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Abstract

Even though the role of energy taxes on emissions has been examined extensively in recent years, there has been limited empirical research on the effect of implicit tax rates on energy on emissions in the European Union. In particular, at the pre-implementation of ETS (Emissions Trading System) era, Jeffrey and Perkins (2015) showed that there was an inverse relationship between a) implicit tax rates on energy and fuel with lower carbon content (effectiveness) and b) implicit tax rates on energy and consuming less fuel per unit of output (efficiency). However, at the post ETS era, they found that only the latter relationship exists and they posit that even though the energy taxation is not generally associated with the effectiveness, this is mainly due to ETS participation. Future research on emissions should consider a) whether energy taxation motivates investment activities (spending) and initiatives for reducing pollution and if so, their nature and b) whether energy taxation could be an impetus to renewable resources.

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1. Introduction

The importance of Corporate Social Responsibility (CSR) which intertwined with the corporate taxation has been emphasized in recent years by academics, researchers and policy makers. One of the major environmental issues that has been investigated relates to
the Greenhouse Gas (GHG) emissions and most businesses are responsible for this issue, so many policy initiatives have been undertaken to this extent.

In 1995, the European Environment Agency (EEA) raised concerns about the inadequacy of policy initiatives to achieve the desired outcomes for sustaining the environmental objectives and each EU member country had to intervene for limiting the environmental damage. Energy taxation and tax policies designed and imposed, brought about profound results to this direction and mitigated the damaging effects of emission but what is more important is to further extend research for assessing the effectiveness of these policies regarding the motivation and achievement pertinent to the desired objectives. After a decade, the European Union Emissions Trading System (EU ETS), (also known as cap-and-trade) was established to fight global warming. Cap-and-trade is a two-step process. In the first stage, allowances (a number of pollution permits) are granted to firms who emit pollutants, by the regulator (government agency). At the second stage, a market is established by trading (buying and selling) those permits according to their emissions needs (Aldy, Krupnick, Newell, Parry, & Pizer, 2010).

To date, there is limited empirical evidence on the relation between energy taxation and greenhouse gas emissions. In addition, until now, there is scant research on how the energy taxation is connected to the different emission reduction strategies. In their paper, Jeffrey and Perkins (forthcoming) conducted a decomposition analysis of overall carbon emissions in order to consider the effectiveness measure (the carbon intensity of energy supply) and efficiency measure (energy intensity). Also, the authors posit that prior research was limited due to the fact that the determination of suitable tax rate was difficult. Jeffrey and Perkins (forthcoming) contribute to the literature in the following respects: First, they found that the higher the energy taxes imposed the lower the level of carbon intensity and also that the energy taxation is not generally related with the choice of using fuels with low concentration of carbon, (effectiveness). Second, ETS participation rendered the relationship between energy taxation and the effectiveness measure insignificant, which was weakly associated at ETS-pre era. This finding is an important due to the fact that optimal tax rate is hard to be estimated (Metcalf & Weisbach, 2009). Third, in the pre-ETS era the inverse relationships between energy taxation with energy intensity and carbon intensity holds whereas in the post ETS era, only the first one holds.

Specifically, we can draw a number of conclusions from this study. First, EU ETS brings about implementations of some jurisdictions which in turn alter the energy taxation system by making it more lenient for local producers due to competition internationally. Secondly, the strong relationship on efficiency can be supported by the effort pertinent to efficiency which is considered more attainable than those efforts on effectiveness.

The remainder of this study proceeds as follows. Section 2 discusses the theoretical framework and the published empirical research related to energy taxation practices. Section 3 evaluates methodological and research design issues. Finally, Section 4 proposes future research on energy taxation.

2. Theoretical framework and empirical research

In the early 1990s, at the same time when Scandinavian countries (together with Norway-non EU member) had set up a scheme to tax carbon, EU proceeded with the development of measures to tackle the GHG emissions.
After the ratification of Kyoto which went into effect in 2005, the EU had committed to curb GHG emissions by 2012, by 8% of the 1990 level. Freedman, Freedman, and Stagliano (2012) showed that neither energy taxation nor EU ETS appeared very effective after the Kyoto agreement. Moreover, they found that UK had a significant carbon related disclosures, for the period 2005–2007 and that after controlling for size and industry group the cap-and-trade had more significant effect on carbon disclosures than the carbon tax system, evidence which is corroborated from the findings of Jeffrey and Perkins (forthcoming). Moreover, since 2005 in the EU the emissions mitigation policies are reinforced by ETS cap-and trade (also known as ‘allowance trading’) which complements to the already existent energy taxes in an attempt to incentivize reductions in GHG emissions (Freedman et al., 2012). This is in contrast to the preference of the economist Summers (The Financial Times 2008) who is in favor of emissions taxes due to heavily regulation approach hidden behind the trading schemes (Aldy, Ley, & Parry, 2008). A profound evidence of the usage of carbon taxes are those taxes which were imposed in northern Europe in 1990’s and bills in the US of House of representatives. Aldy et al. (2008) by making a comparison between CO2 tax and permit trading emissions based on some criteria namely cost-effectiveness and the uncertainty over emission reduction costs corroborated that revenue-neutral CO2 taxes are more advantageous than cap-and-trade system at international level, although at the domestic level the cap-and-trade system could behave in the same way as CO2 tax policy after some features are embedded on them, like auctions allowance, revenue recycling stream. Aldy et al. (2008) by providing the example of ETS, argued that the prohibition of allowance borrowing can be a vulnerable point to the exposure of fuel price shocks. However, according to Freedman et al. (2012) both quantity-based (EU ETS) and price-focused (e.g. carbon tax) incentive-based systems have the same way for achieving the desired outcome by driving the cost of environmental pollution, which is linked to the production function back to the management of the firm. 

