscal constraints.

Given these issues, it becomes obvious that a closer look at the profile of demand which defines consumers' attitudes towards the services provided can yield significant design economies, by rationalizing system size as well as providing the

basis for more equitable tariff design policies (as opposed to the more simple, but regressive, tax based finance used in many industrialised countries). Studies, such as those by Sara and Katz (1998) or Kleemier (2000), examining the impact of project rules on rural water supply sustainability, have demonstrated this importance of the use of demand in system design.

This literature review discusses the role that demand information can play in designing water supply policies and supply systems in developing countries. It begins with a discussion of the role that demand information plays in the policy and planning framework for a country's water supply system. It then discusses a consumer choice framework, which is normally used (e.g. Bateman and Willis (1999)) to describe consumer demand for services. Finally it reviews methods available for demand estimation, and their application in developing countries.

2.2 Project Assessment and Cost-Benefit Analysis

Fundamentally, in assessing the viability of a project, the costs are compared to the anticipated benefits (cost-benefit reference). This is especially true where the project will be utilizing public finances to achieve the likely project benefits. The measurement of project costs in water supply investments is normally confined to physical infrastructure costs, which is normally easily measurable. In many cases the environmental impacts of the project are also relevant to decision makers and are assumed to result in a significant cost of the project. The assessment of the impacts is normally required by regulatory agents or project financiers through their requirement for performance of environmental impact assessments. By assessing the cost of mitigating the anticipated environmental impacts a proxy project cost can be derived.

Measuring the benefits of increased access to water supply is more complicated. In general water supply will result in numerous benefits at the household level (e.g. through time saved in collecting water (e.g. Whittington et al, 1989), increased water availability for small scale agriculture (e.g. World Bank, 1976) as

well as public health benefits (e.g. increased general health levels, reduction in the probability of disease outbreaks). As users often access water supply services at heavily subsidized rates, examining their current demand profile, by looking at the price paid and the quantity consumed, will not give a true indication of the value placed on the household level benefits. And whilst, the connection between increased water service levels and health benefits has been demonstrated (e.g. Saunders and Warford 1976), difficulties in valuing those health benefits makes the assessment of project linked public health benefits difficult.

The division of benefits into public and private benefits is important (Sugden, 1999), as it implies a division along which tariffs can be set. The concept of cost recovery in water supply is now included in international (e.g. ICWE, 1992) and national level water policies which increasingly focus on the setting of user tariffs, as the primary tool for such cost recovery. Tariffs should reflect the private benefits realised by households. This is achieved through setting tariffs at or near the households' true willingness to pay for the service (e.g. Young, 1996). In assessing the private benefits of water supply access it is critical to understand the demand for such services.

2.3 The use of demand information in policy and planning

As is noted above, understanding the nature of demand for water services is of significant importance in planning for such services. Early studies in developing countries, such as that by Katzman (1977), clearly demonstrate the policy implications of economic demand projections where factors such as price and income elasticity are taken into account and are used to predict the amount of water demanded from the system under different pricing policies. Empirically, the International Drinking Water Supply and Sanitation Decade (IDWSSD) during the 1980s, demonstrated the importance of 'soft' issues surrounding the design and implementation of water projects in developing countries (Cairncross, 1992). Such issues were in addition to the provision of simple hardware; pipes, handpumps, reservoirs, and included appropriate training in the management and

organization of the supply system and enquiries into the financial sustainability of water systems. Limited demand information in the planning process has led to low levels of sustainability and over-design of systems (Mu et al, 1990). Alternatively, by assuming that there was insufficient demand for anything other than relatively simple point water sources, systems often proved to be less than sustainable (Singh et al., 1993). Users, whilst not interested in paying small amounts to operate and maintain a simple source, which is similar to their traditional sources, were in fact willing to pay significant amounts for a higher level of service, such as a housetap or a yard tap. Projects which have not designed for demand have resulted in under utilized systems, which are poorly maintained and fail before the end of their design life, and most importantly, fail to deliver any of the private or public benefits associated with increased water supply.

Historically, the role of demand assessments in policy and planning has been historically different in rural and urban areas, with a much longer history in the planning of urban water supplies (e.g. Howe and Linaweaver, 1967, Al-Qunaibet and Johnston, 1985 or Martin and Kulakowski, 1991). With the recent currency of the demand responsive approach in rural water supply (Sara and Katz (1998), Kleemier (2000), Black (1998)), demand estimation has become a central part of rural system design processes as well. Major donors, such as the World Bank have adopted the demand responsive approach as central to rural water projects they finance, and increasingly (Wedgewood and Sansom, 2002, Deverill et al, 2002) demand estimation is being highlighted as a fundamental part of the planning process.

Rural demand measurement – The World Bank Water Demand Research Team (1993) explicitly confronted the role and nature of demand assessments in the policy planning for rural water supply by examining a number of particular country cases. The work associated with that process has fed in to the literature for rural water supply demand estimation in a rather prolific way; through the contribution of methodologies and sufficient case study work to demonstrate the

applicability and appropriateness of those studies. Their studies also highlighted some common factors which affect the demand for rural water supply improvements. Other work in South Africa (Webster, 1999) has used demand assessments to demonstrate the viability of using mixed service levels to increase the number of customers using the system and so maximize the potential financial viability and likely sustainability in designing rural water systems. Numerous other studies have examined the demand for water in rural areas to understand the likely viability of proposed investments. Altaf et al. (1992) conducted such a demand study to explore the nature of demand for piped water, specifically around the demand for attributes such as reliability of supply and level of service. The findings of that study point to the clear demand for individual household connections that provide sufficient reliability of supply. In contrast, Whittington et al. (1990) found that there was very little demand for improved services, due to difficulty in payment of regular fixed amounts for access. In that study, respondents preferred to pay higher unit rates to vendors for smaller amounts of water when needed. Briscoe et al. (1990) conduct demand assessments in Brazil, to demonstrate that at the scheme level, cross-subsidies may be viable to increase the equity of service delivery, by providing a lower, and free, public standpipe service which the poor would access. Ahmed et al. (2003) assess the demand for alternative water systems where current solutions are contaminated with arsenic and find that survey respondents clearly preferred increased service levels through piped water systems over arsenic mitigation technologies. A plethora of demand studies conducted in developing countries have resulted in information very relevant to policy makers but as WSP-SA (1999) discusses, where political will is not sufficient to use the information garnered from such studies, the utility of such studies is reduced. It is apparent, then, that whilst the measurement of demand is very relevant for numerous aspects of policy making in a rural water supply context, it is not sufficient for services to be improved and for sustainability to be increased.

Urban demand measurement – The assessment of demand for rural water supply in developing countries has mostly centered on questions about improvements of systems as a whole. That is, focus has rested on whether entire systems are viable and so interest has been on ascertaining the likely level of cost recovery that is possible given a particular water service solution. Urban studies, in contrast, have mostly focused on the demand for service improvement, where the status quo service level may be low, and insufficient by policy standards, but where some form of 'improved' water supply is mostly available. For instance, Goldblatt (1999) investigates the demand for improved services in informal settlements in Johannesburg to find that there is insufficient willingness to pay to cover all costs associated with service improvements. Other studies, such as that by Whittington et al (1991) have also focussed on service improvements in informal settlements. In that study it is noted that the public utility, if able to provide a reliable service, would be able to capture considerable revenue from the incumbent private water vendors (see Solo (1999) for a comprehensive overview of operating modalities of such private water vendors or small scale independent providers (SSIPs)) in Onitsha, Nigeria. Such studies (e.g. McPhail, 1993b) have also been used to show that there is considerable demand for improved services in informal settlements and that the willingness to pay for those services would make cost recovery for expanded services to those quite likely. Other studies, such as by Altaf (1994) or Zerah (2000) have examined the demand for improved services where considerable household investment has been made in coping with poor current public water service.

In urban areas, demand for improved water services tends to arise from either very low levels of service offered by the public utility, which often has a poor network providing low reliability service, or expensive service offered from private vendors. The demand for improvements is often a result of the potential cost savings that will accrue to the household by eliminating the need for coping strategies associated with the poor public piped infrastructure (i.e. reliance on household level storage or water vendors).

2.4 Ability versus Willingness to Pay

In evaluating demand for water supply, two measures have often been used. The ability to pay concept (Churchill, 1987) relies upon the belief that a fixed proportion of a household's income is 'affordable' to that household. Values used in the literature range considerably, though five percent of income seems to be an accepted maximum. In many developing countries (e.g. McPhail, 1993b) it was assumed that 5% of a poor household's income was an affordable level for a water bill. In many cases (e.g. McPhail,1993a Reddy, 1999) actual amount households were willing to pay were above or below this amount.

Due to the difficulty in assuming a standard level of affordability, which essentially assumes that the price elasticity of demand is constant and equal to unity (Webster, 1999), for policy purposes the concept of willingness to pay is often more useful. Whereas the ability to pay criterion links the cost of supply to availability of finances, it does not directly account for the interest that a household has in spending that proportion of its income. It does not describe the utility that the consumer would derive by gaining access to the service. The direct corollary from this is that a policy maker is not able to investigate the relative benefits of different service packages; rather the minimum cost package (which occupies the minimum proportion of household income) would be valued highest. Numerous studies have demonstrated that not only is income a significant determinant of willingness to pay (e.g. Briscoe et al, 1993), but that education (e.g. Singh et al., 1993), source characteristics such as distance to the source (e.g. Mu et al., 1990), water quality (e.g Ahmed et al., 2003), water demand (e.g. Piper and Martin, 1997) also play a role in explaining the variation in what households are willing to pay for their water supply.

Therefore the investigation into the actual willingness to pay, as opposed to using ability to pay as a proxy, is a valuable exercise for policy makers, as it allows for

the targeting of subsidies and the design of tariffs to maximize revenue by capturing the maximum amount of consumer surplus possible.

The willingness to pay reflects the consolidation of multidimensional preferences, and the resultant welfare, at the individual level, into a single metric of money (Rhoads, 1985, in Young, 1996 pg. 11), and, in the face of limited or non-existent market information from which to assess the willingness to pay, other methods need to be devised in order to do that and represent users' demand for the proposed or anticipated service.

2.5 Methods used for understanding willingness to pay

In attempting to consider what households would be willing to pay for improved water or sanitation services, two general approaches are available. The first relies upon observed behaviour of households to infer what would happen should the situation change, namely a new policy or service be introduced. Techniques relying on observed behaviour are called revealed preference (RP) techniques. Alternatively, stated preference (SP) techniques can be used. As the name suggests, these methods rely on expressed preferences. That is, survey respondents express whether they would, given some hypothetical policy or improvement, participate given a specified price/cost of the policy (Centre for International Economics, 2001).

Revealed preference techniques rely on developing an implicit cost from observed behaviour. For instance, the time taken to collect water may be indicative of the cost incurred by a water user (e.g. Whittington et al., 1989). Given some value for the time of the water carrier, an economic cost can be evaluated and so the willingness to pay for water inferred. One interesting application of the RP technique in the water sector was in Bangladesh (Persson, 1998), where discrete choice models were used to explain the choice of water supply source and sanitation facility. The difficulty with such studies, however, is that it is difficult to include the effect of access to the choice in the model. That is, whilst a

particular alternative may have been 'chosen', other alternatives may not have actually been on offer at any time.

Stated preference techniques have been employed more extensively in the literature for the valuation of improvements to water supply and sanitation facilities. As improvements are often significant, and in parameters that were traditionally uncontrollable, these methods can be more appropriate. That is, if a traditional water source, such as a river, was the only available water source, a revealed preference study would not capture the additional WTP that would be as a result of increased water reliability. Stated preference techniques, therefore, are able to explore ranges of parameters unavailable on the market or to the surveyed population. Where the market offers all realistic alternatives, however, RP techniques may be applied.

The consumer choice approach defined above, based on random utility theory, has been used extensively to explain the WTP for improvements to water supply and sanitation facilities in developing countries (Whittington et al., 1990). Generally, the contingent valuation (CV) method, a stated preference technique, has been used to gather the data required for behavioural model estimation. It is proposed here that an alternative stated preference method, choice modeling or choice experiments, may result in more detailed and relevant policy information.

2.5.1 Contingent Valuation

The CV method has been used in environmental valuation studies since the 1960s and its academic validation has come from the support given to the method from the National Oceanic and Atmospheric Association (Arrow et al., 1993). This class of valuation technique requires that a detailed description of a proposed change be conveyed to the survey respondent. This description often includes visual aids, such as photos and videos. The respondent then must give an estimate of what the change is worth to them. Various methods have been used to elicit the

valuation, such as a referendum, open-ended question, or bidding game. All of the methods used for valuation seek to attain a direct valuation. The method has been subject to considerable criticism on a number of points. Firstly, it has been argued that the hypothetical nature of the question posed to the respondent makes their valuation fundamentally incorrect (Diamond and Hausman, 1994). This could be due to the belief that the question is irrelevant and so does not merit the cognitive effort required to estimate preferences and deliver a valuation. Also, depending upon the value elicitation method used, a number of criticisms have been made. The dichotomous choice model, which requires the respondent to either accept or reject the improved policy at a given price, has been criticized for inducing yea-saying. This is particularly relevant in the environmental valuation case, where the good is sufficiently unfamiliar to allow for a respondent to assume that the offered price is somehow 'correct'. Further the method is subject to a number of other biases. Mitchell and Carson (1989) present a typology of biases in contingent valuation studies, a summary of which follows:

1. CV where the presented scenario provides incentives to misrepresent true WTP.
    a. Strategic bias – Respondent misrepresents WTP in the belief that they will benefit from resulting changes to policies.
    b. Compliance bias – Where the expressed WTP is given in accordance with a perceived 'correct' answer. The perception may originate from the interviewer or may be associated with the perceived sponsor of the study.
2. Biases arising due to over reliance on some portion of the presented scenario.
    a. Starting point bias – Where the WTP elicitation method influences the final maximum WTP value (e.g. a relatively low bid may indicate to a respondent that their true perception, being relatively high, is incorrect).

b. Relational bias – Where the described relationship to other private or public goods influences the WTP for the good being investigated (e.g. when water bills are situated beside other utility bills in the elicitation component of the survey).

3. Biases arising due to misrepresentation or misinterpretation of the presented scenario.
    a. Theoretical misspecification bias – Where the described scenario departs from economic theory or policy elements.
    b. Amenity misspecification bias - Where the intended amenity is different from the perceived amenity. This bias exists in numerous forms, including situations where the respondent attaches to the intended good some degree of symbolic worth, where the perception of quantity, either spatially, or in terms of benefits, differs from the researcher's intended scope. Also, this bias can exist where the respondent uses a different metric scale to evaluate the amenity (e.g. the respondent may value time less precisely than the interviewer and so a time savings of 10 minutes or 15 minutes may be equivalent to the respondent. Finally, this bias includes the situation where the respondent views the likelihood of the policy being implemented differently from the investigator.
    c. Context misspecification bias – Where the perceived context of the market differs from the intended context. This bias includes a number of specific forms. It can arise where the payment vehicle is perceived differently from the intended perception, or where the perception of property right differs. Alternatively, question ordering, non scenario contextual material, or differences between the perceived and intended budget constraints, can all result in context misspecification bias.

The detailed list of potential biases is included, in part, to impress the idea that appropriate design and implementation of the survey tool is mandatory for a successful application.

This technique is employed in environmental valuation as, in that case, the good being valued is not traded in a market, and so observed behaviour is not available. Griffin et al. (1995) argue that such environmental valuation techniques are valid for water supply policy planning as the changes being proposed are outside the experience of the surveyed population. Service features such as reliability may be wholly new to a respondent, making the issue of valuing an increase in reliability, along with other attributes, very similar to, say, valuing the existence of the bald eagle.

Traditionally in the water supply literature, the CV method has been used with a bidding game employed to elicit the maximum WTP of households (e.g. see Altaf et al. 1993 or Briscoe et al., 1990). A bidding game asks a series of dichotomous questions to the respondent. The price is changed at each iteration, depending upon the answer at the previous iteration. A fixed number of levels of iterations will be used. If a respondent agrees to participate in the hypothetical water service improvement proposed the survey enumerator revises the bid upwards, according to some predetermined scheme. In such a way an interval representing the maximum WTP for each respondent can be established. This method attempts to recreate a market environment with the respondent and has been used in studies reported in the literature for some time (e.g. Randall et al, 1974). Numerous other elicitations methods have been used. The open-ended elicitation method, requiring the respondent to state his or her maximum WTP, was a method used in earlier studies. This method, however, was criticized as being susceptible to underestimates of respondent WTP due to unfamiliarity with the questions being asked, free-rider effects, and risk aversion (Bateman et. al, 1999). In response to these criticisms, dichotomous choice formats were introduced as the binary response, or take it/leave it, approach was felt to correspond to familiar choice

situations faced by many respondents. Further, the NOAA panel (Arrow et al., 1993) also recommended the use of the dichotomous choice method. Extensions of the dichotomous choice approach, where a follow up question with a revised bid amount is offered, have been used to increase statistical efficiency by developing more information from each respondent.

Much literature has dealt with the CV method, focussing on issues pertaining to its validity (e.g. Fisher, 1996, Hanemann, W.M., 1996), respondent uncertainty (Loomis and Ekstrand, 1998 or van Kooten, Krcmar, Bulte, 2001, Ready, Whitehead and Blomquist, 1995), and its design and field implementation (e.g. Whittington, 2002, Lindsey, 1994). Also the literature includes numerous examples of applications in the water and sanitation sector (Whittington et al, 1993, Briscoe et al, 1990, Altaf et al, 1992, Whittington et al, 1987).

These numerous applications, together with the significant debate, existent in the literature indicate the relevance of the CV method. The major application of the method in water and sanitation planning is in understanding user demand for large improvements in water supply, or sanitation, services. This understanding allows for the design of interventions that are within users' willingness to pay. The implication is that interventions that are sustainable can be designed. It is interesting to note that the findings of CV studies often suggest that households are willing to pay a significant proportion of their income to receive water service (e.g McPhail, 1993b), in direct contradiction to the common wisdom that households demand only a low level of service at the lowest price possible (e.g. McPhail, 1993a, Reddy, 1999). This method, as implied by its persistence in the literature, is a beneficial tool for the water and sanitation sector. It follows, then, that improvements to aspects of this method would enhance its policy relevance. One major shortfall of the CV method is the difficulty in testing respondent WTP for many scenarios. As the CV method relies upon a fully specified scenario for which the WTP is elicited, the time taken to assess multiple scenarios may often be infeasible. This observation implies that should a test scenario not fully

understand, to some degree, the attribute preferences of survey respondents prior to the design of the scenario, it is possible that a suboptimal policy would be recommended. In other words, the CV method requires the scenario designer to know the preferences of the respondents prior to assessing them. Methods which enable the analyst to investigate the WTP for different scenarios, then, would be beneficial in that they would be more robust with regard to scenario design. The CV method has been applied to value many possible options using complicated split samples (Lauria et al., 1999), though as is implicit, this requires larger more costly surveys. As well, the CV method can be subject to yea-saying (Blamey et al., 1998) and so result in a biased estimate of the WTP of users. This is when users agree with the improvement offered, disregarding their true views. Finally, the CV method has been criticized as it does not require the respondent to consider substitution effects or describe clearly the attributes of the proposed alternative (Merrett, 2002). That is, the respondent may neglect other possible solutions in their valuation of the presented one and so may 'dump' money on the presented alternative.

2.5.2 Discrete choice experiments

Discrete choice experiments, or choice experiments (CE), are relatively new methods first introduced in Louviere and Hensher (1982) and Louviere and Woodsworth (1983), that have gained currency in numerous applied fields such as transportation (Hensher et al, 2001) and tourism (Schroeder and Louviere, 1999). Discrete choice models have also, more recently, been used in environmental valuation (Blamey et al., 1999, Boxall et al., 1996, Hanley et al., 2001, Rolfe et al., 2000). CE is a stated preference technique with its origins in conjoint analysis (e.g. Louviere, 1988), which has seen wide application in market research (Blamey et al., 1999). Further, CE can be regarded as a generalization of the CV method discussed above (Adamowicz, et al., 1998).

In CE sets of choice situations are presented to the survey respondent. The sets are composed of different alternatives, and the attributes which define them. Figure 2.1 shows an example choice scenario.

Indicate the alternative you most prefer			
	Alternative 1	Alternative 2	Alternative 3
Rarity of species	Fairly rare	Not rare at all	Choose neither 1
Ease of visit	No visiting allowed	Easy to visit	nor 2 (status quo)
Area	100 ha	500 ha	
Household Cost	$10	$20	

Figure 2.1: Example choice scenario (Morrison et al., 1996)

A multitude of choice scenarios, such as those found in figure 1, are presented to the respondent. The third alternative, the status quo, is included, to provide absolute measures of value. Or rather, measures of value relative to the current state of affairs. Should the third alternative not be included, valuations would only be relative to one another. The inclusion of a cost allows for the modeling of household willingness to pay, and by including the household cost as an attribute, the method does not overstress the importance of cost and so minimizes the tendency to yea-saying. CE require the presentation of multiple choice sets and so substitutes available must necessarily be considered. This results in a richer understanding of household willingness to pay in that it gives the analyst the ability to evaluate WTP for multiple policy alternatives.

The structuring of choice sets as composed of alternatives, defined by attributes, presents further theoretical benefits. If alternatives are considered to be composed of attributes which can be manipulated by the researcher, then an understanding into the WTP for the inclusion of different levels of those attributes in a policy or

project can be estimated. In the case of water supply, for instance, it is possible to define alternatives, in part, by the reliability of the supply. By varying the level of the attribute, reliability, across choice sets, and modeling the data using discrete choice models, the WTP for improvements to reliability can be assessed. The inclusion of other attributes of water supply improvements would allow for a prioritization of improvements by attribute, and so would facilitate the design of demand responsive interventions.

2.6 Questionnaire Development

In order to verify the relevance of choice modeling in modeling WTP for water service improvements, other issues must be examined. As the CV method has been applied most often in the water sector, and has been shown to, in one water sector case at least (Griffin et al., 1995), reflect the true WTP of respondents a comparison between the results of the CV method and CE is relevant. Comparisons of the two stated preference methods have been presented in the literature, but in other contexts. Adamowicz et al. (1995), present a comparison of the two methods in valuing the passive use of Caribou populations in Canada, and find that while the results of the two methods provide similar estimates of income preferences, the CE approach allows for a more comprehensive analysis of choice which consider additional factors such as non-linear valuations of caribou population sizes. Boxall et al. (1996) also compare the two methods in their ability to capture consumer preferences for different moose hunting sites. This study showed that there were differences in welfare estimates provided by the two methods but did not provide conclusive evidence as to the source of the differences. Adamowicz et al. (1998) compare the scale parameter across the two types of information in a study examining the passive value of caribou population, by using a degenerate nested logit estimation procedure on a combined data set. The scale parameter, found to be not significant, was a test for whether the variances in the two data sets were equal. This study concluded that while there was little difference between the income preferences of the two models, implying their equivalence, the CV method added little statistical power to the CE

estimated MNL model suggesting that the CE method contains a superset of the information that is developed as part of the CV method. Ryan (2004) compares the two methods in the context of the health sector. This study finds no significant difference between the estimated WTP pay from the two methods as the mean WTP from the CE method lies within the 95% confidence interval derived from the CV method. The CV method has been criticised as being insensitive to the 'scope' or amount of the amenity being offered (e.g. Hausman, 1993) and Foster and Mourato (2003) compare the two methods specifically with the ambition of testing the sensitivity of the CE method to 'scope'. They find that the CE method is sensitive to scope whereas the CV method is not. Also, they conclude that the two models provide different estimates of welfare. The CE method is proposed as preferable in the context of estimating welfare effects of single policy changes within a wider context.

Comparisons between the CV method and other choice methods have also been presented in the literature. Stevens et al. (2000) have examined the CV method next to conjoint analysis for the management of ecosystems, with the major result that conjoint analyses produce results biased upwards. Conjoint analysis studies use rating or ranking data to establish preferences of respondents. The increased demands placed on the respondents, to rank as opposed to choose, have been cited as a significant reason for the employment of CE as opposed to conjoint experiments. Despite the result that conjoint analysis results in upwardly biased estimates, Stevens et al. (2000) conclude that the comparison of such methods (conjoint analysis and CV) requires further research.

The CE method has had limited applications in the water sector. Haider and Rasid (2002) describe a CE application in Thunder Bay, Ontario where water source was valued along with attributes defining the quality of water supply. This study examined the valuation on perceived quality of water source as a primary objective. Hensher et al. (Undated) use the CE method to value water supply attributes in Australia, with a focus on the nature and frequency of water outages.

Similarly, MacDonald et al (2004) investigate the value of reducing supply interruptions in Australia. Powe et al. (2004) also use the CE method in a developed country (England) context to value avoided outages in service and environmental impacts of the service. These applications mirror similar investigations into the demand for different attributes of electricity supply, such as in Revelt and Train (2000), Carlsson and Martinsson (2004) or Goett et al. (2000). All these, having been conducted in developed countries, have examined relatively small changes in attribute levels across proposed alternatives, and many of the attributes (such as fish population in river) border on passive use values. Developing country applications have been even more limited, with only three cases being noted in the literature. Hope and Garrod (2004) applied CE to value changes affecting rural water supply levels in South Africa. The application is interesting in that it clearly demonstrates the value of attribute based valuations, where the marginal WTP for changes in level of service for instance can be valued. Abou-Ali and Carlsson (2004) analyse welfare effects using the CE method in Egypt, though focus in that application is on valuing supposed health improvements associated with improved water supply. Given that the empirical link between health benefits and water access is not fully quantified in the literature (whereas a notional or qualitative relationship is clearly presented (WHO, 1993), this does not help much in valuing public investment in water supply. Further, given that the investigation does not capture likely private benefits accruing to the responding household, the true value of water supply investments cannot be assessed. Anand (2001) conducted a small sample (about 150 respondents) survey in Madras, India using the CE method to value different water service attributes. In all three of these studies, no direct comparison of the CE results with results from CV method studies has been undertaken.

The CV method has been examined for its ability to generate models which can be generalized in planning water supply improvements, for benefit transfer where a model developed in one location can be applied directly in another, and has been shown to perform poorly (Griffin et al., 1995). Benefit transfer, if valid for CE

would result in significant cost savings due to the portability of models. Conceptually, CE should be able to develop models which allow for benefit transfer. Models based on CE data would be able to vary characteristics in the status quo situation, which forms the basis of the choice faced by a respondent. Also, the data manipulates levels of the relevant attributes of improved policies. As such, a model can be developed in one area, with the variation in the models ascribed to attributes of the improved policy as well as socioeconomic characteristics of the population. Morrisson et al. (1998) discuss the potential for benefit transfer with models developed through choice modeling exercises. They find, and cite other authors (e.g. Swallow et al., 1994) who found, that the results of benefit transfer studies provide results that are not fully conclusive. This area, due to the potential benefits which may be realised should benefit transfer be possible, requires further exploration.

2.7 Modelling choice data - consumer choice theory and models for representing the demand function

In attempting to estimate the WTP of users for improvements to water or sanitation services, it is first necessary to understand how such users would participate in improved systems. Random utility maximization (RUM) has been used as the underlying theory explaining market functioning and reflects a movement away from aggregate models which describe a market as whole to disaggregate models which examine behaviour at the individual level (Train, 1986). The RUM model has had exceptional influence in travel demand analysis, where planners have sought to anticipate the level of demand for new or different forms of transport services and this work has greatly influenced the application of demand analysis in other fields (see below for details). A comprehensive overview of the development of the RUM model in the transport demand analysis field is provided in McFadden (2000).

The RUM theory was first proposed by Thurstone (1927). In his 'law of comparative judgement' Thurstone supposed that the basis of choice between alternatives could be explained by measurable attributes however not fully. Where choices did not agree with what seemed rational, a stochastic element which described unobserved variables was proposed. Thus, the utility obtained from a particular alternative is composed of two parts; a systematic, observable, one (V) and a stochastic, unobservable one (ε). So the utility of an alternative can be represented as in (1):

$$U = V + \varepsilon \tag{1}$$

If two alternatives, i and j, are available, a consumer will choose i if and only if

$$U_i > U_j \tag{2}$$

That is iff,

$$V_i + \varepsilon_i > V_j + \varepsilon_j \tag{3}$$

As the ε values are unobserved, equation (3) cannot be evaluated exactly. Depending upon the distribution taken by the ε values, a probability that alternative i is chosen can be evaluated. The probability that i is chosen, P_i will therefore be

$$P_i = P(V_i - V_j > \varepsilon_j - \varepsilon_i) \tag{4}$$

Further, the systematic portion of the utility is a function of the attributes of the option. Therefore

$$V_i = \beta_k X_i \tag{5}$$

where X is a vector of k attributes and β is a vector of coefficients. That is, the systematic portion of the utility derived from the choice of a particular alternative is dependent upon the measurable attributes of that alternative. The vector of coefficients relates the attributes to one another in terms of their importance. As specified thus far, the model in (4) assumes respondents' tastes are homogeneous. Modifications to the model to account for respondent heterogeneity are possible. McFadden (1974) shows that by using the assumption that the ε values are distributed according to a Gumbel or extreme value type 1 distribution, the model in (4) is consistent with a multinomial logit (MNL) choice model. If the ε portions of utility are assumed to be normally distributed, the model reduces to a multinomial probit model (Maddala, 1983). The Generalized Extreme Value (GEV) distribution gives rise to the nested MNL model (McFadden, 1981).

From a policy standpoint, it is beneficial to estimate the model in (4) as it then provides the analyst with the ability to examine participation in a policy change, by varying the values in the vector X.

The RUM model within the field of economics has been used as tool to describe the systematic part of consumer behaviour and to predict the likely behaviour of consumers faced with choices (McFadden, 2002). Most recently however, the supremacy of RUM models has been questioned with regard to their ability to explain the behavioural structure of consumer choices. That is, they do not directly allow for an understanding of the reasons for the non-systematic variation in consumer choice. To better understand the cogitative processes involved in making choices, numerous adaptations to standard RUM models and their analysis are being considered. Such analyses would include the development of methods to analyse the random component of utility (e.g. Louviere et al., 2002) and the proposal of hybrid choice models (e.g Ben-Akiva et al., 2002) to allow for

the modelling of effects such as context, history or other latent variables on consumer choice.

The data, once collected must be modeled, in order to make policy decisions. This is not the main focus of this paper, but much work has been done on the estimation of discrete choice models. Train (2003) discusses, comprehensively, the issue of modeling discrete choice data, focussing on the gains in model sophistication which are possible due to the increased computer power, and the resulting use of model simulation. Essentially, simulation methods allow for the estimation of models without a closed form solution, as was required before. Simulated models (such as the multinomial probit, or mixed logit (McFadden and Train, 2000)) are most often employed in addition the simpler conditional logit model and such alternative modeling methods are required to avoid some of the limitations of the standard multinomial logit model. Particularly, the independence from irrelevant attributes (IIA) property of the logit model is often violated and the more complicated models suggested do not require the IIA assumption. The IIA assumption is often illustrated through the use of the red bus–blue bus example from transportation demand forecasting. If three modes, say a car, train, and red bus, are available, the MNL model requires that the introduction of a fourth mode, for example a blue bus, draw market share proportionally from the three existent modes. This is difficult to imagine, given that the red bus is far more similar to the blue bus than to the other modes and so it would be anticipated that the red bus market share be cannibalized more significantly than the other modes'. This situation has been treated in the literature by nesting MNL models within one another, so that the IIA property holds within nests.

Numerous opportunities are available for the modeling of the survey data collected. Of particular interest to the modeling efforts are issues around the incorporation of socioeconomic variables in the discrete choice models and the combination of revealed and stated preference data.

Heterogeneity in consumer tastes can, to some degree, be explained by the inclusion of socioeconomic characteristics in the demand formulation. This variation can be captured, simply, by combining individual specific characteristics with attributes defining alternatives (e.g. Adamowicz et al., 1997).

2.8 Estimating and comparing the willingness to pay for changes

The random utility models discussed above model utility as a dependent variable and as such willingness to pay estimates are not directly available from the estimated models. Two concepts are used to estimate the WTP from the estimated models. First, the effect of a unit change in an attribute level can be estimated as the ratio of the attribute parameter of interest to the parameter of the price variable. These implicit prices (IP) allow for the comparison of changes in different attributes on the WTP of the average respondent. Equation 6 is used to calculate the IP for a given attribute, c.

$$IP = -\left(\frac{\beta_c}{\beta_y}\right) \tag{9}$$

The second method used to assess the WTP for a change in policy, which is a series of attribute changes, is calculated by estimating the compensating surplus (CS) of the change as:

$$CS = \frac{-1}{\beta_y}\left[\ln\sum_{i=1}^{n} e^{V_i^0} - \ln\sum_{i=1}^{n} e^{V_i^1}\right] \tag{10}$$

Where, again, change in utility given a change in policy (from the current situation, 0, to the proposed situation, 1) is rationalized by the parameter of the price variable, β_y (Louviere et al., 2000).

Beyond simply modeling choice data, considerable effort has been made in validating models by statistically testing results of various models with one another. The form of random utility models, as discussed above, develops functions which are linear functions of the parameters, and whose parameters have asymptotically normal distributions (Foster and Mourato, 2003). Functions describing the benefits associated with policy changes, however, are not linear in parameters and so their distributions are not normal. To derive confidence intervals around willingness to pay or implicit values is complicated analytically, and so methods such as those proposed by Krinsky and Robb (1986) (K-R method) are normally used to estimate confidence intervals. The K-R method takes random draws from the multivariate normal distribution defined by the vector of mean parameter values and the corresponding covariance matrix to estimate random parameter values in the distribution. The repeated sampling of the parameter values and calculation of functions of interest allows for an estimation of the distribution of welfare functions. For instance, to estimate the distribution of an implicit value (as in equation 6) random draws are repeatedly taken and for each draw the IP value calculated. Over the 1000 draws often suggested in the literature (e.g. Foster and Mourato and (2003), Krinsky and Robb (1986)) a distribution of IP is simulated. Confidence intervals at the level of $(1-\alpha)$ are then inferred by dropping the $\alpha/2$ and $(1-\alpha/2)$ percentiles from the simulated distribution after Efron and Tibshirani (1993). Other comparative methods have been used to calculate such confidence intervals, including the bootstrap, and in comparison the K-R method has been demonstrated to perform well (e.g. Cooper, 1994)

Comparison of WTP estimates is not simply conducted by investigating overlapping confidence intervals as this leads to an underestimation of the confidence level of the comparison (Poe et al., 1994). Instead, comparison of two distributions requires that a comparison of all possible values in those distributions happens. This can be represented as:

$$D = WTP_1 - WTP_2 \tag{11}$$

Where the difference, D, is calculated by two random draws from the distributions of WTP being compared, WTP_1 and WTP_2 (Poe et al., 1997). Again, by replicating the calculation of D a large number of times, an estimate of the distribution of D is achieved. In order to then estimate the confidence interval around the null hypothesis that D is zero, the mass of the estimated distribution which is below zero is calculated and the estimation of this mass is repeated a large number of times and the results averaged (Poe et al., 2005). That is, if the average number of comparisons across a large number of comparisons is less than some value α, then the null hypothesis of equality is rejected.

2.9 Comparing model specifications: testing for convergent validity and benefit transfer

Of interest in the application of new methods, such as the choice experiment, is the ability of the method to produce results which are realistic. Ideally, the results of the models would be compared to actual choice behaviour as a way to test for validity. This, for obvious reasons is difficult to do though one study does exist in the literature and has did verify the predictive validity of the choice experiment method (Carlsson and Martinnson, 2001). Testing for convergent validity between the new method (choice experiements) and the standard method (Contingent valuation), can also be used, though carefully, as a test for legitimacy. There have been a limited number of such comparisons conducted. Boxall et al. (1996), find that the CV method values environmental policies much higher than the CE method, though no statistical comparison of the results is presented. Adamowicz et al. (1998) examine the scale effect of pooled CV-CE dataset to test for parameter equivalence and find the scale parameter is not significant implying that the parameters estimated by the two models are consistent. Mogas et al. (2002) also compare the results and find that dependent upon the specification of the CE models, the two methods produce similar WTP estimates. Foster and Mourato (2003) compare the two methods in the context of charity valuation in

the UK and find that the two methods produce different estimates based on whether the good being valued was more or less of a public good. Hanley et al. (1998) also compare the methods in the context of conservation of environmentally sensitive areas in Scotland. They find that the results are not equivalent with CV being better at valuing a total policy bundle and CE better at valuing parts of that bundle. Boyle et al. (2004) compare the two methods with the intention of explaining the apparent systematic over valuation seen with the CE method. They find that provision rules, the rules that define how the offered good is to be provided, significantly affect the values produced by the CE method, and possibly, if the provision rules do not correspond to the incentives of the user, that valuations will be overstated.

Also of interest in the use of choice models is their ability to be used in benefit transfer applications. Benefit transfer allows for low cost economic value estimation based on a demand function derived in a site other that where the analysis is being conducted (Groothuis, 2005). That is, the preference structure of a particular site, and its corresponding welfare function, is used in another site context to estimate the likely economic value of a policy action. There are obvious cost savings with such applications and so it is of considerable interest to test for the ability of a method to be applied as such. The CE method, due to its reliance on attributes of policy bundles to value the whole policy bundle, provides possible benefits relative to the CV method (where policies are valued as a whole) and there are multiple examples of testing for this potential ability. Several examples of such comparative work have been developed from cases in Australia (e.g. Morrison and Bennet, 2004, Bueren and Bennet, 2004, Morisson et al., 2002). These studies have shown mixed results, with the ability to use CE methods for benefit transfer estimation always to some degree erroneous. One interesting finding, in Morrison et al., (2002) is that benefit transfer errors are smaller across different sites than across populations. Transfer errors, TE, as defined:

$$TE = \frac{|WTP_p - WTP_e|}{WTP_e} \tag{12}$$

where the subscripts indicate the predicted value using the model developed for a different site, p, or the estimated value, e, from the model developed for the site for which benefit transfer is being tested.

3 Methodology

This section details some of the design issues faced in the implementation of the field work of this thesis. As has been mentioned earlier, the field work centered on the development and administration of a willingness to pay survey in Trinidad and Tobago. The survey sought to understand current levels of services as well as attitudes towards change in service levels in the water sector.

Focus is on the data collection processes and the development of the sampling method used to collect data. First, the design of the choice sets used for the CE portions of the survey is discussed. Specifically, the number of choice sets and attributes of each alternative are discussed and the justification of the levels selected for the attributes presented. In addition, the experimental design process used to set combinations of attribute levels for each alternative is discussed. The design of the contingent valuation portions of the survey is also discussed. Finally, field procedures used to administer the questionnaire, including details of the sampling methodology are presented.

3.1 Designing the contingent valuation scenarios

In deciding upon an appropriate CV scenario, it became apparent that at least two different scenarios would be required. Where respondents were already serviced with in-house connections by the utility, it was assumed that they would be more interested in increases in the reliability and other service attributes. Where, however, respondents used either a standpipe or other water source as their primary water source, significant utility would arise from the increased proximity of a water supply source to their point of consumption and time savings would accrue because the connection would no longer be shared. As such, a second CV scenario was developed for those without an in-house connection. The two scenarios are presented in appendix B.

In defining the service package to be included in the CV scenarios, it was felt that the 'ideal' level of service was most appropriate for analysis. This was despite the

fact that it was unlikely that, from a technical perspective, such a level of service could be offered in the near future. The ideal level of service proposed that the upgrade would bring water 24 hours per day, everyday, to an in house connection with adequate water quality and pressure for all domestic needs. No mention of metering was made in the scenario, due to perceived difficulties in the country regarding the politics of proposed metering programs. The ideal service level was of most interest to the RIC, as from their perspective, this was the only acceptable level of service, given overall national polices on development. The risk of hypothetical bias, therefore, was explicit in the design of the CV scenarios, and was driven by policy interests. This is a likely situation for many other such applications.

3.2 Designing the Choice Sets

Alpizar et al. (2001) discuss the application of choice experiments in non-market valuation. Their review provides a summary of the state of affairs at present in non-market valuation using choice experiments. In addition, Christie and Midmore (2002) review choice modeling as a valuation tool for use in environmental applications. Adamowicz and Boxall (2001) provide a description of the steps involved in conducting a choice experiment.

1. Characterize the decision problem
2. Select the relevant attributes and the levels they take
3. Develop experimental design
4. Develop questionnaire
5. Size sample and collect data
6. Build model and estimate
7. Conduct policy analysis and build a decision support system/tool

Thus far, this paper has considered the first of the seven steps presented. That is, it has defined, broadly, the decision problem being considered. The following three

questions summarize the research problem in water supply improvement planning, as discussed above.

- What is the willingness to pay for water improvements?
- How do different improvements meet demand?
- To what degree are conceivable water service improvements able to recover their associated costs?

The remainder of the paper discusses issues pertaining to the remaining steps.

3.2.1 Attribute selection

This section considers the second step involved in employing a choice model. That is, the determination of the attributes that characterize available alternatives in the improvement of water supply. It should be noted that the reasoning presented here is general and drawn from international experience as presented in the water supply and sanitation planning literature. The specifics of the attributes to be selected, and the levels which they take, required specialist input and focus group involvement as is often the case (e.g. Hyde et al., 2001). Table 3.1 shows the relevant attributes of water supplies in Trinidad and Tobago, together with the levels they took in this study.

Table 3.1 shows that there are 7 attributes, which are used to define a single water supply alternative. Two choice set designs were developed; for respondents with and without in house connections from the water utility. The first, for those with connections, included all attributes except those relating to the upgraded service, level of service and connection fee, as those were assumed to be irrelevant.

The water quality supplied in an offered alternative will affect the respondents' preference of that alternative. If the quality is low, the WTP will be reduced, however, the reduction might not be sufficient to justify a higher quality. For

instance, if the majority of household water is used for cleaning and bathing, the quality demanded may not require treatment for aesthetics of the water supply. This is dependent, however, upon the respondents understanding that though aesthetically poor the water is still fit for most household uses. In such a situation, the respondent may derive more utility from utilizing multiple sources of water for their entire household demand, where the majority of the water used is from a piped network and is of relatively low quality, and a minority of high quality water is supplied through alternative sources, such as vendors or bottled water.

Table 3.1: Choice set attributes with description

Attribute name	Description	Levels of attribute
Pressure	Pressure was treated as a qualitative variable as it was felt that the respondents would not be able relate to quantitative measures. A qualitative description of the levels was provided earlier in the survey	Low Average High
Quality	Quality was again described qualitatively. The assessment of quality could then be related to earlier responses about current quality levels which were described in terms of aesthetic and disease vector impacts on usage	Low Medium High
Reliability – days	Reliability was classed as two separate variables with the days variable used to describe the number of times (days) per week on which water was available	One Four Seven
Reliability – hours	The reliability hours variable was used to describe the duration in a given day where water was available that it was available during that day	2 12 24
Connection fee	The connection fee variable was used only in choice sets applied to those without individual connections and described a one time fee (in TT$) which would be paid for access to the water system	0 300 600
Level of Service	Level of service described the proximity of the service connection to the home	Standpipe connection In house connection
Price	Price was quoted as a quarterly bill (in TT$) as is currently the practice in Trinidad and Tobago	50 150 250 350 450

The degree to which a proposed improvement will allow for water on demand will affect the WTP of survey respondents. This ability to serve water 'on demand' is related to the reliability of the proposed change. This was assessed by defining two separate attributes given the assumed role that local or household level storage facilities could play in buffering inadequate reliability from the utility. The number of days per week, together with the number of hours per day, can be then used to calculate the level of service in terms of hours per week, which is of interest given that this is a common metric of reliability used in Trinidad and Tobago (WASA, 2002). If a household values control over their supply, that is, if a household does not trust the supplying utility, they may prefer a service option which offers a lower reliability, in terms of water available in the network, as they can mitigate this through the installation of tanks locally, provided that the cost of such a supply is correspondingly lower. The ramification of this point is interesting. Water distribution networks build communal storage facilities to ensure reliability of supply. It would be assumed that such central storage is efficient due to scale and so depending upon the confidence that households place in the utility, to manage such storage facilities, they may prefer some combination which results in private storage facilities.

Ease of access to water supply will also determine the WTP of the users. If the water collection point is far from the point of use, usually the home, the WTP for the improvement may be quite low. This feature has been observed in numerous studies, where the WTP of users for in-house connections, despite low incomes, is considerable in relation to their willingness to pay for standpipes (e.g. Gulyani et al., 2002, McPhail, 1993a). As such, the mode of water delivery will affect WTP. A standpipe requires that the user travel a distance away from the home, and often wait in a queue, to collect water. A private house tap is the highest level of service and implies a connection inside the house, which is not shared. Yard tap levels of service were not included as they were viewed as only superficially different from in-house connections by the national regulator, the Regulated Industries Commission (RIC). Often yard tap connectors simply install plumbing

works in their homes and use the yard tap to fill storage tanks to feed internal water consumption and so there is little difference in the water demanded by such houses compared to houses with registered in-house connections.

