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Are energy efficiency standards justified?☆

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ABSTRACT

This paper develops an analytical framework for comparing the welfare effects of energy efficiency standards and pricing policies for reducing gasoline, electricity, and nationwide carbon emissions. The model is parameterized with US data and includes key externalities in the energy/transportation sectors and possible underinvestment in energy efficiency due to "misperceptions" over energy savings. Even with large misperceptions, the extra welfare gains from complementing efficient pricing policies with energy efficiency standards are zero for reducing gasoline and 5 percent for reducing electricity. And when viewed as substitutes, these standards forgo 60 percent or more of the potential welfare gains from corresponding pricing policies. A combination of energy efficiency and emissions standards is more than three times as costly as carbon pricing when there is no misperception over energy savings, and even with large misperceptions, combining carbon pricing with gasoline/electricity taxes is better than combining it with energy efficiency standards.

Introduction

In recent years, there has been a proliferation of actual and proposed energy efficiency standards in the United States. Most prominent are the recent regulations on new light-duty vehicles requiring manufacturers to increase the fleetwide average fuel economy from 25 mpg to about 35 mpg by 2016 and about 54.5 mpg by 2025. In addition, fuel economy standards were recently introduced for heavy trucks, there are numerous standards for household appliances, incandescent light bulbs are being phased out, and federal energy efficiency standards are proposed for residential and commercial buildings.

What kinds of market failure could justify energy efficiency standards? An obvious possibility is pollution externalities, especially carbon dioxide (CO_2). Generally speaking efficiency standards are an inferior instrument to energy or emissions taxes, however. Unlike the pricing approach, efficiency standards do not discourage the use of energy-using products, nor do they reduce pollution emissions per unit of energy (e.g., through encouraging cleaner power generation sources), or produce least-cost outcomes through equating marginal abatement costs across different sectors. If first-best pricing policies are not feasible however, efficiency standards and other second-best policies may have a role to play in environmental protection.

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A second class of potential market failures is associated with the so-called "energy paradox," the observed reluctance of energy users to adopt apparently cost-effective, efficient technologies (Jaffe and Stavins, 1994; Gillingham et al., 2009; Tietenberg, 2009). This is reflected in a series of empirical studies finding very high implicit rates of return on energy-saving technologies, often in excess of 25 percent (Allcott and Wozny, 2009; Hausman, 1979; Sanstad Alan et al., 2006; Kenneth, 1985). Some analysts cite this as evidence of underinvestment in energy efficiency – perhaps because of missing information, consumer inability to process information, the possibility that energy efficiency attributes are not appropriately reflected in used product prices, distinctions between those who make investments and those who pay energy bills (e.g., rented properties), borrowing constraints, and so on – for simplicity, we refer to all these possibilities as a "misperceptions" market failure. Others however, point out that there might be hidden costs not accounted for in these studies such as those related to product attributes (e.g., objectionable aspects of the quality of fluorescent lighting), various search costs, and aversion towards irreversible investments with uncertain returns (Hassett and Metcalf, 1993).

The actual and prospective adoption of energy efficiency standards raises a number of important (and interrelated) policy issues.

First, if policymakers are free to implement or adjust pricing policies what is the role (if any) for efficiency standards? That is, what is the optimal stringency of standards when combined with pricing policies and does this policy combination yield significantly higher welfare gains than pricing policies alone?

Second, if (for political or other reasons) efficiency standards might be easier to adopt than pricing policies, what are the tradeoffs? That is, how much reduction in fuel (or other target quantity) would be optimal under each policy and how do the welfare effects of the policies compare?

These questions need to be understood for policies affecting both the transport and the power sector. They also need to be understood in the context of economy-wide carbon policies—here the primary (and timely) issue is how efficiency standards, when combined with other regulatory policies, perform relative to a broad carbon pricing policy.

This paper provides an overarching framework for understanding all these issues, using an analytical model that incorporates the main market failures and that distinguishes the key effects of different policies. The model is implemented using US data for the energy and transportation system and evidence on behavioral responses and market failures. The heart of the results is a series of graphs representing parameterized expressions for the marginal cost curves for reducing gasoline, electricity, and economy-wide CO_2 under alternative policies and scenarios, where marginal costs are net of marginal benefits from addressing externalities and possible energy misperceptions. The optimal scale of a policy corresponds (in most cases) to where its marginal cost intersects the horizontal axis, and efficiency standards are potentially warranted in cases where their marginal costs lie below those for pricing policies over some range.

The advantage of our approach is its richness of policy results and its transparency. It is easy to see how different assumptions about key underlying parameters affect the intercept and the slope of the marginal costs curves. Exploring this type of policy robustness is important given, for example, uncertainty over the extent of the misperceptions market failure. Of course a more sophisticated framework might incorporate capital dynamics, greater product disaggregation, a detailed treatment of emerging technologies, and so on, but if the magnitude of market failures, policy interventions, and long-run behavioral responses are approximately in line with those assumed here, then we know (although it is often under-appreciated) from basic principles of public finance that the long-run welfare effects should not be too different either (e.g., Harberger, 1964).

The closest study to ours in the literature – that is, one that evaluates, using a consistent methodology, a broad range of power/transport sector and economy-wide pricing and regulatory policies – is Krupnick et al. (2010). Their analysis is based on simulating out to 2030 a variant of the Department of Energy's National Energy Modeling System (NEMS), a model which contains considerable detail on technology adoption in the energy sector. In terms of energy efficiency policies, Krupnick et al. (2010) find, for example, that an aggressive auto fuel economy standard is significantly less effective at reducing oil use and CO_2 emissions, and somewhat less cost-effective, compared with aggressive fuel taxes, even with some allowance for the misperceptions market failure.

One difference in our analysis is that welfare effects are defined net of externalities (in Krupnick et al., 2010 they are gross of externalities) and this distinction can have important implications for policy. Moreover, given that even a single point estimate (for a specific level of a policy) is computationally intensive in models like NEMS, they have difficulty providing a complete picture to the questions posed above. For example, these models cannot readily compute marginal cost curves (which are important for understanding when one policy, or policy combination, is better than another over some range) and optimal policies for one (let alone a broad) set of parameter combinations. Nor can these models easily illustrate (as we do here) combinations of market failures needed to justify efficiency standards of different stringencies. The two approaches (the analytical approach used here and the detailed computational modeling in NEMS) are obviously complementary however (e.g., NEMS can better represent the details of regulation).[1]

We summarize the main findings from our analysis as follows.

As regards the first question posed above, in the case of gasoline, efficiency standards do not appear to have a role in the optimal policy portfolio, even in the presence of significant misperceptions of energy savings—that is, gasoline taxes alone

[1] A number of other studies evaluate energy efficiency policies for automobiles (e.g., Austin and Dinan, 2005; Fischer et al., 2007; Goldberg, 1998; Holland et al., 2009; Jacobsen, 2012; Kleit, 2004; Small, 2009) though none compares marginal cost curves for standards and taxes, integrating the full range of market failures considered here.