Simulating the Socio-Economy-Environment Impacts of Ecotaxes in India:
An Environmentally-extended Social Accounting Matrix Analysis

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Abstract

Climate mitigation strategies are on the rise across the globe to achieve national commitments to net-zero carbon emissions. Pricing carbon, either directly or indirectly, provides a price incentive to producers to reduce their greenhouse gas emissions. Therefore, it is important to examine the impact of such governmental policies on the economy, emissions, and particularly households, who will bear the incidence of such taxes. For developing countries like India, the effect of such policies on marginalised and low-income households is a pertinent question that needs examination. We aim to answer three questions in this paper: (1) what is the incidence of proposed environmental taxes (ecotaxes) on the households in India; (2) what are its impacts on the Indian economy, households, and environmental pollution; and (3) how can revenue recycling dampen the impacts on marginalised households. In this paper, we seek to analyse these issues using an Environmentally-extended Social Accounting Matrix for India 2019-20, which we have constructed (CSEP-ESAM). The disaggregation of household accounts provides a deeper understanding of how ecotaxes affect all sections of society. To the best of our knowledge, this work on the impacts of ecotaxes has not been attempted before in the Indian context using an ESAM. We analyse the incidence of a proposed carbon tax on 5 polluting sectors (fertilisers, aluminium, iron and steel, coal-powered electricity generation, and cement) by using a price-vector model. After that, the relative price changes are used to measure the tax burden on each household by category. We analyse four ecotax scenarios, determined using India's prevailing Goods and Services Tax (GST) rates – 5%, 12%, 18% and 28% – and applied to the 5 polluting sectors. Revenue recycling scenarios have been determined based on the most-impacted household categories and modelled using the ESAM in the form of government transfers to dampen the impact of the ecotax. We find that the ecotax policy scenarios are progressive in both rural and urban India, depicting that the costs of these policies are not disproportionate across regions or social categories. These preliminary findings suggest that revenue recycling helps reduce the impact of the ecotaxes on the GDP and household expenditure and further reduces the air emissions intensity compared to a no-recycling scenario.

1 Introduction

Climate mitigation strategies are on the rise across the globe to achieve commitments to net-zero carbon emissions. India has also pledged to reach net-zero carbon emissions by 2070. It

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has set short-term targets of reducing its emissions intensity of GDP by 45% compared to 2005 levels and reducing the total projected carbon emissions by 1 billion tonnes, both by 2030. One of the fiscal strategies available to policymakers is pricing carbon – directly or indirectly – to provide producers with a price incentive to gradually reduce their polluting production processes and their use of inputs with embodied emissions. For developing countries like India, the effect of such policies on marginalised and low-income households is a pertinent question that needs examination. It is therefore important to examine the impact of such taxation policies on the economy, environment and, particularly, the households who will bear the incidence of the taxes.

We aim to answer three questions in this paper. First, what is the incidence of proposed environmental taxes (ecotaxes) on households in India? Second, what are its impacts on the Indian economy and environmental pollution? And third, how can revenue recycling dampen the negative impacts of tax incidence on the affected marginalised households? In this paper, we seek to analyse these issues using an Environmentally-extended Social Accounting Matrix (ESAM) framework.

2 Data and Scope

2.1 Environmentally-extended Social Accounting Matrix

We have constructed an ESAM for India 2019-20 (CSEP-ESAM)[2], which we use in this study for analysis. The CSEP-ESAM consists of households disaggregated by region (rural and urban), quintiles of annual consumption expenditures, and social categories identified in India (Scheduled Tribe (ST), Scheduled Caste (SC), Other Backward Caste (OBC), and Other Social Group (OSG)). The first three categories are considered marginalised groups in India. The level of disaggregation of industries, factors of production, households and environmental accounts provided in the CSEP-ESAM is novel for India in terms of the level of detail and its recency.