The pressure attribute was included as it was hypothesized that the pressure, affecting flow rates, will impact the time taken to collect water. For example, at a standpipe, lower pressures would mean longer queuing times and so would directly impact the convenience of water abstraction.

Levels for the price attribute were arrived at in discussion with the RIC. It was felt that the prices taken by non-status quo alternatives in the choice sets should be somewhat related to current average bills.

Other attributes were considered in the design of the choice sets. The management arrangements were considered as possibly affecting the willingness to pay of users. However, given the recent negative experience with private sector participation in the country, it was decided that this attribute should be left out. Also, attributes which quantified the amount of water available in some period of time were also considered. Here it was felt that the difficulty in assessing current usage at the household level, owing to the lack of domestic metering in the country, would make respondent valuation of the attribute difficult. Finally, the frequency of billing was considered as a possible determinant of WTP of users. It was not included as general discussions with the RIC and in focus groups indicated that affordability of water rates would not be a major problem and so the benefits of making bill payments more frequent would be minimal.

3.2.2 Experimental Design

Ideally all possible combinations of attributes would be tested on each respondent in what is known as a full factorial design. This would allow for the complete testing of interaction effects between attributes. As is easily noted, however, such a design would require $3^5 7^1 2^1$, 3402, different combinations. This is, clearly, not

feasible from an implementation standpoint. Therefore, experimental design methods (e.g. Winer et al., 1991) are required to ensure that the combinations of attributes used in the survey design result in observations with desirable statistical properties.

As the full factorial cannot be used in the experimental design a fractional factorial must be selected (Louviere et al., 2000). In such a design only a portion of all possible combinations of attributes are tested. The result is that only main effects, and perhaps two way interactions, may be tested. That is, the effect of a change in reliability on the probability of participation in a particular alternative can only be estimated alone, rather than with changes in other attributes as well. This may still result in a very large survey tool still, and so the required combinations, for testing main effects, may need to be split into blocks and different versions of the choice experiment administered to different proportions of the survey sample. Hensher et al. (2001) show that there is little effect on the reliability of the model estimates when the number of choice sets, given to each respondent, is varied, and conclude that 16 to 24 treatments, per respondent, are quite workable from the perspective of respondent fatigue and this was used as a guide to establishing a reasonable limit to the choice set size. Ideally this would be verified experimentally by providing for a split sample with different choice set sizes and/or different ordering of the question modules. Such an experimental verification of respondent fatigue however adds considerably to the administrative and logistic complexity of the survey administration. Given the other novel aspects of the questionnaire and a policy requirement that the questionnaire cover not only water supply but also sewerage services and electricity, the interesting statistical test suggested was deemed to be beyond the scope of this work.

Conventionally, discrete choice experimental designs have been developed from linear design theory (Kuhfeld et al., 1994), resulting in suboptimal designs. Efficient experimental designs have been, and continue to be, discussed in the literature (Kuhfeld et al., 1994, Huber and Zwerina, 1996).

In order to create choice experiments a number of methods are available. Manual methods, using tabled linear designs (e.g. Addelman, 1962) as starting point, can be used, but may not be able to estimate complex effects (Chrzan and Orme, 2000). Alternatively, designs randomized for each respondent can be used. The CBC software package by Sawtooth Software uses this method for deriving choice sets (Chrzan and Orme, 2000). Finally, computerized searches can be used to derive statistically efficient designs. This is the method employed by a macro packaged developed in the SAS language (Kuhfeld, 2002). A good design is one that is orthogonal, where each effect is estimable independent of each other effect, and balanced, where each level occurs equally often in the choice sets. Balance implies that the intercept of the model is orthogonal to the other effects (Kuhfeld, 1997). The SAS macros are able to find efficient designs where orthogonal solutions are not available. This allows for the design of experiments where attributes have different numbers of levels. As well, the SAS macros allow for designs accounting for utility balance (Huber and Zwerina, 1996) amongst alternatives in particular choice set. Given the comprehensive nature of SAS experimental design macros, and specifically the ability of such macros to generate efficient designs where attributes are unbalanced, this work used the SAS macros to develop the choice set designs used in this study.

Central to the application of a utility balanced design, where alternatives offered to respondents are almost of equal utility, is the prior knowledge of the β parameters. This, of course, is the purpose of the experiment in the first place and so it is not possible to know the vector of β with any accuracy prior to the survey. Huber and Zwerina (1996) suggest pre-tests of the surveys be used to develop an estimate of the prior part-worths. Alternatively, managers prior beliefs can be used as an estimate of the priors defining the demand function to be estimated (Sandor and Wedel, 2001). In the case of choice experiments, where focus groups are to be used, as is this case with this research, it is possible that these parameters can be estimated through a ranking procedure employed in the

focus group setting. This potentiality requires further exploration. The use of priors in the experimental design has been shown to result in up to 50% savings in the number of respondents needed for equivalent statistical power (Huber and Zwerina, 1996), and so this issue deserves exploration.

The SAS macros were used to generate generic designs, as there was considered to be little or no brand effect associated with the choice of a particular alternative. Labelled designs allow for the testing of more complicated models, and specifically will allow to verify that the there is no systematic difference between the generic alternatives used in the choice sets. Generic designs require smaller choice sets than labelled designs for similar levels of statistical precision, and so imply either smaller samples, as blocking of the samples may not be required, or higher significance in the estimated parameters.

Interactions are when two or more attributes interact with one another to affect utility, usually the interaction is considered as a multiplicative one. In linear models, such interaction effects may account for up to 30% of the explained variance, making the consideration of their inclusion very important. Two-way interactions generally account for between 5 and 15 per cent of explained variance (Louviere et al., 2000) and so it is often justifiable to consider only these, along with the main effects. This study chose a main effects design due primarily to concerns about respondent cognitive ability and associated difficulties in administering long choice sets. If interaction effects were to be estimable the number of choice sets per respondent would increase considerably. As the choice sets formed only a part of the total questionnaire, it was felt to be important to prevent this section from growing to occupy an overly large proportion of the total questionnaire. The choice sets used in this study are presented in appendix C.

3.3 Field Procedures

3.3.1 Sampling Methodology

The design of an appropriate sample is critical to ensure that the data collected through the survey process is sufficiently representative of population characteristics. Particularly, as this survey was to be relevant for the entire national population, ability to generalize the results required a sufficient sample size correctly selected. As the primary purpose of the survey was to study water service and sewerage characteristics in the population, stratification of the sample along service level would be ideal. Available level of service information, however, is inaccurate and so the potential benefits, a representative sample, would be counteracted by a biased sample frame. The sample frame and methodology used by the Continuous Sample Survey of Population (CSSP) of the Central Statistical Office (CSO, 1987) was therefore used as the sample frame. This methodology uses the national population as a sample frame and a two stage stratification scheme. The first stratum is by geographic region. This is appropriate for this study given a presupposed variation in water and electricity service level by geographic region. The second stratum is by labour characteristics of the population as the CSSP is primarily a labour force study. Such stratification may introduce bias if the level of utility service is not correlated with the characteristics of the labour force at the cluster level. Finally clusters, enumeration districts (EDs), are sampled proportional to size from the strata and random clusters of households selected in the sampled EDs. It was felt that the cost and time savings associated with the choosing of the CSSP sample design were sufficient that it be used over a purpose built sample frame. This choice was reinforced by the fact that to build a sample frame would entail the introduction of significant bias in that current levels of service are only roughly known by the utility. That is, a purpose built sample frame would reduce only marginally, if at all, the bias in the sample design.

The total sample size for the study was 1419 households in both Trinidad and Tobago. In Trinidad 1281 households were selected, giving a sample fraction of 0.4% and in Tobago 138 households were selected amounting to a sampling fraction of 0.9%. The unit non-response rates, including vacant buildings and non existent buildings, for Trinidad was 12% and 16% in Tobago. For the entire study the non response rate amounted to 12.5%. This can be attributed to errors in the listing records, and constraints on the number of call backs possible. In certain remote regions of the country, unit non-response was inevitable given the difficult access. Figure 3.2 shows a map of the sample distribution in Trinidad. Figure 3.3 shows the same for Tobago.

A visual inspection of Figure 3.2 shows that households in all the wards of Trinidad were surveyed, with the exception of three. Those not selected in the sample selection process were Trinity, Turure and Matura. One parish in Tobago also was not selected in the sampling process; the Parish of St. John. In Trinidad the sample sizes are larger in the North-West and South, due to the higher population densities in these areas. Similarly the South-West corner of Tobago has a larger sample size due to its higher population density.

Errors in the collected data can be attributed to sampling errors and non-sampling errors. Sampling errors include errors due to the random variation in sample means. Higher proportions of respondents, who answer a particular question, decrease the sampling error. In cases where a small subsample is taken to measure a phenomenon, the sampling error is higher. Therefore, in estimating the percentage of households which obtain water primarily from river or pond sources, the estimates in this survey will be more uncertain, due to the small number of such households, than the similar estimates for the proportion of households depending upon an in house water connection for their primary source.

Non sampling errors are associated with errors arising from strategic action of the respondents, partial non-response of questionnaires, and gross error, such as mistaken exclusion of particular questions, by enumerators.

Non sampling errors are controllable through strict supervision and field controls whilst sampling errors are a structural feature of the process. As the primary constraint on sample design was cost, the sample was not designed for specific levels of sampling error in specific questions but rather an efficient level of error is expected by maximizing the sample size subject to a fixed budget. Non sampling error, however, was under the direct control of the survey management team and was restricted through the tight control of data collection, with call backs made by supervisors where data was uncertain and thorough survey verification by both field supervisors and in office managers.

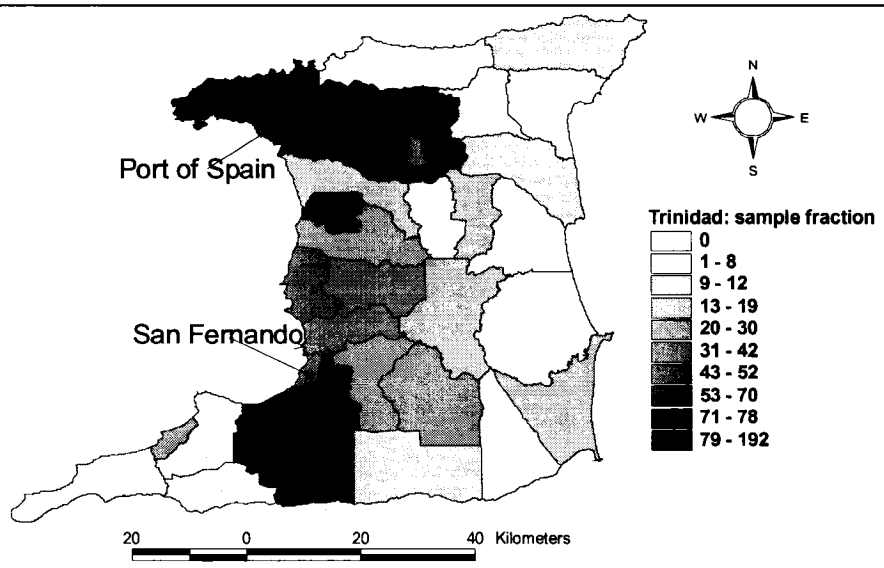

Figure 3.2: Sample distribution in Trinidad

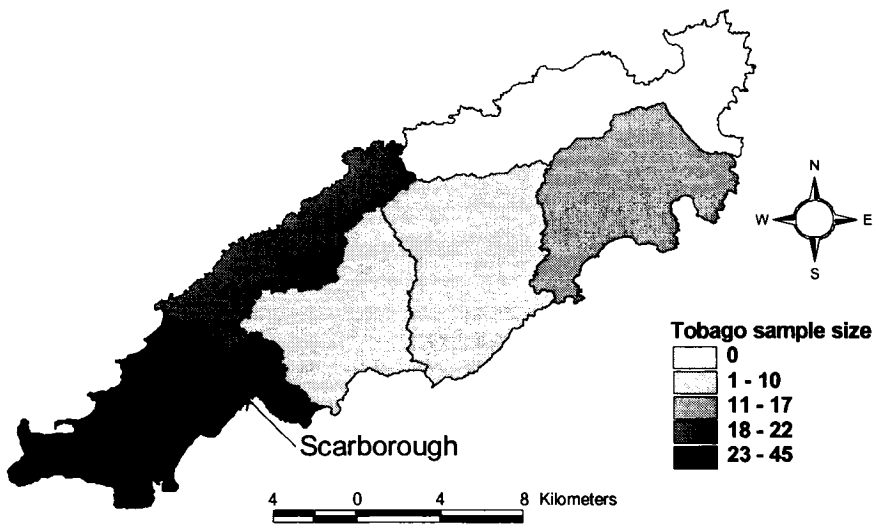

Figure 3.3: Sample distribution in Tobago

3.3.2 Questionnaire Design and Implementation

There were four main sections in the questionnaire:

- Household water supply characteristics
- Wastewater/ sanitation facilities
- Electricity characteristics
- Household socioeconomic variables

The first three sections attempt to meet the objectives outlined above, concerning utility services, and the final section seeks to add context to estimates derived in the preceding sections. Each of the water, wastewater, and electricity sections have both a revealed preference section and a stated preference section, though as has been noted, the monopoly effects of the utility franchise restrict choice sufficiently that the revealed preferences of the respondents are reduced to a measure of the state of the utility service. The stated preference sections in all of the utility sections utilize the CV method to estimate the WTP for service changes of respondents. The water section in addition has choice models to ascertain the same for water.

The draft questionnaire was reviewed by sectoral experts with the aim of maximizing relevance. The tool was then tested in a pilot scale survey nationally. The pilot survey used 60 surveys and the enumerators hired for the full survey to assess the relevance of the questionnaire content. Out of this exercise, the choice models were simplified as many respondents in the pilot experienced difficulty in answering the choice models, given the complexity of the process. As well, flashcards were designed, to act as a visual aid for the choice models during the field process.

The questionnaire was administered over the May 7, 2003 to June 14, 2003 period in Trinidad and from June 1, 2003 to June 8, 2003 in Tobago. The Trinidad portion of the survey was implemented by 30 enumerators hired from the pool of enumerators used by the Central Statistical Office (CSO). The enumerators, whilst experienced in general survey techniques required extra training in the technical aspects of this survey and so a one day training session was held in Port of Spain at the RIC offices on April 22, 2003. The island was divided into six regions and each region was supervised by one supervisor who had also received training specific to this questionnaire. The Supervisor training took place on April 21, 2003. As well, three data entry clerks were trained separately in the use of proprietary data entry interface. Raw data entry was completed by June 27, 2003. A full timeline of activities is shown in Appendix A.

REFERENCES for literature review and methodology

1. Abou-Ali, H., Carlsson, F., *Evaluating the welfare effects of improved water quality using the choice experiment method*, Working Papers in Economics, No. 131, Department of Economics, Gothenburg University, Gothenburg, Sweden, 2004.

2. Adamowicz, W., Boxall, P., *Future directions of stated choice methods for environmental valuation*, Department of Rural Economy, University of Alberta, Edmonton, Canada, 2001.

3. Adamowicz, W., Boxall, P., Williams, M., Louviere, J., Stated preference approaches for measuring passive use values: Choice experiments and contingent valuation, *American Journal of Agricultural Economics*, Vol. 80, pp. 64-75, 1998.

4. Adamowicz, W., Boxall, P., Williams, M., Louviere, J., *Stated Preference Approaches for Measuring Passive Use Values: Choice experiments versus contingent valuation*, Staff Paper, Department of Rural Economy, University of Alberta, Edmonton, Canada, 1995.

5. Addelman, S. Orthogonal main effects plans for asymmetrical factorial experiments, *Technometrics*, Vol. 4, pp. 21-46, 1962.

6. Ahmed, J., Goldar, B.N., Misra, S., Jakariya, M., *Willingness to Pay for Arsenic-Free, Safe Drinking Water in Bangladesh*, Water and Sanitation Program – South Asia, New Dehli, India, 2003.

7. Alpizar, F., Carlsson, F., Martinsson, P., *Using choice experiments for non-market valuation*, Working Papers in Economics No. 52, Department of Economics, University of Goteborg, Sweden, 2001.

8. Al-Qunaibet, M., Johnston, R., Municipal demand for water in Kuwait: Methodological issues and empirical results, *Water Resources Research*, Vol. 21, No. 4, pp. 433-438, 1985.

9. Altaf, A., Whittington, D., Jamal, H., Smith, V.K., Rethinking rural water supply policy in the Punjab, Pakistan, *Water Resources Research*, Vol. 29, No. 7, pp. 1943-1954, 1993.

10. Altaf, M., and Hughes, J., Measuring the demand for improved urban sanitation services: Results from a contingent valuation study in Ouagadougou, Burkina Faso. *Urban Studies*, Vol. 31, No. 10, pp.1763-1776, 1994.

11. Altaf, M., Jamal, H., Whittington, D., *Willingness to pay for water in rural Punjab, Pakistan.* Water and Sanitation Report 4. Water and Sanitation Program. World Bank, 1992.

12. Altaf, M.A., Household demand for improved water and sanitation in a large secondary city: Findings from a study in Gujranwala, Pakistan, *Habitat International*, Vol. 18, No. 1, pp. 45-55, 1994.

13. Anand, P.B., *Consumer preferences for water supply? An application of choice models to Urban India,* Discussion Paper No. 2001/145, United Nations University, Helsinki, Finland, 2001.

14. Arrow, K.J., Solow, R., Portney, P.R., Leamer, E.E., Radner, R., and Schuman, E.H., Report of the NOAA panel on contingent valuation, *Federal Register*, Vol. 58, pp. 4602-4614, 1993.

15. Atwal, H. A two-stage approach to a concession in the water sector, Trinidad and Tobago Experience, Presented at Symposium on Water Regulatory Policy – Jamaica, April, 2002.

16. Bateman, I. and Willis, K. (eds.), *Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU and Developing Countries*, Oxford University Press, Oxford, UK, 1999.

17. Bateman, I.J., Langford, I.H., Rasbash, J., Willingness to pay question format effects in contingent valuation studies, in *Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU and Developing Countries*, Bateman, I. and Willis, K. *(eds)*, Oxford University Press, Oxford, UK, 1999.

18. Ben-Akiva, M., McFadden, D., Train, K., Walker, J., Bhat, C., Bierlaire, M., Bolduc, D., Boersch-Supan, A., Brownstone D., Bunch, D., Daly, A., De Palma, A., Gopinath, D., Karlstrom, A., Munizaga, M., Hybrid Choice Models: Progress and Challenges, *Marketing Letters*, Vol. 13, No. 3., pp. 163-175, 2002.

19. Black, M., *Learning What Works: A Twenty Year Retrospective View on International Water and Sanitation Cooperation*, Water and Sanitation Program, World Bank, Washington DC, 1998.

20. Blamey, R, Bennett, J, Morrison, M, Yea-saying in contingent valuation surveys, *Land Economics*, Vol. 75, No. 1, pp. 126-142, 1998.

21. Blamey, R., Gordon, J. an Chapman, R., Choice modelling: Assessing the environmental values of water supply options, *Australian Journal of Agricultural and Resource Economics*, Vol. 43, No. 3, pp 337-356, 1999.

22. Boxall, P., Adamowicz, W., Swait, J., Williams, M., Louviere, J., A comparison of stated preference methods for environmental valuation, *Ecological Economics*, 18, 243-253, 1996.

23. Boyle, K., Morisson, M., Taylor, L., Why value estimates generated using choice modelling exceed contingent valuation: Further experimental evidence, *Australian Agricultural and Resource Economics Society Conference*, Melbourne, Australia, 2004.

24. Briscoe, J., Furtado de Castro, P., Griffin, C., North, J. and Olsen, O., Toward equitable and sustainable rural water supplies: A contingent valuation study in Brazil, *The World Bank Economic Review*, Vol. 4, No. 2, pp. 115-134, 1990.

25. Briscoe, J., Garn, M., *Financing Agenda 21: Freshwater*, Paper prepared for the United National Commission on Sustainable Development, World Bank, Washington, DC, 1994

26. Briscoe, J., The changing face of water infrastructure financing in Developing Countries, *Water Resources Development*, Vol. 15, No. 3, pp. 301-308, 1999.

27. Bueren, M. and Bennett, J., Towards the development of a transferable set of value estimates for environmental attributes, *Australian Journal of Agricultural and Resource Economics*, Vol. 48, pp. 1-32, 2004.

28. Cairncross, S, *Sanitation and Water Supply: Practical Lessons from the Decade*. Discussion Paper No. 9, UNDP-World Bank Water and Sanitation Program, The World Bank, Washington, DC, 1992.

29. Carlsson, F. and Martinsson, P., Do hypothetical and actual marginal willingness to pay differ in choice experiments? *Journal of Environmental Economics and Management*, Vol. 41, pp. 179-192, 2001.

30. Carlsson, F. and Martinsson, P., *Does it matter when a power outage occurs? A choice experiment study on the willingness to pay to avoid power outages,* No. 155, Working Papers in Economics, Gothenburg University, Gothenburg, Sweden, 2004.

31. Centre for International Economics, *Review of willingness to pay methodologies*, Report for Independent Pricing and Regulatory Tribunal of NSW, 2001.

32. Christie M and Midmore P. *Choice experiments: a new approach to environmental valuation*. Edward Elgar Publishing: Cheltenham (in press 2002).

33. Chrzan, K and Orme, B., *An overview and comparison of design strategies for choice-based conjoint analysis*, Research Paper Series, Sawtooth Software, Sequim, WA, 2000.

34. Churchill, A., *Rural Water Supply and Sanitation: Time for a Change*, World Bank Discussion Paper No. 18, The World Bank, Washington, DC, 1987 .

35. Cooper, J., A comparison of approaches to calculating confidence intervals for benefit measures from dichotomous choice contingent valuation surveys, *Land Economics*, Vol., 70, No. 1, pp. 111-122, 1994.

36. Delcan International Corporation, *Feasibility study on Cost/Benefit Analysis of Universal Metering in Trinidad and Tobago*, Final Report, 1992.

37. Deverill, P., Bibby, S., Wedgewood, A., Smout, I., *Designing Water Supply and Sanitation Projects to Meet Demand in Rural and Peri-Urban Communities*, Water, Engineering and Development Centre, Loughborough University, 2002.

38. Diamond, P., Hausman, J., Contingent valuation: Is some number better than no number?, *Journal of Economic Perspectives*, Vol. 8, No. 4, pp. 45-64, 1994.

39. Efron, B., Tibshirani, R., *An Introduction to the Bootstrap*, Chapman and Hall, New York, 1993.

40. Fairweather-Morisson, I., *Solid Waste in Trinidad,* M.Sc. Thesis, UWI, St. Augustine, Trinidad, 2001.

41. Fisher, A. The conceptual underpinnings of the contingent valuation method, in *The Contingent Valuation of Environmental Resources*, Bjornstad, D. and Kahn, J. eds., Edward Elgar, Cheltanham, UK, 1996.

42. Foster, V. and Mourato, S., Elicitation format and sensitivity to scope: Do contingent valuation and choice experiments give the same results?, *Environmental and Resource Economics*, Vol. 24, pp. 141-160, 2003.

43. Goett, A., Hudson, K. and Train, K., Customers choice among retail energy suppliers: the willingness to pay for service attributes, *The Energy Journal*, Vol. 21, No. 4, pp. 191-215, 2000.

44. Goldblatt, M., Assessing the effective demand for improved water supplies in informal settlements: a willingness to pay survey in Vlakfontein and Finetown, Johannesburg, *Geoforum*, Vol. 30, pp. 27-41, 1999.

45. Griffin, C, Briscoe, J, Singh, B, Ramasubban, R, Bhatia, R, Contingent valuation and actual behavior: predicting connections to new water systems

in the state of Kerela, India, *World Bank Economic Review*, Vol. 9, No. 3, pp. 373-395, 1995.

46. Groothuis, P., Benefit transfer: A comparison of approaches, *Growth and Change*, Vol. 36, No. 4, pp. 551-564, 2005.

47. Gulyani, S., Talukdar, D. and Kariuki, M., *Water for the Urban Poor: Insights from Household Surveys in Kenya*, Water and Urban Region I, Africa Region, World Bank, 2002.

48. Haider, W. and Rasid, H., Eliciting public preferences for municipal water supply options, *Environmental Impact Assessment Review*, Vol. 22, pp. 337-360, 2002.

49. Hanemann, W.M. Theory versus data in the contingent valuation debate, *in The Contingent Valuation of Environmental Resources*, Bjornstad, D. and Kahn, J. eds., Edward Elgar, Cheltanham, UK, 1996.

50. Hanley, N., MacMillan, D., Wright, R., Bullock, C., Simpson, I., Parsisson, D., Crabtree, B., Contingent valuation versus choice experiments: Estimating the benefits of environmentally sensitive areas in Scotland, *Journal of Agricultural Economics*, Vol., 49, no. 1, pp. 1-15, 1998.

51. Hanley, N., Mourato, S., Write, R., Choice modelling approaches: A superior alternative for environmental valuation?, *Journal of Economic Surveys*, Vol. 15, No. 3, pp. 435-461, 2001.

52. Hausman, J.A. (ed.), *Contingent Valuation: A Critical Assessment*, Amsterdam; North Holland, 1993.

53. Hensher, D., Shore, N., and Train, K., *Households' willingness to pay for water service attributes*, Working Paper, 2005.

54. Hensher, D., Stopher, P., Louviere, J., An exploratory analysis of the effect of numbers of choice sets in designed choice experiments: an airline choice application, *Journal of Air Transport Management*, Vol. 7, pp. 373-379, 2001.

55. Hope, R.A and Garrod, G.D., Household preferences to water policy interventions in rural South Africa, *Water Policy*, Vol. 6, No. 6, pp. 487-499, 2004.

56. Howe, C., and Linaweaver, F.P., The impact of price on residential water demand and its relation to system design and price structure, *Water Resources Research*, Vol. 3, No. 1, pp. 13-32, 1967.

57. Huber, J. and Zwerina, K., The importance of utility balance in efficient choice designs, *Journal of Marketing Research*, Vol. 33, pp. 307-317, 1996.

58. Hyde, T., Christie, M., Midmore, P., Designing attribute bundles in choice experiments, Choice experiments: a new approach to environmental valuation' conference, available at: http://www.irs.aber.ac.uk/mec/CEconf.htm, 2001.

59. ICWE, *The Dublin Statement of Water and Sustainable Development*, International Conference on Water and the Environment, Dublin, Ireland, 1992.

60. Joint Monitoring Program (JMP), *Water for Life, Making it happen*, World Health Organization and UNICEF, Geneva, Switzerland, 2005.

61. Katzman, M., Income and price elasticities of demand for water in developing countries, *Water Resources Bulletin*, Vol 13, No. 1, pp. 47-55, 1977.

62. Kleemier, C., The Impact of Participation on Sustainability: An Analysis of the Malawi Rural Piped Scheme Program, World Development, Vol. 28, No. 5, pp. 929-944, 2000.

63. Kuhfeld, W, *Marketing Research Methods in the SAS System*, Version 9.0 edition, SAS Institute, 2003.

64. Kuhfeld, W., *Efficient experimental designs using computerized searches*, Research Paper Series, Sawtooth Software, 1997.

65. Kuhfeld, W., Tobias, R., Garrat, M., Efficient experimental design with marketing research applications, *Journal of Marketing Research*, Vol. 31, pp. 545-557, 1994.

66. Lauria, D.T., Whittington, D., Choe, K., Turngan, C., Abiad, V., Houshoeld demand for improved sanitation services: A case study of the Calamba, the Philippines, *in Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU and Developing Countries*, Bateman, I. and Willis, K. *(eds)*, Oxford University Press, Oxford, UK, 1999.

67. Lindsey, G. Planning contingent valuation: Some observations from a survey of homeowners and environmentalists, *Journal of Planning Education and Research*, Vol. 14, pp.19-28, 1994.

68. London Economics, *WASA Tariff Study*, Final Report, 1998.

69. Loomis, J., Ekstrand, E., Aplternative approaches for incorporating respondent uncertainty when estimating willingness to pay: the case of the Mexican spotted owl, *Ecological Economics*, Vol. 27, pp. 29-41, 1998.

70. Louviere, J and Hensher, D.A, On the design and analysis of simulated choice or allocation experiments in travel choice modeling, *Transportation Research Record,* No. 890, pp. 11-17, 1982.

71. Louviere, J and Woodsworth, G., Design and analysis of simulated consumer choice or allocation experiments: An approach based on aggregate data, *Journal of Marketing Research*, Vol. 22, pp. 1-19, 1983.

72. Louviere, J., *Analyzing Decision Making: Metric Conjoint Analysis*, Sage University Paper 67, 1988.

73. Louviere, J., Hensher, D., Swait, J., *Stated Choice Methods: Analysis and Application*, Cambridge University Press, Cambridge, UK, 2000.

74. Louviere, J., Street, D., Carson, R., Ainslie, A., Deshazo, J.R., Cameron, T., Hensher, D., Kohn, R., Marley, T., Dissecting the Random Component of Utility, *Marketing Letters,* Vol. 13, No. 3., pp. 177-193, 2002.

75. MacDonald, D., Barnes, M., Bennett, J., Morrison, M., Young, M., *What consumers value regarding water supply disruptions: A discrete choice analysis?*, Working Paper, CSRIO, Australia, 2004.

76. Maddala, G.S. *Limited Dependent and Qualitative Variables in Econometrics*, Econometric Society Monographs, Cambridge University Press, Cambridge UK, 1983.

77. Martin, W., and Kulakowski, S., Water price as a policy variable in managing urban water use: Tucson, Arizona, *Water Resources Research*, Vol. 27, No. 2, pp. 157-166, 1991.

78. McFadden, D. Conditional logit analysis of qualitative choice behaviour, in *Frontiers of Econometrics*, Zarembka P. ed., Academic Press, New York, 1974.

79. McFadden, D., Disaggregate behavioural travel demand RUM's side, A 30-year retrospective, Paper presented at International Association of Travel Behaviour Analysts, Brisbane, Australia, July 2000.

80. McFadden, D., Econometric Models of Probabilistic Choice. In *Structural Analysis of Discrete Data with Econometric Applications*, C. Manski and D. McFadden (eds.), MIT Press, Cambridge, MA, pp. 198-272, 1981.

81. McFadden, D., Epilogue, *Marketing Letters*, Vol. 13, No. 3, pp. 307-310, 2002.

82. McPhail, A., Overlooked market for water connections in Rabat's shantytowns, *Journal of Water Resources Planning and Management*, Vol. 119, No. 3, pp. 388-404, 1993a.

83. McPhail, A., The 'five percent rule' for improved water service: can households afford more? *World Development*, Vol. 21, No. 6, pp 963-973, 1993b.

84. Mehta, M., Fugelsnes, T., Virjee, K., Financing the Millennium Development Goals for water and sanitation: What will it take?, *Water Resources Development*, Vol. 21, No. 2, pp. 239-252, 2005.

85. Menendez, A., *Access to Basic Infrastructure by the Urban Poor*, EDI Policy Seminar Report, World Bank, Washington, DC, 1991.

86. Merrett, S., Deconstructing Households' Willingness to Pay for water in low income countries, *Water Policy*, Vol. 4, pp 157-172, 2002.

87. Mitchell R.C. and Carson, R. *Using Surveys to Value Public Goods: The Contingent Valuation Method*, Resources for the Future, Washington, DC, 1989.

88. Mogas, J., Riera, P., Bennett, J., *A Comparison of Contingent Valuation and Choice Modelling: Estimating the Environmental Values of Catalonian Forests*, Occasional Paper No 1., Australian National University, Canberra, Australia, 2002.

89. Morrison, M, Blamey, R., Bennett, J., Louviere, J., *A Comparison of Stated Preference Techniques for Estimating Environmental Values*, Research Report No. 1, Choice Modelling Research Reports, Asia Pacific School of Economics and Management, 1996.

90. Morrison, M. and Bennett, J., Valuing New South Wales rivers for use in benefit transfer, *Australian Journal of Agricultural and Resource Economics*, Vol. 48, pp. 591-611, 2004.

91. Morrison, M., Bennett, J., Blamey, R., Louviere, J., Choice modeling and tests of benefit transfer, *American Journal of Agricultural Economics*, Vol. 84, No. 1, pp. 161-170, 2002.

92. Morrisson, M.D., Bennett, J., Blamey, R., Louviere, J., *Choice modelling and benefit transfer*, Research Report No. 8, Choice Modelling Research Reports, Asia Pacific School of Economics and Management, 1998.

93. Mu, X., Whittington, D., Briscoe, J., Modeling Village Water Demand Behaviour: A Discrete Choice Approach, *Water Resources Research*, Vol. 26, No. 4, pp. 521-529, 1990.

94. Mycoo, M. (1996). *Water Provision Improvements: A Case Study of Trinidad.* PhD Thesis, School of Urban Planning, McGill University.

95. Nankani, H, Testing the waters – A phased approach to a water concession in Trinidad and Tobago, *Public Policy for the Private Sector*, Note No. 103, World Bank, Washington, DC, 1997.

96. Persson, TH., *Demand for water and sanitation in Bangladesh*, Working Paper, Department of Economics, Lund University, Sweden, 1998.

97. Poe, G., Giraud, K., Loomis, J. Computational methods for measuring the difference of empirical distributions, *American Journal of Agricultural Economics*, Vol. 87, No. 2, pp. 353-365, 2005.

98. Poe, G., Welsh, M., Champ, P., Measuring the difference in means willingness to pay when dichotomous choice contingent valuation responses are not independent, *Land Economics*, Vol. 73, No. 2, pp. 255-267, 1997.

99. Poe, GL., Severance-Lossin, EK., Welsh, MP., Measuring the difference (X-Y) of simulated distributions: a convolutions approach, *American Journal of Agricultural Economics*, Vo. 76, pp. 904-915, 1994.

100. Powe, N.A., Garrod, G.D., McMahon, P.L., Willis, K.G., Assessing customer preferences for water supply options using mixed methodology choice experiments, *Water Policy*, Vol. 6, No. 5, pp. 427-441, 2004.

101. Randall, A., Ives, B. and Eastman, C., Bidding games for valuation of aesthetic environmental improvements, *Journal of Environmental Economics and Management*, Vol. 1, pp. 132-149, 1974.

102. Ready, R., Whitehead, J, Blomquist, G., Contingent valuation when respondents are ambivalent, *Journal of Environmental Economics and Management*, Vol. 29, No. 2, pp. 181-197, 1995.

103. Reddy, R., Pricing of rural drinking water: A study of willingness and ability to pay in western India, *Journal of Social and Economic Development*, Vol. II, No. 1, pp. 101-122, 1999.

104. Reddy, R., Quenching the Thirst: The Cost of Water in Fragile Environments, *Development and Change*, Vol. 30, pp. 79-113, 1999.

105. Revelt, D. and Train, K., Customer-specific taste parameters and mixed logit: Households' choice of electricity supplier, Working Paper, Department of Economics, University of California – Berkeley, 2000.

106. Rhoads, S.S., 1985, *The Economist's View of the World: Governments, Markets and Public Policy*. Cambridge, UK, Cambridge University Press, referenced in Young 1996.

107. Rolfe, J., Bennett, J., Louviere, J., Choice modeling and its potential application to tropical rainforest preservation, *Ecological Economics*, Vol. 35, pp. 289-302, 2000.

108. Ryan, M., A comparison of stated preference methods for estimating monetary values, *Health Economics*, Vol., 13, pp. 291-296, 2004.

109. Sandor, Z and Wedel, M., Designing conjoint choice experiments using managers prior beliefs, *Journal of Marketing Research*, Vol. 38, pp. 430-444, 2001.

110. Sara, J. and Katz, T., *Making Rural Water Supply Sustainable: Report on the Impact of Project Rules*, Water and Sanitation Program, World Bank, Washington, DC, 1998..

111. Saunders, R. and Warford, J., *Village Water Supply: Economics and Policy in the Developing World*, World Bank, Washington, DC, 1976.

112. Schroeder, H., Louviere, J., Stated choice methods for predicting the impact of fees at public recreation sites, *Journal of Leisure Research*, Vol. 31, No. 3, pp. 300-324, 1999.

113. Singh, B., Ramasubban, R., Bhatia, R., Briscoe, J., Griffin, C., Kim, C., Rural Water Supply in Kerala, India: How to Emerge from a Low Level Equilibrium Trap, *Water Resources Research,* Vol. 29, No. 7, pp. 1931-1942, 1993.

114. Solo, T.M., Small scale operators in the urban water and sanitation market, *Environment and Urbanization*, Vol. 11, No. 1, pp. 117-131, 1999.

115. Stevens, T.H., Belkner, R., Dennis, D., Kittredge, D., Willis, C., Comparison of contingent valuation and conjoint analysis in ecosystem management, *Ecological Economics*, Vol. 32, pp. 63-74, 2000.

116. Stiggers, D., Private participation in water and wastewater services in Trinidad and Tobago, in *Can Privatization Deliver? Infrastructure for Latin America*, eds Basanes, F., Uribe, E., Willig, R., Inter-American Development Bank, Washington, DC, 1999.

117. Sugden, R., Public Goods and Contingent Valuation, *in Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU and Developing Countries*, Bateman, I. and Willis, K. *(eds)*, Oxford University Press, Oxford, UK, 1999.

118. Swallow, S., Weaver, T., Opaluch, J., Michelman, T., Heterogeneous preferences and aggregation in environmental policy analysis, *American Journal of Agricultural Economics*, Vol. 77, pp. 613-619, 1994.

119. Swedish International Water Institute (SIWI), *Making water a part of economic development: The economic benefits of improved water management and services*, Paper prepared for the United National Commission on Sustainable Development, SIWI, Stockholm, Sweden, 2005.

120. Thurstone, L.L., A law of comparative judgement, *Psychological Review*, Vol.4, pp. 273-286, 1927.

121. Train, K., *Discrete Choice Methods with Simulation*, Cambridge University Press, Cambridge, UK, 2003.

122. Train, K., *Qualitative Choice Analysis*, MIT Press, Cambridge, MA, 1986

123. Van Kooten, G.C., Krcmar, E. and Bulte, E., Preference uncertainty in non-market valuation: A fuzzy approach, *American Journal of Agricultural Economics*, Vol. 83, No. 3, pp. 487-500, 2001.

124. Water and Sanitation Program – South Asia, *Willing to Pay but Unwilling To Charge: Do 'willingness to pay studies' make a difference?*, World Bank, New Dehli, India, 1999.

125. Water and Sewerage Authority (WASA), *State of the Utility*, Status Report, 2002.

126. Webster, M., *Effective Demand for Rural Water Supply in South Africa, Water*, Engineering and Development Centre, Leicestershire, UK, 1999.

127. Wedgewood, A. and Sansom, K., *Streamlined Approach to Willingness to Pay Surveys: Guidance Note for Small Town Water Services*, Water, Engineering and Development Centre, Loughborough University, 2003.

128. Whittington, D. Mu, X., Roche, R., *The Value of Time Spent Collecting Water, Some Estimates for Ukunda Kenya*, Infrastructure and Urban Development Department, World Bank, Washington, DC, 1989.

129. Whittington, D., Briscoe, J., Mu, X. and Baron, W., Estimating the willingness to pay for water services in developing countries: A case study

of the use of contingent valuation surveys in southern Haiti. *Economic Development and Cultural Change*, Vol. 38, pp. 293-311, 1990.

130. Whittington, D., Briscoe, J., Mu, X., *Willingness to pay for water in rural areas: Methodological approaches and an application in Haiti*, Wash Field Report No. 213, US Agency for International Development, Washington, DC, 1987.

131. Whittington, D., Improving the performance of contingent valuation studies in developing countries, *Environmental and Resource Economics*, Vol. 22, pp. 323-367, 2002.

132. Whittington, D., Okorafor, A., Okore, A., McPhail, A., Strategy for cost recovery in the rural water sector: A case study of Nsukka District, Anambra State, Nigeria, *Water Resources Research*, Vol. 26, No. 9, pp. 1899-1913, 1990.

133. WHO, *Domestic Water Quantity: Service Level and Health*, Geneva, Switzerland, 2003.

134. Winer, B.J., Brown, D., Kenneth, M., *Statistical Priniciples in Experimental Design*, McGraw-Hill Series in Psychology, New York, NY, 1991.

135. Winpenny, J., *Financing Water For All*, Report of the World Panel of Financing Water Infrastructure, 2003.

136. World Bank Water Demand Research Team., The demand for water in rural areas: Determinants and policy implications. *World Bank Research Observer*, 8, 47-70, 1993.

137. World Bank, *Village Water Supply*, Washington DC, 1976.

138. Yepes, G. and Dianderas, A., *Indicators: Water and Wastewater Utilities*, 2nd edition, World Bank, Washington, D.C., 1996.

139. Young, R.. *Measuring Economic Benefits for Water Investments and Policies*. World Bank Technical Paper No. 338. World Bank, Washington, DC, 1996 .

140. Zerah, M.-H., Water: *Unreliable Supply in Dehli*, Manohar Publishers and Distributors, New Dehli, 2000.

4 PAPER 1

Coping with poor water services and the demand for change in Trinidad and Tobago

4.0 ABSTRACT

Trinidad and Tobago, a two island nation in the Eastern Caribbean, has approximately 1.3 million residents who depend upon the Water and Sewerage Authority (WASA) for access to water supply and sewerage services. Service levels have been inadequate through the recent past, largely due to a lack of investment in utility infrastructure. A willingness to pay study was conducted to ascertain the degree to which residents of the nation would accept water tariff increases. Further, the survey assessed the degree of coverage and quality of service provided by the utility. The results of this survey, a picture of current service levels and the willingness to pay for service level changes, are presented. The implications for rate increases, and the resulting availability of revenue for infrastructure finance are also briefly discussed.

4.1 Introduction

Access to clean water supplies in sufficient quantities has considerable and immediate impacts on public health. As well, convenient access to water can result in significant time savings and so economic benefits to a household. Therefore, the sustainable provision of this service to households is of critical importance in all countries.

Trinidad and Tobago has about 1.3 million residents in 340 000 households, with almost 1.2 million of those citizens residing on the larger island; Trinidad. Figure 4.1 shows a map of the two islands with the major cities and towns marked. The residents of the country are supplied water by the Water and Sewerage Authority (WASA) which was formed in 1965 by an act of Parliament. Under the Act the utility is responsible for both the expansion and maintenance of waterworks, to supply all residential, commercial and industrial water demands, as well as for water resources management. Private developers and the National

Housing Authority (NHA) are required to provide sanitation facilities in their housing developments and the utility oversees the permitting of those systems. Domestic users account for 36% of the total water usage in the country and unaccounted for water of about 50% being the largest user. Industrial and agricultural water use makes up the rest of the total water abstracted. Unlike many countries, the agriculture sector demands only a minor portion of the total water demand.

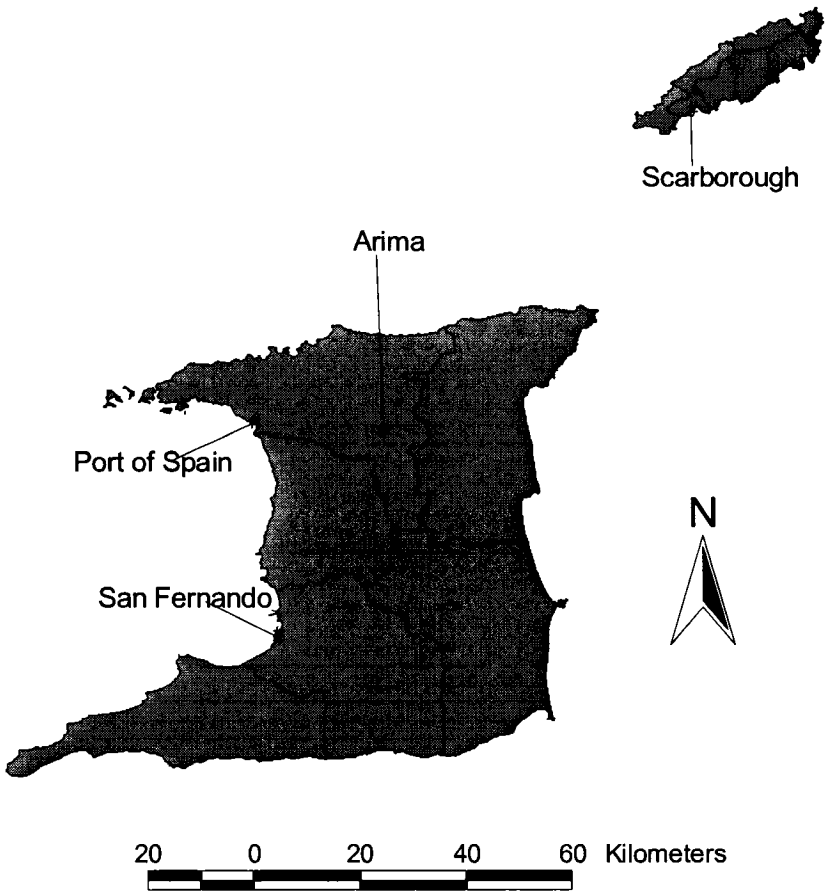

Figure 4.1: Map of Trinidad and Tobago

The utility and its management have traditionally been politicized. Governments have used the utility as an outlet for political patronage and this combined with populist government policies in the 1970s and 1980s, when oil prices were high, has made cost recovery at the utility a distant priority (Virjee and Gaskin, 2003). Nominal water tariffs have not been adjusted resulting in a real decrease in rates

over time. As well, billing efficiency at the utility was low, given the perceived inevitability of central government cash transfers to finance operating shortfalls and planned capital expenditure. The inefficient and decreasing revenue base, together with increasing costs associated with an overly large labour force (16 staff per 1000 connections, (Stiggers, 1999)), has resulted in insufficient funding for investment in physical infrastructure and an under maintained, sub-optimal system. The water distribution network, for instance, loses about 50% of the water entering it through leaks (WASA, 2002).

