High Cost Carbon and Local Government Finance

Patricia Clarke Annez,* Thomas Zuelgaray

Abstract

Global climate change has certain unique features in terms of optimal policy. Some of these have been discussed already at the global level and some at the national level. But what is the impact of these features on local government finance? This paper examines the impact of high cost carbon on municipalities’ finance. We compare municipalities finance in India (State of Maharashtra) and in Spain. We conclude that raising energy prices will create an adverse fiscal shock for local governments, the magnitude of which will depend on the structure of spending. Smaller, less diversified governments currently operating at a low level of service and with a very small operating deficit will be harder hit, precisely because the most basic services tend to be energy intensive, and their energy bill is high in relation to their scope for borrowing to weather the shock. However, all municipalities would appear to be hard hit and a system of compensation from national government would be needed to avoid disruption to essential services.

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1. INTRODUCTION

Global climate change has certain unique features in terms of optimal policy. Some of these have been discussed already at the global level and some at the national level. This paper contends that these features will also have implications for fiscal federalism and this area has yet to be given much consideration. Cities, in particular, need to consider the following points.

1. Climate change is a global externality. Accordingly, any reduction in carbon emissions\(^1\) has equal value for mitigating climate change—no matter where the reduction takes place.

2. This implies that the optimal Pigovian tax for reducing carbon emissions is the same worldwide, and a fortiori, nationwide. In this way, the cost of reducing global emissions will be minimized because all potential emitters face the same incentive to reduce emissions and will thus face price signals to reduce emissions at least cost first.\(^2\)

3. Partitioning the world into different groups who must reduce emissions looking only at their opportunity set rather than the worldwide set of opportunities for least cost emissions reductions will increase the world wide cost of mitigation. Thus, any policy for mitigation should seek to adhere as closely as possible to the principle of a uniform carbon price. Otherwise the efficiency cost of a major reduction of a critical input economy-wide will be increased, and this is neither desirable nor necessary.

4. This does not imply that all emitters should bear equally all the economic and financial costs of reducing emissions. An equitable policy response requires separating these two aspects of policy formulation. It is quite likely to be the case that considerable negotiations will be needed to create a credible system for burden sharing that will compensate poor countries for the costs they must bear to address a problem that is not of their making because their contributions to the existing greenhouse gas (GHG) stocks are minimal. Even future emissions will not materially change this calculus when considered on a per capita basis.

5. Nonetheless, the long term strategy should to move at a suitable pace toward uniform pricing of the marginal GHG emission. This implies that the costs of energy will have to increase in developing countries.

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\(^1\)Following common practice, we refer to all greenhouse gas (GHG) emissions as carbon. This is merely a shorthand for purposes of simplicity. Optimal policies will have to distinguish between GHGs based on their different forcing factors (effect on climate). Abstracting from certain scientific uncertainties, these are relatively easily reduced to broadly accepted carbon equivalence factors.

\(^2\)For purposes of simplicity, we ignore questions of phasing here. It may well be politically impossible to raise carbon prices equally worldwide in the immediate or even medium term.
6. Whether or not carbon taxes or cap and trade systems (C&T) are used to drive up the cost of carbon and reduce emissions, this principle still holds. There are important differences between cap and trade and carbon tax systems, but for the purposes of this paper, the only one that matters is fiscal. A carbon tax, by definition, gives rise to government revenues. C&T systems need not. For our purposes, we will assume that governments would sell emissions permits to obtain an equivalent quantity reduction, so the C&T and carbon tax would have the same revenue implications. Therefore, for simplicity, we discuss carbon taxes in this paper, and leave any discussion of the desirability of a tax vs. C&T outside our discussion.

7. This paper explores a third element of necessary policies—fiscal burden sharing, i.e., possible intergovernmental imbalances that would arise because different levels of government will be exposed to different combinations of higher costs and higher revenues. Discussions have already started regarding the international implications of burden sharing. This paper would delve into the question of intergovernmental burden sharing between sub-national governments, including municipal, and national governments, and to a lesser extent, the question of how to manage the interpersonal burden sharing within the national economy.

1.1 What is the Impact of High Cost Carbon on Local Government Finance?

High cost carbon affects municipal finances from the expenditure side. How significant an effect this will be depends on the functional responsibilities of local government. Interestingly, some of the most basic functions are also some of the most carbon intensive. For example, garbage collection/disposal, street lighting, water delivery, transit, and operating schools and other municipal buildings are energy intensive responsibilities of the local government.

High cost carbon could also affect the revenue side for municipalities. However, it is quite likely to be the case that municipalities’ revenue bases are much less sensitive to energy costs than are their expenditure bases. Moreover, local government revenue sources are often not well structured to capture higher energy prices. For example, water charges in many places in India are charged as a fixed cess (fee) on top of property taxes, and would thus not have any ready mechanism for responding to higher energy costs. In contrast, solid waste collection fees, frequently charged out as a fixed percentage of the electricity bill might fare better. Likewise, Municipalities that receive a share of gasoline taxes, such as in Spain, could fare better than most of those in South Asia where taxation of energy has been kept at the federal level.
To make an assessment of the initial impact of higher carbon taxes on municipalities, the carbon content of their revenues and expenditures needs to be measured, along with the price sensitivity of both flows. A more general equilibrium assessment would look at the impact once higher carbon prices had worked their way through the price system to understand both the medium and longer term impacts. It is probable that unintended fiscal imbalances could be provoked at the sub-national, especially municipal, level due to higher carbon taxation, if there are no compensating measures designed into the tax system.

This paper uses municipal revenue and spending data to develop a simple model of the financial impacts of higher energy costs in various scenarios. The purpose of this exercise is to illustrate the direction of impacts and interactions that may occur in different municipal finance contexts. This rough modeling exercise is intended to sensitize local, central and provincial governments to the likely implications of higher energy prices so that appropriate compensatory measures are considered as part of an overall package of policies for mitigating GHG emissions. Without such measures, there are likely to be unintended consequences that could include a rapid run up of municipal indebtedness or cutbacks of services—all of which might be avoided by properly redistributing tax revenues across levels of government.

