The Dynamic Effects of the Light Bulb Ban
Proposal submitted to the Precourt Energy Efficiency Center

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Duration: 12 months

Summary

There is a long literature that has explained and documented the so-called “light bulb puzzle,” an expression that refers to the fact that consumers appear to be misoptimizing when using inefficient light bulbs.\(^1\) The research so far has focused on understanding the demand side implications of such biases, taking the existing light bulb technologies as given. However, there have been important innovations and advances in the design and production of more efficient light bulbs,\(^2\) some of them directly pursued through policy interventions.\(^3\)

In our project, we want to explore the interaction of demand-side biases with the firms’ incentives to innovate. One of our main questions of interest is to explore the role for government policy in spurring innovation. In particular we are interested in comparing the social and private incentives to invest in light bulb technologies and will consider the question of whether recent innovation in light bulbs would have been likely to happen absent government policy intervention.

Using the tools in the field of industrial organization, we will develop an econometric dynamic industry model that takes into account the interaction of consumers and firms to quantify the effects of various policies in a comprehensive fashion.

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\(^1\)See, for example, recent experimental work in Herberich et al. (2011) and Alcott et al. (2012).

\(^2\)For example, LED technologies have emerged with force. In 2009, 36 models of LED light bulbs qualified for the Energy Star program. Only in the first half of 2012, already over 500 LED light bulbs have received approval. Source: [www.energystar.gov](http://www.energystar.gov).

\(^3\)The Department of Energy has recently awarded a $10 million prize to Phillips for an advanced LED light bulb. See [www.lightingprize.org](http://www.lightingprize.org).
Motivation and Background Information

The emergence of more efficient light bulb technologies has been a slow process. Many have argued that the process has encountered difficulties as consumers do not internalize the benefits of investing in such products. The inability by consumers to realize about the benefits of investing in more efficient lighting has derived in the decision by many countries to enforce efficiency standards and phase-out incandescent light bulbs. These policies have often been called the “light bulb ban.”

At the same time, light bulb technologies have been evolving to better satisfy consumer needs. The type of light emitted by alternative light bulb technologies, such as compact fluorescent lights (CFLs), is now more in line with traditional lightning sources. Light emitting diodes (LEDs) are also regarded as safer options. Another feature is that LEDs make new light bulbs dimmable. Even though LEDs were used in other applications, its commercialization in the form of energy-saving light bulbs has only exploded in recent years. Figure 1 shows the cumulative number of Energy Star qualified light bulbs. One can see that LEDs only start to play a role around 2010. They appear to be exponentially increasing its presence.

Even though consumers are not particularly attentive to purchases of light bulbs, it is arguably the case that the initial energy-saving options were deficient in other dimensions. In this project, we would like to critically evaluate the weight of heterogeneous qualities in consumer choices. We would also like to understand why firms did not innovate in better technologies until these recent years, and whether such delay can be purely explained by the behavioral inattention of consumers or other factors play a role. These are all key questions to assess the real extent and impact of the light bulb policy. We hypothesize that, taking into account the innovations accrued in the last years, the welfare effects of the light bulb ban could be larger.

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4These policies have been implemented not only in developed economies such as the United States, European countries and so on, but also in emergent economies such as China and India.
Research Question

The goal of this paper is to examine the dynamic implications of policies regulating light bulbs. There are two sources of dynamic effects that we plan to investigate. On the consumer side, we would like to explore the potential of dynamic preference changes that arise from policy. In particular, consumers tend to overlook the long run benefits of installing more efficient lighting. However, with the introduction of regulation, light bulb alternatives became more salient. Did this salience also make consumers more aware of the trade offs?

On the producers side, we plan to revisit the so-called “light bulb puzzle” by also studying the decisions in innovation. Since more aggressive light bulb measures have been discussed and introduced, there has been a quick improvement in available technologies to produce light. Even though the fixed cost of the alternatives is larger, these new innovations are cost effective. The technologies are also improving other dimensions that tended to cause consumers to dislike greener options, such as getting an incandescent-like luminiscense. We would like to explore the channels that prevented such innovations from happening before more strict policy was in force. Can these delays be purely explained from the behavioral inattention on the consumer side? Are there any other inefficiencies that were preventing such innovations from happening?