WASA reports that 92% of the population is covered by its water services. That is, 92% of the population has access to an in-house piped connection, a standpipe within 200m of their dwelling or free truck borne water. This figure, however, does not indicate the spatial and temporal variation in reliability of the supply, nor does it account for low pressure water and time spent collecting water.

The reliability of the water supply has been highlighted as a shortcoming of the utility service for some time. Users suffer frequent service interruptions and in some cases have water available for less than half the time. During a brief management contract in the 1990s (Nankani, 1997) an indicator was developed to measure the degree to which users were receiving water at their point of consumption. The full service equivalent (FSE) was based upon the planned schedule of service, and customers were given a weighting dependent upon the utility's assessment of water availability in their portion of the water distribution network. Because insufficient management systems were in place the knowledge of the network was lacking and so there was little guarantee that if a customer was scheduled to receive water it would in fact be available. Due to this, and the lack of district or household level metering, the reliability of the network is not known precisely. WASA reports an FSE of 77% which implies that the average customer receives 77% of a 24 hour supply (WASA, 2002).

Water supply is metered for about 70% of industrial and commercial customers, but is, for the most part, un-metered within the domestic customer class. Un-metered domestic tariffs are based upon the annual taxable value (ATV) of the property with a maximum quarterly rate of TT$ 304 (US$50) where the household has an in-house water service connection. Standpipe users are also billed quarterly but at a flat rate of TT$33.75 (US$5.55). Domestic users account for about 75% of the total number of connections, though only about 35% of the total revenue from water rates for 36% of total water usage (note that due to leakage and the relatively large number of connections, domestic users use about two-thirds of the total delivered water). Rates have been revised only three times in the history of the utility, with the last rate increase taking place in 1993 (RIC, 2003).

The need to recover costs and invest in infrastructure at WASA is considerable. Whilst, to some degree, this is contingent upon the ability of the utility to manage itself effectively, through increasing its billing efficiency and rationalizing its labour force, it is also dependent upon increases in the prices charged to consumers for water. Increasingly it is recognized in international water improvement efforts, that users must be consulted for systems to be sustainable (e.g. Katz, 1998). Users often will demand a higher level of service and be willing to pay for it (e.g. McPhail, 1993a), rather than accept a lower level of service. Therefore, in analyzing the requirements for increasing the financial sustainability of utilities it is relevant to understand consumer perceptions towards change.

This paper discusses the results of a national survey which aimed to assess the current level of domestic water supply, wastewater and electricity service experienced by the residents of Trinidad and Tobago (Virjee, 2004). In addition, the survey aimed to ascertaining the willingness to pay (WTP) for changes in the level of service experienced by users. The paper is divided into three parts. It first discusses the WTP methodology used and similar applications in developing

countries. Next, the survey results for water supply services are presented. This portion of the paper considers the utility service relative to the official coverage values and discusses the coping strategies associated with inadequate supplies. An econometric analysis of the WTP bids for improvements to water services follows this section. The paper finishes by discussing the policy implications of the survey results.

4.2 Willingness to Pay and Contingent Valuation

In many developing country water supply systems service levels are poor or lacking. In attempting to upgrade existing systems, or implement new systems it is beneficial to understand consumer perceptions towards proposed changes. One major component of the perceptions of consumers is their willingness to pay (WTP) for the change. The WTP must be sufficient to cover the costs associated with the project to ensure net positive benefits. In some cases, however, there may be public benefits not captured in individual WTP measures and so investments may be viable even though the WTP is less than the cost of provision. Earlier work has argued that a lack of information concerning the WTP of users has led to the slow expansion of services, on the assumption that users were satisfied with lower levels of service, or large inappropriate infrastructure which has, due to deficient demand, been poorly maintained (World Bank Water Demand Research Team, 1993). In addition, the adoption of the "five percent" rule, where it is assumed that users are unwilling to pay more than 5% of their income for water, has guided the design of water supply systems. In some cases, for instance in Rabat, users were willing to pay significantly more than this assumed upper limit and so the application of this arbitrary maximum cost limits the appropriateness of the system and decreases its sustainability (McPhail, 1993b).

Most studies in developing countries, attempting to measure the WTP for changes to water supply and sanitation services, have employed the contingent valuation (CV) method. This stated preference technique is used as no market for the good being valued exists and so observed behaviour cannot be used to infer the value

placed on the good by users' actual choices. The technique normally uses a multipart household survey administered in person to one adult, ideally the head of household, in each randomly selected household. The respondent will be presented with a hypothetical scenario describing the change to be valued. Valuation will then take place in one of many ways. Open-ended questions, bidding games, dichotomous choices or payment cards can be used to elicit the WTP of the user. All have particular benefits and drawbacks, which are discussed in detail in Mitchell and Carson (1989).

The CV method has been used extensively in developing countries and is recommended by many international organizations as a reliable method for WTP elicitation for environmental projects (e.g. Young, 1996 or Ardila et al., 1998).

An early application was used to evaluate the demand for improved water supplies in a project being installed by CARE in Haiti (Whittington et al., 1987; Whittington et al., 1990). Whittington et al. (1987) demonstrated that careful administration of the CV method resulted in an understanding of the demands of users which could enable system designers to specify more appropriate systems. Since that early application it has been employed numerous times. A large study with about 1200 respondents was carried out in rural villages in Pakistan (Altaf et al., 1992) and demonstrated that the WTP of villagers surveyed was below the 5% of income rule of thumb often used in assessing affordability of different service options. That is, should a system have been implemented that used the assumed willingness to pay of five per cent of income, it would have had difficulty attracting users as the value placed on such an expensive service was small. Briscoe et al. (1990) demonstrate that WTP information can be integrated with policy analysis to determine rates which allow for cost recovery and protect poor sections of society. A persistent criticism of the method has been that users, due to the hypothetical nature of the proposed scenario, have no incentive to give honest answers. In a unique study, Griffin et al. (1995) revisit households in Kerela, India, who were first surveyed in advance of a new water supply system,

with the aim of comparing answers given during the survey prior to system implementation and actual decisions to connect to the system. Overall, the study correctly predicted 91% of the responses, both connectors and non-connectors. Whittington et al. (1998) show how data developed from the CV method can be used to design demand responsive interventions by including significant minorities who are willing to pay considerably more than the average for upgraded private metered connections. Similarly, McPhail (1993a) shows the urban poor in Rabat are WTP for upgraded connections despite plentiful water available at a standpipe level of services.

4.3 Methods

This paper focuses on the current level of water supply services and the demand for changes to this service. The primary source of information in this regard was developed through the administration of a multi-part survey to a randomly selected national sample of households (Virjee, 2004).

4.4 Field procedures

The survey was administered to 1419 households in Trinidad and Tobago over the May – June 2003 period. The questionnaire used in the survey had been developed through an iterative process with expert consultations and extensive pre-testing, which led to considerable revision to the initial draft document. The questionnaire contained multiple sections. A socio-economic section sought to measure variables such as household income, and the maximum education level attained by the respondent, in order to provide context to the remainder of the survey. Questions pertaining to the current service level of water supply were also contained within one distinct section. This was followed by the contingent valuation section, which aimed to understand the demand for change to the just described status quo. The contingent valuation scenario presented to respondents described what is considered to be, by both WASA and the Regulated Industries Commission (RIC), the national utility regulator, an ideal level of service. The described service guaranteed 24 hour reliability of supply with an adequate water

pressure and high bacteriological and aesthetic water quality. This scenario was offered to users currently relying upon an in-house piped supply as well as those using lower levels of service. Thus, the two scenarios, for those using piped and those using non-piped supplies as primary water sources, differed in that the ideal scenario for non-piped users included a service upgrade to an in-house piped connection. The ideal situation was of interest, particularly to the regulator, as the government of the Republic of Trinidad and Tobago (GORTT) has specified that the country will reach 'developed country' status by 2020, 'vision 2020', and the regulator believes that utility service at this ideal level is required, in part, to meet the government's objectives. The demand for intermediate service levels were not examined, nor were the scenarios designed with technical feasibility in mind. This is due to the requirement of the regulator that an upper limit on the WTP for change of the users be established within the overall objectives put forth in the 'vision 2020' program of the GORTT.

A bidding game format (e.g. Randall, 1974) was used to elicit the maximum WTP for service level changes. This was chosen due to the relative cognitive ease associated with the dichotomous nature of the questions associated with the format. In such an elicitation procedure, the respondent is offered a series of bids, to which she must answer either YES or NO. Depending upon the answer given a new bid is offered. The result of the bidding game is an interval in which the true maximum WTP of the respondent lies. The starting point of the bidding game was chosen as the median water bill presently charged to customers with in-house connections.

A two stage stratification scheme was used to develop the sample used in this survey. 1419 households were selected based on the sampling methodology used by the Central Statistical Office's Continuous Sample Survey of Population (CSSP) (CSO, 1989). The first stratum used in the sampling method was based on geography, and the second on labour force characteristics. Whilst the ideal basis for stratification would have been by water source used, a lack of accurate

data closed this sampling route. The CSSP method has been used for various other national scale surveys with satisfactory results (CSO, 1989). The non-response rate for the entire sample was 12.5% and was due mainly to errors in the Central Statistical Office (CSO) supplied listing records and the difficulty in accessing some remote areas.

The CSO provided a list of trained enumerators from which 30 were selected to administer the survey. The selected enumerators were trained, using role plays and other methods, extensively in the particulars of the methods used in this study. These enumerators were supervised by six trained supervisors.

4.5 Survey Results

4.5.1 Sample Characteristics

The proportion of female respondents was higher than male respondents. This feature of the sample was probably due to the fact that most questionnaires were administered during the daytime when male household members were out of the home working. The ramifications of this are twofold. As a larger proportion of respondents were home during the day, it can be inferred that the measurement of the quality of service more accurately reflects the true level of service experienced by the entire household. If the presence of a respondent at home during the day implies that they are unemployed, however, the indications given concerning the household's willingness to pay for improved water service may not be completely reliable. In the sample 80% of the male respondents were responsible for the water bill, whereas only 50% of female respondents were. This feature corroborates the suggestion that there is exaggerated hypothetical bias introduced through the gender bias in the sample. This having been noted, it is most likely that the female respondents who were not directly responsible for bill payment have some input into the household budgeting and so would be able to give reasonable answers to questions pertaining to their willingness to see and pay for changes to water services.

About 60% of the sampled households lived in owner occupied accommodation and almost 15% lived in housing with uncertain tenure associated with it. This compares to tenure profiles measured in other surveys conducted by the CSO (e.g. CSO, 2002) and is of relevance given the constraints to water supply connections associated with land tenure. The WASA Act does not allow the utility to connect properties to the network where there is no title deed to the property. Therefore, squatters in the country can at most access standpipe levels of service through the utility. The mean household income of the sample was TT$2900 per month, which was similar to measures of income from formal wages in other studies (CSO, 2002). Table 4.1 provides a summary of the characteristics of sampled respondents.

4.5.2 Water supply service levels

The study aimed to characterize the sources of water used by households. Further, the importance of the various available sources was required. As most available water sources are unmetered, the assessment of the relative importance on the basis of measured quantity of water abstracted by the household was impossible.

Table 4.1: Socio-economic profile of survey respondents

Total number of respondents sampled	1419
Non-response rate	13%
Total number of completed questionnaires	1235
Proportion of females	59%
Proportion of females responsible for bill payment	21%
Median age of respondent	44
Median level of schooling attained	Secondary
Mean monthly household income	TT$2900
Own dwelling currently residing in	59%
Squatting in present dwelling	8%
Proportion of respondents with access to electricity service	92%

The survey asked respondents to indicate, subjectively, their primary and secondary water sources. 83% of the sample depended upon either an in-house piped connection or a standpipe for their primary water source. This figure compares unfavourably with official measures of coverage supplied by the utility and can be explained by one of two facts. Sampling error could explain some, but not all, of the discrepancy between the figure reported by WASA, 92%, and the

figure obtained here. Alternatively, the coverage is actually lower than WASA's records indicate. The divergence between official and actual statistics is a phenomenon which, recently, has been highlighted in numerous cases (e.g. Satterthwaite, 2003) and this together with WASA's simplistic definition of coverage makes the latter explanation for the divergent statistics more plausible. As coverage is defined in terms of access to piped infrastructure, either in house or by standpipe, with no adjustment for availability of water in the pipe, when water shortages occur, it can be anticipated that the existence of infrastructure is not the best predictor of coverage. In the Trinidad and Tobago case, the routine scheduling of water supplies leads to periods where users must switch to alternate water sources, and rely on piped water as a secondary or tertiary source. In such cases, the measured coverage would be much lower. The survey found that almost a third of the sample relied to some degree on a secondary, or coping, source for their household water needs. Most of these secondary sources were distant standpipes, when in-house connections failed, or rainwater collections systems to complement erratic piped supplies. In fact, 16% of the sample surveyed relied upon rainwater harvesting to meet some portion of their total water demand. Table 4.2 shows the water sources used by respondents.

Table 4.2: Primary and secondary source of water

Water source	Primary Number of Households	% of total	Secondary Number of Households	% of HH using secondary source
Piped water supply	889	72	5	2
Standpipe	139	11	83	24
Truck borne water	36	3	62	18
Supply from neighbour	82	7	42	12
Rainwater	79	6	121	36
Natural sources	10	1	27	8
Total	**1235**	**100**	**340**	**100**

Access to improved water sources, as defined by WASA, includes standpipe users, though sets a limit on the maximum distance the standpipe must be from the household. Of those depending upon a standpipe for their primary water

source, 60% were further than the mandated 200m maximum distance to the closest standpipe and 20% were farther than 800m from the closest standpipe. This observation would act to reduce measured access further.

The survey aimed to characterize the level of service experienced by those covered to some degree by the utility service, and the level of service provided by alternate water sources. A key factor in determining the level of service experienced by water users is the frequency with which water is available to them. The reliability of water sources was characterized by the number of days on which some water is available, and the average number of hours that it is available on those days. Only 27% of the sample had water available for 24 hours seven days per week. On the other end, almost 30% of the sample received no water from WASA at all, during the time of the survey. Despite the significant degree of intermittency of service, however, over 60% of the respondents in this study indicated that they required no further water supply to meet their needs. This phenomenon can be explained by the prevalence of local storage facilities. 68% of the sample had water storage tanks on their premises with an average installed capacity of 610 gallons. As a result of these coping mechanisms, 82% of those with tanks had a 24 hour water supply. The effect of local storage, then, is to directly facilitate 24hr water supplies for at least half of the sampled houses.

As the consumption of most domestic water customers is not metered, it is difficult to ascertain the quantity of water consumed. A limited survey of customers in 1991 (Delcan International Corporation, 1992) has been used in subsequent studies as a measure of the average water consumption in the country. That study installed 53 water meters at different households in the north of the country and monitored the quantity of water used at each finding an average consumption of 330 litres per capita. The studied households enjoyed relatively reliable water supplies and so their consumption can be regarded as true and not constrained by the scheduling practices that did and do affect other households.

The present survey asked respondents about the total storage facilities that they had installed on their property as well as the time that such facilities would last should they receive no other water supply. In cases where installed storage is insufficient to provide a full supply, the number of days that stored water lasts would give an indication of the water consumption of the household. Necessarily, however, houses where there is insufficient storage for a full supply would ration their water use and so the estimate of water use would be depressed. For those houses, in this sample, where storage did not afford a permanent water source the average water consumption was 325 litres per capita per day. With the restoration of a fully reliable water supply, where a household need not ration its storage, the consumption could be expected to be higher.

Wealthier individuals had better access to reliable water supplies. Only 24% of households earning less than TT$ 1500 per month had a 24 hour supply whereas almost 50% of the households earning over TT$ 5500 had the same level of service. This direct relationship between income and reliability of supply was found to be statistically significant. As well as more reliable water supplies, wealthy households had access to in-house piped supplies more frequently than lower income households. 15% of households earning less than TT$ 1500 relied upon standpipes as their primary water source whilst only 3% of households earning more than TT$ 5500 used standpipes as their primary water source. Compounding the reduced service level to the poor due to the reliability bias discussed above was the affordability of coping mechanisms. Only 58% of poorer households had water storage tanks whilst 84% of wealthier households had installed local storage facilities. Table 4.3 presents service levels experienced by WASA customers surveyed in this study given their income group. It is apparent that the quality of service offered to the poor is much lower, in terms of reliability of water as well as the ease of access.

Table 4.3: Water supply level of service by income group

Household income per month	Percentage in group with: In-house piped connection	24 hour water supply	Water storage tanks
Less than TT$ 1500	64%	24%	59%
Between TT$ 1500 and TT$ 5500	76%	25%	73%
More than TT$ 5500	89%	45%	84%

Aside from reliability the quality and pressure of water supplies were assessed. Generally respondents felt that the water they consumed was of high quality, though aesthetic parameters such as taste and colour were reported as contentious in some cases. Users relying upon standpipes for water service were more dissatisfied with water pressure due to the direct impact, in terms of queuing and waiting times, associated with their usage. Those with piped connections are able to install tanks and pumps to circumvent poor pressure in the mains supply and so had higher levels of satisfaction.

Many water users in Trinidad and Tobago do not directly pay their water rates. Fifty-five percent of the sampled households indicated that they directly pay their water rates. Of the remainder, some did not pay as it was included in their rent. Others did not pay due to uncertain housing tenure. 70% of the surveyed standpipe users and almost 30% of the in-house piped users surveyed were not responsible for their water rates. Standpipe users are often unaware of their responsibility to pay water rates. The revenue lost by the utility from this, though, is minor as rates charged to standpipe users are very low at TT$ 34 per quarter. About 10% of the sample depended upon non-utility suppliers for supplementary water supplies. The average amount paid was TT$ 160 (US$ 26 per month), which is four times the average water bill in the survey.

4.6 Multivariate analysis of WTP bids

Multivariate logistic regression (logit model) was used to understand the systematic underpinnings of the WTP values measured in the survey. As the responses to the offered bids were binary (YES/NO) a linear regression model

cannot be used (Menard, 2002). In fact, the direct utility of the offered ideal scenario in the CV exercise cannot be observed and so a model of the choice to accept the bid offered is uncertain. The probabilistic choice can be modeled as in (1).

$$\Pr(improved) = \alpha\ x_j + \beta\ z_j + \varepsilon_j \tag{1}$$

where the probability that the improved option is chosen, Pr(*improved*), is a function of the characteristics of the household, x_j, and the features of the option, z_j as well as a random error component, e_j. The parameters α and β remain to be estimated. Examples of household characteristics would include the size of the household, income and education of the respondent. The price of the options being offered will be its main characteristic. The error includes uncertainty on the part of the respondent as well as measurement error to represent omitted variables in the study.

Table 4.4 shows the results of the logit models (as in (1)) explaining the variance in the accepted contingent valuation bids for water users. The first column gives parameters for water users who rely exclusively upon an in-house water connection. The second column applies to those who use an in-house connection as a primary source, but rely also on a secondary source. Finally the third column gives parameters related to users that do not have in-house piped water connections.

Table 4.4: Logit model parameters describing the choice to accept the improved water supply service

Variable	Model 1[a] Exclusive in-house piped supply	Model 2[a] In-house piped supply + secondary	Model3[a] Non-in-house piped supply
Intercept	0.331	-0.453	-0.187
	(2.37)	(1.73)	(0.453)
Price of improved supply (TT$/ quarter)	-0.009	-0.009	-0.008
	(13.03)	(8.16)	(11.56)
Current bill amount (TT$/ quarter)	0.004		
	(7.17)		
Income (1000TT$/ month)	0.055	0.110	0.141
	(2.27)	(2.62)	(3.23)
Whether household currently treats water (1 – No; 0- yes)	-0.201	0.458	
	(1.75)	(2.41)	
Number of bathrooms in dwelling		0.803	
		(3.61)	
Whether HH incurs other water charges (1 – No; 0-yes)		-0.649	
		(1.86)	
Fraction of the week that storage lasts			-0.249
			(1.71)
Age group of respondent			
Under 20 years			Base case
20-29 years			0.400
			(1.23)
30-39 years			0.892
			(3.66)
40-49 years			0.744
			(3.57)
50-59 years			0.568
			(2.51)
60 years and over			0.707
			(2.91)
Geographic location of HH			
Port of Spain			Base case
San Fernando			0.945
			(1.76)
Arima			0.331
			(0.60)
Rest of Trinidad			0.776
			(1.99)
Tobago			0.163
			(0.44)
Sample Size	722	167	346
Likelihood ratio statistic (χ^2)	227	94	177
Probability	0.00	0.00	0.00
Pseudo R^2	0.14	0.14	0.13
Log-likelihood	-911	-367	-733

[a]- t-values are in parentheses and all parameters are significant at the 10 percent level unless otherwise indicated. The parameter values indicate the size of the effect on the probability that the improved choice is taken.

The interpretation of the results in table 4.4 must be done with care as the nonlinear transform at the basis of the logit model obscures the meaning of the estimated coefficients. Generally, though, the larger the coefficient the larger the effect it has on the probability of acceptance of the option being offered. Therefore, the signs of the coefficients can be hypothesized and this can be used as a preliminary check on the consistency of the data. For example, the coefficient associated with the price of the improved supply should be negative implying that an increase in price decreases the probability that a household will accept the improved system. If a household is more likely to accept the improved system, it follows that their WTP is also higher. Separate models were calculated for customers dependent upon their water sources as the water sources used require different coping mechanisms and attitudes resulting in different preference functions. The first model was constructed to explain preference structures of households depending upon an in-house connection exclusively, the second is for those who in addition rely upon some secondary source, and the third for those whose primary source is some other water supply. As is immediately apparent in table 4.4, both income and the price of the improved option are highly significant in all three models. The positive income parameter implies that richer households are WTP more for the improvement offered in the CV scenario all else being equal. The negative price coefficient, as was anticipated, shows that water is a normal good and that the probability of connection or acceptance decreases with increasing price.

Numerous variations on model specification were tried. The results presented in table 4.4 show those with the highest level of model fit. As is apparent, different household characteristics drive the demand for an improved service. These are detailed below.

In model 1, for users whose one and only water supply is an in-house connection to WASA's network, households who currently treat their water at home, by boiling, bleaching, filtering or some other method, are WTP more than those who

are not. This is likely due to the avoidance of costs associated with treatment. As the cost of most treatment methods used at home are characterized by relatively large variable costs (e.g. the cost of electricity to boil water) and relatively small fixed costs (e.g. the pot to boil the water in), improvements in water quality result in immediate savings to the household. Variables describing the prevalence of storage facilities were not significant. This is due to the nature of that investment. As it is mostly fixed cost, the financial benefits of increased reliability are nonexistent in the short run. The location variables were also not significant implying that the average WTP was similar for residents of rural and urban areas. Age was also not significant as an explanatory variable.

In model 2, the reliance upon a secondary source changes the determinants of the WTP of households. As the cost of water, in terms of time and inconvenience, increases with the utilization of multiple water sources households using these multiple sources will pay more as their water needs increase. A crude measure of this water need is the number of bathrooms in the dwelling as is implied by the positive correlation between a household's willingness to pay and that metric. Where households incur charges in addition to their water bill for their secondary source, for instance from a water tanker, they are willing to pay more than households whose secondary source of water is free. Again, this is reasonable given the immediate avoidance of expenditure associated with a service upgrade. The variable concerning treatment of water is again significant but of the opposite sign. This is due to the nature of water quality coping amongst those using multiple water sources. It is likely that the fixed cost of coping is increased for users relying upon multiple water supplies, so the benefits of increased water quality are realised in the medium term. This supposition is substantiated by the increased levels of dissatisfaction with water quality amongst users depending upon multiple water sources. In model 2, again, the presence of local storage does not affect the WTP for changes by users. Age and geographic location, similarly, are not significant in explaining choice behaviour.

The parameters affecting the WTP of users who depend wholly on non-in-house piped water supplies (model 3) are again different from the first two models. Where houses can store sufficient water to meet their weekly water needs, their WTP for change is lower as the benefits associated with a more consistent supply have already been achieved through the installation of local storage. As well, age impacted upon WTP. Those between the ages of 30 and 50 were WTP significantly more for improvements to the water supply than those who were under 20 years of age. This is most likely due a higher value placed on their time by such individuals who most likely have families and work full time. In addition non-in-house piped users were WTP different amounts for service improvements depending upon their geographic location. Those in rural areas, suffering from distant standpipes and delays in truck borne water in times of shortage, would be WTP more to avoid the coping costs associated with a poor supply. As well the lack of reliability in San Fernando, the major city in the south of the Trinidad, increases its residents' WTP.

The insignificance of some policy relevant variables, such as age and location of respondent, is due to one of two possible reasons. As argued above, it could be due choice homogeneity in the respondent pool and this could be because the sample was representative of a homogenous population or due to the fact that sample was biased and more homogenous than the total population from which it was drawn. Given that a large sample was used and that the sampling technique was random, the second possible explanation of the homogeneity is less likely. The conclusion, then, is that the preferences of respondents were related to the current levels of service as suggested by the different relevant specifications given by the three different model specifications. This conclusion is further supported by the fact that when the data was pooled and a single model estimated, the parameters describing current water supply were significant.

4.7 The demand for improved water services

Table 4. 5 shows the average willingness to pay for an upgrade in the service level from the current status quo level to the ideal level described in the CV scenario for users of different current primary sources. The monthly WTP for in-house piped connections where that is the only source of water used is 20% lower than the average bill (TT$128 per quarter) measured in the survey. This implies that there is no new utility associated with the service upgrade or that the current billing rates are above the willingness to pay of users. Given that 75% of the respondents paid their water bills within one month, the latter explanation of the depressed WTP is not likely. More likely is that those with coping infrastructure, such as local storage, to alleviate the inconvenience associated with the poor supply, have a lower demand for service level changes.

Table 4.5: Mean quarterly willingness to pay for improved water services

Water source	Mean willingness to pay (TT$/quarter)
WASA in house piped connection only	128
WASA in house connection + secondary source	99
No in-house connection	175

The WTP for improved service by users, who use the WASA in-house connection as their primary source of water but also depend upon secondary sources to supplement their primary source, is lower that those who depend on WASA entirely. The WTP of such users is 99TT$/quarter, which is almost 40% lower than current average bills in the sample. The most likely reason for this is that such respondents assume that any improvement in the WASA supply will not remove the requirement of depending upon secondary sources, and so will not reduce the coping costs associated with their water supply. This response is also indicated by the negative sign of parameter, which describes the effect of other charges on WTP in the logit models presented in table 4.4.

Users without an in-house piped connection are willing to pay for the service upgrade associated with the CV scenario. This implies that the CV assessment is

sensitive to scope (e.g. Smith and Osborne, 1996) as the scenario offered to such respondents included the added benefit of a service upgrade to an in-house connection. These users are willing to pay TT$175/ quarter, which represents a 10% increase over the current average in-house bill. This result implies that the value users derive from water supply connections resides in the proximity of supply. This is due to the fact that intermittence can be circumvented through the installation of inexpensive plastic storage tanks at the point of use. Though many standpipe users have local tanks, the distance to the standpipe and the need to share access with other users in the vicinity makes it more difficult to fill and use those tanks. If there is an intermittent supply at the standpipe the available water must be shared between numerous storage tanks in the area and so does not allow for full tanks and a 24 hour supply and so the utility associated with a service upgrade, in terms of distance to the water source, is larger.

In 1994 (Mycoo, 1996) a survey was carried out in the east-west corridor of Trinidad, between Port of Spain and Arima, to assess the WTP for water service improvements. At that time households were WTP, on average, TT$208 per quarter and 80% of the sample was WTP more than they were currently paying. This survey found the average WTP for the nation wide sample to be about TT$ 140 per quarter. As location variables were only significant for the non in-house connected respondents, the effect of geography on this average is minimal. The mean WTP in the East-West corridor is about TT$ 143 per quarter, which is not statistically different from the overall national mean. . This result implies that the WTP for service improvements has eroded over the past decade. The reasons for this are numerous. Firstly, and perhaps most significantly, is the continued poor performance of the water utility (Virjee and Gaskin, 2003). As the utility, through numerous local management changes and an international management contract, has failed to improve service and has been continually chastised in the media for corruption, users are no longer waiting for or believing in the possibility of change. As well, it is reasonable to assume that increased investment in coping mechanisms has made users somewhat immune to the intermittence of water

supply. This argument is supported by the finding in this survey that 68% of the respondents had water tanks whereas only 37% had tanks in 1994 (Mycoo, 1996).

4.8 Policy Conclusions

This survey shows two main results. First, the current water service levels in Trinidad and Tobago are deficient and second, that there is appears to be no consumer surplus with which to finance service changes through increased tariffs. Services are characterized by intermittent supply, variable pressure and questionable quality. As a result, users have invested in coping mechanisms, the most prevalent being inexpensive plastic tanks. The willingness to pay for improved water sources has been eroded over time mostly due to inefficient management of the utility. Private sector involvement in the utility in the mid 1990s did not repair the utility and the significant politicization of that effort has effectively closed that route to utility reform. Users who currently use low levels of service, such as standpipes, are willing to pay more for improved services, but this is most likely due to the convenience of proximity rather than availability of water. As installed coping mechanisms are long lasting, it is difficult to see how changes in the reliability of supply will increase the willingness to pay for the improved service as capacity to cope remains at no cost to the user and limitations in the CV method prevent analysis of such partial policy changes. The results of the survey depend heavily upon the question posed in the CV scenario. As such, the single 'ideal' situation can miss capturing consumer surplus existent for changes in other ways. For example, in this work, the frequency of billing was not investigated, though this may have significant impacts on the affordability of the supply. The potential for misspecification of the scenario is high and care must be taken to avoid this problem.

The results of this survey imply numerous issues for policy makers in the future. As has been noted above, there has not been sufficient tariff increase to sustain sufficient capital investment, and service expansion at the utility. Using the CV method, this study has shown that the willingness of water customers to finance

the gap between the costs and the revenues at the utility is minimal even with large improvements in the quality of service. Whereas in 1994 users were willing to pay almost double their current bills, users presently are almost unwilling to pay current rates. This makes the task of the regulator and water authority difficult. To increase revenues and install infrastructure requires increased finance, whilst to increase rates at present to finance such capital investment would most likely be politically expensive.

Due to constraints in the CV method, however, it is difficult to ascertain the impact of fractional changes on water supply service. For instance, increasing connection density amongst the un-connected might prove to be financially viable, given the apparent willingness to pay for increased proximity of access associated with the higher level of service. Methods which allow for the exploration of such attribute based changes in policy, such as choice modelling (e.g. Louviere et al., 2000), provide promise in this regard.

Ultimately the utility needs to become more aggressive at bill collection and seek to reduce costs. Revenue expansions, through tariff increases must be delayed until service levels have improved. The regulator could institute a service level linked tariff, whereby increased water availability would be subject to an increased water tariff. Such a regulatory mechanism may be expensive when costs associated with system information systems are considered, however the need for such information and management systems is required to allow for long term utility planning.

4.9 References

1. Altaf, M., and Hughes, J., Measuring the demand for improved urban sanitation services: Results from a contingent valuation study in Ouagadougou, Burkina Faso. *Urban Studies*, Vol. 31, No. 10, pp.1763-1776, 1994.
2. Altaf, M., Jamal, H., Whittington, D., *Willingness to pay for water in rural Punjab, Pakistan.* Water and Sanitation Report 4. Water and Sanitation Program. World Bank, 1992.

3. Ardila, S., Quiroga, R., Vaughn, W. *A Review of the Use of Contingent Valuation Methods in Project Analysis at the Inter-American Development Bank.* No. ENV-126. Inter-American Development Bank. Washington, DC, 1998.

4. Briscoe, J., Furtado de Castro, P., Griffin, C., North, J. and Olsen, O., Toward equitable and sustainable rural water supplies: A contingent valuation study in Brazil, *The World Bank Economic Review*, Vol. 4, No. 2, pp. 115-134, 1990.

5. Central Statistical Office (CSO). *Revised Design of the Continuous Sample Survey of Population.* Methodology Report. Government of Trinidad and Tobago, 1989.

6. Central Statistical Office (CSO). *Revised Design of the Continuous Sample Survey of Population.* Methodology Report. Government of Trinidad and Tobago, 1989.

7. Delcan International Corporation, *Feasibility study on Cost/Benefit Analysis of Universal Metering in Trinidad and Tobago*, Final Report, 1992.

8. Louviere, J., Hensher, D., Swait, J., *Stated Choice Methods: Analysis and Application*, Cambridge University Press, Cambridge, UK, 2000.

9. McPhail, A., Overlooked market for water connections in Rabat's shantytowns, *Journal of Water Resources Planning and Management*, Vol. 119, No. 3, pp. 388-404, 1993a.

10. McPhail, A., The 'five percent rule' for improved water service: can households afford more? *World Development*, Vol. 21, No. 6, pp 963-973, 1993b.

11. Menard, S. *Applied Logistic Regression Analysis.* Second Edition. Quantitative Applications in the Social Sciences. Sage Publications, 2002.

12. Mycoo, M. *Water Provision Improvements: A Case Study of Trinidad.* PhD Thesis, School of Urban Planning, McGill University, 1996.

13. Randall, A., Ives, B. and Eastman, C., Bidding games for valuation of aesthetic environmental improvements, *Journal of Environmental Economics and Management*, Vol. 1, pp. 132-149, 1974.

14. Regulated Industries Commission (RIC). *Review of the Current State of the Water and Sewerage Authority (WASA)*, Information Document, RIC, Port of Spain, Trinidad, 2003.

15. Satterthwaite, D., The Millennium Development Goals and urban poverty reduction: great expectations and nonsense statistics. *Environment and Urbanization,* Vol. 15, No. 2, pp. 181-190, 2003.

16. Smith, V.K., Osborne, L.L., Do contingent valuation estimates pass a 'scope' test? A meta-analysis, *Journal of Environmental Economics and Management*, Vol. 31, pp. 287-301, 1996..

17. Stiggers, D., Private participation in water and wastewater services in Trinidad and Tobago, in *Can Privatization Deliver? Infrastructure for Latin America*, eds Basanes, F., Uribe, E., Willig, R., Inter-American Development Bank, Washington, DC, 1999.

18. Virjee, K., *The Willingness to Pay for Changes in Water, Wastewater and Electricity Services in Trinidad and Tobago*, Working Paper, Water Resources Planning and Management, Department of Civil Engineering and Applied Mechanics, McGill University, 2004.

19. Virjee, K. and Gaskin, S., Water supply and sanitation provision with private sector participation: A case study of Trinidad, XI World Water Congress, International Water Resources Association, Madrid, Spain, 10 pgs., October 2003.

20. Water and Sewerage Authority (WASA), *State of the Utility*, Status Report, 2002.

21. Whittington, D, Briscoe, J., Mu, X., *Willingness to Pay for Water in Rural Areas: Methodological Approaches and An Application in Haiti*. WASH Field Report No.213. United States Agency for International Development,1987.

22. Whittington, D., Briscoe, J., Mu, X. and Baron, W., Estimating the willingness to pay for water services in developing countries: A case study of the use of contingent valuation surveys in southern Haiti. *Economic Development and Cultural Change*, Vol. 38, pp. 293-311, 1990.

23. Whittington, D., Davis, J. and McClelland, E., Implementing a demand-driven approach to community water supply planning: A case study of Lugazi, Uganda. *Water International*, Vol. 23, pp.134-145, 1998.

24. Whittington, D., Lauria, D., Wright, A., Choe, K., Hughes, J., Swarna, V., Household demand for improved sanitation services in Kumasi, Ghana: A contingent valuation study. *Water Resources Research*, Vol. 29, No. 6, pp.1539-1560, 1993.

25. World Bank Water Demand Research Team., The demand for water in rural areas: Determinants and policy implications. *World Bank Research Observer*, Vol. 8, pp. 47-70, 1993.

26. Young, R.. *Measuring Economic Benefits for Water Investments and Policies*. World Bank Technical Paper No. 338. World Bank, Washington, DC, 1996.

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Logical Bridge 1

Paper 1 detailed results of a survey carried out in Trinidad and Tobago. The survey aimed to capture respondents' current levels of water service and to characterize the nature of poor service experienced by utility customers as well as non-customers. Coping with this inadequate service was also examined. Using the contingent valuation method, WTP estimates were derived. The particular enquiry centered on the interest that respondents had in experiencing improved service levels where the improvement was defined by an upgrade from their current service levels to what was considered by the regulator, the RIC, to be an 'ideal' service level. This 'ideal' level of service was characterized as an improvement in system reliability such that customers would receive water twenty four hours a day, seven days per week, with adequate water pressure, and water quality to provide for all domestic needs. The second paper in this thesis, entitled "Discrete choice experiments and the willingness to pay for water supply changes in Developing Countries: A case study of Trinidad and Tobago", further analyses WTP for changes in water supply levels of service. The paper utilizes a novel method in the field of water supply change valuation based on experiences from the transport and marketing fields. These discrete choice experimental methods allow for the variation in policy attributes, and so the assessment of WTP on the basis of partial changes to the status quo. By allowing intermediate changes to water supply, that is changes between the current level of service and the 'ideal' level of service, as defined by the national regulator, paper 2 demonstrates the possibility of a richer policy analysis. The analysis demonstrates the different modelling techniques possible with such choice experiment data.

5 PAPER 2

Discrete Choice Experiments and the Willingness to Pay for Water Supply Changes in Developing Countries: A Case Study of Trinidad and Tobago

5.0 ABSTRACT

Users' willingness to pay (WTP) for changes in water supply services has become increasingly used in the planning phases of development projects. The values assessed through WTP methods are used to estimate the benefits of a project and imply the potential revenues based on sustainable tariffs, which may be generated. The estimation of the WTP for water projects has traditionally used the contingent valuation (CV) method. This study presents findings from a WTP study carried out in Trinidad and Tobago. The results are based on an alternate stated preference technique; discrete choice experiments. This method is explored with respect to its ability to present the choice behaviour of potential and current customers of water supply services. The paper demonstrates that there is a willingness to pay for service changes and that water service attributes impact significantly on the total willingness to pay for service changes.

5.1 Introduction

One of major realizations arising from the Drinking Water Supply and Sanitation Decade was that more demand orientation was needed in project design to ensure sustainability of water supplies in developing countries (Cairncross, 1992). This review of experience has also been repeated through more scheme and program specific analyses (e.g. Kleemier, 2000, Sara and Katz, 1998). Whilst this may seem obvious in hindsight, many projects in the past were designed from an 'engineering' perspective, which focussed more on issues of supply. That is, systems were developed to supply service levels perceived to be required by beneficiaries. Investigations into the demand for service found that in some cases potential users were not interested in paying very much for the perceived improvement (e.g. Reddy, 1999) or that they were willing to pay considerable amounts to access improved services (e.g. McPhail, 1993). An understanding of potential customers' willingness to pay (WTP) has become the starting point of the design for potential systems.

The World Bank commissioned a series of studies to investigate (World Bank Water Demand Research Team, 1993) the functioning of possible water demand estimation methods in rural areas of developing countries. As indicated in the literature, the need for such demand studies in urban areas (e.g. Katzman, 1977) has long been understood, but until more recently methods used in industrialised countries have been relied on for the prediction of water demand in developing countries.

This paper discusses the methods used to develop such water demand predictions in developing countries using stated preference techniques, or more specifically the contingent valuation method, and more recent attempts at applying alternate stated preference techniques to the analysis of water demand in developing and other countries. The paper's main focus is on the application of discrete choice experiments as an alternate to the contingent valuation method in Trinidad and Tobago. The paper will highlight the analyses possible with the choice experiments and discuss the policy relevant benefits of the method.

5.2 Stated Preference Methods in the Water Supply Sector

Water supply sectors in developing countries have been using stated preference (SP) techniques to establish demand for water supply options for about 20 years. SP techniques are relevant for two main reasons. Often, in attempting to predict the response of a population to the development of a new water supply, little market choice data exists. That is, given that many potential beneficiaries have no current water supply service which could be considered adequate; there is little observed behaviour upon which to rely for understanding choice preferences and from which to anticipate responses to a proposed system. Further, the monopoly concessions generally associated with water services utilities leads to little market based price variation across the population. Despite this limitation, multiple studies have been conducted to understand the behavioural underpinnings (including coping mechanisms) in current water supply environments. For

example, Whittington et al. (1989) conducted a revealed preference study of water source choice in Ukunda, Kenya, to understand the value that water consumers place on the time spent collecting water. Other examples include another study in East Africa (White et al., 1972) which again, sought to understand current responses to inadequate water supply situations. In both of these cases, however, it was difficult to extrapolate the behavioural observations to project responses to water supply solutions outside of users' realm of experience.

Beyond the need to understand response to a single proposed system, SP techniques, because of their hypothetical nature, would allow for the testing of multiple options and so the development of supply options which maximized the utility of users.

5.2.1 Contingent valuation as a stated preference technique

Contingent valuation (CV) has been used extensively in the water sector to predict the benefits described above. These applications began quite simply and have evolved into very sophisticated applications of the method which rely upon state-of-the-art implementation tools. Early studies, such as those by Whittington et al. (1990) or Briscoe et al. (1990), applied the method to test its relevance, and concluded (especially in Griffin et al. (1995)) that the method had empirical validity in that it was able to sufficiently predict potential customer behaviour. These studies administered face-to-face surveys to respondents in developing countries. The questionnaires were structured to understand the current water supply situation faced by the respondent and normally included factors such as the current costs of services and proxies for the quality of service. The contingent valuation portion of the questionnaire was formulated to ascertain the respondent's willingness to pay for a system improvement and to do this a detailed description of the proposed or hypothetical service was included, often with pictures or other visual aids. Surveys relied largely on the iterative bidding game elicitation method (Randall et al. (1974)) which presented a series of bid values for the respondent to either accept or reject. Bid values depended upon the

previous answer and bid. The data collected was often modelled using probit or logit (e.g. Whittington et al., 1990) analyses owing to the use of repeated referenda associated with the bidding game format. The models were used to predict willingness to pay for the improvement offered and to verify the consistency of the sample's responses.

Given that most water services applications of the CV method present respondents with a single scenario for valuation, it is difficult to access the second benefit discussed above. That is, the effect of changing the scenario is difficult to include in the modelling process. More recent CV studies have tried to address this. Lauria et al. (1999) constructed a very large split sample survey in the Philippines, where different sub-samples were randomly assigned different choice scenarios during the CV portion of the survey. Whilst this results in the ability to estimate the WTP for differing choice scenarios, it requires a larger sample size and does not facilitate the examination of intermediate solutions. Whittngton et al. (2002), used the CV method to understand potential response to improved system as well as to the potential for private sector participation in the management of the improved system, and thus, also used a more complicated CV structure than was used earlier. Again, this still did not allow for the estimation of intermediate changes in management or level of water service.

Despite this criticism, and others (e.g. Merrett, 2002) of the CV method, the application of the method in developing countries has had tremendous influence on policy making (e.g. IADB, 1998) as well as having contributed to the CV methodology and wider survey technique methodology (e.g. Whittington, 2002 or Whittington, 1998).

5.2.2 Other Stated Preference Techniques: Choice experiments in the water sector

Due to these shortcomings in the CV method, and because of their success elsewhere, choice experiments have begun to be applied in the water sector.

Applications, thus far, are few, and cover a wider variety of situations than those already presented.

Choice experiments require respondents to select a preferred alternative from a series of alternatives, which are defined by attributes (Louviere et al., 2000). Attributes levels are defined through experimental design (see for example Louviere and Hensher (1982) or Louviere and Hensher (1983)). The respondent in a choice experiment is exposed to numerous choice scenarios, each of which contains multiple alternatives. In this way, choice experiments allow for considerable data richness to be developed and at the same time facilitate the understanding of choice preferences over a varying set of alternatives and their defining attributes. It is apparent, then, that one reason for these methods' application in the water sector is that they circumvent the constraints imposed by the CV technique, and allow the analyst the ability to examine a variety of policy options.