For this study, we have aggregated the CSEP-ESAM: the labour factors of production from 317 to 32 categories and the households from 80 to 40 (*Figure 1*). This has been done to focus the analysis on inequities between region and socio-economic categories of labour and households.

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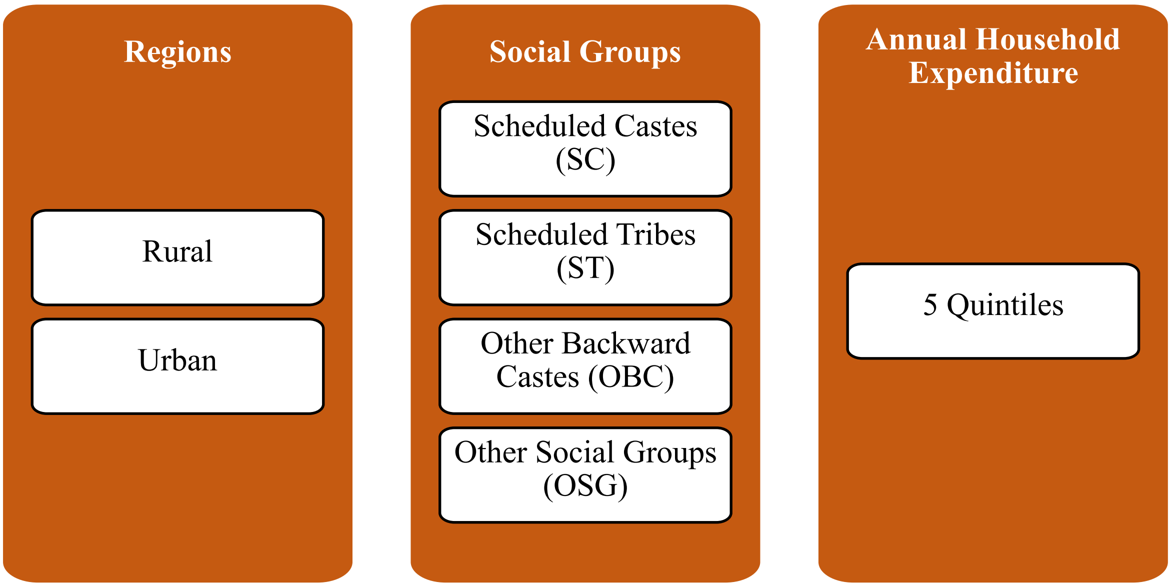
[2] The CSEP-ESAM is to be published as a CSEP working paper in mid-2023.