2. REVIEW OF THE LITERATURE

A large literature already exists on the establishment of an environmental tax and its impact on economy. However, this literature rarely takes into account the case of the developing countries. Moreover, if a literature on the relation between governmental tax and sub national government tax exists, in the case of environmental tax this analysis is almost always posed in the context of unitary government. All this literature seeks to evaluate the optimal environmental tax. Major contributions to this end have been made by Bovenber, Goulder, Parry and many co-authors in the mid 1990’s using general equilibrium system.

The relations between national government taxation and sub-national government can be found in the work of Besley and Rosen on the vertical externalities in tax setting with the cases of gasoline and cigarettes taxes. Estimating the magnitude of the responses of federal tax when federal government increases its taxes, they find that there is a significant positive response of state taxes. However they suggest more research to estimate how analyses of efficiency consequences of federal excise taxes would change when effects upon state tax rates are taken into account. They also warn us that if a positive interdependence between federal and state tax rates exists, then there is a risk that non-cooperative tax setting between federal and state governments results in excessive taxation of common tax bases. Fredriksson and Mamun (2007) also study the vertical externalities in cigarette
taxation. They suggest that an increase in the federal cigarette tax may reduce the average state cigarette tax rate. They conclude that a federal tax hike may reduce state tax revenue via declines in two areas: the state tax base and the state tax rate.

Not many works have been done related to our subject in the case of developing countries. However, we can quote the work of Raja Chelliah and his book “Ecotaxes” on the question of environmental tax. On matter of sub-national government finance and intergovernmental transfers, we can quote the work Anwar Shah with his guide to intergovernmental fiscal transfers. Another work linked to our subject is the paper of Ahmad and Stern on effective carbon taxes and public policy options. This paper based on the Indian case evaluates which level of government might be responsible for the administration of this kind of tax. Their conclusion is that such a tax has to be a central excise and that it is not desirable to introduce differentiation into state level VAT’s, at least for the Indian case. Their conclusion corresponds to our start point for this paper, which is a tax administered at a central level and harmonized between all the countries.

3. Structure of Municipal Finances

To examine the questions described above regarding the impact of higher energy costs on municipalities, we considered two different groups of municipalities, those in Maharashtra, India and those in Spain. For both sets of municipalities, we have reasonably detailed data on the structure of expenditures and revenues. The data for Spain are at the national level, thus covering all municipalities. For India, no such data exists, so we validated this data by comparing it with somewhat more aggregated data from Kundu (2002) for the city of Ahmedabad, and from Mohanty and others (2007) for the 35 metropolitan cities in India. The structure of expenditures and the types of revenue sources in both these alternative data sources, while more aggregated than our Maharashtra data, appear reasonably similar, which gives us some confidence that the more detailed Maharashtra data is representative.

These two examples represent systems that differ in important aspects, including the sources of revenues, the structure of functions devolved and spending, among others. A good knowledge of the structure of municipalities’ expenditure is essential to understand how their finances will be affected by a fluctuation of the energy price. Since there appears to be no direct measurement of energy consumption for municipalities in either country, we approximate the energy consumption by separating into different categories the different type of expenditures by intensity of energy consumption. We have also reviewed the structure of revenue flows, to understand which of these may be sensitive to energy prices.
3.1 Revenue

India and Spain have both decentralized many functions to sub national government: states for India and provinces for Spain. However, there is a considerable difference in how the municipalities are financed in India and in Spain. Spain is examined as a whole because most Spanish municipalities have similar revenue structures (except for the Basque province). For India we choose to study the Maharashtra State, because the State Finance Commission of this state made a great effort to collect data on municipalities’ finances—work that only a few Indian states have made so accurately.

For the Spanish municipalities’ finances we relied on the interesting work of DEXIA3 on finances and competences on sub national government in the European Union.

3.1.1 Spanish Municipalities

In Spain in 2005, 23% of the sub-national governments’ revenue went to municipalities, which represents the amount of 43 EUR billion, or 4% of GDP. The revenue came fairly equally from taxes (33%), grants (36%) and other sources such as fees and asset sales (31%), as shown in Table 1.

| TABLE 1 | Sources of Revenue for Spanish Municipalities |
|-----------------|---------------------------------|-----------------|
| Spanish Municipalities Revenue in 2005 | € MM* | % of Total Revenue |
| Tax revenue | 14 201 | 33.1 |
| of which own-source tax | (13 482) | (31.4) |
| of which shared tax | (719) | (1.7) |
| Grants | 15 540 | 36.2 |
| of which general grants | (7 085) | (16.5) |
| of which earmarked grants | (8 455) | (19.7) |
| Other | 13 132 | 30.6 |
| of which asset sales | (106) | (0.2) |
| of which fees | (8 094) | (18.9) |
| Total | 42 873 | 99.9 |

Source: DEXIA (2005). *MM = Million

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Tax Revenue
Spanish municipalities have their own taxes revenue and revenue from shared taxes. Their own taxes represent 95% of municipal tax revenue. Municipalities raise several local taxes, the most important are shown in Table 2, below:

### TABLE 2
Own-Source Tax Revenue for Spanish Municipalities

<table>
<thead>
<tr>
<th>Own-Source Tax Revenue</th>
<th>Municipalities</th>
<th>% of Tax Revenue</th>
<th>% of Total Municipal Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax on property</td>
<td>6 800</td>
<td>48</td>
<td>16</td>
</tr>
<tr>
<td>Tax on construction, installations and works</td>
<td>2 200</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Tax on motor vehicles</td>
<td>2 000</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Tax on economic activities</td>
<td>1 300</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Tax on capital gains in urban areas</td>
<td>1 200</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13 500</strong></td>
<td><strong>95</strong></td>
<td><strong>32</strong></td>
</tr>
</tbody>
</table>

Source: DEXIA (2005). *MM = Million

Municipalities with more than 75 000 inhabitants and capitals of provinces receive shared tax receipts. A summary of these shared tax revenues are shown in Table 3:

