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Short Communication

Investigating preferences for dynamic electricity tariffs: The effect of environmental and system benefit disclosure

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HIGHLIGHTS

- We evaluate preferences for domestic dynamic electricity tariffs in the US and EU.
- We use an online choice experiment approach with two dynamic tariff options.
- People are more likely to switch if shown environmental and system benefits.
- People are more likely to switch if they find shifting demand easy to do.
- Our results imply the importance of targeted communication and enabling technology.

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ABSTRACT

Dynamic electricity pricing can produce efficiency gains in the electricity sector and help achieve energy policy goals such as increasing electric system reliability and supporting renewable energy deployment. Retail electric companies can offer dynamic pricing to residential electricity customers via smart meter-enabled tariffs that proxy the cost to procure electricity on the wholesale market. Current investments in the smart metering necessary to implement dynamic tariffs show policy makers' resolve for enabling responsive demand and realizing its benefits. However, despite these benefits and the potential bill savings these tariffs can offer, adoption among residential customers remains at low levels. Using a choice experiment approach, this paper seeks to determine whether disclosing the environmental and system benefits of dynamic tariffs to residential customers can increase adoption. Although sampling and design issues preclude wide generalization, we found that our environmentally conscious respondents reduced their required discount to switch to dynamic tariffs around 10% in response to higher awareness of environmental and system benefits. The perception that shifting usage is easy to do also had a significant impact, indicating the potential importance of enabling technology. Perhaps the targeted communication strategy employed by this study is one way to increase adoption and achieve policy goals.

1. Introduction

The deployment of smart electricity meters – devices that can read and relay consumption at discrete time intervals – is progressing quickly. 33% of US households had smart meters as of May 2012, and nearly two-thirds are expected to have them by 2015 (FERC, 2011; IEE, 2012). In parts of the European Union (EU) the deployment of smart meters is moving even faster (Haney et al., 2009; Torriti et al., 2010). Italy has completed its transition; by 2020, France, the Netherlands, Ireland, Norway, the UK, and Spain are projected to reach almost 100% deployment (DECC and Ofgem, 2011; Faruqui et al., 2010; Torriti, 2012).

Smart meters enable dynamic electricity tariffs that allow customers to face the cost of procuring electricity in the wholesale market, which varies by time of day and season (Fox-Penner, 2010: 49). Examples are provided in Supplementary Appendix A. The main benefit of these market-reflective tariffs is that they provide price signals for customers to cut demand during peak, high-priced times (Faruqui and Sergici, 2010; Faruqui and Palmer, 2012; Filippini, 2011). Price-responsive customers can produce efficiency gains for the electricity sector because they: require less

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infrastructure to generate and distribute power at peak times[1]; cut electricity procurement costs through lower peak prices; and reduce vulnerability to service failures, such as blackouts (Faruqui et al., 2010). Responsive demand – via direct customer response or enabling technologies like smart appliances, energy storage, and distributed generation (Strbac, 2008; Clastres, 2011) – becomes more valuable if it is "dispatchable": able to be deployed by the system operator with certainty to respond to market conditions. These cost savings can be passed through; switching to these tariffs can save money for the majority of customers (Faruqui, 2010).

Responsive demand driven by dynamic pricing can also reduce greenhouse gases and local pollutants. Enhanced price signals can cause customers to shift demand away from peak times, avoiding emission-intensive generators used to serve system peak in some regions.[2] Customers may also cut demand entirely due to enhanced price signals and better consumption information from smart metering (PNNL, 2010). Demand that can be dispatched is the largest potential source of environmental benefits. Responsive, dispatchable demand would be able to support higher levels of intermittent renewable generation without compromising reliability (Delucchi and Jacobson, 2011). The CO_2 reductions of smart metering and dynamic pricing, and resulting demand response have been quantified in studies, some specific to the US (EPRI, 2008; Hledik, 2009), others global in scope (IEA, 2010; Webb, 2008). They show modest direct benefits, at maximum around 5% of total emissions in 2030. Renewable energy deployment in the 25–40% range supported by a smarter grid can deliver another 5–10% of cuts in CO_2 emissions (PNNL, 2010).

Despite these environmental and system (E&S) benefits and potential bill savings, in the UK only about 15% of customers opt for a simple dynamic Time of Use tariff with a peak and off-peak price (Faruqui and Palmer, 2012). On the other hand, in a US pilot when dynamic tariffs were the default only 10% opted out (Herter, 2007). Other studies have confirmed this status quo bias (MMI, 2003). An on-going research programme by the US Department of Energy (2013) also highlights the higher recruitment rates for default offers (78–87%) in contrast to opt-in methods (5–28%). Low uptake does not bode well for smart metering's cost effectiveness. In the EU, smart meters' cost is only justified when dynamic tariffs are offered and customers switch to them at higher levels than traditionally experienced (Faruqui et al., 2010).