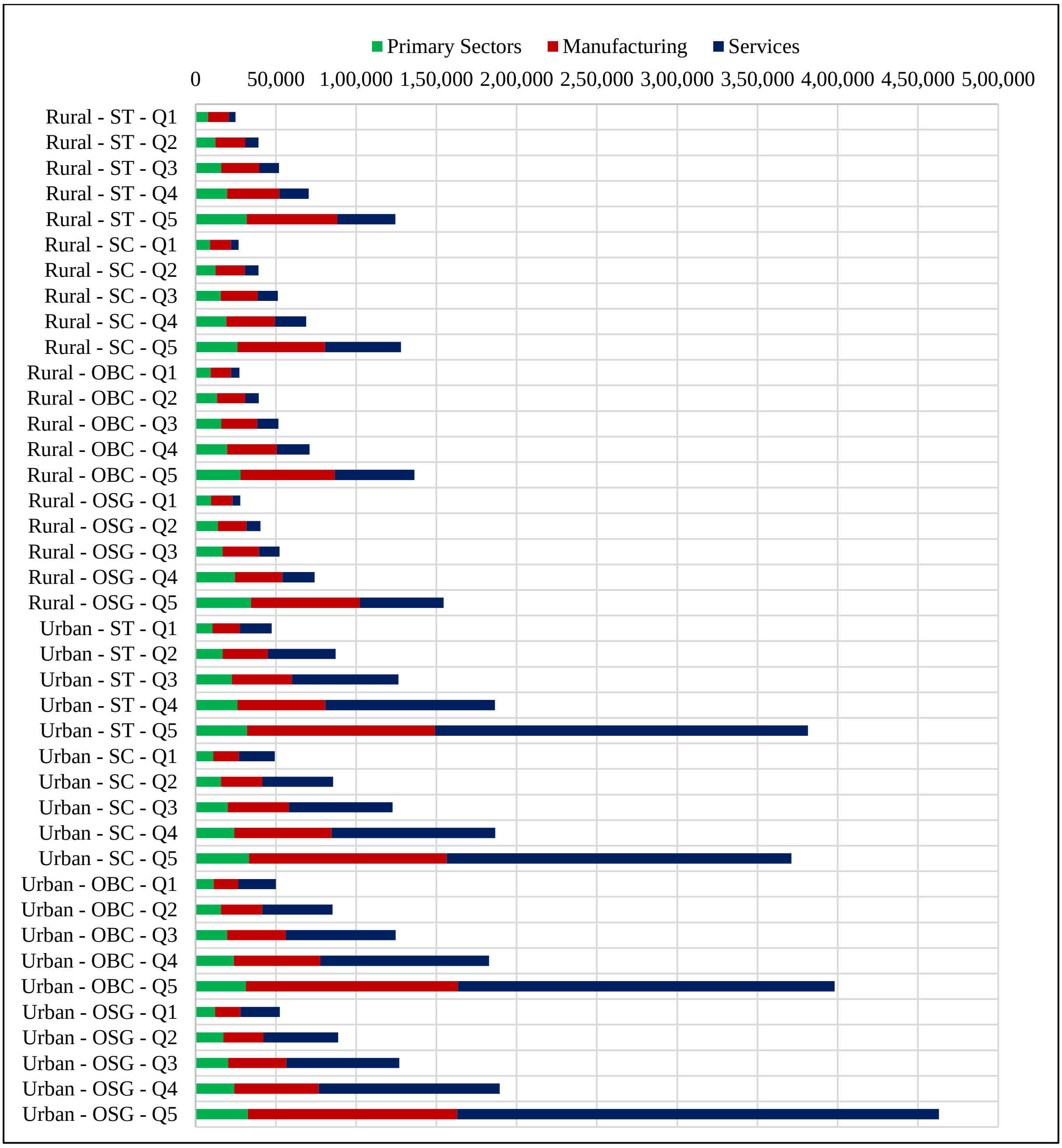
Figure 1: Forty Household Categories of the ESAM



Source: Authors' construction

There is a large variance in annual per capita private consumption expenditure (*Figure 2*) based on the region, social group, and expenditure class of a household. For example, a household belonging to the 'rural – ST – Q1' group spends more similarly (in quantum and product shares) to someone from the 'rural – SC – Q1' group compared to someone from the 'urban – ST – Q1' group. The share of expenditure in primary sectors (which mainly comprises agriculture and allied sectors expenditure and a smaller proportion of coal and lignite expenditure) is much higher in the Q1 and Q2 groups of any region or a social group. This share in the consumption basket changes from the lowest quintile to higher quintiles, with the share in services sectors' consumption increasing steadily in the urban region vis-à-vis the rural area. Thus, the impacts of any proposed ecotax will differ due to the differences in each household group's consumption baskets. This is the essential idea used in this study to examine the incidence of ecotaxes on household groups in India.

