



Green fiscal reform in Sweden: Econometric assessment of the carbon and energy taxation scheme[☆]



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ABSTRACT

Empirical econometric assessment of environmental policy effectiveness is capable of demonstrating which tools have been helping to achieve the desired effect of reducing harmful emissions or stimulating technological change. This paper employs an econometric approach to analyse the effectiveness of energy and carbon taxes in Sweden, the country, which was one of the first to introduce a CO₂ tax as well as an extensive environmental tax reform. The results showed that taken in isolation a CO₂ tax was not sufficient to result in a significant change in CO₂ emissions in Sweden, except in the case of petrol. On the other hand, energy taxes for coal and LPG have been statistically significantly effective. It was also clear that a technological innovation in the form of development of nuclear and hydro energy played a significant role in reducing CO₂ emissions and higher oil price was also important in reducing national CO₂ emissions in Sweden. At the same time, renewable energy (excluding hydro), a more recent innovation, has not been a statistically significant driver of CO₂ emissions reduction, perhaps due to the fact that wind and solar play a much lesser role in Sweden at the moment. The net electricity imports from other countries have contributed positively towards reducing CO₂ emissions in Sweden, while the use of coal and biomass tended to increase CO₂ emissions. Compared to the ex-ante modelling results from the literature review, the findings confirm the role of environmental taxation as a viable policy instrument effective in reducing CO₂ emissions in Sweden, although point towards a more nuanced picture. The paper raises important policy questions focused on the effectiveness of environmental policy tools.

1. Introduction

Climate change presents one of the most important global challenges for humanity in the twenty first century. The global CO₂ concentrations have reached 400 ppm and policy makers around the world are trying to bring GHG emissions to the sustainable path of reaching a maximum 2 °C [42] with the Paris agreement aiming to limit the increase to 1.5 °C [78]. Economic theory suggests that introduction of an emissions tax is capable of reducing the quantities of a harmful substance [12,13,34], following the idea originally proposed by Pigou [62]. Two major approaches are known for the establishment of the magnitude of the tax: assessment of external costs to derive the exact value going back to Pigou, and iterative adjustment arriving at an emissions reduction via consecutive increases in tax rates following Baumol and Oates [13]. The former approach of internalising these external costs is to set a tax rate equal to the marginal social costs and the marginal benefit from emitting an additional unit of pollution. The latter method follows a more pragmatic approach as the tax rate is set

on a level estimated to be sufficient to reach a given and predetermined political environmental objective. The benefit of this method is that the tax rate can be adapted over time and therefore does not require all the information which would be needed in setting a Pigouvian tax. Both methods share a principle that the tax rate should be uniform for all polluters guaranteeing that the objective is achieved at least costs.

Sweden offers a particularly useful example as a country where fuel taxes were introduced as early as 1920s, energy and natural gas tax in 1957 and carbon tax was introduced in 1991 (Shmelev, [66]). We will explore empirical evidence in support of the effectiveness of energy and climate change taxation in Sweden to drive CO₂ emissions down based on time series data.

This paper will employ an econometric approach with an aim to explain changes in Sweden's CO₂ emissions through changes in policy, technology, lifestyle and macroeconomic variables (Fig. 1).

CO₂ emissions have been falling in Sweden since the 1970s, several key policy measures and economy wide changes explain this cut in emissions. At the same time the economy has undergone structural

