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Spillover health effects of energy efficiency investments: Quasi-experimental evidence from the Los Angeles LED streetlight program

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ABSTRACT

Payback estimates of energy efficiency investments often ignore public health externalities. This is problematic in cases where spillover health effects are substantial, such as when the application of new technology alters environmental exposures. When health externalities are included in return on investment calculations, energy efficiency programs may look more or less attractive than suggested by conventional “energy savings only” estimates. This analysis exploits the quasi-experiment provided by the 2009 Los Angeles (LA) LED streetlight efficiency program to investigate the returns on investments inclusive of an originally estimated health externality. Using the synthetic control method, we find that the LED streetlight program is associated with a lagged increase in breast cancer mortality of 0.479 per 100,000. Inclusive of the effects of LEDs on breast cancer and avoided carbon emissions, the LA LED program provides a −146.2% 10-year return compared to +118.2% when health outcomes and carbon emissions are ignored.

1. Introduction

Energy efficiency investments are regularly touted as win-win scenarios. The refrain is a common one: efficiency investments can reduce environmental externalities while helping participants reduce their energy costs. Public support for these programs is reinforced by statements from businesses and government officials alike that monies saved from reduced energy expenditures will be re-invested in creating new jobs, increasing incomes, or expanding social services. It is common to see energy efficiency investments advertised as “no-brainer” decisions. This narrative was echoed in 2014 by then President Obama who said that energy efficiency investments are “one of the easiest, cheapest ways to create jobs, save money and cut down on harmful pollution that causes climate change”, calling them a “win-win-win” (Obama, 2014).

Despite such statements, the win-win nature of energy efficiency investments are not assured. Efficiency investments are known to create externalities (i.e., “spillover effects”) that remain largely unmeasured, but that might have significant policy

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implications (Fowlie et al., 2015a; Davis et al., 2014; Allcott and Greenstone, 2012). This paper is particularly concerned with spillover effects of energy efficiency investments on human health outcomes. There is an important distinction between health outcomes affected by displaced air emissions of energy efficiency investments, and health outcomes due to non-energy related changes in individual-level environmental exposure or stimuli; what we term the technology-induced effect. Prior attention has been given to the displaced air emissions effect, which may be associated with substantial positive health benefits (Buonocore et al., 2016). This paper focuses on the often ignored technology-induced health effects where the application of more efficient technology alters air, water, or light quality, aesthetics, or other environmental attributes in a physical way that is health altering.

The win-win nature of installing more energy efficient technology may depend on the intensity of the technology-induced health effect, which can unintentionally result in more (or less) harmful health outcomes compared to the status quo. For example, tightening buildings through air sealing and other weatherization techniques reduces the escape of heated or cooled air (saving energy), but can exacerbate indoor air pollution problems, posing health risks (Schenck et al., 2010). Compact florescent light bulbs, a more energy efficient alternative to incandescent light bulbs, can release unsafe levels of mercury if broken (Stahler et al., 2008). In such cases, accounting for costly changes in health outcomes becomes a necessary component in assessing the relative payoff of a proposed energy efficiency program. However, quantitative evidence on the benefits and costs of technology-induced health effects of energy efficiency investments is largely lacking and thus often ignored when setting social policy.

To address this gap, this paper investigates technology-induced spillover health effects of a prominent and high-profile energy efficiency program in Los Angeles (LA), California completed in partnership with former President Bill Clinton and the Clinton Climate Initiative that replaced over 140,000 roadway streetlights with high-efficiency light-emitting diodes (LED). There may be health-altering externalities associated with this program. For instance, there are concerns that the "blue-rich" light producing LED streetlights used in LA may be more harmful to health compared to the lights they replaced. In 2016 the American Medical Association (AMA) produced a white paper summarizing some of the evidence on the harmful health effects of blue-rich LED streetlights and encouraged communities to seek out less harmful alternatives (AMA, 2016). In particular, blue-rich LED light is associated with increased rates of cancer, reduced sleep times, insomnia, and obesity (AMA, 2016; Haim & Portnov, 2013). Positive health spillover effects of LED streetlights may also exist. LEDs can be made to produce brighter, more broad-spectrum light than older fixtures. Adaptive technologies can be used to dim or brighten individual streetlights allowing real-time responses to changing weather and visibility conditions. These features of LED technology may improve nighttime visibility, increase perceptions of safety and security, and reduce crime (Kuhn et al., 2013).

Though LED conversions are often described as a win-win scenario that pay for themselves through reduced energy costs, this remains an open empirical question in light of potential spillover technology-induced health effects. This paper address two outstanding issues. First, existing evidence linking blue-rich LED streetlights to population health outcomes in actual urban areas is largely correlational. By exploiting the quasi-experimental setting provided by the LA LED conversion program, we seek to provide the first causally-consistent estimates of the streetlight-health connection. We employ the synthetic control method of Abadie and Gardeazabal (2003) to compare health outcomes in LA to a synthetically-derived control group that did not experience LED conversions over the same time period. Second, using the empirical results from the synthetic control method, we calculate the aggregate health costs associated with the LA LED program and compare them to the value of energy saved and avoided CO2 emissions. Energy savings and CO2 reductions were among the primary goals of the efficiency program (City of Los Angeles, 2009) and are often the focus of engineering analyses of streetlight payoffs (US DOE, 2013).

Results suggest considerable spillover health effects of the LA LED energy efficiency investment. Lagged rates of breast cancer mortality in LA are significantly higher by 0.479 per 100,000 after the program was initiated compared to the synthetic control. We find no evidence linking the program to elevated rates of prostate cancer, transportation accidents, or homicide mortality. Inclusive of the health externality and avoided CO2 emissions, the efficiency program has a return on investment of −146.2% after 10 years compared to a +118.2% 10-year return based on a pure energy savings accounting.

This paper contributes to a branch of the economics literature that evaluates the *ex post* payoffs of energy efficiency investments using quasi-experimental designs (Kotchen, 2016; Fowlie et al., 2015a, 2015b; Davis et al., 2014), addressing a need for credible empirical work in this area that is not based on engineering analyses or observational studies which can suffer from well-known biases (Allcott and Greenstone, 2012). Widespread, nationwide investments in LED streetlight technology represent a rare opportunity to investigate the spillover technology-induced health effects of energy efficiency investments. This work has policy implications for other energy efficiency investments where newly installed technology affects health outcomes through environmental exposure.

2. Streetlights, energy efficiency, and health externalities

Streetlights are ubiquitous in modern life, placed on roads, highways, bridges, and sidewalks to improve nighttime visibility (Fig. 1). The estimated 26.5 million streetlights in the US consume approximately 20.8 million MWh of electricity annually, at a cost of $2 billion (US DOE, 2013). Inclusive of operation and maintenance costs, the US spends $4–6 billion/year on streetlights, with 90% of funding coming from public taxes (US DOE, 2013). Streetlighting is often one of the largest recurring monthly expenses for municipalities, which has motivated many cities to look for ways to cut costs while continuing to deliver light at night.