

# Investigating attitudes to water conservation, additional water price and willingness to pay among Italian university students

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# Outline

## ▶ Introduction

- Theoretical framework
- Objectives and research hypotheses

## ▶ Research design, data and variables

- Survey characteristics
- Characteristics and measurement of variables

## ▶ Methodology: Structural Equation Models

## ▶ Results

- Model fit
- Structural model and coefficients

## ▶ Final remarks

## ▶ Bibliography

# Introduction

- ▶ **Theoretical framework** (1/2)
  - ▶ One of the most pressing issues facing the world today is the conservation and preservation of **natural resources** (Gregory and Di Leo, 2003; Sauri, 2013).
  - ▶ In coming years, **water resources** will be placed under further pressure by many factors, such as population growth, urbanisation, economic development and climate change (United Nations, 2009).
  - ▶ Accordingly, policy makers face the **challenge** of balancing the increasing **water demand** and the essential protection of the ecosystems' sustainability.

# Introduction

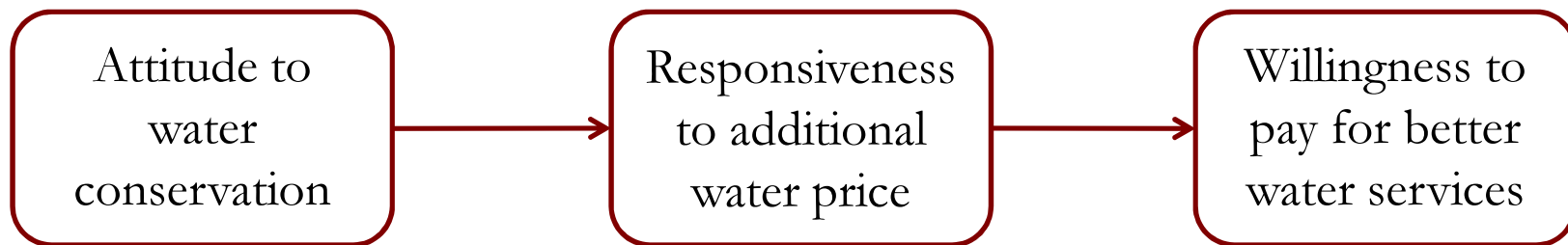
## ▶ Theoretical framework (2/2)

- ▶ Many studies have tried to outline the main **determinants of water demand** (Worthington and Hoffmann, 2008), and the following three dimensions appear to be particularly significant:
  - habits of water consumption/conservation
  - responsiveness of consumption to water prices
  - willingness to pay for better use of water resources
- ▶ These dimensions are relevant when taken **individually** but they could also provide even more interesting information if analysed **together**, to see whether and how they are related ...

# Introduction

## ► Objectives and research hypotheses (1/2)

- Develop a **theoretical model** to investigate the relationship among the following **constructs**:

