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Energy policy with externalities and internalities ☆

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ABSTRACT

We analyze optimal policy when consumers of energy-using durables undervalue energy costs relative to their private optima. First, there is an Internality Dividend from Externality Taxes: aside from reducing externalities, they also offset distortions from underinvestment in energy efficiency. Discrete choice simulations of the auto market suggest that the Internality Dividend could more than double the social welfare gains from a carbon tax at marginal damages. Second, we develop the Internality Targeting Principle: the optimal combination of multiple instruments depends on the average internality of the consumers marginal to each instrument. Because consumers who undervalue energy costs are mechanically less responsive to energy taxes, the optimal policy will tend to involve an energy tax below marginal damages coupled with a larger subsidy for energy efficient products. Third, although the exact optimal policy depends on joint distributions of unobservables which would be difficult to estimate, we develop formulas to closely approximate optimal policy and welfare effects based on reduced form "sufficient statistics" that can be estimated by using field experiments or quasi-experimental variation in product prices and energy costs.

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1. Introduction

Since a seminal paper by Hausman (1979), it has frequently been asserted that consumers "undervalue" energy costs relative to purchase prices when they choose between energy-using durable goods, perhaps because they are inattentive to or imperfectly informed about these costs. Although more empirical evidence is needed, this assertion would be consistent with findings that we are inattentive to other ancillary product costs such as sales taxes (Chetty et al., 2009), shipping and handling charges (Brown, Hossein, and Morgan 2010), and the out-of-pocket costs of insurance plans (Abaluck and Gruber, 2011). In the language of Herrnstein et al. (1993), undervaluation could cause consumers to impose "internalities" on themselves as they buy goods that are less energy efficient than they would choose in their private optima. Consumer undervaluation of energy costs has become an important policy issue: along with energy use externalities such as local air pollution and climate change, many policymakers use undervaluation to justify significant regulations such as Corporate Average Fuel Economy (CAFE) standards and billions of dollars in subsidies for energy efficient durables such as air conditioners and lightbulbs.

Despite the important implications, however, there is little formal guidance on how to set and evaluate energy policy in the presence of

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both externalities and internalities. Three questions stand out. First, how do internalities affect the traditional logic of Pigouvian externality taxation? Second, what is the optimal combination of policy instruments to address externalities and internalities? Third, what are the key empirical objects that empiricists should estimate in order to set optimal policy and measure welfare impacts?

We analyze these three questions using both a theoretical model and numerical simulations. In our model, consumers choose between two energy-using durable goods, one of which is less energy-intensive than the other. Consumers then choose utilization, incur energy costs, and consume a numeraire good. When choosing between the two energy-using durables, some consumers misoptimize: while they should be indifferent between \$1 in purchase price and \$1 in energy costs because both equally affect consumption of the numeraire good, they undervalue or overvalue energy efficiency relative to their private optima. In addition to this internality, there is a linear externality from energy use. To address these two sources of inefficiency, the policymaker has two policy instruments: "energy taxes," by which we mean carbon taxes, cap-and-trade programs, gas taxes, and other policies that change the retail energy price, and "product subsidies," by which we mean subsidies for hybrid vehicles, home weatherization, and energy efficient appliances, fuel economy standards, feebates, and other policies that affect the relative purchase prices of energy intensive durables. After deriving theoretical results, we simulate optimal policies and welfare effects for the U.S. automobile market, using a realistic representation of the choice set and driving patterns plus estimated internalities, externalities, and utility function parameters from the literature.

To answer our first question, we consider the "third best" world in which the policymaker sets only the energy tax given zero product subsidy. In the standard Pigouvian world with a homogeneous externality but no internalities, an energy tax at marginal damages achieves the first best. This increases social welfare but decreases "consumer welfare," by which we mean social welfare with zero weight on the externality. For example, a carbon tax is generally thought to be bad for the economy in the short term, even as the reduction in global warming generates positive net benefits over the long term. However, when consumers undervalue energy costs, a positive energy tax increases social welfare both by reducing externalities and by inducing more consumers to buy the energy efficient durables that they would buy in their private optima. In fact, our automobile market simulations suggest that a carbon tax set at marginal damages could in fact *increase* consumer welfare, and this effect is large enough to *more than double* the social welfare gains that an analyst would predict for the case with no internalities. This result is conceptually related to the Double Dividend hypothesis in Bovenberg and Goulder (1996), Parry (1995), and others in the basic sense that it identifies a potential additional benefit from environmental taxes other than externality reduction. We thus call this the *Internality Dividend from Externality Taxes*.