### TABLE 3
Shared Tax Revenue for Spanish Municipalities

<table>
<thead>
<tr>
<th>Shared Tax Revenue</th>
<th>Municipalities</th>
<th>% of Tax Revenue</th>
<th>% of Total Municipal Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7% of the Personal Income Tax</td>
<td>370</td>
<td>2,6</td>
<td>0,9</td>
</tr>
<tr>
<td>1.8% of the VAT</td>
<td>250</td>
<td>1,8</td>
<td>0,6</td>
</tr>
<tr>
<td>2.0% of the excise taxes</td>
<td>99</td>
<td>0,7</td>
<td>0,2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>719</strong></td>
<td><strong>5,1</strong></td>
<td><strong>1,7</strong></td>
</tr>
</tbody>
</table>

Source: DEXIA (2005). *MM = Million
There are several pathways through which energy price increases could affect this municipal revenue base. For own-source revenues, however, all of these would be second order effects, since none of the revenues are directly tied to energy prices. These second order effects could be significant if, for example, the relative price of housing and motor vehicles, for example, were to decline in the face of higher energy prices. A Computable General Equilibrium model (CGE) would be an excellent tool for exploring these impacts. In this simplified model, municipal own-source revenue is assumed to be unaffected by fluctuations in the price of energy. However, in the case of Spain, we consider that the shared excise taxes fluctuate with the fluctuation of the price of energy because this tax includes a hydrocarbon tax. Currently, this excise is a per unit charge, and would thus not fluctuate with energy prices. However, a carbon tax that is ad valorem, could at least be shared following the current sharing principle.

Grants
Municipalities receive an unconditional grant from the central government: the municipal share of the State Tax (Criteria are population, fiscal effort and the inverse of fiscal capacity). It represents 17% of total revenues.

Municipalities also receive earmarked grants for specific investment projects such as transport infrastructure. They represent 20% of total revenues.

Other revenue
User charges on services or administrative functions supplied to all citizens, fees and asset sales are the other sources of financing available to Spanish municipalities.

3.1.2 Indian Municipalities (Maharashtra)
Maharashtra has two forms of Urban Local Bodies (ULB): Municipal Corporations and Class Municipal Councils. The Municipal Corporations include megacities like Mumbai which are interesting in their own right, but quite different from the smaller cities and towns covered in the Municipal Councils. Class Municipal Councils form depend on the population. In Maharashtra there are three types: 'A', 'B' and 'C' municipal councils representing in this order the most populous cities to the least. We amalgamated the sum of incomes and expenditures of the three types of municipal councils.

The structure of revenues in Maharashtra is different from the Spanish municipalities. Grants from the state government represent two-thirds (64%) of the total revenue for municipalities in Maharashtra (compared to 37% in Spain), whereas

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4 The budgets for Spanish municipalities taken from Dexia include capital budget items. However for the Indian municipalities, the capital budget items were insignificant and fluctuated greatly across municipalities and over time. Since we were concerned with the reliability of this data, we did not include capital budget items on either the cost or revenue side for the Maharashtra municipalities.
own Source Tax revenue represents just 17% of the total. This is partly a consequence of the difficulty to collect taxes for Indian municipalities. Moreover, the absence of a system of shared taxes explains why grants in municipalities’ revenue are so important. The general revenue structure and a breakdown of Maharashtra own-source tax revenues are shown in Table 4 and Table 5 respectively.

**TABLE 4**
Sources of Revenue for Maharashtra Municipalities

<table>
<thead>
<tr>
<th>Municipalities Revenue in 2000</th>
<th>Rs.MM</th>
<th>% of Total Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax revenue</td>
<td>1 875</td>
<td>16,6%</td>
</tr>
<tr>
<td>Grants</td>
<td>7 272</td>
<td>64,2%</td>
</tr>
<tr>
<td>Other</td>
<td>2 178</td>
<td>19,2%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>11 326</td>
<td>100,0%</td>
</tr>
</tbody>
</table>


**Tax Revenue**
Indian municipalities have own taxes revenue but no revenue from shared taxation. Municipalities raise several local taxes, the most important are the following:

**TABLE 5**
Own-Source Tax Revenue for Maharashtra Municipalities

<table>
<thead>
<tr>
<th>Own-Source Tax Revenue</th>
<th>Municipalities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rs.Mm</td>
</tr>
<tr>
<td>Property Tax</td>
<td>1,038</td>
</tr>
<tr>
<td>Water Charges</td>
<td>578</td>
</tr>
<tr>
<td>Conservancy and Sanitation</td>
<td>21</td>
</tr>
<tr>
<td>Street Lights</td>
<td>0,1</td>
</tr>
<tr>
<td>License Fees and Entertainment</td>
<td>67</td>
</tr>
<tr>
<td>Building Rents</td>
<td>171</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1 875</td>
</tr>
</tbody>
</table>

Grants
Grants from the States represent 64% of municipalities’ revenue. Municipalities receive financing from about 30 state grants. Most of these grants are for specific purposes, although incentive grants are provided to encourage better performance in collecting water charges and property taxes. The most important grants are: Dearness Allowance Grant, Grant for reimbursement of salary and leave salary of Chief Officers, Land revenue and non agriculture assessment grant, Entertainment Grant, Stamp Duty Grant, Pilgrim Tax, Minor Mineral Grant, Profession Tax Grant, Road Grant, Octroi Compensation Grant (Octroi have been abolished in 2000), Primary Education Grant, Slum Improvement, Incentive Grant.

Many of these grants compensate municipalities for local taxing powers that were repealed, most notably octroi. The principles upon which they are distributed are not uniform, and often times are ad hoc. This lack of predictability affects planning of expenditure strategies for municipalities.

Other Revenue
Other revenue represents 19% of municipalities’ revenue. These sources include parking fees, permit fees, service fees and user charges, rent from commercial complexes, development fees for granting permission to construct buildings on vacant plot, and other fees and charges etc.

3.2 Expenditures
Here we explore expenditures for Spanish and Indian municipalities side-by-side. The structure of expenditure is very different between Spanish and Indian municipalities. Whereas Spanish municipalities spend 30% of their revenue in capital expenditure, almost all the revenue of Indian municipalities is spent in current expenditure, most of which is dedicated to staff cost.

Functions assumed by municipalities are not the same either, even if there are some in common such as water supply, garbage collection etc… However these common expenditures do not represent the same percentage of the total expenditure in the two countries. In the following we will detail these expenditures under the point of view of energy consumption.