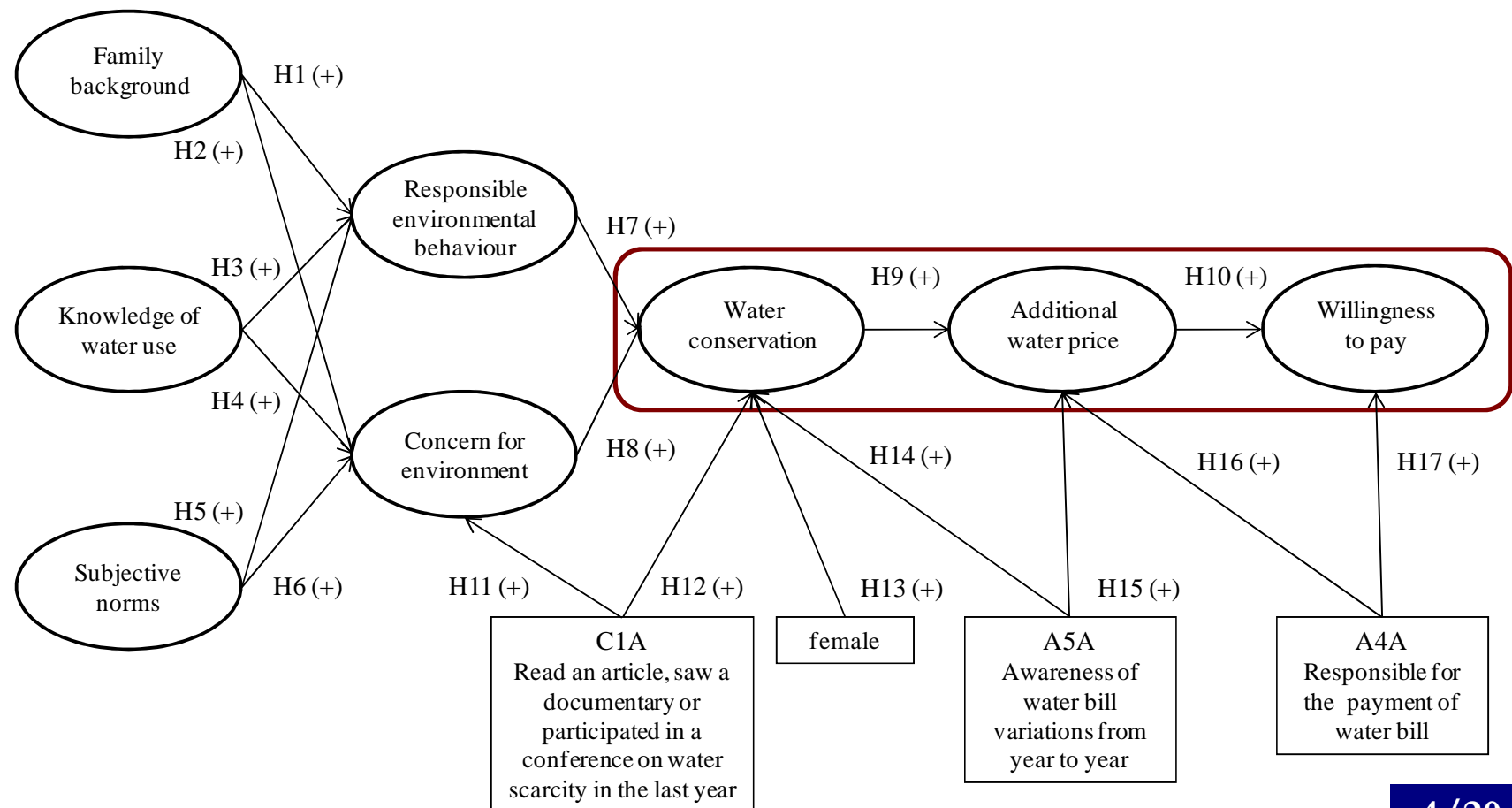


- Other dimensions were considered as potential **explanatory factors**, as suggested by the existing literature:
  - family lifestyle, knowledge of the risks related to water scarcity, attitude to pro-environmental behavior, external conditioning that individuals receive to behave in a certain manner, and possible concern for environmental issues, in addition to personal characteristics.

# Introduction

## ► Objectives and research hypotheses (2/2)

- Several research **hypotheses** (path diagram) were formulated on the basis of the existing literature and tested by using a Structural Equation Model.



# Research design, data and variables

## ▶ Survey characteristics

- ▶ Data were collected with a **sample survey** carried out on university students.
  - **Target Population:** 44,159 students under 32 years enrolled at the University of Pisa in the 2015-2016 academic year.
  - **Sampling Design:** a simple random sample of 429 units from the target population.
  - **Method of data collection:** a well-structured questionnaire, and telephone interviews carried out by 10 trained part-time students at the university's CATI Laboratory in May and June 2016.

# Research design, data and variables

## ► Characteristics of variables

- In this research, substantive theory underlying the proposed model involves the analysis of two different **kinds of variables**.
  - **Observable (or manifest) variables**: can be observed and measured directly, such as gender, age or other questionnaire responses.
  - **Latent variables**: also referred to as ‘theoretical’ or ‘hypothetical’ constructs, cannot be directly measured by a single observed variable, since they correspond to complex and abstract concepts, such as attitudes and behaviors.
    - In practice, latent variables can be considered as unobservable variables but whose existence influences responses to a number of questionnaire items and from which they can be inferred.



# Research design, data and variables

## ▶ Measurement of latent variables (1/6)

### ▶ Eight latent constructs were defined:

- Family background (FAMBA)
- Knowledge of water use (KNWATUSE)
- Subjective norms (SUBNORM)
- Responsible (or pro-environmental) environmental behaviour (RENVBEH)
- Concern for environment (ENVCON)
- Water conservation (and saving practices) (WATCONS)
- Additional water price (ADDWATPR)
- Willingness to pay (WILLTPAY)

### ▶ Each construct was measured by a set of observed indicators, formulated as statements (questionnaire items) for which the level of agreement was evaluated on a 7-ordered-categories Likert scale.