Applications in the water sector in developed countries have included an analysis of behaviour given differing levels of reliability of water supply in Australia (MacDonald et al. 2005), an analysis of simple level of service parameters of water (taste and pressure) in Thunder Bay, Canada (Haider and Rasid, 2002) and environmental and service attributes in South East England (Powe et al., 2004) and analysis of reliability and drought restrictions on water usage in Canberra, Austraila (Hensher et al., 2005). These applications have all been in a context where change to the status quo is minimal and have focussed on valuing small changes in probabilistic reliability, as an extension from the electricity reliability valuation literature (e.g. Goett et al., 2000).

Developing country applications of the method to water supply improvement valuations have also been limited. Anand (2001) applied choice experiments to value changes in water supply services in the context of Chennai, India. The small sample size used and the limited variation in attributes, however, makes it

difficult to develop a detailed understanding of the preference structure of residents of Chennai and demonstrate the method's benefits. Hope and Garrod (2004), apply choice experiments to evaluate rural water supply improvements in South Africa. Attributes included variables to describe quality, quantity and reliability of the water service however, the exclusion of a price attribute raises questions around the validity of the choices made by respondents and makes it difficult to extrapolate results for policy implications.

5.3 Modelling choice data

The models used in this paper to explain preference structures in choice set data normally conform to random utility theory (McFadden, 1974), which implies that the decision maker is a utility maximizer, and so chooses the alternative which has the highest utility or welfare. In general the utility, U, of the decision maker can be represented by

$$U = V + \varepsilon \tag{1}$$

And if two alternatives, i and j, are available, a consumer will choose i if and only if

$$U_i > U_j \tag{2}$$

That is iff,

$$V_i + \varepsilon_i > V_j + \varepsilon_j \tag{3}$$

As the ε values are unobserved, equation (3) cannot be evaluated exactly. Depending upon the distribution taken by the ε values, a probability that alternative i is chosen can be evaluated. The probability that i is chosen, P_i will therefore be

$$P_i = P(V_i - V_j > \varepsilon_j - \varepsilon_i) \tag{4}$$

Further, the systematic portion of the utility is a function of the attributes of the option. Therefore,

$$V_i = \beta_k X_i \tag{5}$$

where X is a vector of k attributes and β is a vector of coefficients. If the error term is assumed to take an extreme value I, Gumbel, distribution the model reduces to a multinomial logit model (MNL) (McFadden, 1974) and the probability of choosing alterative i from a set of alternatives $j = 1...n$ is:

$$p(alternative\ i\ chosen) = \frac{e^{V_i}}{\sum_{j=1}^{n} e^{V_j}} \tag{6}$$

5.4 An application of choice experiments for water service improvements in Trinidad and Tobago

5.4.1 The water supply sector in Trinidad and Tobago

Trinidad is a two island nation in the south Caribbean with a population of 1.3 million. A national utility, the Water and Sewerage Authority (WASA) was mandated by an Act of Parliament in 1965 to provide the entire population of the country with access to water supply services. Within this mandate WASA is responsible for the installation and operations and maintenance of all waterworks serving domestic, commercial and industrial water demands in the country. Sanitation services are to be provided by private developers and the National Housing Authority, but are subject to oversight by WASA given its mandate to oversee water resources management issues in the country. Domestic water demands account for 36% of the total water supplied by the system. This demand is second only to unaccounted for water, which is about 50% of the total water

abstracted by WASA (WASA, 2002). WASA has historically been run as an autonomous Authority under the Ministry of Public Works, and has been subjected to a brief period where a private management operator was installed to rationalize performance and prepare WASA for more significant private sector engagement (Virjee and Gaskin, 2003).

Services have been regarded as poor, and Virjee and Gaskin (2006a) show that the official coverage statistics provided by the utility are likely to be an overestimate, and where the Authority does provide service to customers it does so at relatively low levels of service. A choice experiment study was conducted in 2003 in Trinidad and Tobago to understand preference structures and inform regulatory decisions required of the Regulated Industries Commission (RIC), mandated as the independent water services regulator in the country.

5.4.2 Field Procedures

The survey was administered throughout the country with a total sample size of 1419 households selected for inclusion in the survey. This sample was developed from the Central Statistical Office's Continuous Sample Survey of Population (CSSP) (CSO, 1989). This methodology uses the national population as a sample frame and a two stage stratification scheme. The first stratum is by geographic region. This is appropriate for this study given a presupposed variation in water service level by geographic region. The second stratum is by labour characteristics of the population as the CSSP is primarily a labour force study. Such stratification may introduce bias if the level of utility service is not correlated with the characteristics of the labour force at the cluster level though given the lack of data on the drivers of variability in the survey, current water service levels, it was difficult to design a proprietary sampling regime. Finally clusters, enumeration districts, are sampled proportional to size from the strata and random clusters of households selected in the sampled enumeration districts. The unit non-response rates, including vacant buildings and non existent

buildings, for Trinidad was 12% and 16% in Tobago. For the entire study the non response rate was 12.5%.

The questionnaire included details about current water, sanitation and electricity services experienced by respondents (Virjee, 2004). The contingent valuation method (e.g. Mitchell and Carson, 1989) was used as a primary method to establish willingness to pay for those services.

The questionnaire also posed choice experiments for improved water supply (but not wastewater and electricity) to respondents. Table 5.1 shows the attributes used in the choice sets and the levels which those attributes took. The attributes and realistic levels of the attributes were developed through expert consultations with the RIC and through pilot testing in focus groups. Other variables were considered but were not included for various reasons. A variable describing the nature of the manager of the service as either public or private was not included as it was felt that this was not a realistic option at present given recent experiences with private sector participation in the water sector. Also, intermediate levels of service, such as by private vendors, were considered inadequate by the regulator and so were not considered. The reliability parameter is characterized differently to probabilistic shortage formulations as are used elsewhere. This was in response to the nature of water reliability in the country, which was also considered to be far below a 24 hours per day seven days per week service and which was considered to vary considerably over the population. The reliability parameter was split into two parameters, as shown in table 5.1, to attempt to isolate water usage patterns given the significant level of coping storage facilities (details are in Virjee and Gaskin, 2006a). Figure 5.1 shows a sample of the choice card shown to respondents, who, at the time of the survey, were not connected to the WASA distribution network. The socio-economic characteristics of the sample are shown in table 5.2.

5.4.3 Experimental design

Each respondent was shown a series of 12 choice scenarios, with each scenario including a status quo option in addition to three other generic alternatives. Table 5.3 shows the average attribute levels of the status quo options. The number of choice sets was less than suggested maximum numbers (e.g. Hensher et al., 2001), due primarily to the feeling that more than 12 sets would be tiresome for the particular respondents anticipated in the study. As no brand significance of the alternatives was anticipated, an experimental design which could capitalize on the design efficiencies associated with such generic alternatives was used to develop the choice scenarios Kuhfeld (2003).

Choice Set 1

Outcome of change:		Alternative A	B	C	D
Reliability	Days/week Hours/day	four twelve	seven twelve	one twenty four	
Pressure		high	medium	low	
Quality		high	low	medium	I prefer my current service level
Connection Cost	TT$	300	0	600	
Level of Service **Price**	 TT$/quarter	in house 350	standpipe 450	standpipe 50	
Which alternative do you prefer?		☐	☐	☐	☐

Figure 5.1: Sample choice card – unconnected household

Table 5.1: Attributes used in choice experiments

Attribute name	Description	Levels of attribute
Pressure	Pressure was treated as a qualitative variable as it was felt that the respondents would not be able relate to quantitative measures. A qualitative description of the levels was provided earlier in the survey	Low Average High
Quality	Quality was again described qualitatively. The assessment of quality could then be related to earlier responses about current quality levels which were described in terms of aesthetic and disease vector impacts on usage	Low Medium High
Reliability – days	Reliability was classed as two separate variables with the days variable used to describe the number of times (days) per week on which water was available	One Four Seven
Reliability – hours	The reliability hours variable was used to describe the duration in a given day where water was available that it was available during that day	2 12 24

Connection fee	The connection fee variable was used only in choice sets applied to those without individual connections and described a one time fee (in TT$) which would be paid for access to the water system	0 300 600
Level of Service	Level of service described the proximity of the service connection to the home	Standpipe connection In house connection
Price	Price was quoted as a quarterly bill (in TT$) as is currently the practice in Trinidad and Tobago	50 150 250 350 450

Two different choice sets were developed; one for respondents who indicated earlier in the survey that they obtained their primary water supply from a WASA in house connection and another for all others. This was primarily due to the irrelevance of two attributes to one group. A total of 327 valid responses were obtained for the un-piped household sets and a total of 846 valid responses were obtained for those having in-house piped connections already. Also, it was anticipated that the utility derived from water supplies would be different between the two groups owing to the differing nature of their water consumption. The attributes used to describe the status quo option offered to users was not specified in the experiment. Rather, these were inferred from other parts of the survey and inserted into the data during the modeling process

5.5 Results

In modelling the choice set data collected during the choice experiments, two separate models were developed; one for households who indicated that they had an in house WASA connection as their primary water source and a separate one for households indicating that they relied upon another source of water for their primary water supply. The second category included households who utilized WASA standpipe services as their primary water source. The price, connection fee and reliability variables were coded as continuous and the remainder as discrete. Coding reliability as a series of discrete variables was also attempted but model fit was not affected by assuming a linear (and so continuous) relationship.

Table 5.2: Socio-economic characteristics of survey respondents

Total number of respondents sampled	1419
Non-response rate	13%
Total number of completed questionnaires	1235
Proportion of females	59%
Proportion of females responsible for bill payment	21%
Median age of respondent	44
Median level of schooling attained	Secondary
Mean monthly household income	TT$2900
Own dwelling currently residing in	59%
Squatting in present dwelling	8%
Proportion of respondents with access to electricity service	92%

Table 5.3: Average status quo scenario for respondents

Attribute Name	**Average levels of status quo options**	
	Customers **without** in house connection from WASA	Customers **with** in house connection from WASA
Quality:	Average	Average
Pressure:	High	Average
Reliability: days	2	5
Reliability: hours	6	18
Connection fee	N/A	N/A
LOS:	Standpipe	In House Connection

Table 5.4 shows the MNL models estimated for the two different choice sets and a number of observations are salient in examination of that data. For each choice set, two different MNL models are estimated. Firstly, a main effects model, describing attribute parameters only is evaluated. Secondly, the main effects model is supplemented with individual specific characteristics. In order for the individual specific features to enter the model they have been interacted with the alternative specific constant (ASC), so that they vary within a particular choice scenario (for details see for example, Greene, 2003). Numerous model specifications were attempted, with the ones presented in table 5.4 showing the best model fit and significance of parameters. The status quo option was coded using the answers to relevant survey questions during the model fitting process. This is required as the individual level choice behaviour in the experiment can only be explained when contextualized by the actual current level of service experienced by the user.

Model 1, shows an improvement in model fit by including individual specific parameters over the main effects model, with model fit, indicated by ρ^2. The final model fit of $\rho^2 = 0.19$ is adequate, given that good model fit for discrete choice MNL models is in the range of 0.2-0.4, which as been demonstrated to be equivalent to a R^2 of 0.7-0.9 in standard ordinary least squares regression (Louviere et al., 2000). The main effects and full versions of model 2 have similar levels of model fit, implying that less information is contained within the individual specific parameters, and that the ASC, indicating status quo choice bias, describes a considerable amount of variation in the data. This is most probably due to the considerable proportion of choices which indicated the status quo as the preferred option (80%). The fit for model 2 is also very high, again, because of the consistent choice of the status quo as the preferred alternative. It should be noted that the high preference for the status quo option does not indicate that WTP for changes to the status quo are zero. The analysis of this requires that after controlling for bias associated with reticence induced by the status quo the attribute parameters be considered.

In both choice sets, an alternative specific constant set to unity for choices other than the status quo was significant. This specification was arrived at by first attempting to model separate ASCs for each of the three non status quo alternatives. It was noted, however, that separate ASCs, whilst all significant in the main effects models estimated, were similar in scale to one another. The different alternatives were not labelled, other than as either a new choice (choices 1-3) or the current choice (choice 4). Theoretically, then, the choice of alternatives was based only on the attributes of the alternatives and individual specific features, this result is surprising.

Table 5.4: Results from MNL Models

Attribute Name	Estimated Coefficient Values			
	Model 1 MNL models for those **without** In house connection from WASA		Model 2 MNL models for those **with** in house connection from WASA	
	(a) Main Effects Model	(b) Full Choice Model	(a) Main Effects Model	(b) Full Choice Model
Quality = average	0.275**	0.330**	0.040	0.038
Quality = high	0.359**	0.412**	0.143**	0.141**
Pressure = average	0.159**	0.163**	-0.053*	-0.066*
Pressure = high	0.352**	0.457**	-0.002	0.017
Reliability – days	0.054**	0.137** (0.138)**	0.324**	0.323**
Reliability – hours	0.021**	0.047** (0.041)**	0.054**	0.054**
Connection fee	0.001**	0.001**		
LOS = in house connection	0.351**	0.441**		
Price	-0.002**	-0.002**	-0.002**	-0.002**
ASC	-1.425**		-2.426**	-2.497**
ASC interacted:				
Other water charges incurred by the HH		-1.650**		0.556**
Whether primary water source is WASA		0.997**		
Whether respondent was in Port of Spain		1.247**		
Island (0=Trinidad)		-1.238**		
Whether respondent is over 50		-0.347**		
Whether respondent has more than Secondary education				-0.319**
Storage at household (100 m3)				0.010**
Log-likelihood function	-4721.0	-4388.9	-5026.3	-4838.0
ρ^2	0.13	0.19	0.64	0.64

Notes:
ASC is coded 1 for alternatives that are not the status quo
** indicates that parameter is significant at or below the 1% level
* indicates that parameter is significant at or below the 5% level

The significance of the ASC in both sets of models indicates a systematic disutility associated with choices other than the status quo; a status quo bias. Other studies (e.g. Adamowicz et al., 1998) have noted similar status quo bias. In this case, it may be arising as a result of two different drivers. Firstly, current water service combined with the already installed coping mechanisms at a household level may be sufficient to provide the services needed by the

household. Though the household may prefer an improved source, the status quo is cognitively easier to evaluate, as there is certainty of its implications, and so there would be a tendency to over select it. This implies the second reason for the systematic selection of the status quo option. The status quo is known with certainty, whilst any other alternative is purely hypothetical.

As such, the significant ASC might indicate to some degree the hypothetical bias associated with the choice experiment. Such a finding may, in future, be reduced in such studies by a clearer definition of the implications of change. Though in the case of Trinidad and Tobago, given the history of under performance by the utility, despite numerous attempts at reform (Virjee and Gaskin, 2003), believability of hypothetical alternatives might consistently prove to be low.

In model 1, all the attributes included in the choice scenarios were significant and signs of model parameters were as suggested by economic theory, with the exception of connection price. The positive coefficient for this attribute indicates that utility from the alternative increases with increasing connection fee. This could be due to the implied value associated with paying for access to the system. If a respondent pays for access to the system, he or she then has more of a right to demand service from that system. This argument also underpins the logic of requiring community participation in water projects in rural areas with the demand responsive approach (e.g. Sara and Katz, 1998). The parameters for individual specific constants also appear to have reasonable signs. If other charges are being paid by the respondent as a coping mechanism, utility of improved water service is reduced. This is most probably due to the fixed costs which are associated with coping, so that improved services do not lead to the avoidance of coping costs. Further, distrust in the utility would lead to a tendency for favouring private or coping solutions. Where the primary water source is a standpipe service, the utility gained from increased service levels is positive, which is due to reliance on the WASA service. Where primary sources are not linked to WASA delivery, an increase in WASA service levels will not impact and so not result in

utility. Residents in Port of Spain derive more utility from improved services than those elsewhere in Trinidad, who in turn derive more utility from improvements than residents of Tobago. This is most likely as a result of the value placed by respondent on their time. Where services are poor, more time would be required to access the services, in queuing and such. Residents of Port of Spain, the capital city of the country, because of higher levels of economic activity are likely to place more value on their time given their higher opportunity cost of time. Finally, older respondents derive less utility from service increases than younger ones. Again, this could be due to the value of time associated with higher levels of retirement. The ASC is not significant in the full specification of model 1. This indicates that the individual specific constants which are introduced capture the major drivers of the status quo utility.

Model 2 shows less consistency in the parameters describing service attributes. In both versions of the model, high pressure and average quality are not significant in the utility function. Due to local storage, coping strategies such as the installation of pumps would reduce the benefits of high pressure, making it irrelevant in the choice scenario. Average pressure, however, has impact on the filling of local storage facilities and given the low reliability of the current water supply, there would be a premium on at least an average level of pressure. Average water quality is likely to be indistinguishable from poor quality to respondents in model 2, and given any qualities less than the highest may suggest some treatment at the household level, implying that an intermediate improvement to an average quality from a low quality would be of no real impact on utility. As before the reliability and price parameters are significant. Interestingly, those who incur other water charges would see an increase in utility associated with increased service levels. This indicates that such coping costs are variable and so improved services would reduce those costs correspondingly. This result is intuitively reasonable given that all respondents in model 2 have WASA connections and so would experience increased water services. Those with higher levels of education value a proposed change in service less than those of lower

education most likely due to varying degrees to which the two different groups believe the offered scenario. More educated respondents might, again due to the history of service, be less inclined to value suggested service increases and so larger increases would be required to mobilize them to vote for the change. Storage facilities increase the utility from a service level increase presumably because service level increases are perceived to be less than full always, and so small increases from the status quo increase the effectiveness of the water tank buffer by ensuring it is frequently filled. Finally, the ASC remains significant, implying that there is considerable residual status quo bias, even after the introduction of individual specific parameters.

Table 5.5 shows the mean marginal rates of substitution, or implicit prices (IP), between model attribute parameters. These are calculated as the ratio of the attribute β s to the β for the price variable (equation 7) (Louviere et al., 2000) and describe the willingness to pay for a change in the attribute by one unit.

$$IP = -\left(\frac{\beta_c}{\beta_y}\right) \tag{7}$$

It is apparent that across all models the changes in reliability of service leads to significant WTP and that the WTP for reliability changes is more for respondents who already have an in-house connection. Increases in the number of days per week during which water is available in the system are higher for those with in-house connections by a factor of 2.5 to 6, although changes in the number of hours per day are similar for all survey respondents. The relative importance of daily reliability for those with in-house connections most likely results from the higher consumption levels that such houses would have, and so the need to replenish local storage more frequently. As standpipe and other non connected users would fetch water at communal water points, hourly reliability has more significance as it would directly impact upon the time spent collecting water by reducing queuing times.

The relative value of water pressure for users relying upon public stand posts is higher than for users with in house connections again, due to the impact that this has on time spent collecting water. The WTP for changes in quality also are higher amongst those deriving their water supply from non in-house connections. This is likely due to greater difficulty in coping with low water quality through point of use treatment. Given the statistical linkage between higher levels of service and income observed elsewhere (Virjee and Gaskin, 2006a), the cost of point of use treatment might also cause a more significant income effect amongst those who do not have in-house connections, given their lower incomes

Table 5.5: Marginal Rates of Substitution

Attribute Name	Marginal rates of Substitution (TT$/quarter)			
	Model 1 MNL models for those **without** In house connection from WASA		Model 2 MNL models for those **with** in house connection from WASA	
	Main Effects Model	Full Choice Model	Main Effects Model	Full Choice Model
Quality: low to average	80	165	20	19
Quality: low to high	180	206	72	71
Pressure: low to average	80	82	-27	-33
Pressure: low to high	176	209	-1	9
Reliability: per additional day	27	69	162	162
Reliability: per additional hour	11	24	27	27
Connection fee	0.5	0.5		
LOS: from standpipe to in house connection	176	221		
Other water charges incurred by the HH		-825		278
Whether primary water source is WASA		499		
Whether respondent was in Port of Spain		624		
Island (0=Trinidad)		-619		
Whether respondent is over 50		-174		
Whether respondent has more than Secondary education				-160
Storage at household (100 m3)				5

Users who do not have in-house connections also show a considerable WTP for that level of service. For an upgrade in service level to an in house connection, users surveyed would be WTP four times their current bill and over one and half times the average connected household bill for this greater level of access. Such

unconnected households would need to move from water being available for 8 hours per day to 24 hours per day to achieve similar increases in utility as that achieved through upgraded access.

Table 5.6 presents users' willingness to pay for aggregate changes in attributes. The first observation is that the MNL models suggest that both groups of respondents are willing to pay significant increases to the current bill for improved water supply. Following the analysis on the marginal rates of substitution, users' are willing to pay the most for situations where the reliability of the supply is increased. Those without current in-house connections are willing to pay over double the current bill paid by houses already connected to connect. This would imply that there is significant consumer surplus to be captured by the utility, in expanding services to those currently without connections. Such a policy decision however would be very much contingent on an analysis of the costs of such service expansion. The indication from this simple WTP analysis should also be taken as an indicator to the RIC, whose mandate it is to set tariffs for WASA. Given increased service levels, the MNL model results suggest again that for all customers, there is considerable potential for the capture of the consumer surplus. This is as would be anticipated; higher levels of service would be associated with less time and money spent in coping with inadequate supplies.

Table 5.6: Average WTP for service changes

Description of Service Change	Average WTP (TTS/quarter)	
	Customers **without** in house connection from WASA	Customers **with** in house connection from WASA
Current Bill	60	159
24 hours – 7days per week at same quality/pressure	548	645
24 hours – 5 days per week at same quality/pressure	411	321
12 hours – 7days per week at same quality/pressure	266	321
Current reliability at with high quality/pressure	101	236
Same service as those currently connected (assuming that connection rate is 0)	202	N/A

5.6 Summary and Conclusions

This study has discussed the potential of a choice experiment methodology, which has gained increasing acceptance in other academic sectors, such as transportation demand modelling and marketing, for modelling domestic water demand in the face of different service levels in Trinidad and Tobago. The paper has given an overview of the details of choice experiments and contextualized this methodology within the history of such investigations which have taken place in developing countries' water supply sectors. MNL models are used to develop models to describe the preference structure of respondents in the study, and it has been shown that respondents are WTP considerable amounts for service changes. All survey respondents have indicated interest in increased reliability of water supply, which was also something noted in the qualitative portions of the survey (Virjee and Gaskin, 2006a). The response to other attributes were found to be more complicated, in that it appears that coping mechanisms reduce the need for improvements to water quality and pressure, though it is also possible that the qualitative nature of the variables made it harder for respondents to value them. Variation in WTP for service level changes was also influenced by other individual specific attributes. The current water situation, as captured by expenditure on and use of other water sources, apart from WASA, were significant indicators of the utility to be realised should service levels change. Also, coping strategies, such as local storage, indicated variations in WTP and utility from service level changes. Finally, location variables were significant in all the utility functions estimated. This is due to variations in both employment rates, and the value of time, which impacts upon the willingness to invest time in coping with poor water supplies. As anticipated, those in Port of Spain derive increased utility from improved water supply, whilst those on Tobago derive less that the average utility.

The policy implications from such choice experiments are numerous. The implicit prices measured will aid in the prioritization of equal cost investments targeting

different types of service improvements. Interestingly, comparing the implicit values associated with the level of service attribute for non connected households to the value of changes in reliability for those already connected helps in the analysis of policies which either target increased access for un-connected households or increased service levels to connected households. Such policy analysis, however, needs a more comprehensive treatment than simple indicative strategies from the ratio of two parameters, given concerns about equity and the capture of public benefits in addition to private benefits.

The choice experiment method, at an aggregate level was not verified in this paper. Rather the richness of the data collected and nature of analysis that is possible from such experiments was demonstrated. It is of policy interest to be able to understand the relative merits of different changes to water service, along the lines of defining attributes and the discussions above have shown typical insights available from such choice experiment methodologies. It remains however, to demonstrate the accuracy of aggregate attribute changes.

5.7 References

1. Adamowicz, W., Boxall, P., Williams, M., Louviere, J., Stated preference approaches for measuring passive use values: Choice experiments and contingent valuation, *American Journal of Agricultural Economics*, Vol. 80, pp. 64-75, 1998.

2. Anand, P.B., *Consumer preferences for water supply? An application of choice models to Urban India,* Discussion Paper No. 2001/145, United Nations University, Helsinki, Finland, 2001.

3. Ardila, S., Quiroga, R., Vaughn, W. *A Review of the Use of Contingent Valuation Methods in Project Analysis at the Inter-American Development Bank.* No. ENV-126. Inter-American Development Bank. Washington, DC, 1998.

4. Briscoe, J., Furtado de Castro, P., Griffin, C., North, J. and Olsen, O., Toward equitable and sustainable rural water supplies: A contingent valuation study in Brazil, *The World Bank Economic Review*, Vol. 4, No. 2, pp. 115-134, 1990.

5. Cairncross, S, *Sanitation and Water Supply: Practical Lessons from the Decade*. Discussion Paper No. 9, UNDP-World Bank Water and Sanitation Program, The World Bank, Washington, DC, 1992.

6. Central Statistical Office (CSO). *Revised Design of the Continuous Sample Survey of Population.* Methodology Report. Government of Trinidad and Tobago, 1989.

7. Greene, W., *Reference Guide*, NLOGIT, Version 3.0, Economic Software, inc., 2002.

8. Goett, A., Hudson, K. and Train, K., Customers choice among retail energy suppliers: the willingness to pay for service attributes, *The Energy Journal*, Vol. 21, No. 4, pp. 191-215, 2000.

9. Haider, W. and Rasid, H., Eliciting public preferences for municipal water supply options, *Environmental Impact Assessment Review*, Vol. 22, pp. 337-360, 2002.

10. Hensher, D., Shore, N., and Train, K., *Households' willingness to pay for water service attributes*, Working Paper, 2005.

11. Hensher, D., Stopher, P., Louviere, J., An exploratory analysis of the effect of numbers of choice sets in designed choice experiments: an airline choice application, *Journal of Air Transport Management*, Vol. 7, pp. 373-379, 2001.

12. Hope, R.A and Garrod, G.D., Household preferences to water policy interventions in rural South Africa, *Water Policy*, Vol. 6, No. 6, pp. 487-499, 2004.

13. Katzman, M., Income and price elasticities of demand for water in developing countries, *Water Resources Bulletin*, Vol 13, No. 1, pp. 47-55, 1977.

14. Kleemier, C., The Impact of Participation on Sustainability: An Analysis of the Malawi Rural Piped Scheme Program, *World Development*, Vol. 28, No. 5, pp. 929-944, 2000.

15. Kuhfeld, W, *Marketing Research Methods in the SAS System*, Version 9.0 edition, SAS Institute, 2003.

16. Lauria, D.T., Whittington, D., Choe, K., Turngan, C., Abiad, V., Houshoeld demand for improved sanitation services: A case study of the Calamba, the Philippines, *in Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU and Developing Countries*, Bateman, I. and Willis, K. *(eds.)*, Oxford University Press, Oxford, UK, 1999.

17. Louviere, J and Hensher, D.A, On the design and analysis of simulated choice or allocation experiments in travel choice modeling, *Transportation Research Record,* No. 890, pp. 11-17, 1982.

18. Louviere, J and Woodsworth, G., Design and analysis of simulated consumer choice or allocation experiments: An approach based on aggregate data, *Journal of Marketing Research*, Vol. 22, pp. 1-19, 1983.

19. Louviere, J., Hensher, D., Swait, J., *Stated Choice Methods: Analysis and Application*, Cambridge University Press, Cambridge, UK, 2000.

20. MacDonald, D., Barnes, M., Bennett, J., Morrison, M., Young, M., Using a choice modelling approach for customer service standards in urban water, *Journal of the American Water Resources Association*, Vol. 41, No. 3., pp. 1-10, 2005.

21. McFadden, D. Conditional logit analysis of qualitative choice behaviour, in *Frontiers of Econometrics*, Zarembka P. ed., Academic Press, New York, 1974

22. McPhail, A., Overlooked market for water connections in Rabat's shantytowns, *Journal of Water Resources Planning and Management*, Vol. 119, No. 3, pp. 388-404, 1993.

23. Merrett, S., Deconstructing Households' Willingness to Pay for water in low income countries, *Water Policy*, Vol. 4, pp. 157-172, 2002.

24. Mitchell R.C. and Carson, R. *Using Surveys to Value Public Goods: The Contingent Valuation Method*, Resources for the Future, Washington, DC, 1989.

25. Powe, N.A., Garrod, G.D., McMahon, P.L., Willis, K.G., Assessing customer preferences for water supply options using mixed methodology choice experiments, *Water Policy*, Vol. 6, No. 5, pp. 427-441, 2004.

26. Randall, A., Ives, B. and Eastman, C., Bidding games for valuation of aesthetic environmental improvements, *Journal of Environmental Economics and Management*, Vol. 1, pp. 132-149, 1974.

27. Reddy, R., Pricing of rural drinking water: A study of willingness and ability to pay in western India, *Journal of Social and Economic Development*, Vol. II, No. 1, pp. 101-122, 1999.

28. Sara, J. and Katz, T., *Making Rural Water Supply Sustainable: Report on the Impact of Project Rules*, Water and Sanitation Program, World Bank, Washington, DC, 1998.

29. Train, K., *Discrete Choice Methods with Simulation*, Cambridge University Press, Cambridge, UK, 2003.

30. Virjee, K and Gaskin, S., The demand for improved water supply and sanitation: The case of Trinidad and Tobago, *Journal of Eastern Caribbean Studies*, *submitted*, 2006a.

31. Virjee, K. and Gaskin, S., Water supply and sanitation provision with private sector participation: A case study of Trinidad, XI World Water Congress, International Water Resources Association, Madrid, Spain, 10 pgs., October 2003.

32. Virjee, K., *The Willingness to Pay for Changes in Water, Wastewater and Electricity Services in Trinidad and Tobago*, Working Paper, Water Resources Planning and Management, Department of Civil Engineering and Applied Mechanics, McGill University, 2004.

33. Water and Sewerage Authority (WASA), *State of the Utility*, Status Report, 2002.

34. White, G.F., Bradley, D.J and White, A.U., *Drawers of Water: Domestic Water Use in East Africa*, University of Chicago Press, Chicago, USA, 1972.

35. White, G.F., Bradley, D.J and White, A.U., *Drawers of Water: Domestic Water Use in East Africa*, University of Chicago Press, Chicago, USA, 1972.

36. Whittington, D., Administering contingent valuation surveys in developing countries, *World Development*, Vol. 26, No.1, pp. 21-30, 1998.

37. Whittington, D., Briscoe, J., Mu, X. and Baron, W., Estimating the willingness to pay for water services in developing countries: A case study of the use of contingent valuation surveys in southern Haiti. *Economic Development and Cultural Change*, Vol. 38, pp. 293-311, 1990.

38. Whittington, D., Improving the performance of contingent valuation studies in developing countries, *Environmental and Resource Economics*, Vol. 22, pp. 323-367, 2002.

39. Whittington, D., Pattanayak, S., Yang, J-C., Kumar, K.C., *Do Households Water Privatized Municipal Water Services, Evidence from Kathmandu, Nepal*, Working Paper 02_03, Research Triangle Institute, Raleigh, USA, 2002.

40. World Bank Water Demand Research Team., The demand for water in rural areas: Determinants and policy implications. *World Bank Research Observer*, Vol. 8, pp. 47-70, 1993.

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Logical Bridge 2

Paper 1 in this thesis presented WTP analyses using a method, the contingent valuation method, most often used in assessing WTP for water service changes in developing countries. Paper 2 then presented an alternate method which has been extensively applied in transportation and marketing contexts, but only minimally in a water supply valuation context. The main purpose of paper 2 was to detail the results of such a novel application and the method used to develop data according to the choice experiment method and then to develop appropriate models based on that data. The paper also discussed the policy analysis benefits of using such a sophisticated attribute based stated preference technique for the valuation. Paper 3, entitled "Using choice experiments for valuing water supply changes: testing for convergent validity and benefit transfer", provides a rigorous comparison of the two methods used in paper 1 and paper 2. As contingent valuation has been used as a dominant method for water supply service change valuation, convergent validity between the two methods is tested. As well, given the notional possibility of transferring models developed in one context to applications with differing characteristics, the possibility of benefit transfer with models developed from choice experiments was also tested. Given the limited empirical work comparing the two methods and benefit transfer properties of the choice experiment method, the results presented in paper 3 are contextualized within the wider methodological literature, as opposed to only the water supply valuation literature. It is shown convergent validity applies under specific conditions. Where choice experiment models do not include a status quo attribute, that is an attribute which distinguishes between a new choice and the status quo, convergent validity is observed. When however, more detailed models are constructed, which account for the structure bias associated with the status quo option, convergent validity does not hold. Statistical tests of benefit transfer show that models developed from choice experiment data cannot be applied to different populations though full specification of such models does reduce transfer errors in such applications to levels which might be considered acceptable for welfare valuation policy analysis.

6 PAPER 3

Using choice experiments for valuing water supply changes: testing for convergent validity and benefit transfer

6.0 ABSTRACT

Choice experiments have become increasingly applied to value environmental changes and estimate the policy benefits associated with different interventions. Few analyses have compared the welfare estimates derived from this stated preference technique with estimates from the more widely used contingent valuation method. This paper discusses two issues around the validity of the choice experiment method in policy applications using a case study from Trinidad and Tobago. The paper discusses the convergent validity between the choice experiment and contingent valuation methods for this water services case study as well as evaluates the performance of choice experiments in tasks of benefit transfer. Convergent validity is demonstrated between the two methods, when status quo biases interact with water service attributes to artificially depress willingness to pay estimates. The paper also suggests that choice experiment models developed in one context are not fully exchangeable with those developed in other contexts.

6.1 Introduction

Numerous studies have employed the contingent valuation method for valuing water supply service changes (e.g. Whittington et al, 1990, Briscoe et al 1990, McPhail, 1993). These examinations have sought to understand the preferences of respondents regarding possible improvements to their water supply services to estimate the possible levels of cost recovery through user charges attainable as well as to assess total project benefits within the context of project cost benefit analysis. Applications have therefore sought to estimate the willingness to pay for service level changes.

The contingent valuation method is, to some degree, limited in its ability to perform this function by its nature. As the CV method usually presents a single

scenario to respondents for them to consider, the valuation of variations in service level changes outside of the presented changes are difficult to assess. The method therefore is sensitive to the specification of the question. As well, the method has been criticized for its insensitivity to scope. This means that the sum of valuations of subsets of the offered policy option do not necessarily equal the total value of the option (e.g. Hoen and Loomis, 1993). The method's application, however, has been used extensively in many environmental valuation problems, and has been recognized as being a legitimate way of arriving at such valuations provided that sufficient care is taken (Arrow et al., 1993). In the water supply valuation sector the method has been extensively applied, with at least on investigation into its ability to predict future behaviour based on the hypothetical decisions it elicits. Griffin et al. (1995) revisited sites in Kerela which were earlier analysed using the CV method after the completion of a rural water project to assess the actual choice behaviour of respondents. They found that the earlier CV study performed very well, predicting actual behaviour across the sample correctly 91% of the time. The ability of the method to be used for benefit transfer however was less successful.

Despite the prolific application of the CV method, alternative stated preference methods have been explored in the field of environmental valuation. The choice experiment methodology (e.g. Louviere et al., 2000) has recently been used to assess varying levels of attributes within environmental policy bundles. By characterizing alternative policy scenarios by bundles of attributes, whose levels can vary across choice tasks and presenting a series of such choice tasks to each respondent, the method captures considerably more information from each respondent as well as facilitates the valuation of fractional policy changes. These methods have been applied in only a limited way for water supply service valuation. Water supply reliability, defined as the probability of a shortage, in Australia has been analysed using CE methods by Hensher et al. (2005) and MacDonald et al. (2005). Powe et al. (2004) used CE method to value environmental impacts of changing water supply. Only three studies in the

literature have attempted the use of these methods for valuation of a set of service level changes. Haider and Rasid (2002) estimate the WTP for changes in taste and pressure parameters in Thunder Bay, Canada. Developing country applications have been limited to Anand (2001) and Hope and Garrod (2004). In all of these studies little attempt has been made to validate the results relative to actual choice behaviour, or some proxy for it.

Given its wider acceptance, comparisons between the CE and CV methods for convergent validity have been used in other studies to assess the applicability of the CE method. Boxall et al. (1996) present an early comparison of the two methods, and find that the CV method produces valuations which are far larger than those derived from the CE method. A later study (Adamowicz et al., 1998) examines the relative scale effect of the two data sets, using an artificial nested logit model (e.g. Louviere et al., 2000), as a test for equivalence in the parameters of the different model. Their study shows no significant difference between the two methods, but notes that the ability to analyse the effect of varying attributes in the CE method was very beneficial. Mogas et al. (2002), in an afforestation valuation application find the two methods provide similar welfare estimates dependent upon specification of the models. Lockwood and Carberry (1998) also compare the two methods in the context of conservation valuation to find that they produce similar estimates of the welfare associated with conservation. Foster and Mourato (2003) compare WTP estimates from the CE and CV methods in the context of charity valuation in the UK and find that the nature of the good affects the relative valuation placed on it by the respondent, with public goods being valued more highly by the CE method than the CV method. This study also compares the two methods with regard to sensitivity to scope and finds that the CE method does not suffer the same 'adding up' problem that the CV method presents. This brief summary of some of the literature demonstrates lack of consistency in the findings of comparative studies. Boyle et al. (2004) attempt to explain the apparent trend that the CE method produces higher estimates of welfare than the CV method by proposing that the provision rules by which the

good will be delivered are not well specified in CE applications leading to an overestimate of the value associated with a particular alternative.

Given the significant cost associated with conducting stated preference surveys a considerable premium is placed upon the ability to use models developed in one context to estimate the likely benefits and willingness to pay for service changes in another context, that is the ability to use models for benefit transfer estimates (Brouwer, 2000). Choice experiments, due to their valuation on the basis of varying attribute levels and the ability to assign target site attributes to the application of developed models, have the potential to perform better at such benefit transfer tasks than the CV method (Morisson et al., 2002). Analysis of the potential for CE models to transfer benefits, however, is minimal. Morrisson et al. (2002) demonstrate the transferability of implicit prices associated with the change in a level of an attribute; however contest the ability of CE models to estimate the compensating surplus of an aggregate change at a different site or in a different population. Other studies (e.g. Bueren and Bennett and Morrison and Bennett) have found that the implicit prices at different sites vary and so benefit transfer using CE is more contentious than might be assumed. Colombo et al. (2005) also consider the use of CE models for benefit transfer of soil erosion projects in Spain and find, that by using random parameters logit (e.g. McFadden and Train, 2000) to capture preference heterogeneity transfer errors can be reduced.

This paper discusses these two related questions. It compares CE and CV models and tests for convergent validity as well as testing the applicability of benefit transfer across different populations for the valuation of water supply improvements in a developing country context. The paper uses a case study from Trinidad and Tobago.

6.2 Modeling stated preference data

The CV and CE methods are both based on premise that decision makers are random utility maximizers (McFadden, 1974). As such, the results they produce are directly comparable as models analysing choice behaviour are fundamentally based on the utility that different options provide to the decision maker. The utility derived from a particular option can be represented as

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{1}$$

Where U_{ij} is the utility person *i* derives from alternative *j* and is composed of a deterministic component of utility, V_{ij}, and a stochastic component, ε_{ij}. A person chooses a particular alternative if

$$V_1 + \varepsilon_1 > V_2 + \varepsilon_2 \tag{2}$$

And given that the stochastic component is not measurable, the probability of choosing an alternative is

$$P_1 = P(V_1 - V_2 > \varepsilon_2 - \varepsilon_1) \tag{3}$$

And as the systematic component of utility is dependent upon the attributes of the alternative and their levels it can be represented by

$$V_i = \beta_k X_i \tag{4}$$

where X is a vector of k attributes and β is a vector of coefficients. If the error terms take a Type I extreme value distribution the model reduces to the multinomial logit model (MNL). For a detailed discussion of the MNL model and its use in modelling stated preference data see Louviere et al. (2000)

6.3 Testing for convergent validity and benefit transfer

Performing tests of equivalence between two estimates of welfare given models developed from CV or CE data is somewhat more complicated than might initially appear. Estimated parameters are known to be asymptotically normally distributed, but welfare estimates are non-linear functions of parameters and so the estimation of welfare is not normally distributed. The equivalent variation or willingness to pay for an increment in an attribute of a proposed alternative is given by (5).

$$WTP = -\left(\frac{\beta_c}{\beta_y}\right) \tag{5}$$

where β_c the parameter is linked to the attribute variable and β_y is the coefficient of the price variable (Louviere et al., 2000).

Simulation methods are normally used to estimate the distribution of the welfare function and infer confidence intervals (Cooper, 1994). One method particularly used in the estimation of confidence intervals for WTP estimates was proposed by Krinsky and Robb (1986) (K-R method). The K-R method is similar to the bootstrap method, which is based on random draws from the observed data set (e.g. Efron and Tibshirani, 1993). Random draws are taken from the multivariate normal distribution defined by the mean of the parameter vector and its covariance matrix. For each random draw the WTP value is estimated and based on a large number of draws a distribution is inferred. Confidence intervals are then defined by the relevant cut off points in that distribution, for instance the 2.5% and 97.5% levels for a 95% confidence interval. Kling (1991) compares different simulation methods, including the bootstrap and K-R method and finds that the K-R method gives estimates of welfare standard deviation and confidence intervals similar to the bootstrap method. Frequent use in the literature (e.g. Foster and Mourato, 1993, Mogas et al., 2002 or Lockwood and Carberry, 1998) has further legitimized the method.

In order to test for convergent validity or benefit transfer, two different welfare functions are compared. This raises complications given the uncertainty of the form of the functions. Poe et al. (1997) propose a method to compare two empirical distributions, as developed by the Krinsky and Robb procedure for example. This involves taking random draws from each welfare distribution and comparing the values from two distributions at each draw. The null hypothesis of there being no difference between the two distributions is tested, over many draws, by counting the percentage of calculated differences below zero. Confidence tests are then those for one-tailed tests, with, for example, more than five percent of the differences less than zero indicating a rejection of the null hypothesis at a 95% confidence level. Poe et al. (2005), note that for the procedure to give unbiased estimates for the test of the null hypothesis, the procedure must be repeated a large number of times. This has often not happened in the literature with many researchers taking only one series of draws of differences between distributions (e.g. Foster and Mourato, 2003, Morisson et al., 2002). In the context of benefit transfer tests specifically, Kistofersson and Navrud (2005) have questioned the applicability of testing the null hypothesis that there is no difference between the two distributions being analysed, suggesting that some tolerance should be used to test for equivalence, in contrast to equality. Their rationale is that policy analysis will tolerate some estimation error given that there would be significant cost savings in transferring benefits. Whilst this line of reasoning is enticing, the lack of experience in setting such levels of tolerance makes the application of the suggested equivalence tests difficult.

6.4 The study

A willingness to pay survey was administered, using an in-person questionnaire, in Trinidad and Tobago in 2003. The survey aimed to capture the current water, wastewater and electricity service levels experienced by the population. The full results are presented in Virjee (2004), Virjee and Gaskin (2006a) and Virjee and Gaskin (2006b). A total sample of 1419 households was selected using the Central

Statistical Office's Continuous Sample Survey of Population (CSSP) (CSO, 1989), and 87% of these households participated in the survey.

Water services are provided by a national utility, the Water and Sewerage Authority (WASA) that is responsible for ensuring access to water services for the entire population.

Respondents were asked about current water service levels and also were exposed to a contingent valuation question, with an iterative bidding game elicitation format. The CV scenario described a change in service from the respondent's current service level to an ideal service level, 24 hour water supply with adequate water pressure and good bacteriological and aesthetic water quality. Where respondents did not currently have a private household connection to the water system (27% of respondents) the CV scenario included the upgrade to an in-house connection. In addition, respondents were presented a series of 12 choice sets of 4 alternatives each, including a status quo option in a CE section. The attribute levels used in the choice set design were inferred from experience in the sector by the Regulated Industries Commission (RIC) as well as by reviewing utility performance documents, and were set to capture current levels as well as higher levels of service, up to the full service specification of the CV scenario. An experimental design using the methods developed in Kuhfeld (2003) for unbalanced designs were used. Two different CE designs were used in the survey; one administered to respondents who indicated that their primary water supply was from an in-house connection, the other to those relying on other lower levels of service. Table 6.1 gives details of the attributes used for the two sub-samples in the CE application of the study as well as the two sub-sample sizes.