In 2005, Spanish municipalities’ expenditure reached 43.5 EUR billion, which represents 13% of total public expenditure in Spain, and 4.5% of GDP. These ratios are among the highest in the European Union. 70% of municipalities’ expenditure is current expenditure, of which 45% (representing 30.6% of total expenditures) is staff costs. The remaining 30% are capital expenditure.

In contrast, municipalities’ expenditure in Maharashtra, India reached 11 121 Rs.MM. This expenditure is almost entirely current expenditure, as the reported capital expenditure is minimal.

Municipal expenditures for India and Spain have been itemized by function and are shown in Table 6 and Table 7, respectively. It should be noted that for
India, differentiation is made between obligatory functions such as water supply, fire brigades and street lighting, versus discretionary functions such as urban poverty alleviation and destruction of harmful animals. For both Spain and India, it is expected that different municipal functions will require energy inputs at varying degrees of intensity.

Unfortunately, there is little published data on the actual use of energy in different municipal functions. This is because separate activities are often not ring-fenced and actual energy usage is not tracked. Therefore, we imputed energy intensities to different activities based on the likely profile of energy use. To do so, we created three different categories of spending based on energy intensity of total spending, and made reasonable assumptions about the extent of energy use in each, which we then vary later in sensitivity testing. We categorized the different functions according to percentage of costs incurred for energy: insignificant (0%), significant (20%) and intense (90%). These imputed intensities reflect fairly conservative assumptions on intensity of energy use by category.

### TABLE 6
Energy Intensity of Municipal Expenditures in Maharashtra, India

<table>
<thead>
<tr>
<th>Energy Consumption</th>
<th>Sector</th>
<th>% of Total Expenditure</th>
<th>Budget (Rs.Mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insignificant</td>
<td>General Administration, Salaries, Pension &amp; Pensionary Benefits etc</td>
<td>28.7%</td>
<td>3 389</td>
</tr>
<tr>
<td></td>
<td>Administration of Shops &amp; Establishment Act 1948, &amp; Markets (D)</td>
<td>0.3%</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td><strong>total</strong></td>
<td><strong>29%</strong></td>
<td><strong>3 423</strong></td>
</tr>
<tr>
<td>Significant</td>
<td>Fire Brigade (O)</td>
<td>0.3%</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Slaughter Houses (D)</td>
<td>0.0%</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Education, Libraries, Free Reading Halls etc. (D)</td>
<td>9.3%</td>
<td>1 099</td>
</tr>
<tr>
<td></td>
<td>Museums, Art Galleries, Recreation Centres, Playgrounds, Gardens etc. (D)</td>
<td>0.7%</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>Epidemics &amp; Public Health (O)</td>
<td>1.4%</td>
<td>169</td>
</tr>
<tr>
<td></td>
<td>Other Expenditure</td>
<td>32.8%</td>
<td>3 873</td>
</tr>
<tr>
<td></td>
<td><strong>total</strong></td>
<td><strong>45%</strong></td>
<td><strong>5 263</strong></td>
</tr>
<tr>
<td>Intense</td>
<td>Roads (O)</td>
<td>8.1%</td>
<td>953</td>
</tr>
<tr>
<td></td>
<td>Street Lighting (O)</td>
<td>3.3%</td>
<td>386</td>
</tr>
<tr>
<td></td>
<td>Sanitation, Solid Waste Management &amp; Drain, Mechanical &amp; Electrical etc (O)</td>
<td>5.6%</td>
<td>664</td>
</tr>
<tr>
<td></td>
<td>Water Supply (O)</td>
<td>9.6%</td>
<td>1 133</td>
</tr>
<tr>
<td></td>
<td><strong>total</strong></td>
<td><strong>27%</strong></td>
<td><strong>3 137</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>100%</strong></td>
<td><strong>11 822</strong></td>
</tr>
</tbody>
</table>
TABLE 7
Energy Intensity of Municipal Expenditures in Spain

<table>
<thead>
<tr>
<th>Energy Consumption</th>
<th>Sector</th>
<th>% of Total Expenditure</th>
<th>Budget (€ MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Insignificant</td>
<td>General public services</td>
<td>33</td>
<td>16 432</td>
</tr>
<tr>
<td></td>
<td>Social protection</td>
<td>8</td>
<td>4 068</td>
</tr>
<tr>
<td></td>
<td><strong>total</strong></td>
<td><strong>42</strong></td>
<td><strong>20 500</strong></td>
</tr>
<tr>
<td>2. Significant</td>
<td>Education</td>
<td>5</td>
<td>2 200</td>
</tr>
<tr>
<td></td>
<td>Health</td>
<td>1</td>
<td>622</td>
</tr>
<tr>
<td></td>
<td>Recreation, culture and religion</td>
<td>11</td>
<td>5 351</td>
</tr>
<tr>
<td></td>
<td>Public order and safety</td>
<td>8</td>
<td>3 882</td>
</tr>
<tr>
<td></td>
<td><strong>total</strong></td>
<td><strong>25</strong></td>
<td><strong>12 055</strong></td>
</tr>
<tr>
<td>3. Intense</td>
<td>Housing and community amenities</td>
<td>10</td>
<td>4 693</td>
</tr>
<tr>
<td></td>
<td>Economic affairs</td>
<td>14</td>
<td>6 998</td>
</tr>
<tr>
<td></td>
<td>Environment protection</td>
<td>10</td>
<td>4 993</td>
</tr>
<tr>
<td></td>
<td><strong>total</strong></td>
<td><strong>34</strong></td>
<td><strong>16 684</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>100</strong></td>
<td><strong>49 239</strong></td>
</tr>
</tbody>
</table>

We used the same coefficients for the municipalities in Spain and India for simplicity, since there is little data available to determine whether these differ. Thus what drives the differences between the two is the distribution of spending by function. Of course, with better data, such estimates could be refined.

In comparison to Spanish municipalities, we observe that the share of functions not using energy is more important in the Spanish case than the Indian. This is somewhat surprising given that a large share of Indian municipality spending is for payrolls. Actually the difference is the share of spending for services that use little energy. Spanish municipalities have programs of social protection, which represents almost 10% of their expenditure. In Indian municipalities the amounts spent on that type of program is much smaller.