# Research design, data and variables

## ▶ Measurement of latent variables (2/6)

▶ **Family background (FAMBA)**: influences and conditioning which arise from family members' behaviour.

- Think of living in an eco-friendly family ( $y_1$ )
- Does your family agree that putting into practice actions that make eco-sustainable housing is an important thing to do ( $y_2$ )

▶ **Knowledge of water use (KNWATUSE)**: awareness of water consumption required for the production of some typical goods, and waste due to losses.

- Producing a standard cup of coffee requires 150 liters of water ( $y_3$ )
- Producing one kilo of beef requires 15,000 liters of water ( $y_4$ )
- Per 100 liters of water, 40 do not reach their destination because of the losses (in the aqueducts) ( $y_5$ )

# Research design, data and variables

## ▶ Measurement of latent variables (3/6)

▶ **Subjective norms (SUBNORM)**: perceived social pressure that individuals receive to behave in a certain manner and the belief that people will approve and support that particular behaviour.

- Making an effort to reduce water consumption is indicative of good education and culture ( $y_6$ )
- You feel morally obliged to use water carefully ( $y_7$ )

▶ **Responsible environmental behaviour (RENVBEH)**: a behaviour that consciously tries to minimize the negative impact of one's actions on the natural world.

- Separating waste for collection (paper, glass, plastic, organic) ( $y_8$ )
- Buying books/sheets produced with recycled paper ( $y_9$ )
- Reducing heating in unused rooms ( $y_{10}$ )

# Research design, data and variables

## ▶ Measurement of latent variables (4/6)

▶ **Concern for environment (ENVCON)**: evaluation of human–environment relations, that is human behavior that has consequences for the environment, and it is based on the New Ecological Paradigm (NEP) Scale (Dunlap and Van Liere, 1978).

- Human being has the right to change the natural environment to meet their own needs ( $y_{11}$ )
- The natural balance is strong enough to resist the pressure of modern industrialized countries ( $y_{12}$ )
- The so-called "ecological crisis" that humanity must face has been highly exaggerated ( $y_{13}$ )

# Research design, data and variables

## ▶ Measurement of latent variables (5/6)

▶ **Water conservation (WATCONS)**: valuable practices aimed at reducing water consumption, losses and waste in normal daily activities.

- Close the tap while you brush your teeth ( $y_{14}$ )
- Always close the tap when washing dishes ( $y_{15}$ )
- Usually rinse the fruit in a bowl instead of under running water ( $y_{16}$ )

▶ **Additional water price (ADDWATPR)**: evaluate the potential reaction to the introduction of additional costs with the aim of encouraging a waste reduction.

- Current water prices encourage waste reduction practices ( $y_{17}$ )
- It would be appropriate to provide for an additional cost for those who have higher water consumption ( $y_{18}$ )
- It would be appropriate to increase water prices to encourage people to reduce their consumption ( $y_{19}$ )

# Research design, data and variables

## ▶ Measurement of latent variables (6/6)

▶ **Willingness to pay (WILLTPAY)**: to understand the propensity of households to pay for having a better water service, both in terms of quality of water drinking and the policies for maintenance investments designed to increase the efficiency of water resource management.

- Would you be willing to pay more for the water companies to provide better quality tap water ( $y_{20}$ )
- Would you be willing to pay more for services to reduce losses from wasteful water pipes ( $y_{21}$ )

# Research design, data and variables

## ► Measurement of observed variables

► Four observed variables were also included as explanatory variables to represent demographic characteristics and personal experiences:

- **Female:** indicating whether the student is female (dummy variable)
- **C1A:** read an article, saw a documentary or participated to in a conference on water scarcity in the last year (dummy variable)
- **A5A:** indicating whether the student is aware of water bill variation from year to year (dummy variable)
- **A4A:** indicating whether the student is responsible for the payment of water bill (dummy variable)

## ► Structural Equation Models (1/3)

- Structural equation modeling (SEM) is a powerful statistical technique for estimating the **dependency relationships** among a set of endogenous and exogenous variables (observed or latent) (Bollen, 1989).
- **Measurement model:** defines the latent variables in terms of a set of observed variables (or indicators) through a confirmatory factor model (CFA; Jöreskog, 1969).

$$\mathbf{y} = \mathbf{\Lambda}\boldsymbol{\eta} + \boldsymbol{\varepsilon}$$

- **Structural model:** defines the theoretical model by specifying the structure of direct and indirect relationships among the latent variables and among the latent and observed variables, through a **system of equations**.

$$\boldsymbol{\eta} = \boldsymbol{\mu} + \boldsymbol{\beta}\boldsymbol{\eta} + \boldsymbol{\Gamma}\mathbf{x} + \boldsymbol{\zeta}$$



# Methodology

## ► Structural Equation Models (2/3)

► The elements of the matrix equations.