The results of the survey were analysed using discrete choice models (Louviere et al., 2000) and these results are presented in table 6.2. Model 1 results describe the choice behaviour of respondents whose primary water supply was not an in-house connection and model 2, those who did have such a service as their primary water

supply. The choice experiments were analysed using multinomial logit models specified with only attribute levels determining utility (main effects model) as well as with other significant individual specific variables (full model). The CV data was analysed with only price and an intercept as explanatory, and for model 2, was also analysed with significant individual specific variables used in the CE specifications. No individual specific variables were significant for model 2 and so only the intercept-price model is shown in table 6.2. The independence from such individual specific variables is frequently found in similar comparative studies (e.g. Adamowicz et al. 1998, Foster and Mourato, 2003)

Table 6.1: Choice experiment attributes and sample size

	Attribute variables	Attribute levels	Sample Size
Sub-sample 1 Households **without** in-house connection	Reliability – days Reliability – hours Pressure Quality Level of Service Price Connection fee	1,4,7 2,12,24 low, average, high low, average, high Standpipe, in-house 50, 150,250,350,450 0,300,600	327 households
Sub-sample 2 Households **with** in-house connection	Reliability – days Reliability – hours Pressure Quality Price	1,4,7 2,12,24 low, average, high low, average, high 50, 150,250,350,450	846 households

Table 6.2: Model results: CV and CE models

Attribute Name	Estimated Coefficient Values				Model 2		
	Model 1 MNL models for those without In house connection from WASA				MNL models for those with in house connection from WASA		
	CE – Main effects	CE- Full Choice Model	CV Method	CV Method	CE – Main effects	CE- Full Choice Model	CV Method
Quality = average	0.275*	0.330*			0.040	0.038	
Quality = high	0.359*	0.412*			0.143*	0.141*	
Pressure = average	0.159*	0.163*			-0.053*	-0.066*	
Pressure = high	0.352*	0.457*			-0.002	0.017	
Reliability – days	0.054*	0.137*			0.324*	0.323*	
Reliability – hours	0.021*	0.047*			0.054*	0.054*	
Connection fee	0.001*	0.001*					
LOS = in house connection	0.351*	0.441*					

Price	-0.002*	-0.002*	-0.006*	-0.006*	-0.002*	-0.002*	-0.007*
ASC	-1.425*		0.540*		-2.426*	-2.497*	0.586*
ASC interacted:							
Other water charges incurred by the HH		-1.650		0.437*		0.556*	
Whether primary water source is WASA		0.997*		0.336*			
Whether respondent was in Port of Spain		1.247*					
Island (0=Trinidad)		-1.238*					
Whether respondent is over 50		-0.347*					
Whether respondent has more than Secondary education						-0.319*	
Storage at household (100 m3)						0.010*	
Income (TT$ 1000 / month)				0.136*			
Log-likelihood function	-4721.0	-4388.9	-834.0	-828.3	-5026.3	-4838.0	-2143.6
ρ^2	0.13	0.19	0.12	0.13	0.64	0.64	0.13

Notes:
ASC is coded 1 for alternatives that are not the status quo
* indicates that parameter is significant at or below the 5% level

6.5 The willingness to pay for service upgrades

Table 6.3 shows the willingness to pay for service upgrades as derived from both the CE and CV methods and 95% confidence intervals as shown in brackets below the mean values. The confidence intervals for the WTP estimates were derived using the Krinksy and Robb (1986) procedure discussed above. The WTP measures are calculated using equation (5) for the CV estimates, with the numerator in the equation equal to the intercept value of the model. The CE estimates are derived using the principle of compensating variation (e.g. Louviere et al., 2000) where the WTP is equal to the price change that would leave the respondent with no net utility increase after the policy change. That is, the extra utility derived from the policy change is set equal to the disutility of a price increase, and this price increase is equal to the WTP for the policy change. Thus for a change from initial conditions, V_I^0 to the new conditions, V_I^1 the compensating surplus (CS) is given in (6).

$$CS = \frac{-1}{\beta_y}\left[\ln\sum_{i=1}^{n} e^{V_i^0} - \ln\sum_{i=1}^{n} e^{V_i^1}\right] \quad (6)$$

where β_y is, as before, the parameter describing the utility effect of price changes. To estimate the CE WTP, attributes were set at levels representing the ideal level of service described in the CV scenario.

The CV estimates of WTP show a similar valuation placed on the improved service bundle by both those with in-house connections and those without. This is counter intuitive given the different levels of service experienced by the two groups and the implication of this result taken alone is that there is some fixed utility associated with the service attributes common to the two groups. That is, service attributes which are not shared between the two groups, notably the ease of access or level of service, have no marginal value to those with a lower level of service. This result could also be explained by the observation that the two sets have different incomes (Virjee and Gaskin, 2006a) and so the income effect of a price change at the household level is not the same for the two groups. The confidence intervals around the mean WTP estimates are wider for the non-piped households. This is for two reasons; firstly the sample size is smaller for non-piped households, and secondly the status quo service level for this sub-sample is more varied than for those with in-house connections. The latter reason is substantiated by the second CV model WTP estimates, for non-piped households, where those who rely on WASA standpipe water are willing to pay more for the improved water situation than those who get water from non-utility sources.

Table 6.3: Willingness to pay for water service changes

	Households without in-house connection	**Households with in-house connection**
Contingent Valuation Method		
Intercept only	88.8 (62.2, 111.8)	89.2 (74.4 , 102.4)
Respondents – primary source WASA	103.7 (63.4, 134.9)	
Respondents – pay other water	177.9	

charges	(111.3, 247.3)	
Choice Experiments		
Main effects model – with no intercept	48.8 (-1.5, 96.1)	87.1 (70.0, 105.2)
Full model	1094.7 (839.5, 1411.7)	476.8 (396.3, 554.0)
Respondents – primary source WASA	1325.0 (1062.1, 1676.2)	
Respondents – pay other water charges	263.8 (167.6, 364.8)	

Note: Bracketed numbers are 95% confidence intervals estimated by the Krinsky and Robb (1986) procedure

The CE estimates of WTP are different in scale depending upon the model formulation used. A qualitative comparison between the main effects model without intercept and the CV estimates seems to indicate that similar estimates of WTP are observed. This is discussed more formally below. In contrast, the CE model formulations which include individual specific variables in contrast produce estimates which are much higher than those developed by the CV method. Again, confidence intervals are wider for the sub-sample without in-house connections, which substantiates the assertion that preferences are more varied in this sub-sample. The CE context presented 12 choice situations to each respondent, resulting in a much larger set of observations than in the CV case, and so reducing the likelihood that the wide confidence intervals result from small sample sizes. Confidence intervals of the CE and CV in-house connection models are similar in scale. Estimates for the two sub-samples (with and without in house connections), using the main effects CE model also appear to be different, with those without in-house connections willing to pay less for the ideal service than those with in-house connections. The full models, however, do capture the intuitive result that there is utility, and therefore WTP, for upgrading services in terms of proximity of the connection (i.e. that WTP is higher for those without in-house connections).

One main reason CE are becoming frequently used, as reported in the literature, is the ability they provide to analyse changes to attributes of policy bundles, as opposed to only the total policy change as is the case with the CV method. Table 6.4, presents confidence intervals around the marginal rates of substitution for the

attributes of water supply used in the CE models. Again, a qualitative analysis of the variables implies that the two different sub-samples have different valuations of changes in the levels of attributes. The exception to this observation is the status quo bias present in both models. The value of moving away from the current water service solution to any other is negative and similar in scale for the two models.

Table 6.4: Implicit Prices for main effects CE model

	Households without in-house connection	Households with in-house connection
Reliability – hours	12.7 (9.1, 17.2)	22.0 (19.2, 25.5)
Reliability – days	33.4 (22.3, 46.0)	132.1 (116.3, 150.0)
Pressure – High	218.0 (133.0, 313.8)	-1.3 (-20.8, 19.4)
Quality – High	223.4 (142.2, 314.9)	58.5 (38.1, 81.3)
LOS – from standpipe to in-house connection	219.8 (142.8, 313.5)	N/A
Constant – New choice	-885.0 (-1179.1, 672.6)	-988.6 (-1132.3, -865.1)

Note: Bracketed numbers are 95% confidence intervals estimated by the Krinsky and Robb (1986) procedure

6.6 Testing for convergent validity

As was noted earlier in the paper, the validity of the CE method for water supply variation can be assessed by comparing the results from such experiments to model results from the CV method. Table 6.5 explores the hypothesis test suggested in (7).

$$H_0 : WTP_{CE} = WTP_{CV} \qquad (7)$$

$$H_A : WTP_{CE} \neq WTP_{CV}$$

The null hypothesis, H_0, is that the WTP derived from the CE method is statistically equal to the estimate from the CV method and the alternate hypothesis, H_A, is that the two estimates are not statistically equal. This test was applied to both sub-samples in the study and for different formulations of the

different models. The comparison of the CV model to the CE main effects model without intercept leads to the acceptance of the null hypothesis, at a 95% significance level, that the two models generate similar results. This finding is reversed in the comparison of the CE full models to the CV models, also for both sub-sets.

Table 6.5: Hypothesis test: Convergent validity (H_0: $WTP_{CE}=WTP_{CV}$) (H_A: $WTP_{CE} \neq WTP_{CV}$)

	Difference between models - 95% confidence interval*	**Significance Level**	**Accept/ reject null hypothesis – H_0**
Households **without** in-house connection			
CV – CE main effects	-74.5, 37.8	0.056	Accept
CV- CE full model	526.6, 874.5	0.000	Reject
Households **with** in-house connection			
CV– CE main effects	-23.4 , 17.6	0.066	Accept
CV – CE full model	0.6, 249.1	0.001	Reject

One explanation for this finding lies in the treatment of the status quo bias mentioned earlier. Given that both the CV models and the CE main effects models do not explicitly include a status quo variable, the effect of such a bias is to interact with attributes of the 'improved' policy being offered. For the CV case, the intercept will be depressed due to the disutility associated with the status quo bias. Analogously for the CE main effects models, status quo bias would require that other attributes take on much larger values to entice a respondent to choose a non status quo alternative and so the parameters in the model would be deflated. The implication is that there is convergence between the results of the CV and CE methods provided that the effect of status quo bias is not explicitly modeled as an alternative specific constant in the CE model. In addition, the inability to separate out status quo biases in the CV context makes it difficult to know what the 'true' WTP of respondents to that method is. The source of the status quo bias will influence its legitimacy as a determinant of actual choice and therefore also its effect on the 'true' WTP of users. In this particular study, status quo bias is most likely due to uncertainty on the part of the respondent as to the feasibility of a

service change. This arises from a history of poor utility performance and failed reform attempts (Virjee and Gaskin, 2003) and given this, it is plausible that given an actual choice situation, where the utility was to offer a service upgrade, the status quo bias would not be present and other parameters defining the service attributes of the new conditions would define the utility from the alternative service level. Therefore, CV methods and CE models which do not explicitly control for status quo bias would suggest WTP values that are too low. This is possibly the case in this situation given that current average water bills for in-house customers of WASA are about double the mean WTP suggested by the CV and CE main effects models.

6.7 Testing for benefit transfer

This study conducted two separate choice experiments; for households with in-house connections and for those using other water sources as their primary water source. A comparison of the two models resulting from the different sub-samples and the ability of the models to predict WTP for the other sub-sample can be used as a test for benefit transfer across populations. The segmentation of the sub-samples was along the lines of differing contextual decision making frameworks. As one of the primary benefits of using benefit transfer is to ascertain the likely benefits for a non-sampled population comparing the results as is done in table 6.6 is relevant. This test for benefit transfer is across different populations, from the same 'site', and so does not assess the transferability of benefits across sites as is commonly tested in such transfer tests (e.g. Barton, 1999).

Table 6.6 presents two tests of benefit transfer. The first tests the null hypothesis that the marginal rate of substitution for the different model parameters is different. The second test compares the transferred benefits determined from the model for one sub-sample to the other sub-sample. That is, model 2 was used to value the policy change to the ideal level of service for the non-in-house connected sub sample and conversely, model 1 was used to test the WTP for changes in service level for those with in house connections.

On the first test, a comparison of model parameters, the null hypothesis of equivalence of marginal rates of substitution or implicit prices is accepted for all the parameters except for the constant representing the decision of opt for a non-status quo alternative.

Table 6.6: Hypothesis test: Benefit transfer (HO: $\beta_1=\beta_2$) (HA: $\beta_1\neq\beta_2$) and (H0: $WTP_1=WTP_2$) (HA: $WTP_1\neq WTP_2$)

	Confidence Intervals	**Significance Level**	**Accept/ reject null hypothesis – H_0**
Reliability – hours	3.8, 13.4	0.000	Reject
Reliability – days	80.4, 124.4	0.000	Reject
Pressure – High	-283.6, -180.4	0.000	Reject
Quality – High	-195.9, -138.5	0.000	Reject
Constant – new choice	-366.0, 79.7	0.078	Accept
Difference between transferred and actual – without in house connection	538.4, 637.8	0.000	Reject
Difference between transferred and actual – with in house connection	158.3, 285.4	0.000	Reject

The null hypothesis for the second test is given by (8).

$$H_0 : WTP_{1\to 2} = WTP_{1\to 1} \qquad (8)$$
$$H_A : WTP_{1\to 2} \neq WTP_{1\to 1}$$

where $WTP_{i\to j}$ represents the WTP assessed by model i for sub-sample j. The test is rejected for models from both sub-samples, implying that the two models do not value the relevant policy changes to the two sub-samples equally. It is also instructive to quantify the degree to which the use of the wrong model would cause mis-estimation errors. This transfer error, TE, can be defined in (9).

$$TE = \frac{\left|WTP_p - WTP_e\right|}{WTP_e} \qquad (9)$$

where the subscripts indicate the predicted value using the model developed for a different site, p, or the estimated value, e, from the model developed for the site for which benefit transfer is being tested. Table 6.7 summarizes the transfer errors calculated for different model specifications. It is apparent that there is considerable variation in transfer errors. As noted earlier, the exclusion of an intercept variable, to capture status quo biases, leads to suppressed WTP values, and so results in the most erroneous benefit transfer estimates. When correcting for status quo bias however, the transfer errors are much smaller and for the fully specified model they are in the range of 15%-24%, which may be small enough to be used for policy level decision making. This level of transfer error is considered acceptable in other applications such as for pharmaceutical research (Kristofersson and Navrud, 2005). It is apparent, in any case, that model specification has significant impact on the ability to use CE models for benefit transfer analysis and that fully specified models estimate parameters that are more likely to relate to the actual preference structure of respondents.

Table 6.7: Transfer errors for different model specifications

	Model 1	**Model 2**	**Transfer error**
Without in-house connection *(Model 1)*			
Main effects specification	50	552	1003%
With status quo constant	659	1094	66%
Full model	1299	1108	15%
With in house connections *(Model 2)*			
Main effects specification	-137	87	257%
With status quo constant	311	457	32%
Full model	588	475	24%

6.8 Conclusions

This paper has discussed the use of choice models as an alternate stated preference technique for valuing changes to water services. Using data from a stated preference study in Trinidad and Tobago convergent validity and benefit transfer have been analysed. It has been demonstrated that convergent validity is achieved when the variables capturing status quo biases are excluded from the multinomial logit model. This has practical implications as the exclusion of status

quo effects biases attribute parameters downwards giving lower estimates of respondents' WTP. It can be concluded from this analysis therefore, that the CE method, in part due to its ability to explicitly treat the status quo effect as an attribute of the decision scenario adds considerable value to the modeling of hypothetical choices in the face of water service improvements. This is a specific benefit associated with the method's ability to value implicit prices of policy attributes.

This paper in discussing benefit transfer possibilities with the CE method, has considered two statistical tests. The first, comparing the implicit prices of two models generated separately for households with and without in-house water service connections showed that implicit prices differ across the two models. The second test, comparing the compensating surplus from the two models also showed that equality is not achieved. A more qualitative analysis, however, around the concept of equivalence, where some tolerance defines acceptable levels variation in estimation has shown that by using a fully developed MNL model, transfer errors can be rather minimal, and in line with those suggested as acceptable in other studies (Kristofersson and Navrud, 2005).

The results presented here do not conclusively validate the CE method as acceptable for analysis of water supply improvements though the main two points do suggest that the method has potential for increased relevance in developing information for policy analysis. Further research in comparing the results of CV and CE applications is required, with specific focus on status quo effects where they are anticipated to be systematic and introduce bias as in the cased presented here. Another significant area for future work is exploration around tests of equivalence for benefit transfer, which would seek to set acceptable levels of error for the application of models in contexts they were not explicitly developed for. Given the significant impact model specification has on transfer errors, research focussing on improvements associated with other model specifications (such as

analysis around the inclusion of preference heterogeneity in the modeling process (e.g. Colombo et al., 2005) also shows promise.

6.9 References

1. Adamowicz, W., Boxall, P., Williams, M., Louviere, J., Stated preference approaches for measuring passive use values: Choice experiments and contingent valuation, *American Journal of Agricultural Economics*, Vol. 80, pp. 64-75, 1998.

2. Anand, P.B., *Consumer preferences for water supply? An application of choice models to Urban India,* Discussion Paper No. 2001/145, United Nations University, Helsinki, Finland, 2001.

3. Arrow, K.J., Solow, R., Portney, P.R., Leamer, E.E., Radner, R., and Schuman, E.H., Report of the NOAA panel on contingent valuation, *Federal Register*, Vol. 58, pp. 4602-4614, 1993.

4. Barton, D., *The transferability of benefit transfer – an experiment in varying the context of willingness to pay for water quality improvements*, Discussion Paper #D-10/1999, Agricultural University of Norway, Norway, 1999.

5. Boxall, P., Adamowicz, W., Swait, J., Williams, M., Louviere, J., A comparison of stated preference methods for environmental valuation, *Ecological Economics*, Vol. 18, pp. 243-253, 1996.

6. Boyle, K., Morisson, M., Taylor, L., Why value estimates generated using choice modelling exceed contingent valuation: Further experimental evidence, Australian Agricultural and Resource Economics Society Conference, Melbourne, Australia, 2004.

7. Briscoe, J., Furtado de Castro, P., Griffin, C., North, J. and Olsen, O., Toward equitable and sustainable rural water supplies: A contingent valuation study in Brazil, *The World Bank Economic Review*, Vol. 4, No. 2, pp. 115-134, 1990.

8. Brouwer, R., Environmental value transfer: state of the art and future prospects, *Ecological Economics*, Vol. 31, pp. 137-152, 2000

9. Bueren, M. and Bennett, J., Towards the development of a transferable set of value estimates for environmental attributes, *Australian Journal of Agricultural and Resource Economics*, Vol. 48, pp. 1-32, 2004

10. Columbo, S., Hanley, N., Calatrava-Requena, J., *Testing choice experiments for benefit transfer with preference heterogeneity*, Working Paper, 2005.

11. Cooper, J., A comparison of approaches to calculating confidence intervals for benefit measures from dichotomous choice contingent valuation surveys, *Land Economics*, Vol., 70, No. 1, pp. 111-122, 1994.

12. Efron, B., Tibshirani, R., *An Introduction to the Bootstrap*, Chapman and Hall, New York, 1993.

13. Foster, V. and Mourato, S., Elicitation format and sensitivity to scope: Do contingent valuation and choice experiments give the same results?, *Environmental and Resource Economics*, Vol. 24, pp. 141-160, 2003.

14. Griffin, C, Briscoe, J, Singh, B, Ramasubban, R, Bhatia, R, Contingent valuation and actual behavior: predicting connections to new water systems in the state of `, India, *World Bank Economic Review*, Vol. 9, No. 3, pp. 373-395, 1995.

15. Haider, W. and Rasid, H., Eliciting public preferences for municipal water supply options, *Environmental Impact Assessment Review*, Vol. 22, pp. 337-360, 2002.

16. Hensher, D., Shore, N., and Train, K., *Households' willingness to pay for water service attributes*, Working Paper, 2005.

17. Hoen, J.P., and Loomis, J.B., Substitution effects in the valuation of multiple environmental programs, *Journal of Environmental Economics and Management*, Vol. 20, pp. 56-75, 1993.

18. Hope, R.A and Garrod, G.D., Household preferences to water policy interventions in rural South Africa, *Water Policy*, Vol. 6, No. 6, pp. 487-499, 2004.

19. Kling, C., Estimating the precision of welfare measures, *Journal of Environmental Economics and Management*, Vol. 21, pp. 244-259, 1991.

20. Krinsky, I., Robb, A.,L., On approximating the statistical properties of elasticities, *The Review of Economics and Statistics*, Vol. 68, No. 4, pp. 715-719, 1986.

21. Kristofersson, D., Navrud, S., Validity tests of benefit transfer – Are we performing the wrong tests?, *Environmental and Resource Economics*, Vol., 30, pp. 279-286, 2005.

22. Kuhfeld, W, *Marketing Research Methods in the SAS System*, Version 9.0 edition, SAS Institute, 2003.

23. Lockwood, M and Carberry, D., *Stated preference surveys of remnant native vegetation conservation*, Report No. 104, Johnstone Centre, Albery, Australia, 1998.

24. Louviere, J., Hensher, D., Swait, J., *Stated Choice Methods: Analysis and Application*, Cambridge University Press, Cambridge, UK, 2000.

25. MacDonald, D., Barnes, M., Bennett, J., Morrison, M., Young, M., Using a choice modelling approach for customer service standards in urban water, *Journal of the American Water Resources Association*, Vol. 41, No. 3, pp. 1-10, 2005.

26. McFadden, D and Train, K., Mixed MNL models for discrete response, *Journal of Applied Econometrics*, Vol. 15, pp. 447-470, 2000.

27. McFadden, D. Conditional logit analysis of qualitative choice behaviour, in *Frontiers of Econometrics*, Zarembka P. ed., Academic Press, New York, 1974.

28. McPhail, A., The 'five percent rule' for improved water service: can households afford more? *World Development*, Vol. 21, No. 6, pp 963-973, 1993.

29. Mogas, J., Riera, P., Bennett, J., *A Comparison of Contingent Valuation and Choice Modelling: Estimating the Environmental Values of Catalonian Forests*, Occasional Paper No 1., Australian National University, Canberra, Australia, 2002.

30. Morrison, M. and Bennett, J., Valuing New South Wales rivers for use in benefit transfer, *Australian Journal of Agricultural and Resource Economics*, Vol. 48, pp. 591-611, 2004.

31. Morrison, M., Bennett, J., Blamey, R., Louviere, J., Choice modeling and tests of benefit transfer, *American Journal of Agricultural Economics*, Vol. 84, No. 1, pp. 161-170, 2002.

32. Poe, G., Giraud, K., Loomis, J. Computational methods for measuring the difference of empirical distributions, *American Journal of Agricultural Economics*, Vol. 87, No. 2, pp. 353-365, 2005.

33. Poe, G., Welsh, M., Champ, P., Measuring the difference in means willingness to pay when dichotomous choice contingent valuation responses are not independent, *Land Economics*, Vol. 73, No. 2, pp. 255-267, 1997.

34. Powe, N.A., Garrod, G.D., McMahon, P.L., Willis, K.G., Assessing customer preferences for water supply options using mixed methodology choice experiments, *Water Policy*, Vol. 6, No. 5, pp. 427-441, 2004.

35. Virjee, K and Gaskin, S., The demand for improved water supply and sanitation: The case of Trinidad and Tobago, *Journal of Eastern Caribbean Studies, submitted*, 2006a.

36. Virjee, K., and Gaskin, S., Discrete Choice Experiments and the Willingness to Pay for Water Supply Changes in Developing Countries: A Case Study of Trinidad and Tobago, *Water Policy, submitted*, 2006b.

37. Virjee, K., *The Willingness to Pay for Changes in Water, Wastewater and Electricity Services in Trinidad and Tobago*, Working Paper, Water Resources Planning and Management, Department of Civil Engineering and Applied Mechanics, McGill University, 2004.

38. Whittington, D., Briscoe, J., Mu, X. and Baron, W., Estimating the willingness to pay for water services in developing countries: A case study of the use of contingent valuation surveys in southern Haiti. *Economic Development and Cultural Change*, Vol. 38, pp. 293-311, 1990.

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Logical Bridge 3

Papers 1, 2 and 3 developed empirical analyses of WTP for service level changes in the country. These three papers used the results of a survey carried out in 2003 in Trinidad and Tobago. They sought to provide details about method application and to compare the relatively un-tested choice experiment method to the industry standard contingent valuation method. The main conclusions of these analyses were that the choice experiment method offered a degree of richness for policy analysis and that estimates of WTP for changes derived from the method were perhaps more representative of respondent valuations, given the ability to correct for biases associated with the status quo option.

Paper 4, entitled "Reform, regulation and pricing of water services in Trinidad and Tobago: How can willingness to pay data help?" applies the results of the choice experiment method in a tariff planning context in Trinidad and Tobago. Paper 4 begins with a review of global water sector reform and the role that tariff policies play within that. It then discusses the case of reform in Trinidad within this context, and of pricing policy in the country. The choice experiment data is used to compare the likely service level effects of planned investments, and the marginal costs of those investments, to the WTP for such changes. It discusses the need to highlight service impacts of investments beyond simple capacity expansion analysis to include attributes such as reliability, which drive welfare accumulation of service consumers. Also, the comparison of WTP to marginal costs provides a basis for assessing the social acceptability of tariffs based on such costs, as marginal cost based tariffs underpin much tariff reform owing to their theoretical implications for economic efficiency.

7 PAPER 4

Reform, regulation and pricing of water services in Trinidad and Tobago: How can willingness to pay data help?

7.0 ABSTRACT

Financing of the water supply and sanitation sector has been increasingly identified as a constraint to improving the sector. The total funds available and the manner in which they have been used have been discussed. Cost recovery, through user tariffs, has repeatedly been identified as a major, often untapped, source of finance for the sector. Tariff design is discussed and a proposed tariff based on marginal costs of new investments in the system is analysed from the perspective of social acceptability. Analysis of the sufficiency of willingness to pay to justify tariff increases is conducted using willingness to pay assessments derived from choice experiments performed in Trinidad and Tobago. The use of choice experiments as a policy informant is demonstrated and the role that such analyses can play in price setting discussed.

7.1 Introduction

Within the context of the Millennium Development Goals (MDGs), financing issues regarding water supply and sanitation (WSS) have become increasingly highlighted in international debates (Mehta et al., 2005). One focus area of the MDGs is increased access to water supply and sanitation services, with the target set at reducing the un-served by half by 2015. The increasing relevance of financing issues in the WSS sector led to the development of a high level panel report investigating issues and options. This Camdessus report (Winpenny, 2003) presented its results at the 3rd World Water Forum in Kyoto in 2002. One of its recommendations emphasized sustainable cost recovery in the sector. Its recommendation that promotion of local capital finance markets as potential financing source also rests on the assumption of financial viability of water utilities and hence cost recovery from tariffs and sustainable fiscal transfers. This explicit focus on increased access and finance linked issues in the WSS sector arises from the persistent observation that the WSS sector has under-performed,

and left coverage levels low. Access to WSS services impacts upon health outcomes (e.g. Briscoe and Garn, 1994) as well as affecting economic growth at a macro level (e.g. SIWI, 2005).

Efforts to improve water access have been numerous. The water supply and sanitation decade (Cairncross, 1992) focussed international efforts on reducing the number of people without access to basic services. The trend of private sector participation (PSP) in the sector during the 1990s (e.g. Briscoe, 1999) was also in response to lack of performance associated with the status quo. More recently, the debate about changing the sector has evolved more generally to discuss elements of reform.

This paper briefly discusses the financing challenge associated with the WSS sector globally and then reviews the global reform agenda in the WSS sector focussing on three main elements. The role of PSP, the separation of provision responsibilities from oversight responsibilities and pricing reform are all discussed. The particular WSS reform context in Trinidad and Tobago is analyzed with a review of major elements associated with its reform process. Focus is on the role that tariff reform can play in promoting financial viability in the sector. The paper uses stated choice models generated by Virjee and Gaskin (2006b) to compare likely investments in the sector, proposed tariff increases and willingness to pay. The paper also demonstrates how stated choice methods can be used in a regulatory environment to consider issues about quality of service standards. Finally, recommendations on tariff reform linked to the investment plan of the water utility in Trinidad and Tobago are discussed.

7.2 International financing of water supply

Reviews of financing the water sector (e.g. Annamraju et al., 2001, Winpenny, 2003, Mehta, 2003) have highlighted the need for innovation in approaching the financing of water systems which is critical if the MDGs are to be attained. Key issues in this innovation are the better use of public funds to promote efficiency

and equity, the need to leverage resources and the need for increased levels of cost recovery from users.

Public finances have historically been used to subsidize services for the general population. This has meant that operations did not recover their costs from user payments and that new infrastructure development was slowed by fiscal constraints. Further, the reliance upon public finance has led to inefficient management of water services. As fiscal transfers were made irrespective of performance, incentives for service expansion and efficient operations of existing services were minimal. Mehta (2003) argues that for public finance to be effective, subsidies need to be targeted at those who need them; the poor. Further, transfers, including intergovernmental fiscal transfers within decentralization contexts, need include performance based components. The reform of public finance mechanisms is increasingly becoming a focus for reform in the sector (Mehta et al., 2005).

Given limited levels of public finance, due to competing needs for the finance and fiscal austerity measures required for macroeconomic stability, better use of public finances is required to increase resources to the sector. Public finances should therefore be used to leverage other resources into the sector, rather than 'crowd' them out. A second major area of innovation regarding sector finance is how to access alternative sources of finance. One such opportunity exists in financial markets, especially domestic financial markets. As fiscal constraints have often reduced the levels of domestic borrowing by Government, liquidity in the financial sector has led to increased availability of finances for non-conventional projects. The use of such finance for the water sector has been noted as an important area to increase finances to the sector (e.g. Winpenny, 2003). Private sector participation has also been advocated for its ability to leverage additional funding into the sector. Many longer term arrangements such as concessions require the private operator to expand the utility network or develop

new water sources and therefore access private capital markets to finance those improvements.

The final element in financing the sector is increased levels of cost recovery from users. Increased levels of demand responsiveness, that is designing systems for the demands of the users, have been advocated, particularly in the rural water sector, as a way to increase cost recovery. Also, pricing reform, which uses efficient levels of pricing to capture consumer surplus and cross subsidies to finance access and supply for disadvantaged sub-populations, are highlighted as important. Linked to this issue is the use of targeted subsidies, which are able to reach the poor only.

7.3 Reform in the water sector

The concept of reform in the WSS sector has revolved around institutional changes which make the sector more efficient. Changing the way the sector works to utilize the necessary financing innovations, discussed above, is critical to ensure sustainable access and expansion of water services.

Private sector participation, in all of its various forms, was, in the 1990s, almost synonymous with sector reform attempts. Out of growing experience with PSP, reform became more widely defined as the policy changes to support change in the sector. This has required far ranging restructuring efforts, including re-defining national policies, the creation of independent regulators who can design efficient and equitable tariff structures and policies targeted to vulnerable groups as well as PSP linked reforms.

Private sector participation has numerous theoretical benefits though many have been moderated in practice by confounding issues, such as poor policy and institutional frameworks (e.g. Menard and Clarke, 2000), inadequate provisions in contract documents and poor tendering processes. These confounding issues have led in many instances to the renegotiation of contracts after their start date

(Gausch, 2004). The absence of pricing reforms, or difficulty in implementing the required reforms due to pre-existing low tariffs, have also prevented the successful implementation of PSP arrangements (e.g. Haggarty et al. 2001,Alcazar, et al. 2000). Comparative reviews of the success of PSP in the WSS sector have been rather sceptical of its actual benefits, often due to the lack of increased finances which flow to the sector and the inadequate targeting of the poor in the reform process (e.g. Budds and McGranahan, 2003). In one interesting study (Clarke et al., 2004), which followed changing water access over time with household surveys, little difference was found between areas where there was PSP in comparison to control areas.

Difficulties with PSP in the water sector have led to an increased focus on the role of regulation and corporatization of public utilities to achieve reform objectives (Kessides, 2004). Due to the natural monopoly characteristics of water supply utilities, strong regulators are required to ensure that the possibilities of reform are captured. Insufficient information and difficulties in balancing the interests of taxpayers, consumers and investors in the utility often constrain regulators. Further, political interference frequently prevents the regulator from designing the most efficient policies for the sector.

7.4 Concepts in Tariff reform

As has been noted thus far, one central area for financing the WSS sector globally is increased cost recovery from users. The implied pricing or tariff reforms form a central place in overall sector reforms, and emphasize the need for developing institutional mechanisms of pricing reform through the creation of independent regulators. This section discusses the theory of pricing water services and applications of this theory and then discusses water pricing reforms in the context of Trinidad and Tobago, with an emphasis on the use of willingness to pay data to inform price setting.

The difficulty in measuring benefits associated with water supply improvements (Saunders et al., 1977) has led to an emphasis on the pricing of water services to act as indicators to consumers of their associated value. Marginal cost pricing, in theory, requires the setting of tariff equal to the cost of producing an additional unit of output. It is therefore efficient, in that total benefits in surplus to costs are maximized (e.g. Train, 1991). Despite the theoretical appreciation of such pricing mechanisms, a number of issues exist in attempting to apply marginal cost pricing policies in the water sector.

The natural monopoly characteristics of water supply utilities arise in part from the economies of scale which define service expansions. From theory this implies that marginal cost pricing can lead to the firm losing money, when marginal costs are below average costs of production. The regulator in such situations strives for second-best pricing, where total benefits are maximized subject to the firm making zero profits. Where the firm produces multiple outputs, price discrimination can be used to achieve this second-best pricing using the Ramsey Method (Train, 1991). As well, the treatment of theoretical time and definition of what marginal costs constitute makes the application of marginal cost pricing difficult (Fisher, 1990).

Different interpretations of marginal cost can be used in assessing marginal costs, further complicating its application (Saunders et al., 1977). The average incremental cost (AIC) method is forward looking and looks at all investments anticipated over a period of 10-15 years. The marginal capital cost (MCC) is defined as:

$$MCC = \frac{PV_{IS}}{PV_{IO}} \tag{1}$$

Where PV_{IS} is the present value of the least cost investment stream and PV_{IO} is the present value of the stream of incremental outputs from the investments (Saunders et al., 1977).

Practical solutions in circumventing the loss-making outcome under marginal cost pricing also include the use of a two part tariff, where the first is a fixed charge to cover fixed costs, and the second a variable charge set equal to the marginal cost (Coase, 1946). As well, the use of increasing block tariffs, where the unit rate charged by the utility increases in blocks with consumption, have been used to achieve cost recovery and to address concerns about conservation (Duke and Montoya, 1993). In addition, the use of a 'lifeline' block has been advocated on the basis of equity concerns (e.g. Saunders et al., 1977). Interestingly, more recent analysis about the application of block tariffs has shown that because poor users often share connections, the total consumption for a given connection might push rates into upper blocks, increasing the average tariff paid by poor households beyond the 'lifeline' rate (Whittington, 1992). Boland and Whittington (2000) suggest that the use of a uniform tariff with a fixed rebate can help reduce the inequity associated with the increasing block tariff rate structure, and show that smaller consumers pay less using the uniform tariff with rebate than the increasing block tariff.

Baietti and Curiel (2005) discuss different revenue requirements estimation methods for use in determining cost recovery tariffs and argue that eligible costs should include contingency amounts, often mis-interpreted as profits, to finance future capital requirements. Other practical discussions of defining user charges try to balance the different objectives inherent in tariff setting (e.g. Dole and Bartlett, 2004).

The principles defining good tariff design are implied in the discussion above but can be summarized as (Boland and Whittington, 2000, Rogers et al., 2002):

The need for financial sustainability and economic efficiency – Fundamentally, tariffs should allow the utility to cover its costs and should give indications to consumers about the costs of supply so that they can consume amounts in line with the benefits they accrue from consumption. Included in this, is the need for

conservation of resources and the need to capture environmental costs in the tariff design.

The need for equity and fairness – Ensuring tariffs are affordable and do not adversely affect poor households is a critical requirement of tariff policies. Users should therefore pay for what they use, which has further implications on arguments about metering of consumption. Equity issues also apply across different water use types; agricultural, domestic, industrial. Fair tariffs will also be within users' willingness to pay for services.

Administrative ease and simplicity – The cost of implementing the tariff structure is important as a determinant of its practical ease. Linked to this is the transparency of the method used for setting tariffs. If setting tariffs is as a result of an over complex process, it is likely that the fairness criterion will be impacted as consumers will not understand the justification of their water bills

7.5 Reform in Trinidad and Tobago

7.5.1 A history of water service delivery in Trinidad and Tobago

Trinidad and Tobago is a middle income two island country located in the southern Caribbean, with a population of 1.3 million inhabitants spread over the two islands. The responsibility for provision of water services in the country, both water supply and sewerage, belongs to the Water and Sewerage Authority (WASA), incorporated in 1965. A government appointed board of commissioners oversees the operations of the state owned utility.

WASA has traditionally been dependent upon government transfers to finance its operations and the availability of transfers has historically been tied to the international oil price, which constitutes the major source of public finance. With declining oil revenue in the 1980s and 1990s, public sector infrastructure declined. Capital expenditure accounted for only 8% of total government expenditure in 1989 (Mycoo, 1996).

The decline in capital spending reduced the available resources for utilities, such as WASA, to invest in service expansions. Decades of government support for balance sheet deficits had eroded the WASA's management efficiency, with billing collection efficiency at about 50%. Costs of operation were also inflated. Foremost on the list of cost inefficiencies has been inflated personnel costs. As WASA had been used as an outlet for political patronage (Ryan, 1992), the number of staff per connection was high as compared to a well run utility. In the early 1990s WASA had 16-18 staff per 1000 connections. This compares poorly with 4 per 1000 connections suggested as good practice in Yepes and Dianderas (1996). Salaries amounted to as much as 60% of operating costs (Atwal, 2002).

WASA's operations, since its incorporation, have been overseen by a notionally autonomous regulator, the Public Utilities Commission (PUC). A rate-of-return regulatory mechanism was used to provide for adequate tariffs to cover the operational costs of the utility. However, government policy focussed on subsidized service delivery which discouraged necessary tariff reviews to enable WASA to achieve adequate levels of cost recovery.

The reliance upon shrinking public finances for capital rehabilitation and extension had, by the early 1990s, forced a severe demand management program limiting twenty-four hour water supply to only 10% of the utility's customers. In 1997/98 it was estimated that the deficit in the availability of water was about 50Ml/day, out of a total production of 800Ml/day in 1997 (London Economics, 1998). Due to the inadequate investment in the aging capital stocks of the utility, system leakages rose to about 50% of the total water abstracted (Delcan International Corporation, 1992). Good practice levels of water losses in developed countries such as Canada, the United States of America, and France are between 10 and 15% of the total water abstracted (Yepes and Dianderas, 1996).

Thus the low revenues of the utility, insufficient budgetary support for capital expansion and maintenance, and general mismanagement led to the seeking of innovative changes in the utility. In the early 1990s a team of local private sector management specialists were engaged to overhaul the management of the authority. Primary focus was given to the utility's inadequate billing collection however insufficient financial support for the necessary capital development, to increase service levels to customers, together with the eroded real tariff and outdated customer database, meant that the reform required was much deeper.

7.5.2 Reforming the water sector in Trinidad and Tobago

Due to the consistent under-performance of WASA, the government embarked upon a PSP led reform process in a phased approach and, because of inadequate information and the lack of a sufficient regulatory framework (Nankani, 1997), a private operator would first be engaged for a short management contract. This interim operating agreement (IOA) was envisaged as a preparatory stage in the move towards a full concession and took place from 1995-1999. During the IOA period a new national independent regulator, the Regulated Industries Commission (RIC) was created. The RIC was to be responsible for creating pricing policies along the lines that have been discussed, and to develop quality of service standards. However, by 2003, the RIC had not yet fully mobilized with only initial steps having been taken to consider the tariff issues that faced WASA.

Ultimately, the PSP reform failed in Trinidad and Tobago, primarily due to political forces, though poor execution, by seconding under-experienced staff, by the operator did not help. The reform process is on-going in Trinidad and Tobago, with the public utility, WASA, striving to increase the reliability of service and increase its billing collection. The issue of tariff reform has not been addressed, and this is the focus of the remainder of this paper.

7.6 Towards pricing reform in Trinidad

In 1997/98 a tariff study was conducted in Trinidad and Tobago (London Economics, 1998) as pre-cursor to the concession arrangement anticipated at the time. The tariff reform proposed by the study was to be a major element of overall sector reform as discussed above. The study derived a volumetric water charge using the principles of marginal cost pricing, although application of the tariff would have been made difficult by the lack of metering at domestic connections. The following discussion analyses the recommended tariff using data gained from a large sample survey conducted in 2003 (1419 respondents). The survey developed information on current water service levels, the full results of which are presented in Virjee and Gaskin (2006a). In addition, the survey investigated the willingness to pay for service level changes using the contingent valuation method (Virjee and Gaskin, 2006a) and choice experiments (Virjee and Gaskin, 2006b). Table 7.1 shows summary characteristics from that survey.

Table 7.1: Water service characteristics in Trinidad and Tobago

	Official Statistics	Survey Statistics
Coverage	92%[a]	83%
In house connections		72%
Standpipe users		11%
Coverage – MDG target	96%	92%
Average water consumption		
In house connections	370[b]	328
Standpipe users		242
System Water production (Ml/day)	799[b]	N/A
Domestic Water Demand (Ml/day)	301[c]	342

Sources:
a – WASA (2002)
b – London Economics (1998)
c – Delcan International Corporation (1992)

7.6.1 Water consumption

Users in Trinidad and Tobago on average consume approximately between 330-370 l/capita/day. This result was first developed by JICA (1991) and corroborated by analysis in Virjee and Gaskin (2006a). JICA installed 53 meters at households with relatively reliable water supplies and monitored their consumption (London

Economics, 1998). Virjee and Gaskin (2006a) derived their estimate by asking respondents the total volume of storage available to them, and the number of days this storage lasts. In modelling water demand over time, normally price and income elasticity are used in simple continuous models. In the analysis of the effect of the water bill on water consumption for this survey data, no statistical relationship was found, as expected given that water bills are not currently determined by the amount of water consumed. Further, income in the sample was not correlated with water use. This is most likely due again to the disconnect between water bill and amount consumed.

As well, water consumption was inferred from the time local storage lasts in the event of no water supply from WASA, this was expected to lead to an underestimate of the un-constrained consumption due to rationing water usage at the household level. To test for this relationship, the availability of water supply was regressed on the inferred consumption and no relationship was found. The implication is that consumption levels are not currently constrained by poor water supply reliability.

Reliability of the water supply, as defined as the number of days per week and hours per day where water is available, would be expected to impact on water demand. However, in the case of Trinidad and Tobago, the prevalence of local storage facilities buffers consumers from the system unreliability and affords a far greater proportion of the population access to a 24 hour water supply. The effect of such local storage is to increase the percentage of the population with 24 hour service from 27% as supplied by WASA to 82% including all coping effects. The implication of this is that little aggregate capacity is required to increase service levels to users, but rather investments in increasing the reliability of services, by investing in storage and booster stations, are required. For investments to be efficient the marginal cost of increasing reliability of service must be lower for system level investments as compared to household level investments.

The effect of increasing capacity of the system on the average reliability is dependent upon customer response. Currently, the total supply on average is sufficient to meet customer demands given household storage. Increased water supply will not impact upon reliability unless consumers reduce their daily abstraction from the system. That is, if consumers believe that the increased water availability from the system is dependable, or if it actually does become more reliable, they will take less water from the system in a given day for the increased number of days water is available. If, however reliability of the system prevents water being extracted on all days they will maintain their abstraction levels, and so increased water available in the system will not increase the daily or hourly reliability as experienced by consumers. The conclusion is that at an aggregate level the system is producing sufficient water currently for the needs of the population. The logic of this analysis is:

$$TC_{LT} = LT \times D_{daily} \times R \times Ov \tag{2}$$

where the total consumption in over the long term, TC_{LT}, is equal to the daily demand, D_{daily}, times the length of the period, LT, only if the product of reliability, R and over-consumption in a day, Ov, is unity. If, reliability drops to some fractional level, say 3 days per week, then Ov must increase to allow for sufficient water for the full week. As reliability of the system increases, over-consumption decreases in a given day to ensure that total water consumed over a longer period, for example a week, remains unaltered. Equation (2) assumes that, as is the case in this data, households overall consumption is not reduced by poor reliability. If this were not the case then the equality need not hold.

Water demand projections made in London Economics (1998) assume that the effect of metering and increased prices will act to reduce the per capita consumption over time, and that income growth will increase the consumption. As values of price and income elasticity are not easily measured, it is assumed that

price elasticity is -0.3 (in line with international experience) and that the income effect on demand (in line with projected GDP growth) is 2%. This projection is rather severe. Firstly, the likelihood of a universal metering program be initiated is rather low, despite the well documented benefits (Delcan International Corporation, 1992) given that it has been an issue of debate for almost 15 years. Second, the per capita consumptions, as has been argued are already quite high and an arbitrary increase with GDP growth over time seems to be unlikely.