By contrast, a larger share of the Indian municipalities’ spending is for activities where the consumption of energy is significant. This is due to the important number of public buildings that require energy for heating and cooling as well as public transport which appears in the category “other expenditure.” Since public transport and environment are important items in this category, we chose to categorize this spending as having a “significant” energy content, i.e. 20%.

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5 Unfortunately, the expenditure accounts of Indian municipalities include a large item (other expenditures) greater than 30% of total, which includes a large number of disparate items. More breakdown of those items would be needed to get a better sense of how energy intensive spending is.
Functions with an intense consumption of energy are more important in Spain mainly due to the amounts spent on public transport infrastructures, industry, communication etc…and construction and upkeep of social housing which do not exist in India municipal expenditures. Functions of Indian municipalities which appear in this category are essentially water supply, garbage collection, street lighting and sewage, representing 27% of total expenditure.

Using the breakdown of spending and assumptions with regard to energy intensity, we find that despite all of the differences in the basic structure, both sets of municipalities (Spain and India) end up with roughly one-third of spending being energy price sensitive.

4. ECONOMIC MODEL

We now present the model used to simulate the impacts of higher energy prices on municipalities’ finances with a view to understanding the effects of policies that increase the price of traditional energy. For these simulations, we will establish three different scenarios. In the first one, we allow municipalities to increase their deficit in the face of higher energy costs. This implicitly assumes that higher deficits can be financed. In the second one and the third, the initial deficit will be constant, and municipalities will have to decide to make cuts in their expenditure.

To simplify, we will consider only two prices. First the average unit price of energy (whatever the source of energy) $P_E$ in municipal expenditures. The other price $P_{NE}$ is the average unit price of all the municipal expenditures except energy goods. At these prices are associated quantities. $Q_E$ is the quantity spending on energy and $Q_{NE}$ the quantity of spending that do not consume energy.

**Notations:**

- $P_E$: Unit price of energy
- $P_{NE}$: Unit price of municipal expenditures not linked to energy
- $Q_E$: Quantity of spending on energy
- $Q_{NE}$: Quantity of spending that do not consume energy
- $R$: Municipalities revenue
  - $R_E$: Revenues linked to energy prices
  - $R_{NE}$: Revenues not affected by energy prices
$E$: Municipalities expenditure

$E_E$: Expenditures only linked to energy prices

$E_{NE}$: Expenditures not affected by energy prices

$X$: Municipalities deficit

Equations:

\[ E_i = P_i \cdot Q_i \] (Equation of expenditure)

\[ R + X = E \] (Budgetary equation)

### 4.1 Scenario 1: Deficit Endogenous

In this scenario we consider the deficit as an endogenous variable. $Q_E$ is also an endogenous variable which depend on the fluctuation of the energy price with an elasticity $\varepsilon$. $P_E'$, the new energy price, is the exogenous variable. All the rest is constant. The aim is to highlight the impact of fluctuation in energy price on the municipalities’ deficit. The full derivation of the following equations has been omitted, but can be obtained by contacting the authors.

The budgetary equation is:

\[ P_E \cdot Q_E + P_{NE} \cdot Q_{NE} = R + X = E \]

We shock the price of energy:

\[ P_E \cdot Q_E + \Delta (P_E \cdot Q_E) + P_{NE} \cdot Q_{NE} = R + X + \Delta (R + X) = E + \Delta E \]

The new budgetary equation is:

\[ P_E' \cdot Q_E' + P_{NE} \cdot Q_{NE} = E' \]

With:

- \[ P_E' = P_E + \eta \]

- \[ Q_E' = \left[ \varepsilon \left( \frac{P_E'}{P_E} - 1 \right) + 1 \right] \cdot Q_E \]

- \[ E' = R' + X' \]
Then we have two different cases due to structural differences between Spanish and Indian municipalities’ sources of income.

**Indian case:**
Incomes of Indian municipalities are not sensitive to the price of energy. Thus energy prices only affect the cost base and spending: \( R' = R \) and \( X' = E' - R \)

We have therefore the new deficit:

\[
X' = P' E \left[ \varepsilon \left( \frac{P'E'}{P_E} - 1 \right) + 1 \right] Q_E + P_{NE} Q_{NE} - R
\]

**Spanish case:**
Spanish case is more complex because some of the municipal incomes came from shared tax which is linked to the hydrocarbon price. Municipal incomes are therefore composed of a part which is not linked with energy price, and another which fluctuate with the price of energy (with an elasticity \( \varepsilon_R \)):

\[
R = R_E + R_{NE}
\]

with elasticity:

\[
\varepsilon_R = \frac{\Delta R_E}{\Delta P_E}
\]

After several intermediate steps, the form of the new incomes is given by:

\[
R' = R_{NE} + R'_E
\]

With: \( R' = R + \Delta R \) and \( R'_E = R_E \left[ 1 + \varepsilon_R \left( \frac{P'E'}{P_E} - 1 \right) \right] \)

For the simulation, we will take: \( \varepsilon_R = 1 \). This merely assumes that any increase in energy prices and tax revenues will be passed through fully in the taxes shared with the municipalities. As municipal revenues increase, they must decide how to spread income between the two types of spending, energy sensitive and non-energy sensitive. We assumed to share this increase in income between energy and non-energy expenditures according to their share in total spending after the price shock.
a is the percentage of new energy expenditure in total new expenditure:

\[ a = \frac{P_E' \cdot Q_E'}{E'} \]

And b is the percentage of non-energy expenditure in total new expenditure:

\[ b = \frac{P_{NE} \cdot Q_{NE}}{E'} \]

Finally:

\[ E'_E = P_E' \cdot Q_E' - a \cdot \Delta R \]
\[ E'_{NE} = P_{NE} \cdot Q_{NE} = b \cdot \Delta R \]

And:

\[ X' = E'_E \cdot E'_NE - R \]

4.2 Scenario 2: Non-Energy Expenditures Endogenous

In this scenario, we consider the municipal deficit as a constant—a municipality cannot increase its deficit. With this consideration, the quantity \( Q_{NE} \) becomes an endogenous variable of the model. However the elasticity of \( Q_{NE} \) face to \( P_E \) is considered to be zero. \( Q_E \) remains an endogenous variable and \( P_E \) an exogenous one. All the rest is constant.

