Journal of Cleaner Production 127 (2016) 282–288

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

# Are American households willing to pay a premium for greening consumption of Information and Communication Technologies?

Natalia Milovantseva*

*National Research University Higher School of Economics, Myasnitskaya, 20, Moscow, 101000, Russia*

ARTICLE INFO

*Article history:*
Received 16 July 2015
Received in revised form
31 March 2016
Accepted 2 April 2016
Available online 9 April 2016

*Keywords:*
Environmental policy
Generalized ordered logit
Green cell phone
Green ICT consumption
Stated preference
Willingness to pay

ABSTRACT

The United States lags other nations in adapting policy approaches that would stimulate cleaner consumption of Information and Communication Technologies (ICT) by limiting the use of potentially toxic materials in electronics production. This study analyzes nationally-representative U.S. data from a unique web-based survey to investigate whether American households are willing to support greening the ICT devices by paying a premium for a green cell phone. Green cell phone does not contain hazardous materials and can be safely disposed with general municipal waste. A survey-based economic technique of contingent valuation was utilized to examine the relationship between socio-psychological and economic parameters for evaluating and explaining a stated willingness to pay a green phone premium, controlling for socio-economic and demographic characteristics. The findings indicate that respondents with higher scores on general environmental beliefs, greater engagement in pro-environmental behavior, and positive attitudes toward recycling small electronics are likely to be willing to pay a premium to purchase a green cell phone compared to a conventional cell phone with similar capabilities. This suggests that educating the public about benefits of electronics recycling, promoting pro-environmental norms, and encouraging pro-environmental behavior can help increase public support for implementing policies aimed at greening ICT production and consumption in the United Sates.



## 1. Introduction

Spurred by rapid technological change and greater economic prosperity, mass consumption of ICT produces increasing volumes of obsolete electronics, known as electronic waste (e-waste). Its improper disposal threatens environmental integrity and represents a potential health hazard. Possible options to prevent potential risks of e-waste include two broad areas of activities: boosting the rates of e-waste recycling in environmentally safe ways and transitioning to green ICT consumption by replacing toxic components in most conventional electronics with environmentally harmless materials.

To mitigate e-waste problem, comprehensive policy approaches have been adopted worldwide (Maxianova, 2008). For example, to decrease ecological and human health hazards of e-waste, the European Union (EU) was first to enact the RoHS Directive. This Directive restricts six hazardous substances in consumer electric and electronic equipment (EU, 2003). These include: lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, and polybrominated diphenyl ether. The EU Directive is often viewed as a model and similar policies are being adopted worldwide, including the U.S. state of California (CDTSC, 2006). Nevertheless, other U.S. states seemingly do not perceive material composition in consumer electronics as a priority. A national U.S. attempt to pass federal legislation aimed at helping develop greener electronics (S. 1397) failed in 2011.

Cell phones, on average, contain a proportion of materials similar to other electronics with a 2.7% overall estimated fraction of highly toxic materials (Lincoln et al., 2007; Widmer et al., 2005). In particular, they include potentially toxic metals such as cadmium, copper, lead, nickel, and zinc, as well as various flame retardants containing polybrominated diphenylethers, polychlorinated dioxins, and furans, which are known to be harmful to human health and to ecosystem (Alaee et al., 2003; Petreas and Oros, 2009; Sepulveda et al., 2010). Although current cell phones are fairly small, their potential environmental risk in case of improper afterlife handling (processing or disposal) is compounded by the magnitude of their popularity and by their short useful life. On average, a U.S. consumer replaces a cell phone every 21 months

* Tel.: +1 949 464 7915.
*E-mail address:* natalimil@gmail.com.

http://dx.doi.org/10.1016/j.jclepro.2016.04.001
0959-6526/

(Entner, 2011). With consistently low collection rates for recycling in the U.S., an estimated 129 million units were either incinerated or landfilled in 2009 (U.S. EPA, 2011).

Partly driven by existing regulations and thanks to technological progress, an increasing range of nontoxic materials suitable for today's electronics market has been identified (Kang et al., 2006). For example, current substitutions allow meeting EU RoHS Directive's requirements by eliminating lead from solder mixes. From a cost perspective, economies of scale permit new devices to be priced affordably. Consequently, a consumer does not incur a cost burden of new, greener technologies. However, devices currently touted by the cell phone industry as green and RoHS-compliant electronics with lead-free solders and other restricted materials eliminated from the production are not yet completely environmentally benign (Henshall et al., 2011). Designing and manufacturing truly green, or environmentally harmless, cell phones will likely result in more expensive equipment for consumers, at least initially.

