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Salience of carbon taxes in the gasoline market ☆

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ABSTRACT

We demonstrate that the carbon tax imposed by the Canadian province of British Columbia caused a decline in short-run gasoline demand that is significantly greater than would be expected from an equivalent increase in the market price of gasoline. That the carbon tax is more salient, or yields a larger change in demand than equivalent market price movements, is robust to a range of specifications. As a result of the large consumer response to the tax, we calculate that during its first four years, the tax reduced carbon dioxide emissions from gasoline consumption by 2.4 million tonnes.

1. Introduction

On July 1st, 2008, the Canadian province of British Columbia (BC) enacted North America's first broad-based carbon tax designed to reduce greenhouse gas emissions. While several jurisdictions have implemented emission reduction programs, no other state or province has implemented a policy that is as ambitious and comprehensive as the BC policy and no other North American greenhouse gas control policy taxes households directly based on greenhouse gas emissions[1]. Media have both lauded the BC carbon tax as a major policy achievement and condemned it as a "nightmare" for industry and families.

While carbon taxes have been in place in various European countries since the 1990s, econometric analysis of their impact is limited[2], and there is minimal evidence on the effectiveness of similar programs in the North American context.

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[1] The Regional Greenhouse Gas Initiative (RGGI) is a leading example of a US emission control program. A joint initiative of nine states – Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont – its objective is to develop a market-based program aimed at "reduc[ing] CO_2 emissions from the power sector [by] 10 percent by 2018" (RGGI, 2012). Similarly, the Canadian provinces of Alberta and Quebec have enacted carbon pricing policies. Alberta effectively taxes large industrial emitters (> 100,000 tonnes) at $15 per tonne of CO_2, while Quebec, prior to joining California's cap-and-trade system in 2014, had a carbon tax on natural gas, coal and petroleum equal to $3 per tonne CO_2.

[2] Anderson (2010) describes European carbon taxes and provides some evidence on their effectiveness using a simulation model. Econometric research on carbon taxes includes Martin et al. (2014) who examine the UK's Climate Change Levy and Enevoldsen et al. (2007) who examine Scandinavian industrial carbon taxes. It is difficult to use the limited empirical evidence from these studies in other contexts because (1) European carbon taxes were

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Research on the implications of an actual carbon price is particularly important as several states and provinces are currently debating whether or not to introduce similar broad-based policies[3]. By exploiting cross-provincial panel data variation and performing a wide-range of robustness checks, this study provides the first causal evidence of the effect of a carbon tax on the short-run gasoline decisions of North American households.

Throughout our analysis we concentrate on the salience of the BC carbon tax. Specifically, we adopt a narrow definition of tax salience: tax salience refers to the hypothesis that tax-induced price changes generate distinct demand responses when compared with equivalent market-determined price movements. An emerging literature delves into this hypothesis (see Chetty et al. (2009), Finkelstein (2009), Congdon et al. (2009), Goldin and Homonoff (2013) and Gallagher and Muehlegger (2011)). This paper, in particular, can be viewed as an extension of Davis and Kilian (2011) and Li et al. (2014), who compare consumer responses to excise taxes with responses to price changes induced by other shocks in the gasoline market. By evaluating a situation where a carbon tax actually exists, this study makes an important contribution to this growing literature. To the best of our knowledge, ours is the first empirical investigation into the salience of environmental taxation. Carbon taxes differ from excise or other consumption taxes in that, by imposing a disincentive on fossil fuel consumption, they are explicitly designed to reduce environmental externalities. Even though excise and sales taxes reduce gasoline demand in the short-run, they are not overtly designed to correct environmental externalities. Revenues from gasoline taxes, for example, are frequently earmarked for road infrastructure, projects which lower the long-run costs of driving. Concentrating on carbon pricing permits us to identify the consumer response to a carbon tax compared with the underlying market price of gasoline when the unambiguous purpose of the policy is to reduce gasoline demand.

The introduction of BC's carbon tax was coincident with the recession of 2008–2009. Identification relies on the assumption of common trends in BC and other provinces after conditioning on a range of time-varying, province-specific macroeconomic variables. Heterogeneous effects from the recession across provinces could still confound the estimation of the effect of the carbon tax—for example, Hoffmann and Lemieux (2013) demonstrate that different Canadian regions experienced distinct labour market reactions during the Great Recession. As a result, we perform a wide array of robustness checks. Due to the robustness and consistency of our estimates across this range of specifications, we think that our results can be interpreted as causal.

Our main result is that the BC carbon tax generated demand response that is 4.1 times larger than is attributable to an equivalent change in the carbon tax-exclusive price. In our preferred model, a five cent increase in the market price of gasoline yields a 2.1% reduction in the number of litres of gasoline consumed in the short-run, while a five cent increase in the carbon tax, a level approximately equal to a carbon price of $25 per tonne, generates a 8.4% short-run reduction in gasoline demand. These results lead us to claim that the carbon tax is more salient than market-determined price changes: carbon taxes produce larger demand responses than tax-exclusive price increases.

We use our econometric results to construct counterfactual scenarios in order to calculate the change in gasoline-related emissions stemming from the carbon tax. We find that the BC policy reduced carbon dioxide emissions from gasoline consumption by more than 2.4 million tonnes during its first four years. Of this total, 74.5%, or 1.8 million tonnes, is due to the additional salience of the carbon tax—it is an environmental bonus that would not have been achieved if individuals responded to carbon taxes in the same way as to identical changes in gasoline prices caused by other factors.

Our results are in line with Li et al. (2014) who find that consumers are more responsive to changes in gasoline excise taxes than to tax-exclusive prices. Li et al. estimate a tax saliency ratio (i.e., the mean consumer response to an increase in gasoline taxes divided by an equivalent increase in market prices) equal to approximately three, a value that is within the range of our estimates. Unlike the Li et al. analysis however, explicit environmental objectives motivated BC's policy. As such, we emphasize a distinct interpretation of the results, one based on consumers' intrinsic and extrinsic motivations related to environmental outcomes.

The remainder of this paper contains five sections. Section 2 describes the design of the BC carbon tax policy. Section 3 presents our data and empirical methodology. The main results are in Section 4, including calculations of the reduction of carbon dioxide emitted. The majority of the paper focuses on empirics and is agnostic with respect to the underlying mechanism generating our results. Section 5 nonetheless discusses potential explanations for the large consumer response to the carbon tax. Section 6 concludes.

2. Design of the BC carbon tax

The announcement that BC was introducing a carbon tax came as a surprise to the vast majority of residents (Harrison, 2012). The province's Finance Minister formally revealed the revenue-neutral carbon tax in her February 2008 budget speech. By July 1st, 2008, BC became the first jurisdiction in North America to have a significant carbon tax on all fossil fuels

(*footnote continued*)
often introduced as replacements for existing energy taxes, not as stand-alone taxes, (2) they include numerous exemptions and differences in rates across sectors (Bruvoll and Larsen, 2004; Sumner et al., 2009), and (3) there may be different preferences, culture or geography in these countries compared to others.

[3] Most notable is the state of California which adopted a state-administered cap-and-trade system on October 20, 2011. California's emission trading market is expected to be the cornerstone of the larger Western Climate Initiative, a collaborative effort with four Canadian provinces to develop a North American greenhouse gas emissions trading program.