Equations and development are the same than for the scenario 1, except that \( Q_{NE} \) has became the endogenous variable instead of \( E \). Therefore we obtain:

\[ P_E' \cdot Q_E' + P_{NE} \cdot Q_{NE}' = E \]

With:

\[ P_E' = P_E + \eta \]
\[ Q_E' = \left[ \varepsilon \cdot \left( \frac{P_E'}{P_E} - 1 \right) + 1 \right] \cdot Q_E \]
\[ Q_{NE}' = \frac{E - P_E' \cdot Q_{NE}'}{P_{NE}} \]
Indian case: In the Indian case, this is the final equation.

Spanish case: In the Spanish case, we still have the incomes which are endogenous.

Then:

\[ P_E' \cdot Q_E' = P_E' \cdot Q_E' - a \cdot \Delta R \]

\[ P_{NE} \cdot Q_{NE}' = P_{NE} \cdot Q_{NE} - b \cdot \Delta R \]

With \( a \) and \( b \) the percentages of non-energy expenditure in total expenditure if the total expenditure was endogenous variable.

We finally obtain:

\[ Q_{NE}' = \frac{E - P_E' \left( Q_E' - a \frac{\Delta R}{P_E'} \right)}{P_{NE}} \]

### 4.3 Scenario 3: Non-Energy Spending Endogenous, Redistribution of Expenditure Shares

This scenario is similar to the scenario 2 because deficit is a constant and \( Q_{NE} \) an endogenous variable. Difference is that we consider that the cost of this fluctuation in energy price on quantity of goods and services supply by municipalities will be redistributed between quantities spending on energy and non-energy. In this case, the local government chooses to keep the part of each energy and non-energy expenditures in total expenditure after the shock of the energy price constant.

\[ P_E' \cdot Q_E' + P_{NE} \cdot Q_{NE} = E' \]

With:

- \( P_E' = P_E + \eta \)
- \( Q_E' = \left( \varepsilon \left( \frac{P_E'}{P_E} - 1 \right) + 1 \right) \cdot Q_E \)
\( \alpha \) is the percentage of energy expenditure in new total expenditure, and \( \beta \) the one of non energy expenditure:

\[
\alpha = \frac{P_E' Q_E'}{E'} \quad \beta = \frac{P_{NE} Q_{NE}'}{E'}
\]

The final equation is given as:

\[
E - P_{E'} \left( Q_{E'} - a \frac{\Delta R'}{P_E'} \right)
\]

\[
Q_{NE}' = \frac{Q_{NE}'}{P_{NE}}
\]

With:

- \( P_{E'} = P_E + \eta \)
- \( Q_{E'} = \left[ \epsilon \left( \frac{P_{E'}}{P_E} - 1 \right) + 1 \right] Q_E \)
- \( \Delta E \) the variation of total expenditure if \( E \) would be an endogenous variable.

**Indian case:** In the Indian case, this is the final equation.

**Spanish case:** In the Spanish case, we still have the incomes which are endogenous. So we finally obtain on the same structure than equation founded in scenario 2:

\[
Q_{NE}' = \frac{E - P_{E'} \left( Q_{E'} - a \frac{\Delta E}{P_E'} - a \frac{\Delta R'}{P_{E'}} \right)}{P_{NE}}
\]
5. SIMULATIONS AND RESULTS

Using the preceding economic model, we simulated the three scenarios with different parameters to evaluate the impact of an increase of the energy prices on municipalities’ finance. In this part we will discuss the results, bringing back the model results to the reality facts. We will also analyze the influence of the different parameters on the model.

5.1 Initial Conditions

First of all we input the initial conditions for the two different types of municipalities of our model.

<table>
<thead>
<tr>
<th>TABLE 8</th>
<th>Initial Conditions for Economic Model of Maharashtra Municipalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>R (Incomes)</td>
</tr>
<tr>
<td></td>
<td>E (Expenditures)</td>
</tr>
<tr>
<td></td>
<td>Ee (Energy expenditure)</td>
</tr>
<tr>
<td></td>
<td>Qe (Quantity of energy consumed)</td>
</tr>
<tr>
<td></td>
<td>Ene (Non energy expenditure)</td>
</tr>
</tbody>
</table>
### TABLE 9
Initial Conditions for Economic Model of Spanish Municipalities

<table>
<thead>
<tr>
<th>Spain</th>
<th>R (Incomes)</th>
<th>E (Expenditures)</th>
<th>X (Deficit)</th>
<th>Ee (Energy expenditure)</th>
<th>Ene (Non energy expenditure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>€ MM</td>
<td>42 873</td>
<td>49 239</td>
<td>6 366</td>
<td>17 427</td>
<td>31 812</td>
</tr>
<tr>
<td></td>
<td>Insignificant: 0%</td>
<td>Significant: 20%</td>
<td>Intense: 90%</td>
<td>Qe (Quantity of energy consumed)</td>
<td>Qne (Quantity of non energy goods consumed)</td>
</tr>
</tbody>
</table>

Initially the unit prices of energy and non energy good are input to value 1. That explains the equality between quantities and expenditures in these charts.

The types of municipalities in India and Spain are too different to compare the sums that appear in these charts. We can, however, compare the distribution of the finances. The part of Ee\(^6\) and Ene\(^7\) in the total expenditure are almost the same for India and Spain as we saw in the structure of municipalities (see chapter -II-). By contrary, the ratio deficit over expenditure X/E is much higher in the Spanish case. That will have consequence on the increase of deficit in the scenario 1. Of courses it is possible that this ratio is undervalued in the Indian case with a deficit relatively low. But this fact will not influence the aim of our results as we work on the comportment of the deficit face to a shock of energy price and not its original level.

Elasticity of the municipalities’ quantity of energy good face to the price of energy is an important parameter. In the literature we found elasticity around -0.4 and -0.2 (depend on long/short term: -0.2 short term provided by INSEE\(^8\) and the RAND\(^9\)) for individuals.