Figure 2: Annual Per Capita Private Consumption Expenditure by Household Category in 2019-20 (₹)



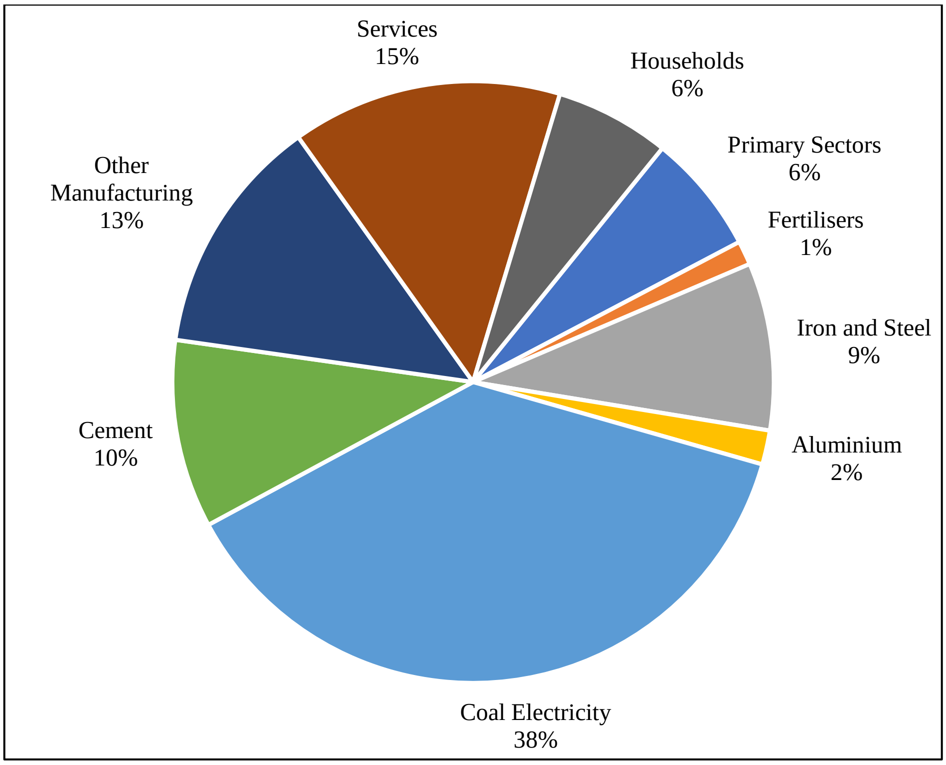
Source: Authors' computations based on NSSO (2013)

2.2 Polluting Sectors

Five polluting sectors have been selected to simulate the impact of an ecotax on the Indian economy: fertilisers, aluminium, iron and steel, coal-powered electricity generation, and cement. These are some of the more polluting sectors in direct air emissions, contributing almost 60% of the direct net air greenhouse gas emissions in India in 2019-20 (*Figure 3*).

Additionally, these are five of the six sectors included in the first phase of the European Union's Carbon Border Adjustment Mechanism (CBAM) (European Commission, 2023). The CBAM puts a price on the embodied carbon emissions of goods being imported by the EU – if the carbon price is already paid in the exporting country, then this can be deducted from the amount due by the EU importer.

Figure 3: Net Air Emissions in India by Sector in 2019-20



Source: Biennial Update Report 3 (BUR, 2021) and authors' computations

2.3 Choice of Ecotax Rates

Since there are no existing ecotaxes in India (barring the Clean Environment Cess / tax on coal production (Verma & Sivamani, 2022)), the prevailing Goods and Services Tax (GST) rates in India have been chosen as the four possible ecotax rates on the five polluting sectors – 5%, 12%, 18% and 28% (Goods and Services Tax Council, 2023). In this study, these ecotaxes have been applied to the outputs of these sectors, excluding the net indirect taxes (i.e., taxes minus subsidies) paid or received. This way of levying carbon taxes is more pragmatic and efficient, in terms of its implementation and monitoring (Chelliah et al. 2007 and Verma, 2021).

2.4 Revenue Recycling Avenues

Given the importance of the welfare of poorer and marginalised communities, this study investigates the use of direct monetary transfers to select households to reduce their ecotax burden – this is referred to as 'revenue recycling'. We have considered five revenue recycling cases (*Table 1*) for one ecotax rate of 18% across all five polluting sectors (this exercise can be repeated for other ecotax rates). Within the ESAM framework, revenue recycling is in the form of transfer payments from the government to the relevant household categories. The amount of revenue recycled for a particular household group has been taken as the total computed tax burden of that group.