Since it may be legally or politically impossible to make dynamic pricing the default option, experts on both sides of the Atlantic (Faruqui et al., 2010; Torriti et al., 2011) have suggested that informing customers about the E&S benefits of dynamic pricing could break this status quo bias and increase switching rates. This short paper uses a survey-based choice experiment to determine the effect of E&S benefits information on household preferences for dynamic pricing.

2. Materials and methods

Choice experiments (CEs) are a popular survey-based stated preference technique. In a CE, respondents choose one option out of sets of multiple options, each with different attributes varying at different levels, where price is one of the attributes (Bateman et al., 2002; Louviere et al., 2003; Champ et al., 2003). Willingness to pay (WTP) or willingness to accept (WTA) is inferred indirectly by analysing how respondents trade off attributes against cost (Holmes and Adamowicz, 2003). The key advantage of CEs is the possibility of eliciting values for multiple attributes and options at once. However, CEs can add complexity to valuation (Bateman et al., 2002; Hanley et al., 2001; Foster and Mourato, 2002). Although no stated preference study to date has examined the effect of E&S benefits in dynamic tariff choice, relevant studies exist on load-shifting and dynamic tariff choice (MMI, 2003; Platchkov et al., 2011), electricity outages (Pepermans, 2011; Carlsson and Martinsson, 2008; Abdullah and Mariel, 2010), and tariff choice (Goett et al., 2000).

The complexity of electricity tariffs makes designing an appropriate CE difficult, especially for residential customers. Goett et al. (2000), for example, used over 40 different attributes, such as price, 'greenness', customer service, and additional services. The authors chose to accept ambiguity in some attributes to avoid technical complexity, and surveyed more sophisticated business customers. Taking a different tack for households, MMI (2003) focused exclusively on dynamic pricing and a pre-defined tariff set. By limiting the survey's scope, the authors avoided complexity by designing tariffs that communicated cost, possible savings, and behaviours to get those savings (Lineweber, 2012a).

We use a simple web-based choice experiment to elicit preferences for dynamic pricing. Our design drew on similar studies, especially Platchkov et al. (2011) and MMI (2003).[3] Specifically, we use a labelled CE design (Fimereli and Mourato, 2013) where we proxy the choice to switch from a fixed tariff to one of two dynamic tariffs: Time of Use (TOU) and Critical Peak Pricing (CPP).[4] Together with the tariff label (i.e. fixed tariff, TOU or CPP), we provide a description (via words and graph) of the TOU and CPP tariffs as well as information on the actions required (e.g. shifting appliance usage away from system peak) and risks involved in obtaining a bill discount. Given the complexity of tariff-related information, we opted to vary only the price attribute. The price attribute was framed as an electricity bill discount (i.e. a WTA format) to switch to the dynamic tariff, and varied among 1%, 2%, 5%, 10%, 15%, and 20%. This discount was displayed both in percentage and dollar savings based on bill information entered by respondents.

Respondents were presented with four labelled choice cards.[5] In each, they were asked to choose one among three tariffs – fixed, TOU or CPP – taking into account the information provided about the tariffs and the varying bill discount. To determine the effect of E&S benefits on customer switching, respondents were randomly divided into two sub-samples, with E&S benefits information presented to only one. Supplementary Appendix B contains examples of choice cards both with and without E&S information.

To model customer preferences for dynamic tariffs we estimated both a conditional and mixed logit model, consistent with other studies reviewed. These models allow the analyst to derive a model of the probability that a respondent will choose one tariff over another, and ultimately WTA, based on the attributes of the tariff and respondent. The conditional logit is a basic model; the

[1] Safety margins for peak demand conditions cause some power generation and delivery infrastructure to remain unutilized most of the year: 5–12% of power plants serve demand only 1% of the time (Faruqui et al., 2007).

[2] This direct benefit depends on peak and off-peak generation mix. For example, shifting demand from coal to natural gas is beneficial, while the opposite is not. Hledik (2009, p. 11) provides an example of two different load shifting scenarios in the United States. We also note that reducing demand completely is not subject to this caveat – it is purely a benefit.

[3] Survey design was also aided by comments from electric industry consultants, academics, and employees of electricity supply and distribution companies, a full list of whom can be found in the Acknowledgements section.

[4] The market reflective Real Time Pricing tariff shown in Appendix A is not studied, as existing meta-analyses noted that residential participation in RTP programmes is generally low (DECC, 2013; Barbose et al., 2004).

[5] The full factorial of thirty-six possible dynamic tariff options was used. The options were randomly grouped into nine blocks of four choice cards, which were presented randomly to respondents (Holmes and Adamowicz, 2003).