Another common characteristic of both aforementioned methods that were examined by Jeffrey and Perkins (forthcoming) is that all the cost of reduction of pollution is shared among the market participants, namely consumers and producers. This additional cost relies on price elasticity of demand and supply. So, the more elastic the demand is the more willingness to be shown for alternative products and likewise the more elastic the supply the more the willingness for shifting to less carbon-based energy sources. This is documented by Ramsey (1927) who suggests that taxes should be imposed on the least elastic commodity to minimize the efficiency loss. Since energy price elasticities are generally low, the energy taxation, like the one of carbon tax, may be captured on Ramsey principle which advocates taxing the least elastic commodity such as electricity. 

Furthermore, the two incentive-based methods have their roots on the economic theory that incentives impact market behavior. Pigou (1920) suggests that pollution should be subject to tax and the costs should be internalized as an element of market transactions and in turn firms should be responsible for these costs and for the usage of the natural resources. In general, this theory is based on internalizing the externalities through taxes (Pegouvian tax). Basically, the theory asserts that the tax rate should equal the social marginal damage from producing an extra unit of emission. Specifically, based on this theory, Metcalf and Weisbach (2009) demonstrated that a well- established upstream (at first stage of the production process) imposition of carbon tax successfully covered 80%
of US emissions. They argued that using upstream instead of midstream used in EU, i.e.,
taxing the source (fossil fuel) rather than output (emissions), would be beneficial due to the
following reasons. First, under the physical angle of view, a unit fossil fuel emits the same
carbon amount no matter where or when the combustion takes place. Second, according to
the economic view, under the upstream method there are fewer producers which results in
lower collection tax per unit. Also, lower tax administrative cost per unit would be due to
economies of scale. Under their consideration of the design of an ideal tax, was to balance
off the internalization of externalities with administrative and collection costs and without
considering any political concessions that can be an actor in the midstream imposition in
EU trading regime.

Political environment, political concessions and jurisdictions are saliently different
among EU countries and this fact does not allow carbon tax uniformity to EU countries. Jeffrey
and Perkins (forthcoming) also tried to control and capture country effects on their
models since the policy implications vary across countries. A related study by Bye and
Bruvoll (2008) supports that the taxation varies substantially across western countries and
economic activities and this in turn is an indicator of divergence between theory on
efficient means and energy related policy. In their study they show that the average energy
and environmental taxes in EU15 made up 7% of total tax revenue ranging from 5% to
12%. In addition, total environmental taxes comprises 2.7% in 2004. An exception is
Norway, a non EU member, total energy taxes of which comprises 28% of total tax
revenues. They explained further that the variation in energy taxation among countries
resulted from three types of differences on: (1) energy production patterns (2) the
production structure (3) political emphasis on distributional effects. Beyond that, the
imposition of reduced rates or exemptions from carbon taxes in industry led to the desired
levels of preservation of employment (Organization for Economic Co-Operation and
Development (OECD), 2004). The effect of energy subsidies like tax exemptions and
rebates on climate policies have been taken into consideration by Li and Lin (2013) in their
equilibrium model when they examined different climate policy options to reduce carbon
emissions in China where they found that carbon tax contributes more to carbon intensity
reduction compared to energy tax. However, when they used the subsidy removal effect
this resulted in more carbon intensity reduction for energy tax and less carbon intensity
reduction for carbon tax.