We then consider our second question, the "second best" combination of energy taxes and product subsidies. The first best policy would deliver heterogeneous corrections to decision utility that exactly offset each consumer's internality. The second best policy requires the two feasible instruments to deviate from their no-internality levels so as to best approximate the first best pattern. The problem is related to other analyses that use multiple instruments to address heterogeneous market failures, such as Fullerton and West (2002, 2010) and Innes (1996), who study the optimal combination of gas taxes and vehicle taxes to address heterogeneous pollution externalities. We derive optimal tax formulas that show that the level of each instrument is determined by the externality, the average internality of consumers marginal to that instrument, and the average internality of consumers marginal to the *other* instrument. This gives what we call the *Internality Targeting Principle*: the second best approximation to the perfectly targeted first best policy is determined by consumers' marginal internalities with respect to each of the instruments.

When our two instruments are used to address undervaluation, the Internality Targeting Principle typically gives an energy tax *below* marginal damages combined with a large product subsidy. The reason is that consumers who undervalue energy costs the most, and thus need the largest correction to decision utility, are mechanically the least sensitive to the energy tax because it works through changes in energy costs. Thus, the average marginal internality is large for the product subsidy relative to the energy tax, and a large subsidy will be used to correct the decisions of consumers that undervalue the most. This in turn causes a distortion to the less-biased consumers, which is corrected by keeping the energy price below social cost. However, the extent to which the energy tax deviates from marginal damages is tempered by the distortion that this causes on the utilization margin. In our automobile market simulations, the second best policy is a gasoline tax set 15% below marginal damages combined with a large product subsidy which would decrease the purchase price of 25 vs. 20 mile per gallon vehicles by about \$700.

In answer to our third question, we present a general but tractable approach to optimal policy design and welfare analysis in the spirit of the Chetty (2009) sufficient statistic approach. The intuition is that if consumers correctly value energy costs, their product purchases should be equally elastic to energy costs and upfront prices. The ratio of "energy cost elasticity" to price elasticity gives a valuation weight that is less than one if the average marginal consumer undervalues energy costs. Multiplying this by the energy cost savings from a more energy efficient product allows one to estimate the dollar value of the average marginal internality. This makes it possible to approximate the optimal product subsidy and its welfare effects given any fixed level of energy tax. In our auto market simulations, the "heuristic policy" of a gasoline tax at marginal damages and a product subsidy set using the sufficient statistic approach generates 94 to 99% of the welfare gains of the true second best policy, even as we simulate markets with distributions of the internality and correlations between unobservables that would be extremely difficult to identify empirically. The sufficient statistic approach offers clear benefits in setting energy policy: optimal taxes can be closely approximated and evaluated without a structural model, using reduced-form elasticities that can be estimated using variation in product prices and energy costs.

Our paper is related to a number of other analyses of public policies when agents misoptimize, including in the contexts of health care (Baicker et al. (2012), Handel (2011)), cellular phone contracts (Grubb and Osborne, 2012), drug addiction (Bernheim and Rangel (2004, 2005), Gul and Pesendorfer (2007)), taxation (Chetty et al., 2009), and many others.[1] Perhaps the most closely-related paper is O'Donoghue and Rabin (2006), who study optimal taxation on a hypothetical good ("potato chips") that some people over-consume relative to their long-run optima due to time-inconsistency. There are also several important related papers that study energy policy when consumers undervalue energy costs, including Fischer et al. (2007), Heutel (2011), Parry et al. (2010), and Krupnick et al. (2010).

Our paper makes three contributions. First, we study the optimal combination of multiple policy instruments under heterogeneous internalities, which is a natural question for energy policy and many other settings. This allows us to highlight and quantify the importance of targeting the more biased consumers based on the average internality of consumers marginal to each instrument. This discussion does not arise in most related papers because they either analyze only one policy instrument or assume that all consumers misoptimize in exactly the same way. Second, while most models assume a particular behavioral bias, we derive theoretical results that are general to many different

[1] Mullainathan et al. (2012) review this literature and discuss additional important papers too numerous to cite here. In a discussion in the Journal of Economic Literature, Kroft (2011) argues that there is much progress yet to be made: "The public finance literature is only recently beginning to consider behavioral welfare economics, and there exist few theoretical explorations of optimal policy with behavioral agents."

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