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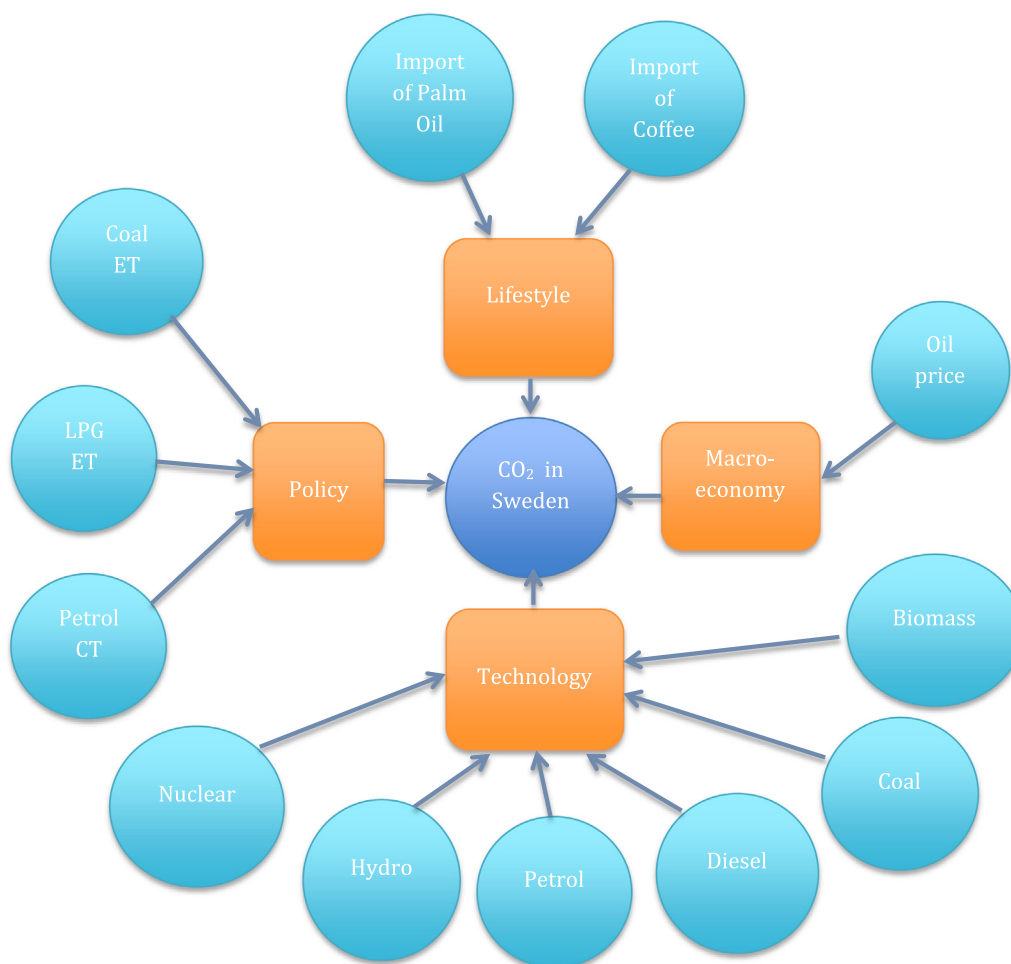


Fig. 1. Conceptual model of CO₂ emissions reduction in Sweden. Note: ET – energy tax; CT – carbon dioxide tax.

adjustment (90 s), two energy crises (70 s and early 80 s) and an income shock triggered by the great recession (2008–10). This paper aims to examine how changes in the macroeconomy, and in the electricity mix in the Swedish economy, have reduced carbon emissions, whether carbon taxes have been effective and whether the rationale for the taxes is justified. The paper develops a macro-econometric model of the Swedish economy to explain growth and reduction in carbon emissions.

Swedish economy grew 2.5 times in real terms since 1960. At the same time, CO₂ emissions reached their absolute maximum in 1970 and kept declining since, demonstrating a 2.1 times reduction in 2009 [80]. Overall, CO₂ emissions in Sweden reached the 1960 level by 2010, which is a clear sign of relative decoupling, and even absolute decoupling if the period since 1970 is taken into account. To study how Sweden achieved such a result, we use data on Sweden's national energy mix, petrol and diesel use, deployment of nuclear energy, hydro electricity, renewables, oil price, energy and CO₂ taxes, and imports of agricultural commodities to build an evidence-based policy assessment model of the Swedish economy. We show that several factors have been most important in influencing Sweden's CO₂ emissions: development of nuclear energy and hydro electricity, petrol and diesel use, and combined energy and carbon taxes. CO₂ taxes or renewables taken separately appear not to have had a statistically significant effect on CO₂ emissions reduction on their own.

The remainder of this article is organized as follows. Section 2 provides a review of earlier econometric studies designed to empirically test the effectiveness of environmental policy measures. Section 3 presents the case of Sweden and key macroeconomic, energy and emissions trends since 1960. Section 4 describes the econometric model

used to assess environmental policy in Sweden. Section 5 offers a policy discussion. Section 6 concludes.

2. Literature review

Several studies addressed the theory and implementation of the environmental tax reform¹ and the application of environmental taxes in major world economies. They include research on environmental tax reforms in Europe in general ([29], [33], [34], [4], [41], [68], [69], [71], [23], [24], Bosquet, [19], [46]), UK [31,28], [22], [8], Germany [14], UK and Germany [5], Scandinavia [2], [53], [70], [63], Sweden [50], [72], [75], [76], [77], Norway [55], Czech Republic [65], Poland (Kiuila and Sleszynski, [45]), Japan [47] and the global economy [10,9]. We will review contributions focused on the evidence based policy assessment using macro-econometric models. Such an approach allows consideration of time-related effects, intersectoral linkages, and could test the effectiveness of a given policy instrument. Table 1 presents a structured comparative analysis of selected empirical studies focused on the assessment of effects from environmental tax reforms in different countries. The table highlights the authors of the contribution, the central method employed, the countries under consideration, and

¹ Environmental tax reform (ETR) also known as green or ecological tax reform is a 'reform of the national tax system where there is a shift of the burden of taxation from conventional taxes, for example on labour, to environmentally damaging activities, such as resource use or pollution' [24]. An environmental fiscal reform is broader concept as it refers not only to changes in the taxation structure but also to reforming and abolishing environmentally harmful subsidies and implementing pricing measures in areas like water and sanitation [58].

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