This study focuses on consumer stated preferences for greener electronics containing no toxic materials. It investigates how much of a premium U.S. households are willing to pay for green cell phones compared to conventional cell phones with similar capabilities. The cell phone is used in the study because it represents a current technological trend toward the proliferation of hand-held electronics, cell phones are very popular and frequently replaced, and the materials they contain are similar to those of other electronic products. Previous studies have attempted to measure willingness to pay (WTP) for green electronics (Nnorom et al., 2009; Saphores et al., 2007). However, they used non-generalizable samples and did not incorporate response uncertainty in their analysis. This study addresses this gap.

The paper is organized as follows. A brief review of recent research analyzing WTP for green technologies and some key studies that focus on the significance of pro-environmental attitudes, beliefs, and behavior are set forth in the next section. Next, survey instrument and data are discussed, followed by an explanation of the modeling methodology. Finally, results pertaining to the estimation of WTP are offered along with discussion of factors that influence the amount of WTP, followed by a conclusion that includes pertaining policy implications.

## 2. Literature

A great deal of research has focused on identifying determinants of green consumption, and the results are varied. Among socio-demographic variables, income appears to be an important factor of increased willingness to make pro-environmental choices along with education and age, while other studies find the opposite (Barr, 2007; Clarke and Maantay, 2006; Ferrara and Missios, 2005; Jenkins et al., 2003; Spash, 2006). Findings on gender and ethnicity are mixed as well. Studies on green energy find that WTP a green premium depends on people's overall environmental awareness and their age and education (Bollino, 2009; Grösche and Schröder, 2011; Hansla et al., 2008; Kotchen and Moore, 2007; Zoric and Hrovatin, 2012). Several papers found a positive link between both income and younger age and WTP more for green electricity (Oliver et al., 2011; Yoo and Kwak, 2009). Socio-demographic characteristics were found to play no role in the decision to pay a premium for green energy in other studies (Claudy et al., 2011). Literature focused on assessing households' WTP a premium for more energy efficient home appliances reports that positive attitudes toward general environmental issues influence the WTP (Bull, 2012; Ward et al., 2011; Yamamoto et al., 2008). Studies on green transportation found, in most cases, that WTP for more sustainable transportation increases with education and income but decreases with age (Avineri and Waygood, 2010).

Literature that has grounded its analysis on the theory of planned behavior combines both internal and external variables. These studies suggest beliefs, attitudes, and past pro-environmental behavior play important roles in making pro-environmental consumption decisions (Fielding et al., 2008; Kaiser et al., 2005; Menzel and Bögeholz, 2010; Oreg and Katz-Gerro, 2006). Environmental beliefs seem to explain households' greater propensity to make various pro-environmental choices (Sauer and Fischer, 2010). Additional literature also reports evidence of significant positive relationship between positive pro-environmental attitudes and pro-environmental choices (Bernath and Roschewitz, 2008; Knussen and Yule, 2008; Milovantseva and Saphores, 2013a; Schläpfer et al., 2004; Veisten, 2007).

Few studies examined WTP for green cell phones. There are two surveys undertaken in California and two elsewhere (Nixon and Saphores, 2007; Nixon et al., 2009; Nnorom et al., 2009; Song et al., 2012). Results broadly suggest that common predictors of increased WTP across studies include environmental attitudes, age, income, and education. None of the existing studies, however, used a generalizable sample or accounted for preference uncertainties in their analyses.

## 3. Methods

### 3.1. Data

This study uses nationally representative data from a random subset of an established online research panel of over 43,000 U.S. adults. The panel is based on a sampling frame afforded by the random digit dialing (RDD) technique which includes both listed and unlisted telephone numbers to avoid limiting the sampling to only web or computer owners. The RDD is augmented by randomly sampling the U.S. Postal Service Delivery Sequence File to ensure inclusion of underrepresented minorities, low-income households, and people with no landline telephone. The enrolled panel members are routinely asked for socio-economic and demographic information that included gender, age, race, income, education, and size and geographic location of their households. This information is updated annually and available for subsequent customized surveys. In exchange for their monthly survey participation, panel members are offered a free laptop and monthly Internet access, or, alternatively, receive points redeemable for cash. This approach is convenient for respondents and permits conducting surveys quickly and economically.[1] The survey for this study was completed by 3156 panelists (69% response rate) in 2010.

The first part asked respondents about their environmental beliefs, recycling-related attitudes, and pro-environmental activities in the last twelve months. The second part concerned respondents' use and disposal of cell phones and included randomly assigned questions to elicit each respondent's WTP a premium for a green cell phone. A contingent valuation survey must include a hypothetical scenario and a payment vehicle with respect to preceding scenario (Arrow et al., 2001). Survey's hypothetical scenario described a choice between purchasing a green phone and a conventional cell phone. We defined a green cell phone as a cell phone with functional capabilities similar to the conventional cell phones commonly used by consumers. However, the green phone is made from hypothetical non-toxic biodegradable materials. The green phone's material composition renders it environmentally friendly

[1] Additional details on research panel are available in Milovantseva and Saphores (2013b) and at www.knowledgenetworks.com/knpanel/index.html.