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\(^6\)Expenditure on energy.

\(^7\)Spending on good not using energy.


We expect a municipality to have lower short term price elasticity for energy spending, since reducing energy expenditures could involve reductions of critical public services like street lighting and garbage collection. Soft options like using public transport rather than a car are not possible for these public services. But with time and technological progress this elasticity will become higher in absolute terms. That is why we will separate short term and long term. Short term will be assigned an elasticity of -0.1 and long term -0.4 which represent extreme values.

5.2 Simulations and Results Scenario 1

In scenario 1 the deficit is endogenous. This means that municipalities are able to borrow to finance an increase in their deficit which bears the brunt of the increase in the price of energy. Municipalities refuse to reduce their spending on goods non using energy, and the reduction of their spending on energy in just influence by the elasticity and no other political reason.

Results:

5.2.1 Short term: Elasticity = -0.1

FIGURE 1
Short-Term Impact of Energy Price Variation on Municipal Deficit
As it was predictable, the deficit increases with the increase of the price of energy. First observation is that for an increase of 20% of the price of energy, deficits in India (Maharashtra) rose by 140% and by 50% in the Spanish case (see Figure 6). It is therefore easily understandable that a municipality cannot sustain such an increase of energy price. An increase of 5% already leads to an increase of 50% of the deficits in India. Expenditures are too sensitive to energy price to be able to sustain an increase of 5%. The intuition behind this result is essentially that in municipalities with limited resources and functions and financial capacity, their deficit is relatively small in relation to their energy related spending. A significant increase in the price of energy could put them in financial distress.

The percentage impact on the deficit in Spain is much less significant for the same increase in the energy price, even though the percentage of spending that linked to the price of energy is relatively similar. This is because the baseline Spanish municipalities’ deficit in relation to total spending is much higher, indicating significantly more access to deficit finance than in the Indian case. That explains that the increase of deficit is lower in the Spanish case. Figure Omitted illustrates this by tracking the ratio of the deficit to total expenditure as the energy price increases. This ratio moves similarly for both Spanish and Indian municipalities.

If we examine the quantity of energy consumed (see Figure 7), we first note that both groups reduce energy use substantially even though energy spending increases. Because of the relatively low elasticity with respect to price, the price increase much outpaces the capacity to conserve on the quantity of energy consumed, at a rate of 10 to 1 for an elasticity of 0.1.

**FIGURE 2**
Short-Term Impact of Energy Price Variation on Quantity of Energy Expenditures

![Graph showing the influence of energy price on quantity of energy expenditures](image-url)
To summarize scenario 1, for the short term, a small increase of energy price has the desired effect of reducing the quantity of energy consumed, although it is quite limited. This comes at the cost of an increase in the deficit for both sets of municipalities, a very dramatic one in the Indian model. The impact of the shared tax on energy is limited because it is very small in relation to the increase in spending. If we examine Spain with and without this shared tax, the increase of deficit is 1% lower for a 70% increase in the price of energy.

5.2.2 Long term: Elasticity = -0.4

Over the long term, with technical progress and investments in new technologies, municipalities are better able to reduce consumption in the face of higher energy prices. We represent this longer term scenario by increasing the price elasticity to -0.4. The results are shown in Figure 8 below.

Before discussing the results, it is worth noting that there is nothing automatic about moving from the short to the long term scenario. As we saw above, municipalities will face chronic deficits as a result of energy price increases, and will thus have no fiscal space for investment in energy efficient technologies. Their creditworthiness ratios will all be deteriorating as spending increases, yet they will need to borrow to finance current spending. Without some concessional finance or grants, it is hard to imagine moving to this longer term scenario.

FIGURE 3
Long-Term Impact of Energy Price Variation on Municipal Deficit
In the long terms with an elasticity of -0.4 we see that the impact of an increase of energy price on deficit is, as expected much less than in the previous case. This time for an increase of 20% of the price of energy, deficits in India rose by 80% and by 30% in the Spanish case (see Figure 8), as opposed to 140% and 50% in the previous case. The quantity of energy consumed declines much more than in the earlier case (see Figure 9). This scenario illustrates that the longer term impact on municipalities’ deficit is much less serious, although still substantial, provided they are able to invest in energy saving technologies.

5.3 Simulations and Results Scenario 2: Fixed Fiscal Deficit

In scenario 2, we assume that municipalities are not able to expand borrowing to absorb the impacts of an energy price increase. The deficit remains fixed at its initial value and spending must be restructured to cope with higher energy costs. In this scenario, we assume that spending on energy based goods responds as in scenario 1, based on the elasticity with respect to price. All other spending is reduced to meet the fixed deficit target.
**Results:**

5.3.1 **Short term: Elasticity = -0.1**

In this scenario, the impact of an increase of energy price on the quantity spending on energy is the same as before. We still have a decrease of 1% of quantity for a 10% increase of energy price. Now it is the quantity spending on activities that do not use energy ($Q_{ne}$) that must be reduced to meet the deficit target. As discussed above, this would cover items like social welfare spending, salaries, including teachers in the case of Spain, and general administration. The intuition behind this formulation is that the energy spending is related to basic services that must be maintained. If fiscal restraint is needed, the salary bill, social safety nets and administration costs are more likely candidates for spending cuts.

This set of assumptions results in fairly dramatic cuts in non-energy spending. $Q_{ne}$ decreases by close to 20% when the energy price rises by 50%. Such a 20% across the board cut in non-energy spending seems hardly conceivable for any municipality, even those most committed to belt tightening.

Figure 5 and Figure 6 show the quantities of goods and services provided by local governments in response to higher energy prices in a fixed deficit scenario. The first line $Q_e$ plus $Q_{ne}$ shows the total impact of the higher prices on ability to spend. The two others show how it is divided between energy and non-energy if one seeks to protect energy public services and absorb the shock with more discre-
tionary spending. It seems highly unlikely, however, that such dramatic cuts could actually be sustained. Hence it is more likely that spending in both areas would have to be cut in a scenario of strong fiscal restraint. This is examined in scenario 3.