7.6.2 An investment plan for improvement

On the assumption that water shortages in the country are a result of insufficient capacity, WASA's investment plan contains projects which will increase the total capacity of the system. Assuming that there is a portion of planned investments directly targeting increased system reliability, increased capacity might also mean increased reliability. Thus increased system capacity will draw responses from consumers that will be somewhere between two extremes. If investments contain no explicitly targeted reliability improvements, users may continue to abstract the same daily amounts currently being taken, which are above their required daily consumption but are necessary for coping with unreliability. Alternatively, if reliability increases to perfect levels, investments might lead to the reduction of daily abstraction to a lower bound of the amount consumed by the household. Table 7.2 shows a summary of investments being planned by WASA.

The likely impact on service reliability is linked to the nature of the investment. If the investment is focussed on improving the reliability of the system, then it will most likely result in reduced daily abstraction from the system by users as they will be able to get the water they need in a day rather than needing to abstract more than their daily demand for storage. If, however, the system does not target reliability, but rather increases only the capacity of the system, consumers will continue to abstract similar amounts from the system. Possible reliability impacts from the leakage reduction program and the South Water Project are analysed in table 7.3. Obviously the move to higher levels of service, as implied by increased

numbers of individual connections, would have a result on the total water demand and so reduce average reliability in the system. Table 7.3 further assumes that population is constant over the period of the investment, or alternatively, that the projects take no time to develop. The purpose of this assumption is to discuss the impacts of the projects on tariffs, rather than to assess the adequacy of supply augmentation. In the long run, the planned investments, and the anticipated capacity expansions, together with the expected rationalization of abstraction behaviour of customers which would occur given persistent improvements to reliability, are likely to be adequate for demand (London Economics, 1998).

Table 7.2: WASA investment plan: summary

Name of project	Description	Anticipated increase in water available (Ml/day)	Long Run Marginal Cost (TT$/m^3)	Notes
Domestic metering	Installing 10000 domestic meters	6	1.34	Assumes that price elasticity follows international trends
Leakage reduction	Repairing and replacing pipes	44	3.29	Includes regularization of illegal connections (6% of commercial losses)
South Water	Developing new large scale resources	123	4.86	Mostly includes increased abstraction and improved treatment facilities
North East Water	Developing new large scale resources	65.5	4.35	Increased capacity
La Fillette	Developing new small scale resources	4.4	10.46	Major extension in underserved areas
Richmond	Developing new small scale resources	24	9.62	Expansion of treatment works and network extension

Source: London economics (1998)

Two scenarios are considered. First is where there is no change in the coverage profile with increased water availability. That is, increased water is used to increase reliability for those using WASA services. In the second scenario, it is assumed that coverage increases from 83% to 95%. In both scenarios, the effect of the leakage reduction program and the North-East Water Project are assessed with respect to the change in reliability levels. Assumptions have been made as to the degree to which each program will affect reliability, and these are presented as the

degree to which households take more than their daily requirement from the system. This over-abstraction from the system is the storage effect discussed earlier.

Table 7.3: Possible service impacts of two planned investments by WASA

Water Supply Provision	Days per week	Hours per day	Total Hrs per week	Reliability effect of Project (% over consumption required on days of provision)
Scenario 1: No change in coverage – Standpipes (11%) – In-house connections (72%)				
Current	**4.2**	**14.3**	**59.3**	
Standpipes	3.7	11.9	44.4	89%
In- house	5.2	18.1	93.6	35%
After leak reduction	**6.1**	**17.7**	**107.5**	
Standpipes	5.8	16.0	92.8	70%
In- house	6.1	18.0	109.8	25%
After North East Water	**7.0**	**21.5**	**150.3**	
Standpipes	7.0	18.0	126.0	60%
In- house	7.0	22.0	154.0	15%
Scenario 2: Increased coverage – Standpipes (15%) – In-house connections (80%)				
After leak reduction	**5.6**	**14.5**	**93.2**	
Standpipes	5.3	12.0	74.2	70%
In- house	5.7	17.0	96.9	25%
After North East Water	**6.7**	**19.4**	**129.2**	
Standpipes	6.5	16.0	104.0	60%
In- house	6.7	20.0	134.0	15%

7.6.3 An analysis of willingness to pay for changes in service level

Virjee and Gaskin (2006b) use choice experiments to model the effects of service level changes on willingness to pay (WTP) and so welfare of consumers. A particular benefit of such methods is their ability to value fractional changes to policies (e.g. Foster and Mourato, 2003), in contrast to the more commonly used contingent valuation (CV) method (e.g. Whittington et al., 1990a) which measures the impact of policy changes as a whole. In this context, the CV method would tend to value an increase in service level to what might be considered as a 'full' service level, where consumers get access to a 24 hour service. Given that the proposed investments are likely to increase reliability, and other service attributes of interest, such as pressure and water quality, but not to such a 'full' level as

demonstrated in table 7.3, the models based on CV data are difficult to use in assessing the likely tariff increases possible from investments in service improvements. The use of WTP as an informant to the tariff setting process and for the analysis of cost recovery potential has been advocated in the literature (e.g. Altaf et al., 1992, Whittington et al., 1990b) but the detailed analyses have been minimal. Table 7.4 shows the WTP for service level changes developed from CE experiments conducted in Trinidad and Tobago (Virjee and Gaskin, 2006b).

Table 7.4: Implicit prices for changes in reliability and level of service in Trinidad and Tobago

Water Supply Provision	Reliability – Days per week (TT$/additional day upon which there is service)	Reliability – Hours per day (TT$/ additional hour in which there is service)	Increase in service level – Standpipe → In house connection (TT$/quarter)
Standpipe customers	33.4 (22.3, 46.0)	12.7 (9.1, 17.2)	219.8 (142.8, 313.5)
In-house customers	132.1 (116.3, 150.0)	22.0 (19.2, 25.5)	N/A

Source: Virjee and Gaskin (2006b)

7.6.4 Assessing tariffs – welfare effects of the marginal cost tariff

London Economics (1998) suggests a two part tariff, based on the analysis of the long run marginal costs, as assessed using the average incremental cost methodology, of the anticipated investment stream by WASA. The variable, volumetric, portion of the tariff is suggested at TT$ 3.50/ m^3 and the fixed portion, based on the cost of customer related costs, at TT$ 2.51/ month. Table 7.5 shows the average household bill, assuming that the current consumption levels do not change with the imposition of a marginal cost based tariff. In arriving at monthly consumption estimates, it is assumed that there are four residents per household as inferred from the sample survey. The high water use at standpipes can be explained again by storage prevalence. Consumers routinely use garden hoses to transport water from the public tap to their private storage.

Table 7.5: Projected monthly household water bills with marginal cost based tariffs

	Volume used per month (m3/month)	Fixed Charge (TT$/month)	Variable Charge (TT$/month)	Total Monthly Charge (TT$/month)	Current Bill (TT$/ month)
In-house Connections	39.9	2.51	139.65	142.16	53.33
Standpipe Connections	29.4	2.51	102.90	105.41	11.25

Table 7.6 shows the WTP per quarter for the assumed increases in service level associated with the two investments detailed in table 7.4. In addition, the difference between the average WTP and the average household bill at marginal cost based prices, as given in table 7.5, is presented. Confidence intervals, at the 95% level are shown in brackets. As is apparent, there is significant willingness to pay for the service changes assumed to occur with the two investments associated with leakage reduction and expansion of capacity in the North East Water Project. However, this WTP is not sufficient to cover the implied increase of the marginal cost based prices given the same consumption levels as are currently in place. The exception to this observation is with both investments in place, those who have in house connections would be willing to pay the price increase at a 95% confidence level, assuming that the increased reliability materializes.

Increased prices, such as those suggested in table 7.5, would reduce the level of consumption by households due to a non-zero price elasticity of demand. The implication of no residual WTP is that at the increased level of service suggested by the utility investment plan, one dimension of which is the quantity of water consumed, there would be social acceptability issues about a move to marginal cost prices. The move to such prices would require that quantities of water consumed would reduce to leave the total water bill within a household's willingness to pay.

Scenario 2 discusses the effect of increased coverage coming with the two planned investments. As is apparent, increased coverage implies that the change

in service levels for all customers will be less than in scenario 1, and so the WTP for the changes will be less. This ignores, however, the increased WTP for standpipe users upgrading their level of service to an in-house connection. If all of the new in-house connectors were formerly standpipe users, then 8% of the population would be willing to pay increased water charges for the service level increases, as suggested in table 7.4. This, increased willingness to pay would be temporary and the duration of the increased WTP and its magnitude would suggest the likely connection fees that a consumer would find acceptable. If it is assumed that upgraders would be willing to pay excess amounts for one year after the upgrade to in-house connections, the total amount of welfare associated with the upgrade would be about TT$ 2650. If this is understood as the connection fee financed by the utility over a one year period, and that interest rates are less than 25% per annum, this value is greater than the marginal cost of connecting a new customer with an in-house connection; TT$ 2000 (London Economics, 1998). The implication for utility planning is that standpipe users are willing to pay for in-house connections at a level above the marginal cost of making the connection.

Table 7.6: The willingness to pay for service level changes associated with leakage reduction and capacity expansion investments by WASA

	Willingness to pay for service changes (Change in quarterly bill)			**Difference between WTP and average bill (at MC prices)**
Water Supply Provision	**Days per week**	**Hours per day**	**Total**	
Scenario 1: No change in coverage – Standpipes (11%) – In-house connections (72%)				
After leak reduction				
Standpipes	70 (47,97)	52 (37, 71)	122 (84,167)	-145 (-183, -100)
In- house	119 (104, 135)	-2 (-2, -3)	117 (103, 132)	-165 (-179, -150)
After North East Water				
Standpipes	110 (74, 152)	77 (56, 105)	187 (129, 257)	-79 (-138, -10)
In- house	238 (209, 270)	86 (75, 99)	324 (284, 369)	42 (2, 87)
Scenario 2: Increased coverage – Standpipes (15%) – In-house connections (80%)				
After leak reduction				
Standpipes	53 (37,74)	1 (1,2)	54 (37,75)	-212 (-230,-192)

In- house	66 (58,75)	-24 (-21,-28)	42 (37,47)	-240 (-245,-235)
After North East Water				
Standpipes	94 (62,129)	52 (37,71)	146 (100,199)	-121 (-167, -68)
In- house	198 (174, 225)	42 (36,48)	240 (211,273)	-42 (-71,-9)

7.7 Policy Implications

The above analysis shows that there is insufficient WTP for the full marginal cost of new investments being planned by WASA. A detailed analysis of the financial impact of this departure would require more in depth understanding of the price elasticity of demand, to assess the impact of price changes on consumption. It is demonstrated that there is significant willingness to pay for the assumed service increases associated with two planned projects, with average users currently accessing water from in-house connections willing to pay between 73% more per quarter, where only the leakage reduction program occurs to 200% where both projects occur. Standpipe users are also willing to increase their water bills given the possible increases in service reliability associated with the two projects analysed here. WTP is predicated on service change, so the utility needs to balance increased access to services, by expanding coverage, with increased service levels to the already connected, in order to maximize the total WTP from all customers. A possible strategy for the utility to do this would be to use increased capacities associated with investments to increase the level of service to already-connected households and promote increased connectivity by current standpipe users to in-house connection levels of service to capture the willingness to pay for that service upgrade. Critical as well, is the need to tailor investments to increased service levels as experienced by the users. This means that attributes of services need to be bettered if willingness to pay is to be increased and captured by any revised tariffs. This observation implies the need to look beyond simply capacity expansion projects to projects which increase the reliability, pressure and water quality associated with the utility service.

7.8 Conclusions

This paper has discussed the increased importance of financing within the overall water utility reform framework. Due to increasing fiscal constraints and the need to recover costs from users, utilities and regulators need to formulate pricing strategies which allow cost recovery, promote economic efficiency and are socially acceptable and equitable.

A case study of the social analysis around a proposed revision to the utility pricing structure in Trinidad and Tobago was presented. In this case, the analysis of users' WTP for the likely changes associated with planned investments were analysed against the financial implications on household bills of a proposed marginal cost based price. It was shown that whilst significant WTP did exist, it was insufficient to cover the total price increase, assuming that the consumption levels at present and post project did not change. The WTP for in-house connections however is sufficient to cover marginal costs of such service changes.

Assessment of the social acceptability of increased tariffs can be done by comparing the willingness to pay for service changes to the impact of price changes on household water bills. This paper has shown that choice experiments facilitate the analysis of impacts on WTP of specific projects, and being attribute based, allow sensitivity analyses where project benefits are uncertain. Particularly, the policy analysis benefits of the choice experiment method are significant as compared to the contingent valuation method, which is normally used to assess only one policy option at a time.

The direct service linked willingness to pay analysis presented here has possible applications in defining tariff increases from a regulatory standpoint. Given the likely WTP for service changes, a regulator could arrive at a contingent rate structure which would guarantee rate increases to specified level, contingent upon service level changes. The certainty of this rate change would then influence investment planning by the utility to ensure that investments are in line with user

demands and household level benefits are maximized. The design of such pricing mechanisms deserves further analysis.

7.9 References

1. Alcazar, L., Xu, L. Zuluaga, AM., *Institutions, politics and contracts: The attempt to privatize the water and sanitation utility of Lima, Peru*, Policy Research Working Paper, No. 2478, World Bank, Washington, DC, 2000.
2. Altaf, M., Jamal, H., Whittington, D., *Willingness to pay for water in rural Punjab, Pakistan.* Water and Sanitation Report 4. Water and Sanitation Program. World Bank, 1992.
3. Annamraju, S., Calaguas, B., Gutierrez, E., *Financing water and sanitation : Key issues in increasing resources to the sector*, WaterAid Briefing Paper, London, UK, 2001.
4. Atwal, H. A two-stage approach to a concession in the water sector, Trinidad and Tobago Experience, Presented at Symposium on Water Regulatory Policy – Jamaica, April, 2002.
5. Baietti, A., Curiel, P., *Financing water supply and sanitation investments: Estimating revenue requirements and financial sustainability*, Water Supply and Sanitation Working Notes, No. 7, World Bank, Washington, DC, 2005.
6. Briscoe, J., Garn, M., *Financing Agenda 21: Freshwater*, Paper prepared for the United National Commission on Sustainable Development, World Bank, Washington, DC, 1994.
7. Briscoe, J., The changing face of water infrastructure financing in Developing Countries, *Water Resources Development*, Vol. 15, No. 3, pp. 301-308, 1999.
8. Budds, J., McGranahan, G., *Privatization and the provision of urban water and sanitation in Africa, Asia and Latin America*, Human Settlements Discussion Paper Series, International Institute for Environment and Development, 2003.
9. Cairncross, S, *Sanitation and Water Supply: Practical Lessons from the Decade*. Discussion Paper No. 9, UNDP-World Bank Water and Sanitation Program, The World Bank, Washington, DC, 1992.
10. Clarke, G., Kosec, K., Wallsten, S., *Has private participation in water and sewerage improved coverage? Empirical evidence from Latin America*, Working Paper, No. 04-02, AEI-Brookings Joint Center for Regulatory Studies, 2004.
11. Coase, RH., The marginal cost controversy, *Economica*, Vol. 13, pp. 169-189, 1946.

12. Delcan International Corporation, *Feasibility study on Cost/Benefit Analysis of Universal Metering in Trinidad and Tobago*, Final Report, 1992.

13. Dole, D., Bartlett, I., *Beyond cost recovery: Setting user charges for financial, economic and social goals*, ERD Technical Note Series, No. 10, Asian Development Bank, Manila, Philippines, 2004.

14. Duke, EM., Montoya, AC., Trends in water pricing: Results of Ernst & Young's National rate surveys, *Journal of American Water Works Association*, 1993.

15. Fisher, P., The strange career of marginal cost pricing, *Journal of Economic Issues*, Vol., 24, No. 4, pp. 77-92, 1990.

16. Gausch, JL., *Granting and renegotiating infrastructure concessions: Doing it right*, WBI Development Studies, World Bank Institute, Washington, DC, 2004.

17. Haggarty, L., Brook, P., Zuluaga, AM., *Thirst for reform? Private sector participation in providing Mexico City's water supply*, Policy Research Working Paper, No. 2654, World Bank, Washington, DC, 2001.

18. Kessides, I., *Reforming infrastructure: Privatization, regulation, and competition*, World Bank Policy Research Report, World Bank, Washington, DC, 2004.

19. London Economics, *WASA Tariff Study*, Final Report, 1998.

20. Mehta, M., Fugelsnes, T., Virjee, K., Financing the Millennium Development Goals for water and sanitation: What will it take?, *Water Resources Development*, Vol. 21, No. 2, pp. 239-252, 2005.

21. Mehta, M., *Meeting the Financing Challenge for Water Supply and Sanitation*, Water and Sanitation Program, World Bank, Washington, DC, 2003.

22. Menard, C., Clarke, G., *A transitory regime: Water supply in Conkary, Guinea*, Policy Research Working Paper, No. 2362, World Bank, Washington, DC, 2000.

23. Mycoo, M. (1996). *Water Provision Improvements: A Case Study of Trinidad.* PhD Thesis, School of Urban Planning, McGill University.

24. Nankani, H, Testing the waters – A phased approach to a water concession in Trinidad and Tobago, *Public Policy for the Private Sector*, Note No. 103, World Bank, Washington, DC, 1997.

25. Rogers, P., de Silva, R., Bhatia, R., Water as an economic good: How to use prices to promote equity, efficiency and sustainability, *Water Policy*, Vol. 4, pp. 1-17, 2002.

26. Saunders, R., Warford, J., Mann, P., *Alternative concepts of marginal cost utility pricing: Problems of application in the water supply sector*, World Bank Staff Working Paper, No. 259, 1977.

27. Swedish International Water Institute (SIWI), *Making water a part of economic development: The economic benefits of improved water management and services*, Paper prepared for the United National Commission on Sustainable Development, SIWI, Stockholm, Sweden, 2005.

28. Train, K., *Optimal Regulation*, MIT Press, Cambridge, USA, 1991.

29. Virjee, K and Gaskin, S., The demand for improved water supply and sanitation: The case of Trinidad and Tobago, *Journal of Eastern Caribbean Studies, submitted*, 2006a.

30. Virjee, K., and Gaskin, S., Discrete Choice Experiments and the Willingness to Pay for Water Supply Changes in Developing Countries: A Case Study of Trinidad and Tobago, *Water Policy, submitted*, 2006b.

31. Whittington, D., Briscoe, J., Mu, X. and Baron, W., Estimating the willingness to pay for water services in developing countries: A case study of the use of contingent valuation surveys in southern Haiti. *Economic Development and Cultural Change*, Vol. 38, pp. 293-311, 1990a.

32. Whittington, D., Okorafor, A., Okore, A., McPhail, A., Strategy for cost recovery in the rural water sector: A case study of Nsukka District, Anambra State, Nigeria, *Water Resources Research*, Vol. 26, No. 9, pp. 1899-1913, 1990b.

33. Whittington, D., Possible adverse effects of increasing block tariffs in developing countries, *Economic Development and Cultural Change*, Vol., 41, No. 1, pp. 75-87, 1992.

34. Winpenny, J., *Financing Water For All*, Report of the World Panel of Financing Water Infrastructure, 2003.

35. Yepes, G. and Dianderas, A., *Indicators: Water and Wastewater Utilities*, 2nd edition, World Bank, Washington, D.C., 1996.

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8 Summary and Conclusions

This thesis, through a series of four papers, has explored the willingness to pay for service level changes in the water supply sector through a detailed case study analysis of Trinidad and Tobago.

A description of the context in which the work presented in the body of the thesis is given in the paper presented in Appendix D which details case study of private sector participation in the water sector in Trinidad and Tobago. The case is of interest given the novel approach taken, where a short management contract was to precede a longer term concession arrangement. Given the poor capacity of the utility, it was envisaged that such a management contract could be used to develop capacity and information about services, to increase the efficiency of tendering to the private sector during the longer term concession phase. The conditions leading to the failure of the privatization process were presented as being low tariffs which did not allow for cost recovery by the utility and complicated political constraints which led to management structures that were over-bureaucratic.

The first three papers in the thesis presented the results and analysis of a large household sample survey conducted during 2003 in Trinidad and Tobago. It was shown that service levels are lower than official estimates, and lower still if adjusted for the poor service experienced by many users. In response to the poor service, the prevalence of household level coping mechanisms, predominantly the use of inexpensive plastic tanks to buffer fluctuations in water availability were discussed and the impact of such interventions analysed. It was shown that using the contingent valuation method to assess WTP for service changes little consumer surplus was available, even at upgraded service levels, for tariff increases.

In addition, the results from a novel application of the choice experiment method were presented. This method allows for the valuation of service level changes on

the basis of the attributes of the change rather than for the change as a whole. The resulting attribute based models allow for richer policy analysis as they facilitate the valuation of changes which are fractional or partial relative to what might be considered as ideal changes. They therefore allow decision makers in the sector to approach the analysis of different projects, which may have different system benefits and service level impacts against the likely welfare effects of those projects. Advanced modelling techniques, such as the random parameters logit, were used to demonstrate how the inclusion of respondent heterogeneity can improve model fit and be incorporated into the analysis of WTP.

Given the innovative nature of the choice experiment methods, the thesis then performed a systematic comparison of the contingent valuation method and the choice experiment method. The key finding in this comparison was that convergence in WTP estimates occurs, but only when effects associated with status quo bias is ignored. The effect of ignoring this bias is to depress the modeled WTP, but is inappropriate to include in policy planning, given that it arises, at least in the case presented here, more from scepticism around the plausibility of change rather than the actual preference of the status quo option. In the comparison of the two methods, the ability to value attributes of service changes is highlighted as a distinct benefit of the choice experiment method.

In addition, the ability to use choice experiment models in tasks of benefit transfer was investigated. Given the tremendous cost savings which would occur in such applications there is interest in assessing the ability of the method to model welfare effects associated with particular policy changes at sites or for populations not included in the sample from which the model was developed. It was demonstrated that whilst strict tests of equality between the different model formulations would be rejected, the transfer errors associated with using a well specified model in to predict welfare impacts in a context not explicitly surveyed are rather small and in line with acceptable levels in other sectors.

Finally in the last paper, using the stream of investments planned by WASA for service upgrades, policy analysis of proposed tariff increases was demonstrated using models developed from the choice experiment data. The WTP concept, combined with flexibility of choice experiment data allows for the assessment of social acceptability of tariff changes and so facilitates the analysis of proposed tariffs by adding to often used tests of economic efficiency and models of financial viability. As well, the need to focus on the service level impacts of investments, rather than simpler analyses of capacity expansion, was discussed. This is a direct result of the fact that the drivers of consumer welfare are in the services they receive rather than the capacity of the system alone.

The thesis presents a complete analysis about the WTP for service level changes in the water sector. However a considerable amount of interesting future work is possible. From a methodological perspective, the choice experiment method presented in this work would benefit from wider application given the seemingly beneficial density of information it develops. In relation to the validity of the method, while this work has sought to provide a rigorous examination, only through repeated applications of it in tandem with the more conventionally used contingent valuation method and the systematic comparison of the results can the method achieve absolute validity. In a wider context, increased comparisons of the stated preference choices with actual choice data would add tremendously to this debate on methodological validity. This, of course, requires that stated preference methods be used in the design or choice of actual investments, with post-analysis of actual choices used as the comparative framework. The cost and complexity of such efforts does make them difficult.

The thesis by analysing in depth a single case also points to certain policy implications for Trinidad and Tobago. It appears from this analysis that there is a WTP for service changes. Critical in that statement is the contingency of such WTP on actual changes in the quality of services. So, tariff increases which would be used to finance improvements would only become legitimate after such service

increases are completed. From a regulatory perspective, this implies that the investments prioritized by the utility should focus on service improvements to increase WTP and allow for tariff increases which would further improve the financial condition of the utility. This does not obviate the need for wider sector reforms, especially with regard to the management capacity of the utility as the capture of increased revenues requires that such reforms would take place. A side note to this observation is the need for utility investment planning to focus on the impact of investments to the services received by utility customers, rather than simply the degree to which capacity of the utility is increased. An interesting observation from the aggregate analysis of this work is that utility capacity at an aggregate level is probably sufficient at present and that services are unreliable not because of insufficient capacity but rather inefficient network management. Users currently consume considerable amounts of water, but only through household level coping interventions which are likely to be less than efficient given the probable economies of scale associated with network improvements.

9 Complete References

1. Abou-Ali, H., Carlsson, F., *Evaluating the welfare effects of improved water quality using the choice experiment method*, Working Papers in Economics, No. 131, Department of Economics, Gothenburg University, Gothenburg, Sweden, 2004.

2. Adamowicz, W., Boxall, P., *Future directions of stated choice methods for environmental valuation*, Department of Rural Economy, University of Alberta, Edmonton, Canada, 2001.

3. Adamowicz, W., Boxall, P., Williams, M., Louviere, J., Stated preference approaches for measuring passive use values: Choice experiments and contingent valuation, *American Journal of Agricultural Economics*, Vol. 80, pp. 64-75, 1998.

4. Adamowicz, W., Boxall, P., Williams, M., Louviere, J., *Stated Preference Approaches for Measuring Passive Use Values: Choice experiments versus contingent valuation*, Staff Paper, Department of Rural Economy, University of Alberta, Edmonton, Canada, 1995.

5. Addelman, S. Orthogonal main effects plans for asymmetrical factorial experiments, *Technometrics*, Vol. 4, pp. 21-46, 1962.

6. Ahmed, J., Goldar, B.N., Misra, S., Jakariya, M., *Willingness to Pay for Arsenic-Free, Safe Drinking Water in Bangladesh*, Water and Sanitation Program – South Asia, New Dehli, India, 2003.

7. Alcazar, L., Xu, L. Zuluaga, AM., *Institutions, politics and contracts: The attempt to privatize the water and sanitation utility of Lima, Peru*, Policy Research Working Paper, No. 2478, World Bank, Washington, DC, 2000.

8. Alpizar, F., Carlsson, F., Martinsson, P., *Using choice experiments for non-market valuation*, Working Papers in Economics No 52, Department of Economics, University of Goteborg, Sweden, 2001.

9. Al-Qunaibet, M., Johnston, R., Municipal demand for water in Kuwait: Methodological issues and empirical results, *Water Resources Research*, Vol. 21, No. 4, pp. 433-438, 1985.

10. Altaf, A., Whittington, D., Jamal, H., Smith, V.K., Rethinking rural water supply policy in the Punjab, Pakistan, *Water Resources Research*, Vol. 29, No. 7, pp. 1943-1954, 1993.

11. Altaf, M., and Hughes, J., Measuring the demand for improved urban sanitation services: Results from a contingent valuation study in Ouagadougou, Burkina Faso. *Urban Studies*, Vol. 31, No. 10, pp.1763-1776, 1994.

12. Altaf, M., Jamal, H., Whittington, D., *Willingness to pay for water in rural Punjab, Pakistan.* Water and Sanitation Report 4. Water and Sanitation Program. World Bank, 1992.

13. Altaf, M.A., Household demand for improved water and sanitation in a large secondary city: Findings from a study in Gujranwala, Pakistan, *Habitat International*, Vol. 18, No. 1, pp. 45-55, 1994.

14. Anand, P.B., *Consumer preferences for water supply? An application of choice models to Urban India,* Discussion Paper No. 2001/145, United Nations University, Helsinki, Finland, 2001.

15. Annamraju, S., Calaguas, B., Gutierrez, E., *Financing water and sanitation : Key issues in increasing resources to the sector*, WaterAid Briefing Paper, London, UK, 2001.

16. Ardila, S., Quiroga, R., Vaughn, W. *A Review of the Use of Contingent Valuation Methods in Project Analysis at the Inter-American Development Bank.* No. ENV-126. Inter-American Development Bank. Washington, DC, 1998.

17. Arrow, K.J., Solow, R., Portney, P.R., Leamer, E.E., Radner, R., and Schuman, E.H., Report of the NOAA panel on contingent valuation, *Federal Register*, Vol. 58, pp. 4602-4614, 1993.

18. Atwal, H. A two-stage approach to a concession in the water sector, Trinidad and Tobago Experience, Presented at Symposium on Water Regulatory Policy – Jamaica, April, 2002.

19. Baietti, A., Curiel, P., *Financing water supply and sanitation investments: Estimating revenue requirements and financial sustainability*, Water Supply and Sanitation Working Notes, No. 7, World Bank, Washington, DC, 2005.

20. Barton, D., *The transferability of benefit transfer – an experiment in varying the context of willingness to pay for water quality improvements*, Discussion Paper #D-10/1999, Agricultural University of Norway, Norway, 1999.

21. Bateman, I. and Willis, K. (eds), *Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU and Developing Countries*, Oxford University Press, Oxford, UK, 1999.

22. Bateman, I.J., Langford, I.H., Rasbash, J., Willingness to pay question format effects in contingent valuation studies, , *in Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU and Developing Countries*, Bateman, I. and Willis, K. *(eds)*, Oxford University Press, Oxford, UK, 1999.

23. Ben-Akiva, M., McFadden, D., Train, K., Walker, J., Bhat, C., Bierlaire, M., Bolduc, D., Boersch-Supan, A., Brownstone D., Bunch, D., Daly, A., De Palma, A., Gopinath, D., Karlstrom, A., Munizaga, M., Hybrid Choice Models: Progress and Challenges, *Marketing Letters*, Vol. 13, No. 3., pp. 163-175, 2002.

24. Black, M., *Learning What Works: A Twenty Year Retrospective View on International Water and Sanitation Cooperation*, Water and Sanitation Program, World Bank, Washington DC, 1998.

25. Blamey, R, Bennett, J, Morrison, M, Yea-saying in contingent valuation surveys, *Land Economics*, Vol. 75, No. 1, pp. 126-142, 1998.

26. Blamey, R., Gordon, J. an Chapman, R., Choice modelling: Assessing the environmental values of water supply options, *Australian Journal of Agricultural and Resource Economics*, Vol. 43, No. 3, pp 337-356, 1999.

27. Boxall, P., Adamowicz, W., Swait, J., Williams, M., Louviere, J., A comparison of stated preference methods for environmental valuation, *Ecological Economics*, 18, 243-253, 1996.

28. Boyle, K., Morisson, M., Taylor, L., Why value estimates generated using choice modelling exceed contingent valuation: Further experimental evidence, Australian Agricultural and Resource Economics Society Conference, Melbourne, Australia, 2004.

29. Briscoe, J., Furtado de Castro, P., Griffin, C., North, J. and Olsen, O., Toward equitable and sustainable rural water supplies: A contingent valuation study in Brazil, *The World Bank Economic Review*, Vol. 4, No. 2, pp. 115-134, 1990.

30. Briscoe, J., Garn, M., *Financing Agenda 21: Freshwater*, Paper prepared for the United National Commission on Sustainable Development, World Bank, Washington, DC, 1994.

31. Briscoe, J., The changing face of water infrastructure financing in Developing Countries, *Water Resources Development*, Vol. 15, No. 3, pp. 301-308, 1999.

32. Brouwer, R., Environmental value transfer: state of the art and future prospects, *Ecological Economics*, Vol. 31, pp. 137-152, 2000.

33. Budds, J., McGranahan, G., *Privatization and the provision of urban water and sanitation in Africa, Asia and Latin America*, Human Settlements Discussion Paper Series, International Institute for Environment and Development, 2003.

34. Bueren, M. and Bennett, J., Towards the development of a transferable set of value estimates for environmental attributes, *Australian Journal of Agricultural and Resource Economics*, Vol. 48, pp. 1-32, 2004.

35. Cairncross, S, 1992, *Sanitation and Water Supply: Practical Lessons from the Decade.* Discussion Paper No. 9, UNDP-World Bank Water and Sanitation Program, The World Bank, Washington, DC.

36. Carlsson, F. and Martinsson, P., Do hypothetical and actual marginal willingness to pay differ in choice experiments? *Journal of Environmental Economics and Management*, Vol. 41, pp. 179-192, 2001.

37. Carlsson, F. and Martinsson, P., *Does it matter when a power outage occurs? A choice experiment study on the willingness to pay to avoid power*

outages, No. 155, Working Papers in Economics, Gothenburg University, Gothenburg, Sweden, 2004.

38. Central Statistical Office (CSO). *Revised Design of the Continuous Sample Survey of Population.* Methodology Report. Government of Trinidad and Tobago, 1989.

39. Centre for International Economics, *Review of willingness to pay methodologies*, Report for Independent Pricing and Regulatory Tribunal of NSW, 2001.

40. Christie M and Midmore P. *Choice experiments: a new approach to environmental valuation.* Edward Elgar Publishing: Cheltenham (in press 2002)

41. Chrzan, K and Orme, B., *An overview and comparison of design strategies for choice-based conjoint analysis*, Research Paper Series, Sawtooth Software, Sequim, WA, 2000.

42. Churchill, A., *Rural Water Supply and Sanitation: Time for a Change*, World Bank Discussion Paper No. 18, The World Bank, Washington, DC, 1987 .

43. Clarke, G., Kosec, K., Wallsten, S., *Has private participation in water and sewerage improved coverage? Empirical evidence from Latin America*, Working Paper, No. 04-02, AEI-Brookings Joint Center for Regulatory Studies, 2004.

44. Coase, RH., The marginal cost controversy, *Economica*, Vol. 13, pp. 169-189, 1946.

45. Columbo, S., Hanley, N., Calatrava-Requena, J., *Testing choice experiments for benefit transfer with preference heterogeneity*, Working Paper, 2005.

46. Cooper, J., A comparison of approaches to calculating confidence intervals for benefit measures from dichotomous choice contingent valuation surveys, *Land Economics*, Vol., 70, No. 1, pp. 111-122, 1994.

47. Delcan International Corporation, *Feasibility study on Cost/Benefit Analysis of Universal Metering in Trinidad and Tobago*, Final Report, 1992.

48. Deverill, P., Bibby, S., Wedgewood, A., Smout, I., *Designing Water Supply and Sanitation Projects to Meet Demand in Rural and Peri-Urban Communities*, Water, Engineering and Development Centre, Loughborough University, 2002.

49. Diamond, P., Hausman, J., Contingent valuation: Is some number better than no number?, *Journal of Economic Perspectives*, Vol. 8, No. 4, pp. 45-64, 1994.

50. Dole, D., Bartlett, I., *Beyond cost recovery: Setting user charges for financial, economic and social goals*, ERD Technical Note Series, No. 10, Asian Development Bank, Manila, Philippines, 2004.

51. Duke, EM., Montoya, AC., Trends in water pricing: Results of Ernst & Young's National rate surveys, *Journal of American Water Works Association*, 1993.

52. Efron, B., Tibshirani, R., *An Introduction to the Bootstrap*, Chapman and Hall, New York, 1993.

53. Fairweather-Morisson, I., *Solid Waste in Trinidad,* M.Sc. Thesis, UWI, St. Augustine, Trinidad, 2001.

54. Fisher, A. The conceptual underpinnings of the contingent valuation method, in *The Contingent Valuation of Environmental Resources*, Bjornstad, D. and Kahn, J. eds., Edward Elgar, Cheltanham, UK, 1996

55. Fisher, P., The strange career of marginal cost pricing, *Journal of Economic Issues*, Vol., 24, No. 4, pp. 77-92, 1990.

56. Foster, V. and Mourato, S., Elicitation format and sensitivity to scope: Do contingent valuation and choice experiments give the same results?, *Environmental and Resource Economics*, Vol. 24, pp. 141-160, 2003.

57. Gausch, JL., *Granting and renegotiating infrastructure concessions: Doing it right*, WBI Development Studies, World Bank Institute, Washington, DC, 2004.

58. Goett, A., Hudson, K. and Train, K., Customers choice among retail energy suppliers: the willingness to pay for service attributes, *The Energy Journal*, Vol. 21, No. 4, pp. 191-215, 2000.

59. Goldblatt, M., Assessing the effective demand for improved water supplies in informal settlements: a willingness to pay survey in Vlakfontein and Finetown, Johannesburg, *Geoforum*, Vol. 30, pp. 27-41, 1999.

60. Greene, W., *Reference Guide*, NLOGIT, Version 3.0, Economic Software, inc., 2002.

61. Griffin, C, Briscoe, J, Singh, B, Ramasubban, R, Bhatia, R, Contingent valuation and actual behavior: predicting connections to new water systems in the state of `, India, *World Bank Economic Review*, Vol. 9, No. 3, pp. 373-395, 1995.

62. Groothuis, P., Benefit transfer: A comparison of approaches, *Growth and Change*, Vol. 36, No. 4, pp. 551-564, 2005.

63. Gulyani, S., Talukdar, D. and Kariuki, M., *Water for the Urban Poor: Insights from Household Surveys in Kenya*, Water and Urban Region I, Africa Region, World Bank, 2002.

64. Haggarty, L., Brook, P., Zuluaga, AM., *Thirst for reform? Private sector participation in providing Mexico City's water supply*, Policy Research Working Paper, No. 2654, World Bank, Washington, DC, 2001.

65. Haider, W. and Rasid, H., Eliciting public preferences for municipal water supply options, *Environmental Impact Assessment Review*, Vol. 22, pp. 337-360, 2002.

66. Hanemann, W.M. Theory versus data in the contingent valuation debate, *in The Contingent Valuation of Environmental Resources*, Bjornstad, D. and Kahn, J. eds., Edward Elgar, Cheltanham, UK, 1996.

67. Hanley, N., MacMillan, D., Wright, R., Bullock, C., Simpson, I., Parsisson, D., Crabtree, B., Contingent valuation versus choice experiments: Estimating the benefits of environmentally sensitive areas in Scotland, *Journal of Agricultural Economics*, Vol., 49, no. 1, pp. 1-15, 1998.

68. Hanley, N., Mourato, S., Write, R., Choice modelling approaches: A superior alternative for environmental valuation?, *Journal of Economic Surveys*, Vol. 15, No. 3, pp. 435-461, 2001.

69. Hausman, J.A. (ed.), *Contingent Valuation: A Critical Assessment*, Amsterdam; North Holland, 1993.

70. Hensher, D., Shore, N., and Train, K., *Households' willingness to pay for water service attributes*, Working Paper, 2005

71. Hensher, D., Stopher, P., Louviere, J., An exploratory analysis of the effect of numbers of choice sets in designed choice experiments: an airline choice application, *Journal of Air Transport Management*, Vol. 7, pp. 373-379, 2001.

72. Hoen, J.P., and Loomis, J.B., Substitution effects in the valuation of multiple environmental programs, *Journal of Environmental Economics and Management*, Vol. 20, pp. 56-75, 1993 .

73. Hope, R.A and Garrod, G.D., Household preferences to water policy interventions in rural South Africa, *Water Policy*, Vol. 6, No. 6, pp. 487-499, 2004.

74. Howe, C., and Linaweaver, F.P., The impact of price on residential water demand and its relation to system design and price structure, *Water Resources Research*, Vol. 3, No. 1, pp. 13-32, 1967.

75. Huber, J. and Zwerina, K., The importance of utility balance in efficient choice designs, *Journal of Marketing Research*, Vol. 33, pp. 307-317, 1996.

76. Hyde, T., Christie, M., Midmore, P., Designing attribute bundles in choice experiments, Choice experiments: a new approach to environmental valuation' conference, available at: http://www.irs.aber.ac.uk/mec/CEconf.htm, 2001.

77. ICWE, *The Dublin Statement of Water and Sustainable Development*, International Conference on Water and the Environment, Dublin, Ireland, 1992.

78. Joint Monitoring Program (JMP), *Water for Life, Making it happen*, World Health Organization and UNICEF, Geneva, Switzerland, 2005.

79. Katzman, M., Income and price elasticities of demand for water in developing countries, *Water Resources Bulletin*, Vol 13, No. 1, pp. 47 – 55, 1977.

80. Kessides, I., *Reforming infrastructure: Privatization, regulation, and competition*, World Bank Policy Research Report, World Bank, Washington, DC, 2004.

81. Kleemier, C., The Impact of Participation on Sustainability: An Analysis of the Malawi Rural Piped Scheme Program, World Development, Vol. 28, No. 5, pp 929-944, 2000.

82. Kling, C., Estimating the precision of welfare measures, *Journal of Environmental Economics and Management*, Vol. 21, pp. 244-259, 1991

83. Krinsky, I., Robb, A.,L., On approximating the statistical properties of elasticities, *The Review of Economics and Statistics*, Vol. 68, No. 4, pp. 715-719, 1986.

84. Kristofersson, D., Navrud, S., Validity tests of benefit transfer – Are we performing the wrong tests?, *Environmental and Resource Economics*, Vol., 30, pp. 279-286, 2005.

85. Kuhfeld, W, *Marketing Research Methods in the SAS System*, Version 9.0 edition, SAS Institute, 2003.

86. Kuhfeld, W., *Efficient experimental designs using computerized searches*, Research Paper Series, Sawtooth Software, 1997.

87. Kuhfeld, W., Tobias, R., Garrat, M., Efficient experimental design with marketing research applications, *Journal of Marketing Research*, Vol. 31, pp. 545-557, 1994.

88. Lauria, D.T., Whittington, D., Choe, K., Turngan, C., Abiad, V., Houshoeld demand for improved sanitation services: A case study of the Calamba, the Philippines, *in Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU and Developing Countries*, Bateman, I. and Willis, K. *(eds)*, Oxford University Press, Oxford, UK, 1999.

89. Lindsey, G. Planning contingent valuation: Some observations from a survey of homeowners and environmentalists, *Journal of Planning Education and Research*, Vol. 14, pp.19-28, 1994.

90. Lockwood, M and Carberry, D., *Stated preference surveys of remnant native vegetation conservation*, Report No. 104, Johnstone Centre, Albery, Australia, 1998.

91. London Economics, *WASA Tariff Study*, Final Report, 1998.

92. Loomis, J., Ekstrand, E., Aplternative approaches for incorporating respondent uncertainty when estimating willingness to pay: the case of the Mexican spotted owl, *Ecological Economics*, Vol. 27, pp. 29-41, 1998.

93. Louviere, J and Hensher, D.A, On the design and analysis of simulated choice or allocation experiments in travel choice modeling, *Transportation Research Record,* No. 890, pp. 11-17, 1982.

94. Louviere, J and Woodsworth, G., Design and analysis of simulated consumer choice or allocation experiments: An approach based on aggregate data, *Journal of Marketing Research*, Vol. 22, pp. 1-19, 1983.

95. Louviere, J., *Analyzing Decision Making: Metric Conjoint Analysis*, Sage University Paper 67, 1988.

96. Louviere, J., Hensher, D., Swait, J., *Stated Choice Methods: Analysis and Application*, Cambridge University Press, Cambridge, UK, 2000.

97. Louviere, J., Street, D., Carson, R., Ainslie, A., Deshazo, J.R., Cameron, T., Hensher, D., Kohn, R., Marley, T., Dissecting the Random Component of Utility, *Marketing Letters,* Vol. 13, No. 3., pp. 177-193, 2002.

98. MacDonald, D., Barnes, M., Bennett, J., Morrison, M., Young, M., *What consumers value regarding water supply disruptions: A discrete choice analysis?*, Working Paper, CSRIO, Australia, 2004.

99. MacDonald, D., Barnes, M., Bennett, J., Morrison, M., Young, M., Using a choice modelling approach for customer service standards in urban water, *Journal of the American Water Resources Association*, Vol. 41, No. 3., pp. 1-10, 2005.

100. Maddala, G.S. *Limited Dependent and Qualitative Variables in Econometrics*, Econometric Society Monographs, Cambridge University Press, Cambridge UK, 1983.

101. Martin, W., and Kulakowski, S., Water price as a policy variable in managing urban water use: Tucson, Arizona, *Water Resources Research*, Vol. 27, No. 2, pp. 157-166, 1991.

102. McFadden, D and Train, K., Mixed MNL models for discrete response, *Journal of Applied Econometrics*, Vol. 15, pp. 447-470, 2000.

103. McFadden, D. Conditional logit analysis of qualitative choice behaviour, in *Frontiers of Econometrics*, Zarembka P. ed., Academic Press, New York, 1974.

104. McFadden, D., Disaggregate behavioural travel demand RUM's side, A 30-year retrospective, Paper presented at International Association of Travel Behaviour Analysts, Brisbane, Australia, July 2000.

105. McFadden, D., Econometric Models of Probabilistic Choice. In *Structural Analysis of Discrete Data with Econometric Applications*, C. Manski and D. McFadden (eds), MIT Press, Cambridge, MA, pp. 198-272, 1981.

106. McFadden, D., Epilogue, *Marketing Letters*, Vol. 13, No. 3, pp. 307-310, 2002.

107. McPhail, A., Overlooked market for water connections in Rabat's shantytowns, *Journal of Water Resources Planning and Management*, Vol. 119, No. 3, pp. 388-404, 1993a.