Another study by Sumner, Bird, and Smith (2009) that adds to the aforementioned
literature reviews the existing carbon policies in the United States and internationally. The
authors conducted an analysis regarding carbon policy design and effectiveness. Consistent
with prior studies they showed that there are large differences in tax rates across various
jurisdictions (Bye & Bruvoll, 2008). They focus their analysis on the distribution of
revenues generated from carbon taxes. In Norway, Sweden and Finland, revenues
generated from carbon taxes since 1991 were used to fund governmental budgets. Other
countries, some US States and the province of Quebec in Canada dedicated this income for
climate mitigation programs whereas the province of British Columbia in Canada, France
and UK in Europe used these revenues for the purpose of reducing other taxes. In reference
to carbon taxes effectiveness this study concludes that not only the measurement of
effectiveness can be a challenging task due to the complexity of the factors that come into
play but also due to the limited efforts of evaluating the effectiveness of existing carbon
taxes. Also Bye and Bruvoll (2008) refer to EU ETS as a system that assists the integration of taxes and other carbon policies by providing the illustrative examples, France (using ETS as benchmark to set its tax rate) and UK (using ETS to purchasing allowances through the EU’s ETS). The complexity of carbon tax policy arose also from a recent study undertaken by Fakoya (2013) where he used a multivariate regression analysis and showed that it is highly likely that an introduction of a carbon tax policy in South Africa will have a significant impact on Consumer Price Index (CPI) which in turn, it would cause a rise in the price of energy related-products and consumer goods.

Jeffrey and Perkins (forthcoming) extends prior aforementioned studies by including both ETS effect and energy tax effect simultaneously. The decomposition of the overall carbon intensity into effectiveness and efficiency has also notable results on future research.

3. Methodology and research design

Various research designs are employed in the literature to test the relation between energy taxation and carbon emissions. Table 1 sets forth summary results of the major characteristics of the related carbon emission, participation on EU ETS and the intensities between carbon and energy. The research design of Jeffrey and Perkins (forthcoming) is based on regression analysis (OLS) but at first stage in their methodology they defined carbon intensity as the total carbon content of energy used, energy intensity as the total energy consumption per unit of Gross Domestic Product (GDP). Then they formulate overall carbon intensity to be the product of carbon intensity of the energy supply (effectiveness) and energy intensity (efficiency). Jeffrey and Perkins (forthcoming) use a data set from EU-27 countries for the period 1996–2009. A research question arises. First, is the energy taxation inversely related to the overall carbon intensity? Second, is the energy taxation inversely related to carbon intensity of the energy supply? Third, is the energy taxation inversely related to energy intensity?

Having set their basic research questions stated above, they also tried to shed light on the EU ETS participation effect by incorporating this factor in their models. As it has already been discussed in the previous section, the coexistence of the two systems in EU from 2005 onwards as a response to Kyoto agreement, intrigue them to examine the joint effects of energy taxation combined with the emission trading. Thus, they developed their final research questions based on their belief that would be an interaction between participation in ETS and carbon taxes. Does ETS participation have an impact on the relationship between (1) energy taxation and overall carbon intensity (2) energy taxation and the carbon intensity of the energy supply and (3) energy taxation and energy intensity?

In their empirical model, as a proxy for carbon taxes they use implicit tax rate on energy (ITRE). The other independent variables are the ETS (participation in an emission trading system) and the interaction effect. As control variables, they consider the energy from renewable resources as a percentage of gross electricity consumption (RENEW) on the grounds that solar and wind have lower carbon emissions, Gross Domestic Product growth (GDP) since GDP’s high degree of association with the CO2 emissions and Country–Dummy variables for incorporating the particular characteristics of each country. Supporting evidence from incorporating the GDP as control variable in their empirical model is found at Fang, Tian, Fu, and Sun (2013) where based on scenario analysis they
Table 1
This table presents summary results of the characteristics of the major studies that examine the relation between energy taxation, carbon intensity and energy intensity effectiveness. Area tested refers to the geographic area from which the tested sample comes. Firm-year observations and period tested refer to the total number of observations used in the study, while period tested refers to the entire period that the sample covers to test the examined relation. Dependent Variables refer to the effect or the effect caused by the Independent variables which reflect the main inputs.