FIGURE 6
Short-Term Impact of Energy Price Variation on Municipal Expenditures in Spain (Scenario 2)

Influence of the energy price on the quantities in Spain in scenario 2 (Elasticity = -0.1)

5.4 Simulations and Results Scenario 3

This scenario is similar to the scenario 2 in that the municipalities' deficit is constant. The difference is that in this scenario the burden of an increase of energy price will be shared between the quantity spending on goods non-using energy (Qne) and quantity spending on energy (Qe). Now municipalities will choose to cut even more in their quantity of spending on energy to preserve a little more the quantity spending on goods non using energy (and so payroll and the wages). How do they choose to share the burden? Municipalities are assumed calculate their deficit as if they will be allowed to let it run after the price shock. They then reduce pro rata all expenditure categories by the same percentage to reach the desired new level of spending. The result is that Qe will decrease more significantly than in the scenario 2, and Qne will reduce less than in the previous scenario.
Results:

5.4.1 Short term: Elasticity = -0.1

As in the scenario 2, we follow the evolution of Qne. As expected the reduction of Qne is less important than in the scenario 2 (compare Figure 7 and Figure 8 with Figure 5 and Figure 6). For example, for a 50% increase of energy price, Qne decreases by 12% in scenario 3 whereas Qne decrease by 22% in scenario 2. The results are similar for both India and Spain. The wedge between the two scenarios increases as the energy price increases. Nonetheless even with this more even handed sharing of the pain of higher price increases, the burden on public services, social safety nets, and required reductions in salary bills is dramatic and hardly likely to be sustainable.

Of course, Qne is preserved because Qe decreases more rapidly than in scenario 2. If we take a look at the evolution of the total quantity (Qe + Qne), it decrease more rapidly than in scenario 2 for both Spanish and Indian municipalities. Overall, this shows there is no escaping the costs of higher energy prices. While scenario 3 is a more balanced strategy, if deficits cannot be accommodated, public services suffer considerably as energy becomes more expensive.

FIGURE 7
Short-Term Impact of Energy Price Variation on Municipal Expenditures in India (Scenario 3)

Influence of the energy price on the quantities in India in scenario 3 (Elasticity = -0.1)
5.5 Sensitivity to the Elasticity Parameter

One of the most important parameters of the model is the elasticity of quantity of spending on energy with respect to the price of energy. To evaluate its influence on the model, we will see its impact on the deficit (scenario 1) for an increase of energy price by 50% (see Figure 9). As we see, elasticity has a strong influence on the increase of deficit. That is why we examined different values (-0.1 short term and -0.4 long term) to examine the impact on the deficit. The longer the period of adjustment, the higher one would expect the elasticity to be. This sensitivity thus illustrates that this problem is more one of a temporary adjustment, albeit over a period of decades most likely, provided assistance is provided to facilitate adoption of improved technologies that will in turn decline in price. This graph indicates that, at very high elasticities, i.e. in a very long term, responding effectively to higher energy prices can lower the overall energy bill for municipalities, and thus reduce a significant element in their cost base.
6. CONCLUSIONS

This paper sought to examine the fiscal effects for local governments of very sensible policies for climate change, the most efficient policy for reducing GHG emissions applied economy-wide, that is, application of higher energy prices throughout the global economy to elicit reductions in GHG intensive energy use. These price changes are necessary to provide incentives to invest in energy saving technologies, to improve management practices etc. If designed correctly, such green taxes would provide a fiscal boon to government in general, because taxes (or their equivalent in auctioned permits) will bring substantial revenues to government.

What this paper does is look beyond the unitary government to examine the impacts for different levels of government with different taxation powers and different spending profiles. We used data on the spending and revenue profiles of two sets of local governments, those in Maharashtra, India, and those in Spain. In both cases, we found stylized facts that are quite representative of local governments world-wide. Local government revenues are not highly sensitive to the price of energy. Therefore, there will be no fiscal gain for local governments if energy prices increase, as they must do.

On the other hand, many of the public services that local governments provide are energy intensive. The ability to substitute away from using energy...
in providing these services is quite limited in the short term, even more limited than for individual consumers. For example, garbage cannot be hauled in public transport, but must instead rely upon conventional trucks until alternative technologies are available. So municipalities will have difficulty reducing their energy bills in the short term.

As a result, raising energy prices will create quite an adverse fiscal shock for local governments. Our analysis illustrates just how adverse this shock will be, and how the structure of spending affects the magnitude of the fiscal shock. Smaller, less diversified governments currently operating at a low level of service and with a very small operating deficit will be harder hit, precisely because the most basic services tend to be energy intensive, and their energy bill is high in relation to their current deficit financing envelope. However all municipalities would appear to be quite hard hit. Whether the shock is absorbed in deficit spending or in fiscal restraint, there will be a substantial shock. The pain results from the difficulty of reducing energy spending quickly in the short term.

The policy implications are clear, and they consist in reconsidering fiscal federalism in light of the climate change challenge. The level of government taxing energy will be running large surpluses corresponding to these dramatic fiscal crises provoked at the local level in the scenarios we have examined. Compensation for local governments hard hit by high energy bills makes sense both to protect the financial integrity of local governments and ensure reasonable service delivery. It makes a great deal more sense to compensate these local governments plunged into a crisis that is not of their own making using the extra funds generated at higher levels of government that are generating revenues from energy taxation.

This also makes more sense than the alternatives. Asking municipalities to cover these energy induced deficits by hiking their own taxes or charges would just involve burdening consumers already hit by higher energy prices for their own consumption and could quite likely lead to a tax payer rebellion. Asking them to reduce critical public services like solid waste management to meet a local budget constraint when surpluses are swelling at higher levels is counterproductive. It would also lead to an unintended increase in government saving that throws the overall government fiscal stance out of balance. This notion of compensation of local governments is similar to that which has been occasionally been proposed for private consumers hit by carbon taxes (or the impacts of a cap and trade system). There it has been argued that the carbon tax proceeds could be redistributed to the general public through a reduction in something like the payroll tax. The key is to find a reasonable compensation system that is not tied directly to energy spending, which would blunt incentives to conserve. Something like a poll credit (as opposed to a poll tax) might have the desirable properties.
References