108. McPhail, A., The 'five percent rule' for improved water service: can households afford more? *World Development*, Vol. 21, No. 6, pp 963-973, 1993b.

109. Mehta, M., Fugelsnes, T., Virjee, K., Financing the Millennium Development Goals for water and sanitation: What will it take?, *Water Resources Development*, Vol. 21, No. 2, pp. 239-252, 2005.

110. Mehta, M., *Meeting the Financing Challenge for Water Supply and Sanitation*, Water and Sanitation Program, World Bank, Washington, DC, 2003.

111. Menard, C., Clarke, G., *A transitory regime: Water supply in Conkary, Guinea*, Policy Research Working Paper, No. 2362, World Bank, Washington, DC, 2000.

112. Menard, S. *Applied Logistic Regression Analysis.* Second Edition. Quantitative Applications in the Social Sciences. Sage Publications, 2002.

113. Menendez, A., *Access to Basic Infrastructure by the Urban Poor*, EDI Policy Seminar Report, World Bank, Washington, DC, 1991.

114. Merrett, S., Deconstructing Households' Willingness to Pay for water in low income countries, *Water Policy*, Vol. 4, pp 157-172, 2002.

115. Mitchell R.C. and Carson, R. *Using Surveys to Value Public Goods: The Contingent Valuation Method*, Resources for the Future, Washington, DC, 1989.

116. Mogas, J., Riera, P., Bennett, J., *A Comparison of Contingent Valuation and Choice Modelling: Estimating the Environmental Values of Catalonian Forests*, Occasional Paper No 1., Australian National University, Canberra, Australia, 2002.

117. Morrison, M, Blamey, R., Bennett, J., Louviere, J., *A Comparison of Stated Preference Techniques for Estimating Environmental Values*, Research Report No. 1, Choice Modelling Research Reports, Asia Pacific School of Economics and Management, 1996.

118. Morrison, M. and Bennett, J., Valuing New South Wales rivers for use in benefit transfer, *Australian Journal of Agricultural and Resource Economics*, Vol. 48, pp. 591-611, 2004.

119. Morrison, M., Bennett, J., Blamey, R., Louviere, J., Choice modeling and tests of benefit transfer, *American Journal of Agricultural Economics*, Vol. 84, No. 1, pp. 161-170, 2002.

120. Morrisson, M.D., Bennett, J., Blamey, R., Louviere, J., *Choice modelling and benefit transfer*, Research Report No. 8, Choice Modelling Research Reports, Asia Pacific School of Economics and Management, 1998.

121. Mu, X., Whittington, D., Briscoe, J., Modeling Village Water Demand Behaviour: A Discrete Choice Approach, *Water Resources Research*, Vol. 26, No. 4, pp. 521-529, 1990.

122. Mycoo, M. *Water Provision Improvements: A Case Study of Trinidad.* PhD Thesis, School of Urban Planning, McGill University, 1996.

123. Nankani, H, Testing the waters – A phased approach to a water concession in Trinidad and Tobago, *Public Policy for the Private Sector*, Note No. 103, World Bank, Washington, DC, 1997.

124. Persson, TH., *Demand for water and sanitation in Bangladesh*, Working Paper, Department of Economics, Lund University, Sweden, 1998.

125. Poe, G., Giraud, K., Loomis, J. Computational methods for measuring the difference of empirical distributions, *American Journal of Agricultural Economics*, Vol. 87, No. 2, pp. 353-365, 2005.

126. Poe, G., Welsh, M., Champ, P., Measuring the difference in means willingness to pay when dichotomous choice contingent valuation responses are not independent, *Land Economics*, Vol. 73, No. 2, pp. 255-267, 1997.

127. Poe, GL., Severance-Lossin, EK., Welsh, MP., Measuring the difference (X-Y) of simulated distributions: a convolutions approach, *American Journal of Agricultural Economics*, Vo. 76, pp. 904-915, 1994.

128. Powe, N.A., Garrod, G.D., McMahon, P.L., Willis, K.G., Assessing customer preferences for water supply options using mixed methodology choice experiments, *Water Policy*, Vol. 6, No. 5, pp. 427-441, 2004.

129. Randall, A., Ives, B. and Eastman, C., Bidding games for valuation of aesthetic environmental improvements, *Journal of Environmental Economics and Management*, Vol. 1, pp. 132-149, 1974.

130. Ready, R., Whitehead, J, Blomquist, G., Contingent valuation when respondents are ambivalent, *Journal of Environmental Economics and Management*, Vol. 29, No. 2, pp. 181-197, 1995.

131. Reddy, R., Pricing of rural drinking water: A study of willingness and ability to pay in western India, *Journal of Social and Economic Development*, Vol. II, No. 1, pp. 101-122, 1999.

132. Reddy, R., Quenching the Thirst: The Cost of Water in Fragile Environments, *Development and Change*, Vol. 30, pp. 79-113, 1999.

133. Regulated Industries Commission (RIC). *Review of the Current State of the Water and Sewerage Authority (WASA)*, Information Document, RIC, Port of Spain, Trinidad, 2003.

134. Revelt, D. and Train, K., Customer-specific taste parameters and mixed logit: Households' choice of electricity supplier, Working Paper, Department of Economics, University of California – Berkeley, 2000.

135. Rhoads, S.S., 1985, *The Economist's View of the World: Governments, Markets and Public Policy*. Cambridge, UK, Cambridge University Press, referenced in Young 1996.

136. Rogers, P., de Silva, R., Bhatia, R., Water as an economic good: How to use prices to promote equity, efficiency and sustainability, *Water Policy*, Vol. 4, pp. 1-17, 2002.

137. Rolfe, J., Bennett, J., Louviere, J., Choice modeling and its potential application to tropical rainforest preservation, *Ecological Economics*, Vol. 35, pp. 289-302, 2000.

138. Ryan, M., A comparison of stated preference methods for estimating monetary values, *Health Economics*, Vol., 13, pp. 291-296, 2004.

139. Sandor, Z and Wedel, M., Designing conjoint choice experiments using managers prior beliefs, *Journal of Marketing Research*, Vol. 38, pp. 430-444, 2001.

140. Sara, J. and Katz, T., *Making Rural Water Supply Sustainable: Report on the Impact of Project Rules*, Water and Sanitation Program, World Bank, Washington, DC, 1998.

141. Satterthwaite, D., The Millennium Development Goals and urban poverty reduction: great expectations and nonsense statistics. *Environment and Urbanization,* Vol. 15, No. 2, pp. 181-190, 2003.

142. Saunders, R. and Warford, J., *Village Water Supply: Economics and Policy in the Developing World*, World Bank, Washington, DC, 1976.

143. Saunders, R., Warford, J., Mann, P., *Alternative concepts of marginal cost utility pricing: Problems of application in the water supply sector*, World Bank Staff Working Paper, No. 259, 1977.

144. Schroeder, H., Louviere, J., Stated choice methods for predicting the impact of fees at public recreation sites, *Journal of Leisure Research*, Vol. 31, No. 3, pp. 300-324, 1999.

145. Singh, B., Ramasubban, R., Bhatia, R., Briscoe, J., Griffin, C., Kim, C., Rural Water Supply in Kerala, India: How to Emerge from a Low Level Equilibrium Trap, *Water Resources Research,* Vol. 29, No. 7, pp. 1931-1942, 1993.

146. Smith, V.K., Osborne, L.L., Do contingent valuation estimates pass a 'scope' test? A meta-analysis, *Journal of Environmental Economics and Management*, Vol. 31, pp. 287-301, 1996 .

147. Solo, T.M., Small scale operators in the urban water and sanitation market, *Environment and Urbanization*, Vol. 11, No. 1, pp. 117-131, 1999.

148. Stevens, T.H., Belkner, R., Dennis, D., Kittredge, D., Willis, C., Comparison of contingent valuation and conjoint analysis in ecosystem management, *Ecological Economics*, Vol. 32, pp. 63-74, 2000.

149. Stiggers, D., Private participation in water and wastewater services in Trinidad and Tobago, in *Can Privatization Deliver? Infrastructure for Latin America*, eds Basanes, F., Uribe, E., Willig, R., Inter-American Development Bank, Washington, DC, 1999.

150. Sugden, R., Public Goods and Contingent Valuation, *in Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU and Developing Countries*, Bateman, I. and Willis, K. *(eds)*, Oxford University Press, Oxford, UK, 1999.

151. Swallow, S., Weaver, T., Opaluch, J., Michelman, T., Heterogeneous preferences and aggregation in environmental policy analysis, *American Journal of Agricultural Economics*, Vol. 77, pp. 613-619, 1994.

152. Swedish International Water Institute (SIWI), *Making water a part of economic development: The economic benefits of improved water management and services*, Paper prepared for the United National Commission on Sustainable Development, SIWI, Stockholm, Sweden, 2005.

153. Thurstone, L.L., A law of comparative judgement, *Psychological Review*, Vol.4, pp. 273-286, 1927.

154. Train, K., *Discrete Choice Methods with Simulation*, Cambridge University Press, Cambridge, UK, 2003.

155. Train, K., *Optimal Regulation*, MIT Press, Cambridge, USA, 1991.

156. Train, K., *Qualitative Choice Analysis*, MIT Press, Cambridge, MA, 1986.

157. Van Kooten, G.C., Krcmar, E. and Bulte, E., Preference uncertainty in non-market valuation: A fuzzy approach, *American Journal of Agricultural Economics*, Vol. 83, No. 3, pp. 487-500, 2001.

158. Virjee, K and Gaskin, S., The demand for improved water supply and sanitation: The case of Trinidad and Tobago, *Journal of Eastern Caribbean Studies*, *submitted*, 2006a.

159. Virjee, K. and Gaskin, S., Water supply and sanitation provision with private sector participation: A case study of Trinidad, XI World Water Congress, International Water Resources Association, Madrid, Spain, 10 pgs., October 2003.

160. Virjee, K., and Gaskin, S., Discrete Choice Experiments and the Willingness to Pay for Water Supply Changes in Developing Countries: A Case Study of Trinidad and Tobago, *Water Policy*, *submitted*, 2006b.

161. Virjee, K., *The Willingness to Pay for Changes in Water, Wastewater and Electricity Services in Trinidad and Tobago*, Working Paper, Water

Resources Planning and Management, Department of Civil Engineering and Applied Mechanics, McGill University, 2004.

162. Water and Sanitation Program – South Asia, *Willing to Pay but Unwilling To Charge: Do 'willingness to pay studies' make a difference?*, World Bank, New Dehli, India, 1999.

163. Water and Sewerage Authority (WASA), *State of the Utility*, Status Report, 2002.

164. Water and Sewerage Authority (WASA), *State of the Utility*, Status Report, 2002.

165. Webster, M., *Effective Demand for Rural Water Supply in South Africa, Water*, Engineering and Development Centre, Leicestershire, UK, 1999.

166. Wedgewood, A. and Sansom, K., *Streamlined Approach to Willingness to Pay Surveys: Guidance Note for Small Town Water Services*, Water, Engineering and Development Centre, Loughborough University, 2003.

167. White, G.F., Bradley, D.J and White, A.U., *Drawers of Water: Domestic Water Use in East Africa*, University of Chicago Press, Chicago, USA, 1972.

168. Whittington, D, Briscoe, J., Mu, X., *Willingness to Pay for Water in Rural Areas: Methodological Approaches and An Application in Haiti.* WASH Field Report No.213. United States Agency for International Development, 1987.

169. Whittington, D. Mu, X., Roche, R., *The Value of Time Spent Collecting Water, Some Estimates for Ukunda Kenya*, Infrastructure and Urban Development Department, World Bank, Washington, DC, 1989.

170. Whittington, D., Administering contingent valuation surveys in developing countries, *World Development*, Vol. 26, No.1, pp. 21-30, 1998.

171. Whittington, D., Briscoe, J., Mu, X. and Baron, W., Estimating the willingness to pay for water services in developing countries: A case study of the use of contingent valuation surveys in southern Haiti. *Economic Development and Cultural Change*, Vol. 38, pp. 293-311, 1990.

172. Whittington, D., Briscoe, J., Mu, X., *Willingness to pay for water in rural areas: Methodological approaches and an application in Haiti*, Wash Field Report No. 213, US Agency for International Development, Washington, DC, 1987.

173. Whittington, D., Davis, J. and McClelland, E., Implementing a demand-driven approach to community water supply planning: A case study of Lugazi, Uganda. *Water International*, Vol. 23, pp.134-145, 1998.

174. Whittington, D., Improving the performance of contingent valuation studies in developing countries, *Environmental and Resource Economics*, Vol. 22, pp. 323-367, 2002.

175. Whittington, D., Lauria, D., Wright, A., Choe, K., Hughes, J., Swarna, V., Household demand for improved sanitation services in Kumasi, Ghana: A contingent valuation study. *Water Resources Research*, Vol. 29, No. 6, pp.1539-1560, 1993.

176. Whittington, D., Okorafor, A., Okore, A., McPhail, A., Strategy for cost recovery in the rural water sector: A case study of Nsukka District, Anambra State, Nigeria, *Water Resources Research*, Vol. 26, No. 9, pp. 1899-1913, 1990.

177. Whittington, D., Pattanayak, S., Yang, J-C., Kumar, K.C., *Do Households Water Privatized Municipal Water Services, Evidence from Kathmandu, Nepal*, Working Paper 02_03, Research Triangle Institute, Raleigh, USA, 2002.

178. Whittington, D., Possible adverse effects of increasing block tariffs in developing countries, *Economic Development and Cultural Change*, Vol., 41, No. 1, pp. 75-87, 1992.

179. WHO, *Domestic Water Quantity: Service Level and Health*, Geneva, Switzerland, 2003.

180. Winer, B.J., Brown, D., Kenneth, M., *Statistical Priniciples in Experimental Design*, McGraw-Hill Series in Psychology, New York, NY, 1991.

181. Winpenny, J., *Financing Water For All*, Report of the World Panel of Financing Water Infrastructure, 2003.

182. World Bank Water Demand Research Team., The demand for water in rural areas: Determinants and policy implications. *World Bank Research Observer*, 8, 47-70, 1993.

183. World Bank, *Village Water Supply*, Washington DC, 1976.

184. Yepes, G. and Dianderas, A., *Indicators: Water and Wastewater Utilities*, 2nd edition, World Bank, Washington, D.C., 1996.

185. Young, R.. *Measuring Economic Benefits for Water Investments and Policies*. World Bank Technical Paper No. 338. World Bank, Washington, DC, 1996.

186. Zerah, M.-H., Water: *Unreliable Supply in Dehli*, Manohar Publishers and Distributors, New Dehli, 2000.

APPENDIX A – Schedule of Field Activities

Table A.1. – Schedule of field activities

Activity	Start Date	Finish Date
Development of draft questionnaire – Included sharing questionnaire with experts in regulation and water supply and sanitation and incorporating suggestions. Also, included statistical design of choice experiments involved in the questionnaire. This also included focus grouping of the draft questionnaire.	Feb 7, 2003	Apr 14, 2003
Sample selection – Including manual transcription of addresses from the central statistical office (CSO), and enumeration district (ED) map reproduction. Also including assignment of EDs to supervisors.	Feb 28, 2003	Apr 18, 2003
Preparation of Training Manual	Mar 31, 2003	Apr 18, 2003
Training of supervisors	Apr 21, 2003	
Training of enumerators	Apr 22, 2003	
Pilot survey and resulting changes	May 1, 2003	May 6, 2003
Survey implementation in Trinidad – 30 enumerators and five supervisors implemented the 1300 questionnaire survey throughout the country	May 7, 2003	Jun 14, 2003
Training of Data entry clerks	May 14, 2003	
Data entry – three data entry clerks were hired to input the 1450 surveys into a database using a purpose designed user interface	May 19, 2003	Jun 27, 2003
Survey implementation in Tobago – two supervisors and six enumerators conducted 150 surveys throughout the island	Jun 1, 2003	Jun 8, 2003
Data entry verification - a sample of the surveys were checked for completeness and accuracy in the electronic database	Jun 27, 2003	Jul 4, 2003

APPENDIX B – Questionnaire Instrument

ELECTRICITY AND WATER AND SEWERAGE
QUALITY OF SERVICE AND WILLINGNESS TO PAY
SURVEY QUESTIONNAIRE

Name of Enumerator_____

County_____

Ward_____

Enumeration District #_____

Building #_____

	First Visit	Last Visit
Start Time		
Finish Time		
Date		

Address_____

_____

Phone No. _____

INTRODUCTION

The Regulated Industries Commission, a statutory body responsible for regulating and monitoring the performance of Utilities in Trinidad and Tobago, is conducting a consumer survey on water, sewerage and electricity services in Trinidad and Tobago. We would like to interview you concerning your water supply, household sanitation systems and electricity supply. Your responses will enable us to suggest changes to WASA and T&TEC, in keeping with our mandate of ensuring the provision of efficient and high quality utility services. It is however important for you to answer accurately, to ensure that changes that may happen in the future most accurately consider your needs.

If respondent is unwilling to answer questionnaire, please give details for non-response:

_____
_____
_____

Enumerator's Instructions

1. Before today were you aware of the existence of the Regulated Industries Commission?
   - ☐ Yes
   - ☐ No

Let the Interviewee provide the response

If no skip to question 4

2. Are you aware of the responsibilities of the Regulated Industries Commission?
   - ☐ Yes
   - ☐ No

Let the Interviewee provide the response

If no skip to question 4

3. Are you aware that the functions of the RIC include,
   - ☐ handling customer complaints
   - ☐ fixing rates
   - ☐ developing quality of service standards
   - ☐ monitoring the performance of the utilities?

Read the pre-selected responses and check each affirmative response

4. Within which category do you fall?
   - ☐ Head of household
   - ☐ Spouse/Partner
   - ☐ Other (specify)_____

Try to get the person who is responsible for paying the Utility Bill

5. Are you the person who is normally responsible for paying the utility bills?
   - ☐ Yes
   - ☐ No

6. What is the gender of the interviewee?
   - ☐ Male
   - ☐ Female

Do not ask this question but select a response based on observation

Enumerator's Instructions

7. What are your primary and secondary sources of water?

Read the pre-selected responses
If primary source is:

1 Continue questionnaire and complete Schedule A.

2or 3 Continue questionnaire & complete Schedule B.

4 to 7 Skip to question 25 and complete Schedule B.

Sources	Primary	Secondary
1. WASA service connection	☐	☐
2. Standpipe/ WASA community tank	☐	☐
3. Truck-borne	☐	☐
4. Supply from Neighbour	☐	☐
5. Rain	☐	☐
6. Pond/River	☐	☐
7. Dug Well	☐	☐

8. Is your household responsible for paying water rates for this building?

If No skip to question 12

- ☐ Yes
- ☐ No

9. What is your billing classification?

Let the Interviewee provide the response

- ☐ A1 – Standpipe: no connection but within1/4 mile radius of a public standpipe.
- ☐ A2 – Externally Serviced: Serviced by a yard tap connection.
- ☐ A3 – Internally Serviced: Fitted with internal plumbing.
- ☐ A4 - Internally Serviced (Metered): Fitted with internal plumbing.
- ☐ A5 – Charitable Institution & P/Worship: Schools, Churches & Social Services.
- ☐ A6 - Charitable Institution & P/Worship (Metered): Schools Churches & Social Services
- ☐ Don't know
- ☐ Other (specify) _____

10. How much do you normally pay for water on a quarterly basis?
$_____

Let the Interviewee provide the response

- ☐ Don't know

11. How soon after receiving your water bill is it normally paid?

Read the pre-selected responses

Enumerator's Instructions

- ☐ Within 2 weeks
- ☐ One month
- ☐ Two months
- ☐ Three months
- ☐ More than 3 months
- ☐ Other (specify) _____

12. Beside the water bill, does your household incur any other charges for water delivery?
    - ☐ Yes
    - ☐ No

If no skip to question 14

13.

From which of the following do you get your water?	Cost per household per month (TT$)
☐ Private vendor truck	
☐ WASA truck	
☐ Supply from neighbour	
☐ Private vendor	
☐ Other (specify)	

Read the pre-selected responses and tick each affirmative response. Let the interviewee indicate the cost per household per month for water from sources listed.

Let interviewee provide the response. Include portions of one full day as a full day.

If the respondent receive water less than one day per week. Example, 1 day every two weeks. Enter this information in the "other" category

14. How many days per week do you receive water from piped system?

0	1	2	3	4	5	6	7
☐	☐	☐	☐	☐	☐	☐	☐

Enumerator's Instructions

Other (specify)

_____

—

15. How many hours per day do you receive water from the piped system?

Read the pre-selected responses
Select by placing a tick in the relevant box.

- ☐ 0-6
- ☐ 7-12
- ☐ 13-17
- ☐ 18-23
- ☐ 24

16. How would you rate the reliability of supply of water from WASA?

Read the pre-selected responses

- ☐ Excellent
- ☐ Good
- ☐ Average
- ☐ Poor
- ☐ Very Poor

17. How many additional hours per day of water supply will be required to meet all your needs?

Let interviewee provide the response

Hours: _____

18. How would you rate your water pressure?

Read the pre-selected responses

- ☐ Excellent
- ☐ Good

If the respondent has indicated that their primary water supply is not a piped connection, record 'not applicable'

Enumerator's Instructions

- ☐ Average
- ☐ Poor
- ☐ Very Poor
- ☐ Not applicable
- ☐ Don't know

(Sufficient for showering/ washing dishes at the same time)

(Cannot rinse dishes properly/ shower only trickles)

19. How would you rate the quality of the water delivered by WASA in terms of?

	Excellent	Good	Average	Poor	Very Poor
a. Taste	☐	☐	☐	☐	☐
b. Odour	☐	☐	☐	☐	☐
c. Colour	☐	☐	☐	☐	☐
d. Overall		☐	☐	☐	

Start with the first quality characteristic and read the pre-selected responses.

For the second "Odour" you can say ***"using the same response selection how would you rate the odour of the water."***

For the third "Colour" you can say ***" and how would you rate the colour of the water."***

For the fourth "Overall" you can say ***"and how would you rate the overall quality of the water."***

20. Within the last six months, has anyone in your household suffered from severe itchy skin after bathing, diarrhoea, or vomiting?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know

Let interviewee provide the response

21. What do you normally do to your water supply to ensure that it is not contaminated?
    - ☐ Filter
    - ☐ Boil
    - ☐ Boil & Filter

Let interviewee provide the response

Enumerator's Instructions

- ☐ Treat with bleach
- ☐ Don't Treat
- ☐ Other (specify)_____

22. How satisfied are you with the level of customer service provided by WASA?

Read the pre-selected responses.

Explain that this includes WASA's reaction to complaints, billing enquiries/ discrepancies, etc.

- ☐ Very Satisfied
- ☐ Satisfied
- ☐ Indifferent
- ☐ Dissatisfied
- ☐ Very Dissatisfied

23. How long have you lived in this building?_____

Let interviewee provide the response in days months or years.

24. How has the water service changed since you have been living in this building?

Read the pre-selected responses and check each affirmative response.

- ☐ Greatly improved
- ☐ Improved
- ☐ No change
- ☐ Worsened
- ☐ Greatly worsened

25. Do you possess any of the following accessories?

Let interviewee provide the response

If No to a., b. & c. skip to question 29

	Yes	No
a. Tanks <u>not</u> connected to WASA system. (e.g. for rainwater/gutter collection, filled with a rubber hose pipe run from a standpipe/house connection)	☐	☐
b. Tanks connected to WASA system.	☐	☐
c. Swimming Pool.	☐	☐

Enumerator's Instructions

26. How many water tanks, by size, do you have at your property? (Please put in the number)

	Tank Size in gallons						
	200	400	500	600	800	1000	2000
Number of tanks							

27. Does your storage allow you a continuous supply?

- ☐ Yes
- ☐ No

Let interviewee provide the response ***(if 'yes' skip to question 29.)***

28. How many days per week does your storage last?

_____ days

Let respondent answer on his/her own, but suggest estimating by evenings/half-day units as well

29. Does your household use bottled water?

- ☐ Yes
- ☐ No

If No skip to contingent valuation

30. What is your household's main use of bottled water?

- ☐ Drinking
- ☐ Cooking
- ☐ Bathing
- ☐ Other (specify)_____

Let the interviewee provide the response

31. What is the main reason your household uses bottled water?

- ☐ It tastes better
- ☐ It is safe
- ☐ It is very convenient
- ☐ Other (specify)_____

Let the Interviewee provide the response

32. How much does your household normally spend on bottled water per week?

$ _____

- ☐ Don't know

Let the Interviewee provide the response

SCHEDULE A
CONTINGENT VALUATION - PIPED SUPPLY

In the previous section you have indicated that there are a number of problems with your current water supply. I want you to consider the following hypothetical change to your water supply situation. It is crucial that you answer honestly. If you and others say that you will not pay for changes, it may be impossible for changes to occur. If you and others suggest that you will pay more than you are able to, you may not be able to afford the changes, should they happen. Please, therefore, be truthful in stating your maximum willingness to pay.

Bidding Game

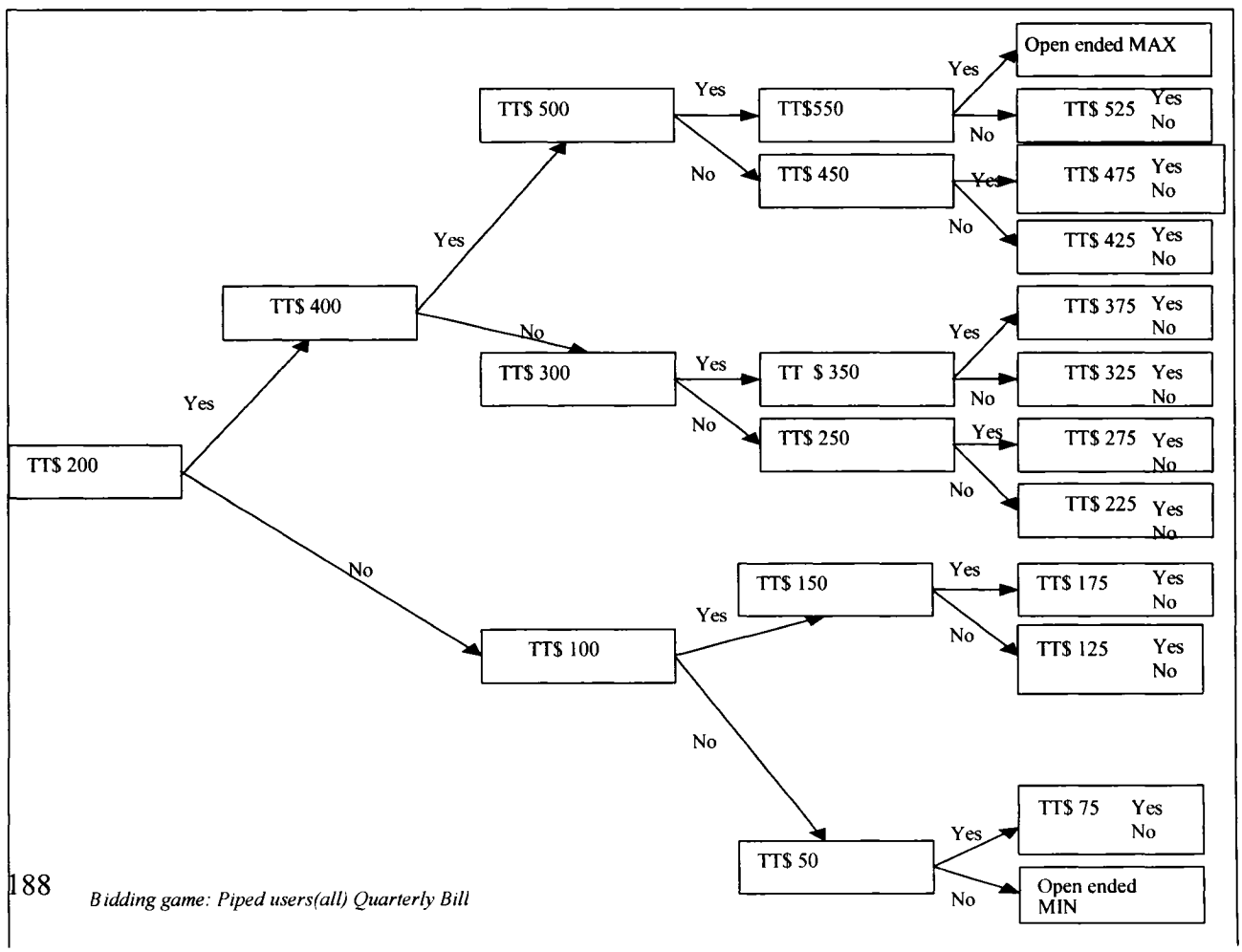
Suppose that the Water and Sewerage Authority, or WASA, was to make the following changes to the water supplied to your household:

- Water would be available in your house for 24 hours per day, everyday of the week;
- Water pressure would be sufficient for showering, washing dishes, doing laundry all at the same time;
- The water would have at least an acceptable taste, no significant odour, and be colourless;
- You would be required to pay bills quarterly for this increased service,

Would you be willing to pay $200 per quarter for this service change?

Follow the arrow depending on the response given. Circle the interviewee's response ("yes" or " no") as you go along and also circle the highest affirmative response. If Open-ended box is selected, circle it and ask the interviewee what is the maximum amount he/she is willing to pay. Fill in this response on the line below.

*$*_____ *(Use space for open ended answer provided by respondent)*



Bidding game: Piped users(all) Quarterly Bill

SCHEDULE A
CHOICE MODELS – PIPED SUPPLY

This section aims to help us understand the changes to your current water situation which are most relevant to you. You will be presented with 12 choice sets, each of which has 4 alternatives. In each case we would like you to choose the alternatives that you most prefer. In each choice set, assume that the offered alternatives are all that is available. Disregard the alternatives you have seen in other choice sets. Some of the alternatives may seem counter intuitive or impossible in practice. We would like for you to consider these alternatives anyhow. All of the alternatives assume that the water will be piped into your house.

Choice Set 1

Outcome of change:		Alternative			
		A	B	C	D
Reliability	Days/week	one	seven	four	
	Hours/day	twelve	two	twenty-four	I prefer my
Pressure		medium	low	high	current service
Quality		medium	low	high	level
Price	TT$/quarter	50	150	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 2

Outcome of change:		Alternative			
		A	B	C	D
Reliability	Days/week	seven	one	four	
	Hours/day	twelve	two	twenty-four	I prefer my
Pressure		low	high	medium	current service
Quality		high	medium	low	level
Price	TT$/quarter	450	250	50	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 3

Outcome of change:		Alternative			
		A	B	C	D
Reliability	Days/week	seven	one	four	
	Hours/day	twelve	two	twenty-four	I prefer my
Pressure		high	low	medium	current service
Quality		high	low	medium	level
Price	TT$/quarter	350	450	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 4

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	seven	one	four	
	Hours/day	two	twenty-four	twelve	I prefer my
Pressure		medium	high	low	current service
Quality		high	low	medium	level
Price	TT$/quarter	350	450	150	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 5

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	seven	one	four	
	Hours/day	twelve	twenty-four	two	I prefer my
Pressure		high	low	medium	current service
Quality		low	medium	high	level
Price	TT$/quarter	50	350	150	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 6

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	one	four	seven	
	Hours/day	twelve	twenty-four	two	I prefer my
Pressure		low	high	medium	current service
Quality		high	low	medium	level
Price	TT$/quarter	250	150	450	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 7

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	four	seven	one	
	Hours/day	twelve	two	twenty-four	I prefer my
Pressure		high	medium	low	current service
Quality		medium	low	high	level
Price	TT$/quarter	350	250	50	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 8

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	one	one	four	
	Hours/day	two	twenty-four	twelve	I prefer my
Pressure		high	medium	low	current service
Quality		high	medium	low	level
Price	TT$/quarter	50	350	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 9

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	one	seven	four	
	Hours/day	twelve	twenty-four	two	I prefer my
Pressure		high	medium	low	current service
Quality		medium	high	low	level
Price	TT$/quarter	150	450	350	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 10

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	seven	four	one	
	Hours/day	twenty-four	two	twelve	I prefer my
Pressure		low	high	medium	current service
Quality		high	medium	low	level
Price	TT$/quarter	150	450	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 11

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	seven	four	one	
	Hours/day	two	twelve	twenty-four	I prefer my
Pressure		low	medium	high	current service
Quality		medium	high	low	level
Price	TT$/quarter	50	450	350	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set **12**

Outcome of change:		Alternative			
		A	B	C	D
Reliability	Days/week	seven	four	one	
	Hours/day	twenty-four	two	twelve	I prefer my
Pressure		high	low	medium	current service
Quality		medium	high	low	level
Price	TT$/quarter	250	50	150	
Which alternative do you prefer?		☐	☐	☐	☐

SCHEDULE B

ONLY FOR CUSTOMERS WHO ARE NOT CONNECTED TO WASA'S MAINS

Respondents who answered 2-7 in Q.7

Enumerator's Instructions

B.1. How far is the nearest public standpipe from your premises?

Read the pre-selected responses. Select by placing a tick in the relevant Box.

- ☐ 1/8 mile (650 ft or 200m)
- ☐ ¼ mile (1300 ft or 400m)
- ☐ 3/8 mile (2000ft or 600m)
- ☐ ½ mile (2650 ft or 800m)
- ☐ Greater than 1/2 mile, please specify _____

B.2. How much water does the household use per day?

Let interviewee provide the response in only one category. If bucket or drum size is known indicate both the number and the size.

Buckets	Drums	Gallons:	Litres:

B.3. How much time do you spend collecting water per day (including walking, waiting at the standpipe and filling your containers)?

Read the pre-selected responses. Select by placing a tick in the relevant Box

- ☐ 1-10 minutes
- ☐ 11-20 minutes
- ☐ 21-30 minutes
- ☐ 31-40 minutes
- ☐ 41-50 minutes
- ☐ 51-60 minutes
- ☐ greater than 60 minutes, please specify_____

Let interviewee provide the response

B.4. What is the main reason for not having in-house connection?

- ☐ Connection fee too high
- ☐ Monthly/Quarterly charges too high
- ☐ Connection is not available/ no mains nearby
- ☐ Rented house
- ☐ Waiting connection from WASA
- ☐ Land tenure not secured
- ☐ Satisfied being a standpipe Customer
- ☐ Other (specify)_____

SCHEDULE B

CONTINGENT VALUATION
ONLY FOR CUSTOMERS WHO ARE NOT CONNECTED TO WASA'S MAINS

In the previous section you have indicated that there are a number of problems with your current water supply. I want you to consider the following hypothetical change to your water supply situation. It is crucial that you answer honestly. If you and others say that you will not pay for changes, it may be impossible for changes to occur. If you and others suggest that you will pay more than you are able to, you may not be able to afford the changes, should they happen. Please, therefore, be truthful in stating your maximum willingness to pay.

Bidding Game

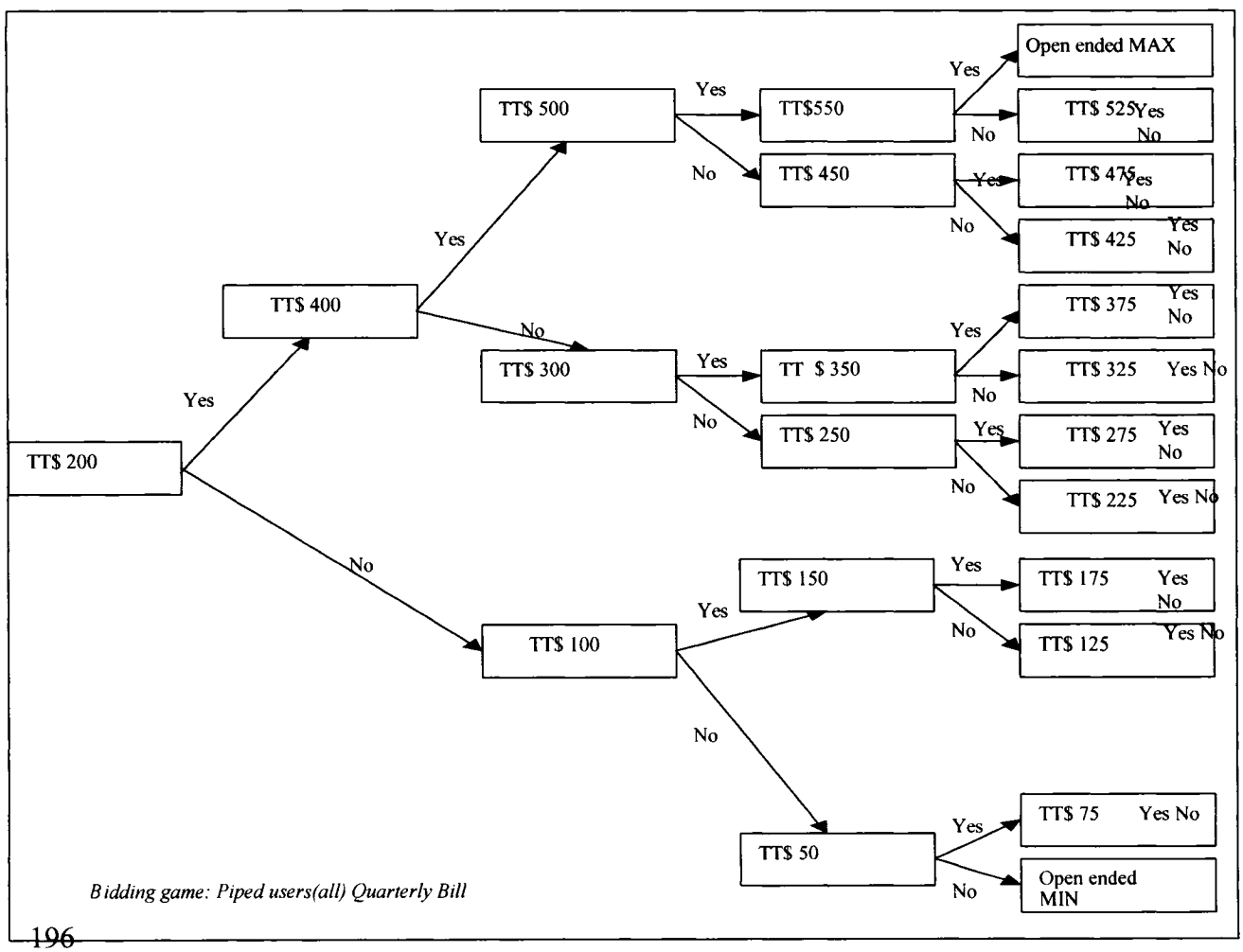
Suppose that the Water and Sewerage Authority, or WASA, was to make the following changes to the water supplied to your household:

Water would be available in your house for 24 hours per day, everyday of the week;
Water pressure would be sufficient for showering, washing dishes, doing laundry all at the same time;
The water would have at least an acceptable taste, no significant odour, and be colourless
You would have private water connection allowing you to install plumbing in your house
Also suppose that you would be required to pay bills quarterly for this increased service.

Would you be willing to pay $200 per quarter for this service change?

Follow the arrow depending on the response given. Circle the interviewee's response ("yes" or " no") as you go along and also circle the highest affirmative response. If Open-ended box is selected, circle it and ask the interviewee what is the Maximum amount he/she is willing to pay. Fill in this response on the line below.

*TT$*_____



Bidding game: Piped users(all) Quarterly Bill

SCHEDULE B

CHOICE MODELS
ONLY FOR CUSTOMERS WHO ARE NOT CONNECTED TO WASA'S MAINS

This section aims to help us understand the changes to your current water situation which are most relevant to you. You will be presented with 12 choice sets, each of which has 4 alternatives. In each case we would like you to choose the alternatives that you most prefer. In each choice set, assume that the offered alternatives are all that is available. Disregard the alternatives you have seen in other choice sets. Some of the alternatives may seem counter intuitive or impossible in practice. We would like for you to consider these alternatives anyhow.

Choice Set 1

Outcome of change:		Alternative A	B	C	D
Reliability	Days/week	four	one	seven	
	Hours/day	two	twenty four	twelve	
Pressure		high	medium	low	I prefer my
Quality		medium	low	high	current service
Connection Cost	TT$	300	600	0	level
Level of Service		0	0	standpipe	
Price	TT$/quarter	150	350	50	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 2

Outcome of change:		Alternative A	B	C	D
Reliability	Days/week	one	four	seven	
	Hours/day	twelve	twenty four	twenty four	
Pressure		low	medium	high	I prefer my
Quality		low	medium	high	current service
Connection Cost	TT$	300	0	600	level
Level of Service		in house connection	standpipe	0	
Price	TT$/quarter	450	50	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 3

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	four	seven	one	
	Hours/day	twelve	twenty four	two	
Pressure		high	medium	low	I prefer my
Quality		low	high	medium	current service
Connection Cost	TT$	600	300	0	level
Level of Service		standpipe	0	in house	
Price	TT$/quarter	450	350	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 4

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	four	seven	one	
	Hours/day	two	twelve	twenty four	
Pressure		high	medium	low	I prefer my
Quality		medium	low	high	current service
Connection Cost	TT$	300	0	600	level
Level of Service		0	in house connection	standpipe	
Price	TT$/quarter	450	150	350	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 5

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	four	seven	seven	
	Hours/day	twenty four	two	twelve	
Pressure		high	medium	low	I prefer my
Quality		low	high	medium	current service
Connection Cost	TT$	0	0	300	level
Level of Service		in house connection	0	standpipe	
Price	TT$/quarter	50	450	150	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 6

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	one	seven	four	
	Hours/day	twelve	twenty four	twenty four	
Pressure		high	low	medium	I prefer my
Quality		high	low	medium	current service
Connection Cost	TT$	300	0	600	level
Level of Service		in house connection	standpipe	standpipe	
Price	TT$/quarter	50	150	450	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 7

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	seven	one	four	
	Hours/day	twenty four	two	twelve	
Pressure		medium	high	low	I prefer my
Quality		medium	low	high	current service
Connection Cost	TT$	300	600	0	level
Level of Service		in house connection	standpipe	0	
Price	TT$/quarter	50	350	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 8

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	seven	four	one	
	Hours/day	twelve	two	twenty four	
Pressure		high	medium	low	I prefer my
Quality		low	high	medium	current service
Connection Cost	TT$	300	600	0	level
Level of Service		standpipe	in house connection	0	
Price	TT$/quarter	250	150	450	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 9

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	seven	four	one	
	Hours/day	twenty four	twelve	two	
Pressure		high	low	medium	I prefer my
Quality		medium	low	low	current service
Connection Cost	TT$	600	600	300	level
Level of Service		in house connection	0	standpipe	
Price	TT$/quarter	450	350	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 10

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	one	one	seven	
	Hours/day	twenty four	twelve	two	
Pressure		high	medium	low	I prefer my
Quality		low	medium	high	current service
Connection Cost	TT$	0	600	300	level
Level of Service		0	0	in house connection	
Price	TT$/quarter	150	250	350	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 11

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	seven	four	one	
	Hours/day	two	twenty four	twelve	
Pressure		high	low	medium	I prefer my
Quality		low	low	high	current service
Connection Cost	TT$	0	300	600	level
Level of Service		standpipe	in house connection	in house connection	
Price	TT$/quarter	350	250	150	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set **12**

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week	one	seven	four	
	Hours/day	twenty four	two	twelve	
Pressure		medium	low	high	I prefer my
Quality		high	low	medium	current service
Connection Cost	TT$	0	600	0	level
Level of Service		standpipe	0	in house connection	
Price	TT$/quarter	450	50	350	
Which alternative do you prefer?		☐	☐	☐	☐

SCHEDULE C

WASTEWATER SERVICES

ALL HOUSEHOLDS

	Enumerator's Instructions
C.1. What type of toilet system do you use?	*Let interviewee provide the response*
☐ 1. Central sewerage system ☐ 2. Septic tank & soakaway ☐ 3. Latrines/outhouse ☐ 4. Other (specify)_____	***If 1 is selected go to C.2*** ***If 2 is selected go to C.5*** ***If 3 or 4 is selected skip to C.7***
C.2. Who operates your sewerage system? ☐ WASA ☐ Private Operator ☐ Don't Know ☐ Other _____	*Read the pre-selected responses*
C.3. Who would you prefer to operate and maintain your sewerage system? ☐ WASA ☐ Private Operator	*Read the pre-selected responses*
C.4. How much do you normally pay for sewerage treatment and disposal on a quarterly basis? _____TT$ per month	*Let interviewee provide the response* ***Skip to C.7***
C.5. How often do you get your septic tank cleaned?	*Let interviewee provide the response*

- ☐ Once per year
- ☐ Once every 2 years
- ☐ Every 3 years
- ☐ Every 4 years
- ☐ Never
- ☐ Other, please specify_____

C.6. How much do you pay for each emptying of your septic tank?

