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Optimal policy instruments for externality-producing durable goods under present bias

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ABSTRACT

When consumers exhibit present bias, the standard solution to market failures caused by externalities—Pigouvian pricing—is suboptimal. I investigate policies aimed at externalities for present-biased consumers. Optimal policy includes an instrument to correct the externality and an instrument to correct the present bias. Either instrument can be an incentive-based policy (e.g. a tax on fuel economy) or a command-and-control policy (e.g. a fuel economy mandate). Under consumer heterogeneity, a command-and-control policy may dominate an incentive-based policy. Calibrated to the US automobile market, simulation results suggest that the second-best gasoline tax is 3–30% higher than marginal external damages. The optimal price policy includes a gasoline tax set about equal to marginal external damages and a fuel economy tax that increases the price of an average non-hybrid car by about $550–$2200 relative to the price of an average hybrid car.

Introduction

A growing body of evidence suggests that consumers regularly and predictably deviate from the predictions of rational choice theory. In particular, they appear to exhibit present bias: they "underweight" future periods in the present period. Present bias is one way in which preferences can be time-inconsistent. This affects decisions over purchases of durable goods with variable operating costs; present bias makes a consumer less likely to spend money upfront to reduce a durable's future operating costs. Many durable goods are energy-intensive and create externalities with consumption, like cars consuming gasoline or appliances consuming electricity. The standard incentive-based solution to the market failure caused by externalities is Pigouvian pricing, but the efficiency of this solution assumes time-consistent preferences.

If consumers are present-biased, does Pigouvian pricing of externalities still lead to a socially optimal outcome? If not, what is the optimal policy? Do incentive-based policies dominate command-and-control policies? How can policies address consumer heterogeneity? The purpose of this paper is to answer these questions by developing a model of optimal policy for externality-producing durable goods in the presence of quasi-hyperbolic preferences. I consider heterogeneity in consumer preferences and in present bias, and I compare incentive-based policies with command-and-control policies. Then, I calibrate the model to the automobile market, simulate, and solve for optimal policy.

The question addressed here is policy-relevant for two reasons. First, empirical support for the existence of behavioral anomalies, especially present bias, is growing. Consumers seem to discount the far future more heavily than the near future, behavior that can be modeled by hyperbolic or quasi-hyperbolic discounting (Laibson, 1997). This has been observed in

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laboratory experiments (Thaler, 1981), in individuals' decisions over exercising (Dellavigna and Malmendier, 2006) and doing homework assignments (Ariely and Wertenbroch, 2002).[1] It also may be relevant to decisions over the energy efficiency of durable goods. The purported "energy paradox" or "energy efficiency gap" finds that households seem to apply very high discount rates in their decisions over energy-intensive durable goods like air conditioners (Allcott and Greenstone, 2012). Gillingham et al. (2009) summarize the literature and find implicit discount rates ranging from 25% to 100%.[2] This paradox may be explained by present bias.

A second reason the question addressed in this paper is relevant is that environmental and energy policy seems to be moving in a direction towards incentive-based policies, especially tradable permits, and away from command-and-control policies. This transition has been fueled by arguments from economists that incentive-based policies achieve substantial cost savings compared to command-and-control policies; some empirical evidence has verified this for some policies (Carlson et al., 2000). If Pigouvian pricing is inefficient under present bias, and if consumers are present-biased, then this push towards these policies may be misguided. More so, if present bias leads to a dominance of some command-and-control policies over Pigouvian pricing, then the push away from command-and-control policies may also be misguided (Shogren and Taylor, 2008).

The theoretical results provide insight into policy design. I show that a Pigouvian tax that only accounts for externalities does not bring about the first-best outcome under present bias. A Pigouvian tax leads to cars that are not fuel-efficient enough and are driven too few miles, compared to the first best. In general, gasoline consumption under present bias can either exceed or fall below the first-best level. In a representative agent model the first-best outcome can be attained through a combination of a Pigouvian tax and a policy to address present bias, which can be either a command-and-control mandate or a fuel-economy tax. Present bias means that future costs are not fully realized by the consumer, but they can be introduced through a price instrument, e.g. a tax on fuel (in)economy. Thus, the common argument that behavioral anomalies give credence to command-and-control mandates over incentive-based mandates is not true in the representative agent case; either policy achieves the first best.

Under consumer heterogeneity incentive-based policies do not necessarily dominate command-and-control policies, in contrast to policies that address market failures caused by externalities. When consumers are heterogeneous only in their degree of present bias, then a uniform performance standard induces the first-best outcome, but a uniform fuel economy tax does not. Under more general forms of heterogeneity, neither a uniform tax nor a uniform performance standard induces the first best, and their welfare ranking is ambiguous. Because of this theoretical ambiguity, I conduct simulations to evaluate the relative performance of different instruments.

The simulation results suggest that, for the automobile market, the welfare gains from policies that address present bias are substantial, and policies that ignore present bias are substantially different from the optimal policies. The deadweight loss of a policy that addresses externalities from gasoline consumption but does not address present bias ranges from $81 to $226 per new vehicle sale, which amounts to an economy-wide deadweight loss of $720 million to $2.01 billion annually. Optimal price policy includes a tax that reduces the price differential between the average hybrid car and the average non-hybrid car by $750 to $2200. The best tax rate on gasoline is 3% to 30% higher than marginal external damages. While in theory a uniform fuel economy standard can achieve higher welfare than a uniform fuel economy tax, the calibrated simulation results suggest that in practice the opposite holds true.

A small number of recent papers ask related questions. O'Donoghue and Rabin (2006) solve for optimal "sin" taxes on goods that cause future damages (e.g. to health) that are underweighted due to present bias. Many of the intuitions developed in that paper can be seen in the results of this paper, for instance, present bias creates an "internality" that can be corrected through price policy (taxation). However, O'Donoghue and Rabin (2006) do not consider externalities; the only market failure is from present bias. In this paper there are two market failures – externalities and internalities – and I consider various policies to address them. Fischer et al. (2007) model both externalities and consumers who are "myopic" about the valuation of fuel costs; some consumers may correctly value fuel costs when purchasing a car, but some may undervalue fuel costs and therefore underestimate fuel savings from high fuel economy. They model two policies: a tax on fuel and a fuel economy regulation (e.g. CAFE standards). They find that fuel economy standards are welfare-increasing only under a scenario where consumers are very myopic. However, their paper does not consider any other policy to counter myopia other than standards; i.e. they do not model a fuel economy tax.

Allcott et al. (2014) study energy policy when consumers undervalue energy costs. In their model, consumers purchase a durable good in the present and pay energy costs in the future. Thus, undervaluation of energy costs can be thought of as an application of time-inconsistent, present-biased preferences.[3] Many of the results from their model mirror results here; for instance their Proposition 2 describes an optimal gasoline tax/energy-efficiency tax policy combination, as does my

[1] The field evidence for this and other types of behavioral anomalies is reviewed in DellaVigna (2009). See also Mastrobuoni and Weinberg (2009), Fang and Silverman (2009), Brown et al. (2009), and Viscusi et al. (2008).

[2] See also Table 1 in Sanstad et al. (2006). By contrast, Greene's (2010) reading of the econometric literature estimating consumers' valuations of fuel economy finds mixed results, with some studies finding under-valuing and some finding over-valuing of improvements in fuel economy (see his Table 2). Allcott and Greenstone (2012) ask the question "is there an energy efficiency gap?" They find that much of the large literature finding the gap suffers from credibility problems, and what evidence there is of a gap indicates that it is small.

[3] Their paper also allows (but does not require) consumers to undervalue other utility differences, for instance the utility from the use of energy-efficient appliances.