- For the **measurement model**:

$$\underset{(21 \times 1)}{\mathbf{y}} = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_{21} \end{bmatrix} \quad \underset{(21 \times 8)}{\mathbf{\Lambda}} = \begin{bmatrix} \lambda_{11} & \dots & \lambda_{18} \\ \lambda_{21} & \dots & \lambda_{28} \\ \dots & \dots & \dots \\ \lambda_{211} & \dots & \lambda_{218} \end{bmatrix} \quad \underset{(8 \times 1)}{\boldsymbol{\eta}} = \begin{bmatrix} \eta_1 \\ \eta_2 \\ \vdots \\ \eta_8 \end{bmatrix} \quad \underset{(21 \times 1)}{\boldsymbol{\varepsilon}} = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_8 \end{bmatrix}$$

- For the **structural model**:

$$\underset{(8 \times 1)}{\boldsymbol{\mu}} = \begin{bmatrix} \mu_1 \\ \mu_2 \\ \vdots \\ \mu_8 \end{bmatrix} \quad \underset{(m \times m)}{\mathbf{B}} = \begin{bmatrix} 0 & \beta_{12} & \dots & \beta_{18} \\ \beta_{21} & 0 & \dots & \beta_{28} \\ \dots & \dots & \dots & \dots \\ \beta_{81} & \beta_{82} & \dots & 0 \end{bmatrix} \quad \underset{(4 \times 1)}{\mathbf{x}} = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_4 \end{bmatrix} \quad \underset{(8 \times 4)}{\boldsymbol{\Gamma}} = \begin{bmatrix} 0 & 0 & \dots & 0 \\ \gamma_{21} & 0 & \dots & 0 \\ \dots & \dots & \dots & \dots \\ \gamma_{81} & \gamma_{82} & \dots & 0 \end{bmatrix} \quad \underset{(8 \times 1)}{\boldsymbol{\zeta}} = \begin{bmatrix} \zeta_1 \\ \zeta_2 \\ \vdots \\ \zeta_8 \end{bmatrix}$$

## ▶ Structural Equation Models (3/3)

- ▶ The parameter estimation method.
  - For the **measurement model**: given the ordinal nature of the observed indicators for the latent variables (7-point Likert scale), an ordered polytomous probit measurement model was specified as proposed by Muthén (1984), through continuous and normally distributed latent variables, underlying each observed indicator.
  - For the **structural model**: a three-stage limited-information procedure, using a weighted least-squares fit function (Muthén, 1984; Muthén and Satorra, 1996).

$$F = (\mathbf{s} - \boldsymbol{\sigma}(\boldsymbol{\theta}))' \mathbf{W}^{-1} (\mathbf{s} - \boldsymbol{\sigma}(\boldsymbol{\theta}))$$

# Results

## ► Model fit

- The goodness-of-fit was evaluated based on the most commonly used **criteria** (Bagozzi and Yi, 1988) for the measurement model and the structural model, respectively.
- First, the eight-latent structure underlying the 21 measures or indicator variables for the latent constructs was assessed by a confirmatory factor analysis (CFA).