Let interviewee provide the response

_____TT$ per emptying

C.7. How satisfied are you with the current disposal of your wastewater?

Read the pre-selected responses

- ☐ Very Satisfied
- ☐ Satisfied
- ☐ Indifferent
- ☐ Dissatisfied
- ☐ Very Dissatisfied

C.8. Would you prefer to have an improved wastewater disposal system?

Let interviewee provide the response
If 'no' then skip to contingent valuation section

- ☐ Yes
- ☐ No

C.9. Which of the following improved wastewater disposal systems do you prefer?

Read the pre-selected responses and check each affirmative response

- ☐ Central sewerage system
- ☐ Septic tank & soakaway
- ☐ Open drainage canals
- ☐ Other (specify)_____

SCHEDULE C

CONTINGENT VALUATION – WASTEWATER SERVICES

In the previous section you have indicated that there are a number of problems with your current wastewater disposal situation. I want you to consider the following hypothetical change to your wastewater disposal system. It is crucial that you answer honestly. If you and others say that you will not pay for changes, it may be impossible for changes to occur. If you and others suggest that you will pay more than you are able to, you may not be able to afford the changes, should they happen. Please, therefore, be truthful in stating your maximum willingness to pay.

Bidding Game

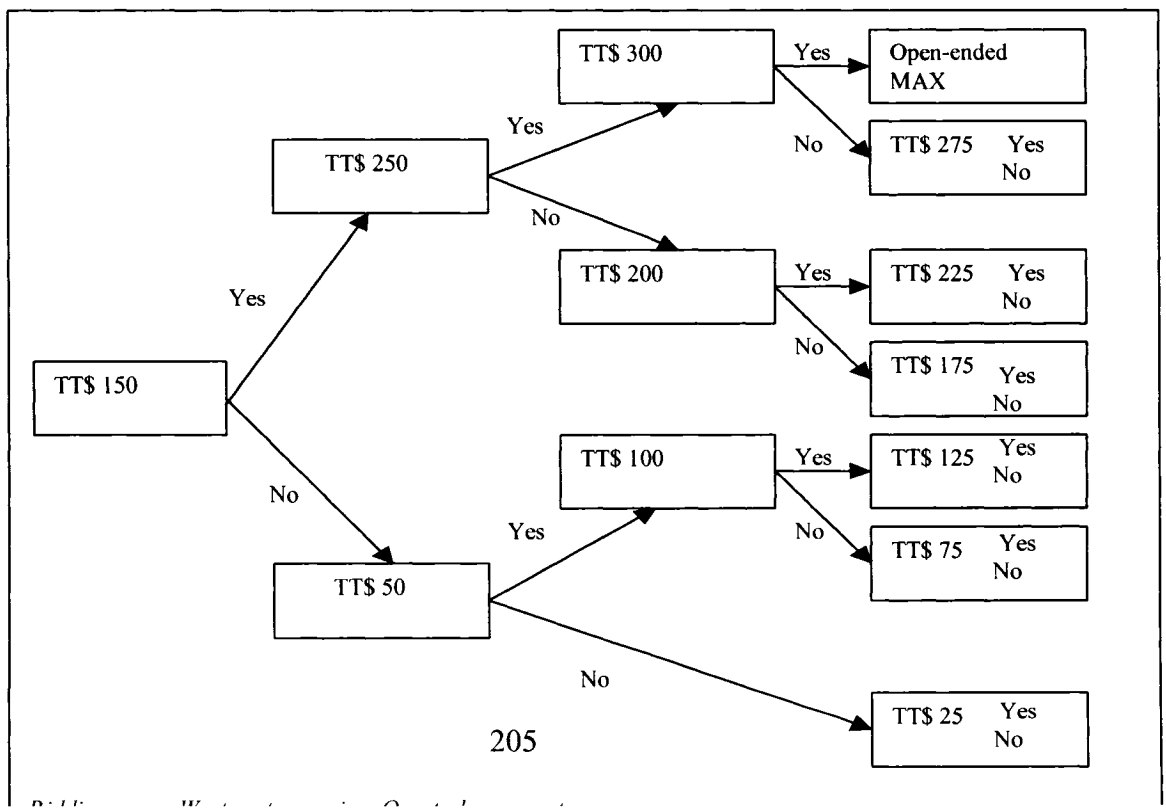
Suppose that WASA were to offer you a fully functional sewer system, including both waste from toilets and from bathing and kitchen activities. WASA would treat the waste to meet environmental regulations stipulated by the government, before releasing the waste into the environment.

Further suppose you would be required to pay for this service. The payment would be included as a separate item on your water bill, and would be a flat rate, not varying from one billing period to another. You would have to pay your water and sewerage bill once every three months, or quarterly. The amount you would pay would be for the entire household.

Would you be willing to pay $150 per quarter for this service change?

Follow the arrow depending on the response given. Circle the interviewee's response ("yes" or " no") as you go along and also circle the highest affirmative response. If Open-ended box is selected, circle it and ask the interviewee what is the Maximum amount he/she is willing to pay. Fill in this response on the line below.

*$*_____



SCHEDULE D

ELECTRICITY

ALL HOUSEHOLDS

	Enumerator's Instructions
D.1. Does your household have electricity?	***If 'no' skip to D.16.***
☐ Yes ☐ No	
D.2. What is your billing classification?	*Ask the interviewee for a T&TEC Bill t verify information.*
☐ Domestic Rate A ☐ General Commercial Rate B	
D.3 How much do you normally pay for electricity? $_____(bi-monthly / monthly)	*Get the information form the bill or Let interviewee provide the response.* ***If bi-monthly bill circle BI-MONTHL if monthly bill circle MONTHLY***
D.4. Would you consider this bill to be?	*Read the pre-selected responses*
☐ Low ☐ Average ☐ High	
D.5. How soon after receiving your electricity bill is it normally paid?	*Read the pre-selected responses*
☐ Within 2 weeks ☐ One month ☐ Two months ☐ Three months ☐ More than 3 months	
D.6. How would you rate the reliability of your electricity supply?	*Read the pre-selected responses*
☐ Excellent	

- ☐ Good
- ☐ Average
- ☐ Poor
- ☐ Very Poor

D.7 How satisfied are you with the level of service provided by T&TEC?

Read the pre-selected responses

- ☐ Very Satisfied
- ☐ Satisfied
- ☐ Indifferent
- ☐ Dissatisfied
- ☐ Very Dissatisfied

D.8. Which of the following best describes your experiences with outages?

Let interviewee provide the response fo only one category

If 'never' skip to D.10

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Infrequently
- ☐ Never
- ☐ Don't know

D.9. Within the last six months, what was the average duration of the outages?

Read the pre-selected responses

- ☐ less than 1 hour
- ☐ 1 to 2 hours
- ☐ 2 to 4 hours
- ☐ 4 to 8 hours
- ☐ 8 to 12 hours
- ☐ more than 12 hours
- ☐ Don't know

D.10. Have you ever made a trouble report?

Let interviewee provide the response
If 'no' skip to D.12.

☐ Yes
☐ No

D.11 What was the average duration of time between the trouble report and the repair of fault?

Read the pre-selected responses

☐ less than 1 hour
☐ 1 to 2 hours
☐ 2 to 4 hours
☐ 4 to 8 hours
☐ 8 to 12 hours
☐ more than 12 hours
☐ Don't know

D.12. How often do you experience voltage fluctuations?

Read the pre-selected responses

☐ Frequently
☐ Rarely
☐ Never

D.13. Within the last year, have any of your electrical appliances been damaged as a result of voltage fluctuations?

Let interviewee provide the response

If no skip to question D .16

☐ Yes
☐ No
☐ Don't know

D.14. Within the last year, have you sought compensation from T&TEC for damaged appliances?

Let interviewee provide the response

If no skip to question D.16.

☐ Yes
☐ No

D.15. How would you rate the level of compensation?

Let interviewee provide the response

☐ Excellent
☐ Good
☐ Average
☐ Unfair

☐ Very unfair

D.16. What would you consider a maximum duration of time for new connections of electricity service?

Read the pre-selected responses

☐ Within 1 working day
☐ Within 3 working days
☐ Within 5 working days
☐ Within 7 working days
☐ Within 10 working days
☐ Other (specify)_____

D.17. Do you possess any of the following electrical appliances?

Let interviewee provide the response

	Yes	No
a. Water heater	☐	☐
b. Washer	☐	☐
c. Dryer	☐	☐
d. Refrigerator	☐	☐
e. Cooking range	☐	☐
f. Television	☐	☐
g. Stereo/radio	☐	☐
f. A/C Unit	☐	☐

SCHEDULE D

CONTINGENT VALUATION
ELECTRICITY SUPPLY

In the previous section you have indicated that there are a number of problems with your current electricity supply. I want you to consider the following hypothetical change to your electricity supply situation. It is crucial that you answer honestly so that we can understand whether you really do want the changes suggested. If you and others say that you will not pay for changes, it may be impossible for changes to occur. If you and others suggest that you will pay more than you are able to, you may not be able to afford the changes, should they happen. Please, therefore, be truthful in stating your maximum willingness to pay.

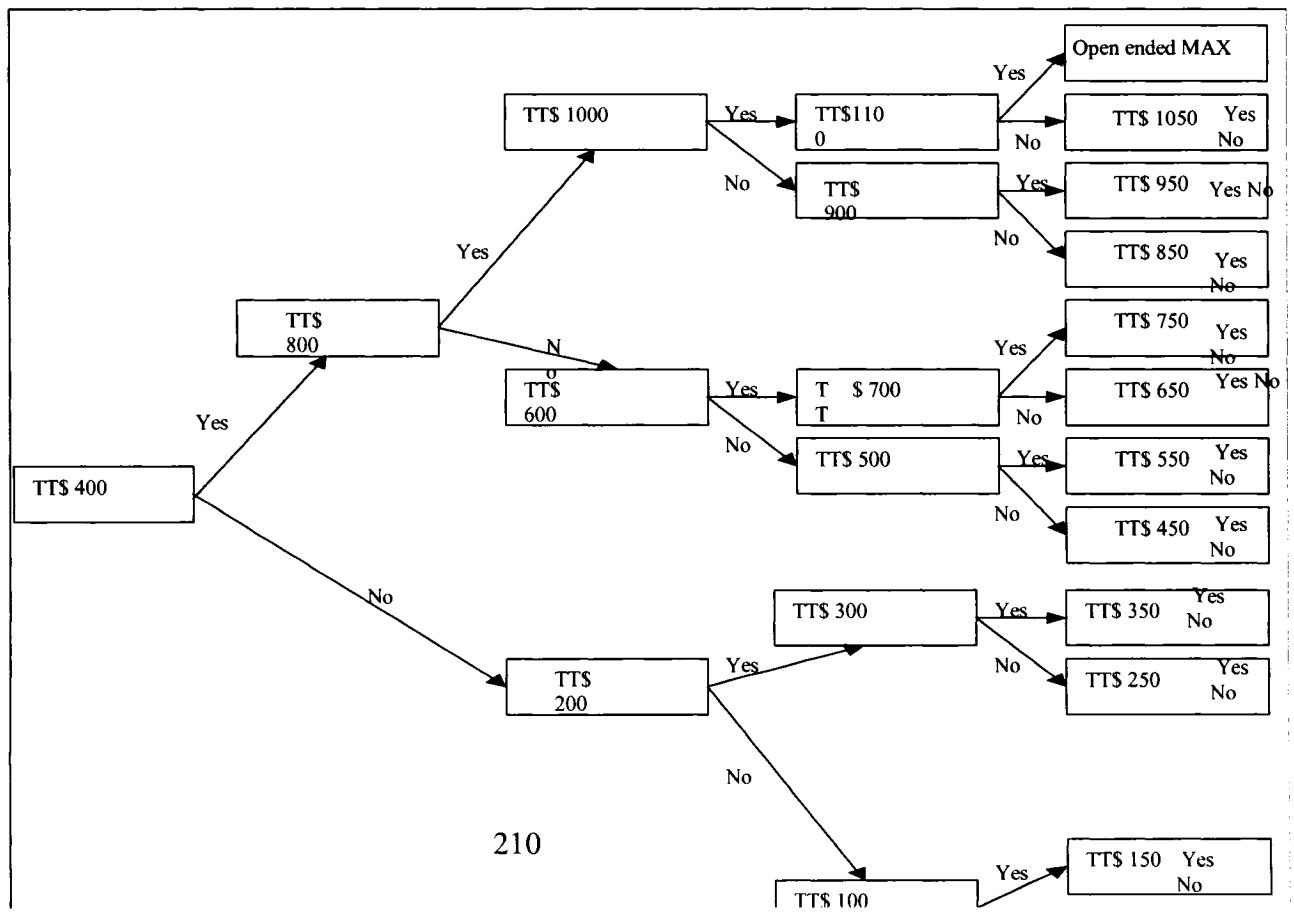
Bidding Game

If T&TEC's reliability of supply is improved, the voltage is supplied within legal limits (voltage fluctuations that don't cause damage to household appliances and equipment), response to trouble calls and time for restoration of supply are significantly improved and estimated bills are more accurate

Would you be willing to pay $400 bi-monthly for this service change?

Follow the arrow depending on the response given. Circle the interviewee's response ("yes" or " no") as you go along and also circle the highest affirmative response. If Open-ended box is selected, circle it and ask the interviewee what is the Maximum amount he/she is willing to pay. Fill in this response on the line below.

$_____



SOCIOECONOMIC SECTION

Enumerator's Instructions

33. Which age group do you belong?

Read the pre-selected responses.

- ☐ Under 20 years
- ☐ 20 – 29 years
- ☐ 30 – 39 years
- ☐ 40 – 49 years
- ☐ 50 – 59 years
- ☐ 60 years and over.

34. What is the maximum level of education you have attained?

Read the pre-selected responses.

- ☐ No Schooling
- ☐ Primary Education
- ☐ Secondary Education
- ☐ Technical/Vocational
- ☐ University
- ☐ Other

35. What is your occupation? _____

Let the interviewee provide the respons

36. What is the main construction material of the house/building?

Do not ask this question but enter a selection based on observation

- ☐ Concrete
- ☐ Wood
- ☐ Galvanize-shed
- ☐ Other (specify)_____

37. Which of the following best describes your occupancy status?

Read the pre-selected responses.

- ☐ You own the house/building and land
- ☐ You are renting the house/building and land
- ☐ You occupy the house/building and land rent free
- ☐ You have leased the house/building and land
- ☐ You are presently Squatting (do not own or rent land)
- ☐ Other (specify)_____

Enumerator's Instructions

38. What is the main use of the building?

Read the pre-selected responses

- ☐ Dwelling
- ☐ School
- ☐ Business
- ☐ Charitable Institution
- ☐ Agriculture
- ☐ Other (specify)_____

39. How many persons are living in the household?

Let interviewee provide the response

No. of adults (16 years and over) _____

No. of minors (under 16 years) _____

40. How many of the following rooms does the house have?

Let interviewee provide the response

a. Bedrooms _____

b. Bathrooms _____

41. What is the Annual Taxable value (ATV) of the building?

Information can be obtained from WAS Bill

- ☐ $0 – $500
- ☐ $501 – $1000
- ☐ $1001 – $2000
- ☐ Over $2000
- ☐ Don't Know

42. How many persons contribute to the household income? _____

Let interviewee provide the response

43. What is the total household income per month?

Let interviewee provide the response

- ☐ $0 – $1000
- ☐ $1001 – $2000
- ☐ $2001 – $3000
- ☐ $3001 – $4000
- ☐ $4001 - $5000
- ☐ $5001 - $6000
- ☐ $6001 - $7000
- ☐ $7001 - $8000

- ☐ $8001 - $9000
- ☐ $9001 - $10000
- ☐ Over $10000
- ☐ Don't Know

GENERAL COMMENTS

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Administered by_____

Checked by _____

Data entered by_____

APPENDIX C – Flashcards Used for Choice Sets

Choice Set 1

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	one twelve	seven two	four twenty-four	
Pressure		medium	low	high	I prefer my current service level
Quality		medium	low	high	
Price	TT$/quarter	50	150	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 3

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	seven twelve	one two	four twenty-four	
Pressure		high	low	medium	I prefer my current service level
Quality		high	low	medium	
Price	TT$/quarter	350	450	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 2

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	seven twelve	one two	four twenty-four	
Pressure		low	high	medium	I prefer my current service level
Quality		high	medium	low	
Price	TT$/quarter	450	250	50	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 4

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	seven two	one twenty-four	four twelve	
Pressure		medium	high	low	I prefer my current service level
Quality		high	low	medium	
Price	TT$/quarter	350	450	150	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 5

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	seven twelve	one twenty-four	four two	
Pressure		high	low	medium	I prefer my current service level
Quality		low	medium	high	
Price	TT$/quarter	50	350	150	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 7

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	four twelve	seven two	one twenty-four	
Pressure		high	medium	low	I prefer my current service level
Quality		medium	low	high	
Price	TT$/quarter	350	250	50	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 6

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	one twelve	four twenty-four	seven two	
Pressure		low	high	medium	I prefer my current service level
Quality		high	low	medium	
Price	TT$/quarter	250	150	450	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 8

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	one two	one twenty-four	four twelve	
Pressure		high	medium	low	I prefer my current service level
Quality		high	medium	low	
Price	TT$/quarter	50	350	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 9

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	one twelve	seven twenty-four	four two	
Pressure		high	medium	low	I prefer my current service level
Quality		medium	high	low	
Price	TT$/quarter	150	450	350	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 11

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	seven two	four twelve	one twenty-four	
Pressure		low	medium	high	I prefer my current service level
Quality		medium	high	low	
Price	TT$/quarter	50	450	350	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 10

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	seven twenty-four	four two	one twelve	
Pressure		low	high	medium	I prefer my current service level
Quality		high	medium	low	
Price	TT$/quarter	150	450	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 12

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	seven twenty-four	four two	one twelve	
Pressure		high	low	medium	I prefer my current service level
Quality		medium	high	low	
Price	TT$/quarter	250	50	150	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 1

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	four twelve	seven twelve	one twenty four	
Pressure		high	medium	low	
Quality		high	low	medium	I prefer my current service level
Connection Cost	TT$	300	0	600	
Level of Service		in house	standpipe	standpipe	
Price	TT$/quarter	350	450	50	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 3

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	seven two	one twelve	four twenty four	
Pressure		high	medium	low	
Quality		low	medium	high	I prefer my current service level
Connection Cost	TT$	600	300	0	
Level of Service		in house	in house	standpipe	
Price	TT$/quarter	350	150	450	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 2

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	seven twelve	four twenty four	one two	
Pressure		low	high	medium	
Quality		high	medium	low	I prefer my current service level
Connection Cost	TT$	0	300	600	
Level of Service		in house	standpipe	in house	
Price	TT$/quarter	350	150	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 4

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	one two	seven twelve	four two	
Pressure		low	high	medium	
Quality		high	medium	low	I prefer my current service level
Connection Cost	TT$	600	0	300	
Level of Service		standpipe	in house	standpipe	
Price	TT$/quarter	150	250	50	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 5

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	four twelve	seven two	one twenty four	
Pressure		high	low	medium	
Quality		low	medium	high	I prefer my current service level
Connection Cost	TT$	600	0	300	
Level of Service		standpipe	standpipe	in house	
Price	TT$/quarter	50	150	450	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 7

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	seven twenty four	four two	one twelve	
Pressure		medium	high	low	
Quality		high	medium	low	I prefer my current service level
Connection Cost	TT$	600	300	0	
Level of Service		standpipe	in house	in house	
Price	TT$/quarter	350	150	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 6

Outcome of change:		Alternative A	B	C	D
Reliability	Days/week Hours/day	four twelve	seven twenty four	four two	
Pressure		low	high	medium	
Quality		medium	low	high	I prefer my current service level
Connection Cost	TT$	600	0	300	
Level of Service		in house	standpipe	in house	
Price	TT$/quarter	450	50	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 8

Outcome of change:		Alternative A	B	C	D
Reliability	Days/week Hours/day	one twenty four	seven two	four twelve	
Pressure		high	low	medium	
Quality		medium	high	low	I prefer my current service level
Connection Cost	TT$	600	300	0	
Level of Service		standpipe	in house	standpipe	
Price	TT$/quarter	250	50	150	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 9

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	seven twenty four	one twelve	four two	
Pressure		low	high	medium	
Quality		low	high	medium	I prefer my current service level
Connection Cost	TT$	600	300	0	
Level of Service		in house	standpipe	standpipe	
Price	TT$/quarter	150	50	350	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 11

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	seven two	one twelve	four twenty four	
Pressure		low	high	medium	
Quality		medium	low	high	I prefer my current service level
Connection Cost	TT$	300	300	0	
Level of Service		standpipe	standpipe	in house	
Price	TT$/quarter	450	350	50	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 10

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	one twenty four	four two	seven twelve	
Pressure		low	high	medium	
Quality		medium	low	high	I prefer my current service level
Connection Cost	TT$	300	600	600	
Level of Service		in house	in house	standpipe	
Price	TT$/quarter	350	450	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Set 12

Outcome of change:		Alternative A	Alternative B	Alternative C	Alternative D
Reliability	Days/week Hours/day	one two	seven twelve	four twenty four	
Pressure		high	medium	low	
Quality		high	medium	low	I prefer my current service level
Connection Cost	TT$	0	600	300	
Level of Service		in house	in house	standpipe	
Price	TT$/quarter	150	50	250	
Which alternative do you prefer?		☐	☐	☐	☐

Choice Models
Flashcards

SCHEDULE A
PIPED SUPPLY

Choice Models
Flashcards

SCHEDULE B
NON-PIPED SUPPLY

APPENDIX D -

Water Supply and Sanitation Provision with Private Sector Participation: A Case Study of Trinidad and Tobago

ABSTRACT

This paper discusses a private sector participation case study in Trinidad and Tobago. The focus of the paper is an international management contract in the water sector which was anticipated to be a pre-cursor to a longer term arrangement where a concession for operations, maintenance and expansion was to be developed. The paper considers the utility's performance during the period of the management contract and highlights constraints faced by the operator and obstacles to the success of the arrangement. Crucially, insufficient revenues, based on inadequate tariff structures and the failure of investment funds for system improvements curtailed the possible success of the endeavour.

Introduction

The supply of water and sewerage services in developing countries often lacks the service levels that are seen in similar utilities in developed countries. Trinidad and Tobago is one such example where historically the water supply and sewerage facilities servicing domestic, agricultural and industrial water needs have been less than ideal.

The two island nation in the eastern Caribbean has a population of 1.3 million and due to significant oil deposits the country is considered a middle income one (World Bank, 1994). Through an act of parliament in 1965, the Water and Sewerage Authority (WASA) was established as an autonomous statutory body to provide the country's water and sewerage needs. A board of commissioners, appointed by and reporting to the government, oversees the operations of the utility.

The policies which have guided the supply of water to the islands' inhabitants have varied through time (Mycoo, 1996). During the 1960s WASA was expected to increase piped water supplies to the population of Trinidad and Tobago and

ensure that the quality and reliability of the supply were adequate. Water rates were set by the Public Utilities Commission, which, using a rate of return price setting mechanism, allowed for a 7 to 8.5% surplus generation at the utility. Into the 1970s, the policy of guiding water provision in the country shifted to stress universal coverage but with income redistribution through subsidization of water services as well. So, during this period real water rates fell, as they were not adjusted with inflation. Over these decades the finance of the deficit caused by significant capital expansion in line with universal coverage objectives was met through direct transfers from the government exchequer. This was possible largely as a result of the significant windfalls realized during the 1970s international oil crisis.

With the fall in oil prices, which occurred in the 1980s, the ability of the central government to use direct transfers to finance operating deficits at WASA was reduced. It was, therefore, necessary to redefine the operating principles of the utility and seek financial sustainability at the utility.

Persistent low revenue and inflated costs had led to a utility where sustainability was a remote possibility. Revenues were low for two reasons. As water rates did not increase with inflation over time, the potential revenue base available to the utility shrank through time. As well, the guaranteed transfers from central government had reduced efficiency in the utility, resulting in low billing collection efficiencies. Political patronage has historically interfered with the labour policies of the utility and so operating costs were inefficiently high due to a bloated labour force which amounted to 60% of the operating costs of the utility in the early 1990s. Shrinking government transfers also had the effect of reducing the ability of the utility to maintain its infrastructure, with the ultimate result of a severely degraded distribution network, with estimated losses ranging from 30% to 80% of total water abstracted, in the early 1990s (JICA, 1991).

The decreasing levels of service, resultant from a degraded network and insufficient capital expansion to meet growing demands, led to the seeking of innovative changes to the utility. It was with this objective that the 'dream team' was appointed to manage the utility in the early 1990s. This group originated from local private sector management and the introduction of such management expertise was expected to rationalize the excess of the previous supply side management. Despite efforts to enhance the operational efficiency of the utility, most significantly through the introduction of a voluntary separation program, the efforts of this team failed to increase the level of service provided by the utility. This is due to the fact that management inefficiencies explained only a portion of the total utility failings. Capital investment was required to upgrade the distribution network and expand production facilities. For this reason private sector participation (PSP) was sought.

This paper discusses that private sector participation, and follows the sustainability of initial improvements, introduced through a management contract and through the period following that contract. The paper then concludes with lessons learned from the recent experience of WASA with private sector participation in various aspects and to different degrees of its business.

The management contract

Owing to the difficulty in rationalizing the operations of the utility as outlined above, the government of Trinidad and Tobago embarked upon an innovative privatization process in 1994. The move towards involving the private sector was also encouraged by international donor agencies, through conditionalities in loans. Various PSP models were available to the government, engaging the private sector to different levels of involvement and, correspondingly, transferring various levels of risk to the private sector. The model considered in the case of WASA was a long term concession. This was due to the fact that significant investment in capital works was required as well as an overhaul in the management of the utility. By employing a concession arrangement the private

partner would be responsible for investment in capital works so allowing for the much needed investment in network rehabilitation and expansion of production facilities. As well the wide scope of responsibilities in a concession arrangement would allow the private sector to introduce management expertise and so refine business practices at the utility. The difficulty with this model, however, was that it requires significant information to ensure workability. Information is required to ensure that adequate regulation can occur, given the universal requirement of water supplies and natural monopoly of any concession. As well, information about the utility and the system it owns and uses is required to ensure that the negotiated contract between the public and private sectors is appropriate. In the absence of good system information it would be anticipated that a risk premium would be added to the negotiated contract costs, either through increased negotiated tariffs or through increased flexibility in the review of tariffs after the start of the concession. In the case of WASA, such system information was lacking and so a concession arrangement arising out of the lack of data would be rather inefficient and potentially result in a higher cost and lower service level for users. Further, regulating the private operator would be complicated by the lack of system information. In the case of Trinidad and Tobago another major obstacle preventing the immediate application of a concession agreement was that the law of Trinidad and Tobago did not allow for a transfer of ownership, such as is implied in a standard concession arrangement. Therefore, for a concession to be given to the private sector, time was required firstly, to refine the act governing the operations of WASA and secondly, to develop sufficient information to allow for an efficient regulatory arrangement and concession agreement to be reached.

Due to the pressing need for reform in the sector, the government opted to engage in a two stage privatization process. As outlined above, the benefits of a concession were ultimately what were desired, so a two stage process was embarked upon. In the first, a private operator was to be engaged in a management contract, in what was called the interim operating agreement (IOA). This was to be followed by a concession, or a long term arrangement (LTA). The

IOA would aid in developing system information, reducing the risk involved in the LTA, and begin management improvements. As well, the IOA would provide time to pursue legal changes to the WASA Act, which would allow for deeper private sector involvement.

The operator for the IOA was selected in a two-stage selection process. Interested parties were pre-qualified on the basis of their experience in the water sector and whether they had sufficient financial strength to enter into an LTA. Five firms were invited to submit detailed proposals for the second stage (Nankani, 1997). This proposal was composed of three main elements; a technical proposal, a financial proposal, and a supplementary proposal (Stiggers, 1999). The technical changes proposed were scored on a predetermined scale, where increased risk taken by the operator was scored higher. In this case, risk was considered to be related to the proportion of the total management fee which would be payable only upon delivery of payment performance indicators. Details of the numbers and qualifications of staff to be seconded to WASA under the proposal were also included in this document. The financial proposal was opened only if the technical proposal was deemed sufficient. It included details of a loan facility, composed of a maximum loan of TT$450 million and an overdraft facility of TT$ 30 million, to be arranged by the private bidder, where lower interest rates were considered as more beneficial, and so rated higher. Finally, the supplementary proposal included other strategies for service improvement which were proposed by the bidder. The winning bidder was a consortium composed of Severn Trent International and George Wimpy (Caribbean) Ltd. (ST/W).

A special purpose company was registered by ST/W, Trinidad and Tobago Water Services (TTWS). This company, together with the Government of the Republic of Trinidad and Tobago (GORTT) and the board of WASA, were signatories of a confidential contract document, signed in November of 1995.

The contract was composed of a main agreement with annexes covering details of the contract. Under the agreement, TTWS was to provide management staff to be seconded to the executive management team at WASA. As well, special purpose teams were to be employed from ST/W to engage in specific tasks. TTWS, through another special purpose company was to arrange an operating loan for WASA, of TT$450 million, to finance operating deficits during the IOA. The executive management team was to report to the WASA board, which was appointed by the government. As part of the agreement, the GORTT was to assume all of the past debts of the utility as well as provide for capital finance for any capital works agreed upon during the contract.

The business plan submitted by ST/W as part of their tender documents was to form the basis for the operational requirements. TTWS was to increase the level of service as measured by a proprietary indicator to be developed after the start of the contract. As well, the operator was to generate an operating surplus by the end of the IOA period. This projection was based primarily on increased revenue to be generated through improved billing collection and increased rates to be applied, under the PUC order 83, to customers who had more than 12 hours of water supply per day.

The operational requirements were to tie into the management fee through performance based pay. In attaining performance payment indicators, according to the schedule laid out in the business plan, the operator would receive 61% of the total management fee. The remainder was to be a guaranteed portion. These payment indicators were to be developed and passed by the WASA board after the start of the contract, and were to reflect the state of affairs at WASA both at the start of the contract as well as progression through the duration.

TTWS was to set up a dedicated procurement unit which would circumvent traditional tendering procedures required under the relevant government legislation. This dedicated procurement unit would allow for faster procurement,

through the reduction of bureaucratic checks, but leave the system more open to possible irregularities. As well, the procurement unit would have access to the greater buying power, and so lower prices, available to the ST/W group of companies, which would reduce the cost of inputs to WASA.

The main contract was signed by the government days before a national election in which they, the Peoples National Movement (PNM), were replaced by the United National Congress (UNC). As a major campaign promise of the UNC was the removal of Severn Trent, upon their gaining office the status of the contract signed by the PNM became tenuous. The significant penalties associated with the reneging of the contract and the poor indicator to multilateral banks and overseas investors made it impossible for the UNC to cancel the contract. Instead, they opted to renegotiate some of the elements, to be more in line with their government's objectives.

Essentially, the renegotiation stressed a customer service orientated organization, which would seek to expand service levels equitably, and protect vulnerable consumers through targeted subsidies. The circumvention of tender procedures, which was implied by the creation of the dedicated procurement unit, was constrained by increased control measures, in that proposed purchases through the TTWS procurement unit would be subject to WASA board approval. Another major change was an enhanced focus on increased capital investment, including the South Water Project and a meter installation project, to be financed by the World Bank.

Performance of the private operator

The private operator was to perform in two major areas; it was to move the utility closer to financial viability as well as increase the level of service given to the utility customers. Further, the renegotiated contract emphasized the latter goal through the development of a 'water for all by 2000' program under the UNC.

In order to assess the performance of the private operator under the IOA numerous of indicators can be considered. Yepes and Dianderas (1996) discuss a number of such indicators and international performance benchmarks. Such indicators will provide insight into the performance of a utility and enable a comparison with international norms. This having been said, it is critical to consider other relevant indicators which highlight a specific areas of interest in the performance of the utility.

With regard to operational performance changes under the IOA did occur. As such changes were highly dependent upon finance to be raised by government, it is unfair to suggest that changes under the IOA are attributable solely to efforts by the private operator. Equally a lack of change could easily be a result of factors outside the private operator's control. The operational performance changed most significantly with regard to the level of management systems in place. Leakage management and mapping activities were initiated, with views for long term performance gains. Pilot studies, such as metering flow in closed districts of the network, were begun which aimed at increasing the level of system knowledge. The lack of reliability in serving customers was a major concern prior to the IOA, and a major justification for the engagement of an international operator. The difficulty presented in the process, however, was the measurement of changes in the reliability of service. The contract originally signed with ST/W specified a performance indicator, to be tied to the performance pay portion of the management fee, based on measured flows in the network called the P-Factor. However, due to the lack of system information collection infrastructure, the detailed P-factor was impractical. Instead, the full service equivalent (FSE) was developed. This used the schedule of water rationing by WASA as a proxy for water in the pipes and was used for contractual performance change measurement. The difficulty with such a measure is the fact that unaccounted for water was very significant and so it would be expected that the planned availability and actual availability of water would not be equivalent. The development of such a reliability indicator is of interest here. This indicator was developed by TTWS as

part of their contractual obligations. The contract then specified that a specific change in the FSE through time was required. A conflict of interest, therefore, existed. Compounded upon this conflict, was the possible constraint of increased risk faced by the operator given uncertainty surrounding external finance. Changes to the FSE, were mostly to be realised through capital works projects, which in turn were contingent upon external finance, and in particular, a World Bank loan.

During the IOA, plant downtime of critical items, which can be taken as a proxy of unscheduled interruptions in supply, was reduced from 50 days to 4 days per year. The water abstracted was increased by 30%, to 176 million gallons per day (Severn Trent, 2002), financed through debt incurred by the government in its north and south water projects.

Financially the utility improved somewhat through the efforts during the IOA. Costs were cut significantly, through the use of another voluntary separation program (VSEP). The VSEP resulted in a reduction of over 30 % in the labour force to leave 8 staff per 1000 connections (due to a concomitant increase in the number of connections), as compared to 15 prior to the IOA.

As well, the revenues generated by the utility were increased over the period. This increased revenue was derived, primarily, from increased billings and billing collections. The increased billing arose from the addition of 50000 customers to WASA's database, through the efforts of a customer cadastre survey. It had been anticipated that revenues should increase further as a result of increased water reliability, and the resultant tariff increase implied in PUC order no. 83. This did not happen due to the lack of change in service level, which in turn was due to lower levels of capital investment to upgrade the network, which only came online towards the end of the IOA period.

So, under the IOA some positive changes were made. The operations of the utility were improved through the introduction of improved management systems. These systems would in the long term reduce costs and optimize maintenance activities. Further, changes in the water abstracted and leak reduction programs increased the reliability of supply, albeit only slightly. The finance of the utility was improved, through increased revenue generation and decreased costs. This resulted in a small surplus at the end of the IOA, as was required for one of the performance payment indicators. It should be noted that the reduced costs were as a result of a one time streamlining of the labour force and that increased revenues were as a result of a singular expansion in billing efficiency. As such neither the cost or revenue changes under the IOA had much scope for further improvements. The IOA did not perform up to all expectations, with the primary constraint being the tardiness and lower levels of finance for capital works which would have resulted in improved reliability of service. Another major constraint was the poorly designed contract. As the contract did not specify the indicators to be used for performance payment portions of the management fee, rather leaving it to the operator to develop the indicators, the integrity of the performance evaluation process was questionable. In addition, numerous delays were introduced due to this requirement.

During the IOA, a new regulatory body was created, the Regulated Industries Commission (RIC), whose mandate it was to regulate utilities in Trinidad and Tobago, under private sector management. Information realised from the improved management systems at WASA was to facilitate this activity, though the pilot scale improvements were not sufficient to monitor performance of the utility at the end of the IOA.

It should be noted however, that the major purpose of the IOA was to facilitate the entry into an LTA through increased system knowledge and management streamlining. As the contract with ST/W gave preferential treatment to the consortium for the negotiation of the LTA, and made the entry into the

negotiation contingent upon performance that essentially was to be specified by the operator through the development of proprietary performance pay indicators, TTWS sought to change operational policies such that they would be ready for an LTA. The IOA, then did not, and was not really designed to, improve the utility to be run on a stand alone basis. Changes made were to facilitate a long term plan that was embodied in the LTA. As such, the performance under the IOA, and its judgement is difficult.

The utility performance after the IOA

The period immediately following the IOA saw the institution of new management, with the advertised intention of filling a transitory position, while the LTA was negotiated. The contract required that negotiations towards an LTA be entered into should the private operator meet performance standards during the IOA and so the government was obliged to negotiate with the ST/W consortium. Given the anti-privatization policy of the UNC government and the poor relationship with the inherited private operator the mandatory negotiations were stillborn. The offer by ST/W was to be included in any further tender process for a long term PSP arrangement, but the favour due to ST/W as a result of the successful completion of the IOA contract was not given. The UNC government moved towards the tendering of a water concession by engaging a private consultant to act as a transaction advisor. With the re-election of the PNM, however, the avenue of greater PSP was effectively closed and a new executive management team and board of directors were engaged.

The post-IOA period can then be broken into two sub-periods. The time immediately following the IOA was characterized by a UNC government and their policy of 'water for all by 2000', with a long term private sector solution as required. After this, from 2002 until the present, a PNM government attempting to distance themselves from UNC policies characterizes the approach to water provision in the country. Under the PNM government, the potential of an LTA was removed and management of the utility reverted to managers having spent

most of their careers inside the organization. Of note is the fact that the initial movement towards PSP was made by the PNM government with the idea becoming politically unacceptable only after the management contract with ST/W was managed by the UNC.

Immediately following the IOA, local managers replaced the outgoing ST/W staff. The government transferred the debt it had assumed for the purpose of the IOA/LTA process back to the utility making WASA again responsible for the considerable debt accrued through its history. The debt burden was significantly larger than at the outset of the IOA given the TT$450 million operating loan, arranged by ST/W as part of their contract, and the loans taken for both the South and North Water Projects, totalling over TT$1 billion.

The local management continued to attempt to increase billings. Revenues from water rates, however, remained approximately constant at TT$350 million. Costs, in the post-IOA period, however rose and were over TT$550 million by 2002. The operating ratio, then, had increased from below one at the end of the ST/W contract to 1.44 by 2002. This increased cost is primarily a result of increasing labour costs introduced by new management teams in the post IOA period.

As well, during this period of time WASA engaged a private operator in a build-operate-transfer (BOT) desalination plant. This plant was to provide water to a rapidly growing industrial estate, Point Lisas Industrial Estate, in the southern part of the country which would be underserved by the intermittent supply that WASA could otherwise offer. To facilitate financing the plant, government authorized a rate increase of TT$ 4, to TT$ 7.50 per cubic meter, to consumers in the Point Lisas Industrial estate. This increased rate was applicable prior to the new plant becoming operational so as to allow for increased revenue to the utility. The decision to utilize desalination technology to expand the supply of water to the area was based on the speed with which increases could happen. Other options included increased surface storage, which would have taken considerably longer to come online resulting in an increased water deficit to industry. Of note, is the

significant mark up associated with the contract. WASA was to sell the water to industry at a TT$ 3 markup due to the increased reliability and quality of the water and so realize a significant windfall that could be used to subsidize other water users. At present, the desalination plant feeds into the domestic supply network during the dry season as demand is below the capacity of the plant. This BOT arrangement has drawn significant criticism due to the high cost of water extraction given the significant water availability in Trinidad. At present, WASA claims that the desalination contract is a significant reason for its financial distress, as its cost to the utility accounts requires almost half of its monthly revenue.

The most recent management team has been appointed from within WASA, with extensive experience within the organization. And despite significant capital investment, in the form of the continuation of the North and South Water projects, in the four years following the IOA, much work remains to be done as water service continues to be poor in many areas of the country, with leakages still estimated at almost 50% (WASA, 2002).

In 2002 WASA's operating deficit was almost TT$450 million, as compared to the breakeven level at the end of the IOA. Some of this is due to the responsibility for debt service, which had been removed through the government's assumption of WASA's past debts during the IOA. At present the debts of the utility amount to about TT$ 2.5 billion resulting in debt service payments of TT$150 million or 40% of total annual revenue (WASA, 2002).

In summary then, significant investment in capital works occurred in the post IOA period, and the cost of this and previously accumulated debt led to a degradation of the operating ratio of the utility. Service levels changed slightly over the period, owing to the increased capital works but remain considerably erratic due to seasonal water availability. The constraints, which curtailed the effectiveness of

the IOA, remain in place. Namely, the lack of the ability to pay for finance for capital works continues to be an inhibitor to service level increases.

Conclusions

The examination of the Trinidad and Tobago case study provides interesting lessons with regard to the private sector involvement in the provision of water services. The water authority of Trinidad and Tobago, WASA, has historically been constrained in providing adequate service to its customers by an overdependence on direct government transfers, due to tariffs set below cost recovery levels, to meet its operating expenses. As well, political interference has traditionally led to an underperforming management team. In order to remedy these two deficiencies WASA moved towards private sector involvement in the management of its operations. The IOA, which was essentially a management contract, resulted in some positive changes, though the persistent constraint of capital works finance and below cost recovery level tariffs reduced the effectiveness of the contract. As well, the poor contract design led to inefficiencies in the operations of TTWS. Changes made under the IOA, namely the installation of improved management systems leading towards improved system information and financial management, have remained in place, after the IOA. Operating expenses however have continued to increase. The constraints preventing increased service levels to customers persist. Finance remains difficult to raise, and revenue remains low, given tariffs set below cost recovery levels. The increased operating costs in the post- IOA period are indicative of insufficient cost controls in the management structure.

In examining the role of the private sector in WASA it becomes apparent that the major benefit would be the ability to engage foreign financial resources to allow for system upgrades. As well, systems to monitor service levels could be introduced. Most likely, in the medium term, private sector involvement will be limited to special purpose projects, such as the BOT desalination plant recently constructed. This form of PSP has the benefit of engaging private finance.

It is of critical importance that any private sector involvement in the water sector be based upon clear contracts with measurable performance targets established a priori to the start of the contract. In the case of WASA, the lack of definition in the contract documents, and the expectation that ST/W would develop the relevant indicators, and then be governed by them, resulted in a conflict of interest where the operator had little incentive to develop a sufficiently rigorous service level performance indicator. Of course, such contractual clarity promotes the success of PSP initiatives only where sufficient government commitment to reform exists, a condition lacking in this particular case.

As well, the regression of the utility, in terms of financial performance in the post IOA period is also of note. The increase in the operating ratio is in part due to rising costs associated with increased personnel costs. Assuming that the ST/W contract rationalized the staff levels, which were prior to the IOA bloated, the rising costs associated with increased staff costs after the IOA are indicative of increased political appointments. That is, any autonomy, and efficiencies, which resulted, realised under the IOA have been eroded in the reversion to a fully public utility.

The sustainability of the utility is based on its ability to recoup the costs associated with the supply of service. For the utility to do so, a TT$ 200 million, excluding debt service, needs to be recouped from tariff increases, assuming that the costs are at an efficient level. Such a rate increase would not be feasible unless service levels increased, and so to recoup costs, capital investment must be made. Given the financial constraints on government, continued general deficit financing of WASA seems an unlikely possibility. As such, alternative finance routes, such as through increased private sector participation, seem to offer an alternative route to allow for capital works required for service level changes at WASA. The prohibitive debt service, amounting to half of the utility's revenue, makes it very unlikely that any operator, whether private or public, will attain financial sustainability. As such, financial sustainability is further predicated upon the

removal of this debt, as had been assumed in the IOA, where the government was to assume the accumulated debt of the utility.

References

1. Japanese International Cooperation Agency (JICA), *The Study on the Improvement of Water Supply Supervisory System in Trinidad and Tobago*, Final Report, for Government of the Republic of Trinidad and Tobago, 1991

2. Mycoo, M. (1996). *Water Provision Improvements: A Case Study of Trinidad.* PhD Thesis, School of Urban Planning, McGill University.

3. Nankani, H, Testing the waters – A phased approach to a water concession in Trinidad and Tobago, *Public Policy for the Private Sector*, Note No. 103, World Bank, Washington, DC, 1997

4. Severn Trent, Water and Sewerage Authority, IOA improvements 1996-1999, received 2002, internal document.

5. Stiggers, D., Private participation in water and wastewater services in Trinidad and Tobago, in *Can Privatization Deliver? Infrastructure for Latin America*, eds Basanes, F., Uribe, E., Willig, R., Inter-American Development Bank, Washington, DC, 1999

6. Water and Sewerage Authority (WASA), *State of the Utility*, Status Report, 2002

7. World Bank, *Infrastructure for Development*, World Development Report, Oxford University Press, Oxford, U.K., 1994

8. Yepes, G. and Dianderas, A., *Indicators: Water and Wastewater Utilities*, 2nd edition, World Bank, Washington, D.C., 1996

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