Data, Methods and Implementation

Data We plan to collect detailed micro data to analyze consumer behavior with regards to light bulb purchases as well as producer innovations. Up to date, we have identified two main data sets that we will use. The first is based on scanner data at retailing centers, which is provided by the company AC Nielsen under an academic agreement. The data set includes information about product purchases made by a panel of consumer households across all retail outlets in all US markets. The data represents approximately 40,000-60,000 US households who continually provide information about the makeup of their households, the products they buy, as well as when and where they make purchases since 2004. Due to their richness, these data are particularly suited to study the behavior of consumers regarding light bulb choices over time.

We have also identified a data set from Energy Star that tracks light bulbs that get certification for a particular standard and category. We plan to use these data to identify innovations and competition across firms in the sector. We are currently exploring other sources that provide detailed data on non Energy Star bulbs.

Methods and Implementation We plan to analyze the interaction of consumers and firms dynamics using method from the industrial organization field. We will use state-of-the-art tools for estimation and simulation of dynamic games. The goal of these models is to carefully represent dynamic interactions across strategic agents. For a given model, the main parameters are estimated. The structure allows us to then simulate what would happen under alternative policies. How would lower energy standards affect consumer choices? What would happen if consumers had no heterogeneous preferences for traditional incandescent lights?

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7See, for example, Pakes and McGuire (1994), Benkard (2004) and Bajari et al. (2007).
Significance and Deliverables

Understanding the dynamic effects of policies related to energy efficiency is an important issue. Such dynamic effects could be potentially important and are oftentimes ignored in the policy debate. At a high-level, our research will be very tangible for policy makers. We also plan to develop research articles that we can publish in high-ranked economics journals, with a focus on developing new tools for modeling dynamic interactions between demand and supply.

References


Addendum A

Team Members

Principal Investigators

C. Lanier Benkard is a Professor of Economics at the Stanford Graduate School of Business, where he teaches courses in Industrial Organization and Econometrics. Before coming to Stanford in 1998, he received his PhD in Economics from Yale University (1998). He has also been a visiting scholar at the Federal Reserve Bank of San Francisco (2005-6) and the University of California at Berkeley (2006).

Professor Benkard’s research is in the areas of empirical industrial organization (I.O.), applied microeconomics, and econometrics, and concentrates on applying microeconomic and game theoretic models to the study of individual markets. His recent work has focused on developing methods that allow us to analyze I.O. models empirically. This includes theoretical work on how to estimate demand systems and dynamic oligopoly models, as well as empirical work that uses these techniques to analyze different industries. The recent empirical work includes studies of learning by doing in the commercial aircraft industry, and studies of personal computer prices and the demand for personal computers.

Professor Benkard is a Research Associate at the National Bureau of Economic Research, and is an associate editor for the Journal of Economic Dynamics and Control. He is a member of the American Economic Association and the Econometric Society, and has organized conferences for numerous other professional organizations, including the EEA, INFORMS, NBER, SCE, and SITE.

Mar Reguant is an Assistant Professor of Economics at the Stanford Graduate School of Business. She holds a Ph.D. in Economics from MIT (2011), specializing in the field of Industrial Organization. Her research focuses on the study of energy and environmental markets. Mar’s research relies in careful modeling of electricity markets and is thus interdisciplinary by nature, often integrating tools from the engineering literature. She has also worked on understanding the potential methods of a cap-and-trade policy in the United States and California developing dynamic industry models.

Professor Reguant is a Faculty Research Fellow at the National Bureau of Economic Research.

Graduate Researcher

Wichsinee Wibulpolprasert is a Ph.D. student in the Department of Economics at Stanford University. Her research focuses on assessing economic implications of different energy/environmental policies. Her background in energy and environment includes working as a research assistant for Professor Larry Goulder during 2010. Wichsinee has also participated in the Stanford Graduate Summer Institute on Green Technologies for Climate Stabilization and Energy Security during the summer of 2011, and has audited the Energy Resource course (CEE 207A) from the department of Civil & Environmental Engineering at Stanford.
Addendum B
Budget

The costs of this project is focused on funding graduate students. This project is thus highly feasible within the proposed budget, as the identified data are available for low fees. A significant share of the proposed budget will be used as stipends and tuition for graduate student research assistants. RA involvements in this project include gathering relevant market information, data collection, cleaning and analyses. We have already identified one student to be part of the project. We plan to get two students for this project. A small portion is left for potential traveling needs to conferences, and one for data, materials and other supplies.

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