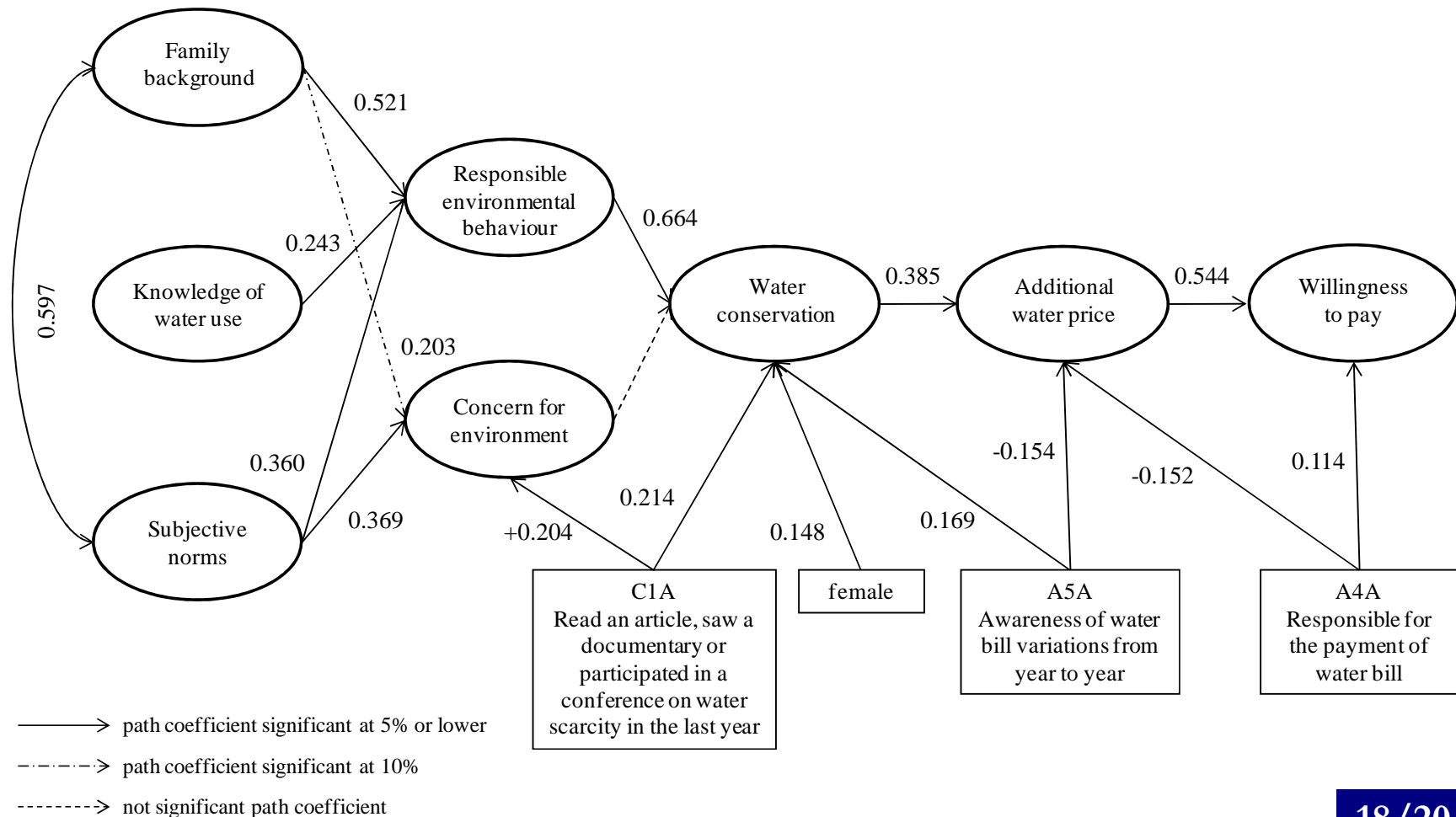
Fit statistics	Measurement	Structural
Chi-square	262.887*	389.111*
CFI (Comparative Fit Index) [0,1]	0.942	0.905
TLI (Tucker-Lewis Index) [0,1]	0.924	0.889
RMSEA (Root Mean Square Error of Approximation) [0,1]	0.036	0.035
WRMSR (Weighted Root Mean Square Residual)	0.844	0.978

\*  $p < 0.01$

# Results

## ► Structural model and coefficients

► Path diagram of the estimated model (standardised coefficients).



## Final remarks

- ▶ The results show that attitude toward water conservation and the potential reaction to incorporating supplementary costs to water prices are related and can influence the willingness to pay for water services.
- ▶ For this reason, it is necessary to provide information about daily life activities useful in reducing water consumption. The policy implications are clear, and decision makers (utilities managers and policymakers) should **invest resources in education campaigns** (conferences, universities activities) to encourage families to behave in an eco-friendly and sustainable way.
- ▶ These results also demonstrate that university students are conscious of the need to reduce water waste and that to improve tap water quality (or water service quality) they would be willing to pay for an additional price.

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# Play your part, be water smart