<table>
<thead>
<tr>
<th>Area tested</th>
<th>Firm-year observations</th>
<th>Period tested</th>
<th>Major Dependent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bye and Bruvoll (2008)</td>
<td>EU/Norway</td>
<td>22 Countries/EU 15, Norway</td>
<td>2004</td>
</tr>
<tr>
<td>Freedman et al. (2012)</td>
<td>Scandinavia, UK, Germany, USA</td>
<td>89 firms (total) (34 Scandinavian, 14 German, 18 UK, 23 USA)</td>
<td>2005–2007</td>
</tr>
<tr>
<td>Fang et al. (2013)</td>
<td>China</td>
<td>N/A</td>
<td>N/A</td>
</tr>
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(continued on next page)
<table>
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<tr>
<th>Study</th>
<th>Major Independent Variables (factors)</th>
<th>Sources of Data</th>
<th>Major Conclusions</th>
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</thead>
<tbody>
<tr>
<td>Bye and Bruvoll (2008)</td>
<td>Countries (categorical)</td>
<td>EUROSTAT</td>
<td>Variation on taxation across countries and the subsequent consequences.</td>
</tr>
<tr>
<td>Freedman et al. (2012)</td>
<td>Caron Tax/Carbon Allocation/both, Country (Based-Headquarters of the company)</td>
<td>Firms’ social/environmental/sustainability report (websites), Carbon/Allocation/Emissions/Taxes, (Corporateregister.com), CDP Questionnaire</td>
<td>1. Firms that used only cap-and-trade associated with higher disclosure concerning carbon (p = 0.05). 2. UK more extensive disclosure for carbon emissions, carbon control systems.</td>
</tr>
<tr>
<td>Fang et al. (2013)</td>
<td>Time dependent Variable of: energy-saving and emission-reduction, carbon emissions, economic growth (GDP), total amount of carbon tax</td>
<td>N/A</td>
<td>Imposing carbon tax duties in developing countries, setting up related policies will reinforce the development of energy-saving and emission-reduction.</td>
</tr>
<tr>
<td>Jeffrey and Perkins (forthcoming)</td>
<td>Energy tax, ETS, ETS*Energy Tax, (interaction variable)</td>
<td>EUROSTAT</td>
<td>Energy taxes reduce carbon intensity, the effect of energy taxation weakened after joining the EU ETS.</td>
</tr>
<tr>
<td>Li and Lin (2013)</td>
<td>Policy Options, Energy tax, Energy tax with (1), (2), (1) &amp; (2), Carbon tax with (1), (2), (1) &amp; (2) 1: subsidy removal, 2: revenue cycling</td>
<td>National Bureau of Statistics of China, IEA and China CEIC Database</td>
<td>The different climate policies affect differently the structure of the economy and reduce the energy consumption, carbon emissions and carbon intensity as well.</td>
</tr>
</tbody>
</table>
considered GDP to be a crucial factor in their energy-saving and emission-evolution system. For dependent variables, they used the overall carbon intensity (CO2IOVR) or its decomposition factors either carbon intensity of the energy supply (CO2IES) (proxy for the effectiveness) measured by the tons of carbon dioxide per ton of oil equivalent, or energy intensity (ENI) (proxy for the efficiency) measured by energy consumption per monetary unit of activity. Results showed that overall carbon intensity CO2IOVR has statistically significant inverse relationship with carbon tax ITRE and ETS participation. However, they did not find any significant relationship between ITRE and CO2IES whereas ETS and CO2IES relationship was marginally significant and more statistically significant was that of the interaction effect. Also, they observed that after joining the ETS the relationship weakened between ITRE and CO2IOVR and ITRE and CO2IES whereas ITRE and ENI relationship was significant prior to and after joining the ETS. Their last result is in line with Fang et al. (2013) where they used scenario analysis, and found that energy intensity constraint plays a more effective role than overall emissions constraint in the reduction of GHG emissions.

4. Future research

Jeffrey and Perkins (forthcoming) document interesting results and provide the scientific motivation for further research to more fully understand the relation between energy taxes and carbon emissions and cap-and-trade systems. However, their research can be extended by using non-linear predicting and control functions for estimating the carbon emissions and then using emissions dynamic evolutionary system or the non-linear dynamic model (four-dimensional energy-saving and emission dynamic evolution system) incorporated by Fang et al. (2013) with carbon constraints to emulate the actual situation very closely rather than using the simplistic linearity feature offered by regression models.

Further industry and size are factors which are incorporated by Freedman et al. (2012) as control variables and these could have been incorporated in their models. Moreover, future research in this area, should provide also more in-depth economic intuition using relationships on the conservation of energy in buildings, the introduction of renewable energies, efficient energy recovery from wastes and carbon emissions and how the redistribution of carbon tax revenue needed to be invested in research and development of new technology of energy-saving and emission-reduction in order to create a continuous improvement cyclical effect as the time progresses.

For example, future studies may focus on the development of both carbon tax, when and where and how much to be increased, without lessening the effect of ETS in order to meet the desired goal, improving both efficiency and effectiveness and at the same time minimizing the energy consumption. This necessitates, a dynamic evolution system to emulate the actual situation and its complexities having both carbon tax and ETS constraints for conducting an ex-ante analysis.

In short, I believe that Jeffrey and Perkins (forthcoming) open a new path for further research by contributing to the post-ETS era regarding energy taxation in EU and by pointing out the effects on the overall carbon intensity and its decomposing factors, efficiency and effectiveness. Their results in an ex-post analysis can be at the forefront of an advanced further investigation, while at the same time they provide plenty of fertile opportunity for future research.
References