Table 1: Revenue Recycling Scenarios

Revenue Recycling Case	**Regions**	**Social Groups**	**Quintiles**
1	None	None	None
2	Rural	Marginalised	Q1, Q2, and Q3
3	Rural	All	Q1, Q2, and Q3
4	Both	Marginalised	Q1, Q2, and Q3
5	Both	All	Q1, Q2, and Q3

Source: Authors' representation

3 Methodology

To address the question of the ecotax incidence on each household group, we have used the methodology presented by Verma (2021), which is an altered methodology of Datta (2010). This method has been used to analyse the incidence of a proposed carbon tax on the 5 polluting sectors by using a price-vector model.

The price-vector model computes the change in the relative prices of the 45 sectors of production, 32 categories of labour factors of production, 1 category of capital factor of production, and 40 categories of households of the CSEP-ESAM. The relative price changes are used to measure the per-household tax burden on the 40 categories of households[3] by computing the change in the budget shares for these households, to give the tax incidence for

[3] Regions (2) x Social Categories (4) x Quintiles (5) = 40 categories

each household group. The equations below have been used to simulate the impact of ecotaxes for four policy scenarios of varying ecotax rates[4].

$$P_{118\times1} = (I - A^{T})^{-1}_{118\times118} \cdot V_{118\times1} \quad (1)$$

$$\Delta P_{118\times1} = (I - A^{T})^{-1}_{118\times118} \cdot \Delta V_{118\times1} \quad (2)$$

$$(Tax\ Burden)_{1\times1} = \left\{\frac{X_k}{Y_k}\right\}_{1\times118} \cdot\ \Delta P_{118\times1} \quad (3)$$

$$Per - Capita\ Tax\ Burden = \frac{Initial\ Expenditure \times Tax\ Burden - Initial\ Expenditure}{Population} \quad (4)$$

Thereafter, the relative price changes (refer to equations 3 and 4) are used to measure the per-household tax burden on the 40 categories of households (2 regions, 4 social categories, and 5 quintiles) by computing the change in the budget shares for these households, to give the tax incidence for each household group.

The impact on the economy has been simulated by modifying the methodology proposed by Grottera et al. (2015), as also has been done by Verma and Sivamani (2022). The impact on the air emissions (GHGs) and land degradation have been computed by using the pollution coefficients from the ESAM. Following equations[5] are used for computing these effects.

$$T = t * Q \quad (5)$$

$$O = \left[1 - \frac{T}{Y}\right] \quad (6)$$

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[4] These equations are used on the CSEP-ESAM which has 118 endogenous sectors and 6 exogenous sectors.
A_T is the transpose of the input coefficient matrix
V is the matrix of the share in value added of the exogenous vectors
P is the price vector
$\left\{\frac{X_k}{Y_k}\right\}$ is the share of kth household's expenditure on the 118 sector commodities of the ESAM

[5] T is the tax revenue, t is the tax rate and Q is Quantity of taxed commodity, in present case the value of 5 polluting sectors
O is Proportion of effective output due to the levy of tax, represented in the diagonal elements of the O matrix, A is the input coefficient matrix pre ecotax and A_{eff} is the coefficient matrix post the levy of ecotax
Y_{eff} is the total output post the levy of ecotax
E is the total pollution for air emissions and P is the pollution coefficient matrix

$$O * A = A_{eff} \quad (7)$$

$$Y_{eff} = [I - A_{eff}]^{-1} * \Delta X \quad (8)$$

$$E = P * Y_{eff} \quad (9)$$

The change in the exogenous matrix (ΔX) listed in Equation 8 was used to compute the changes in the total output due to the levy of an ecotax.

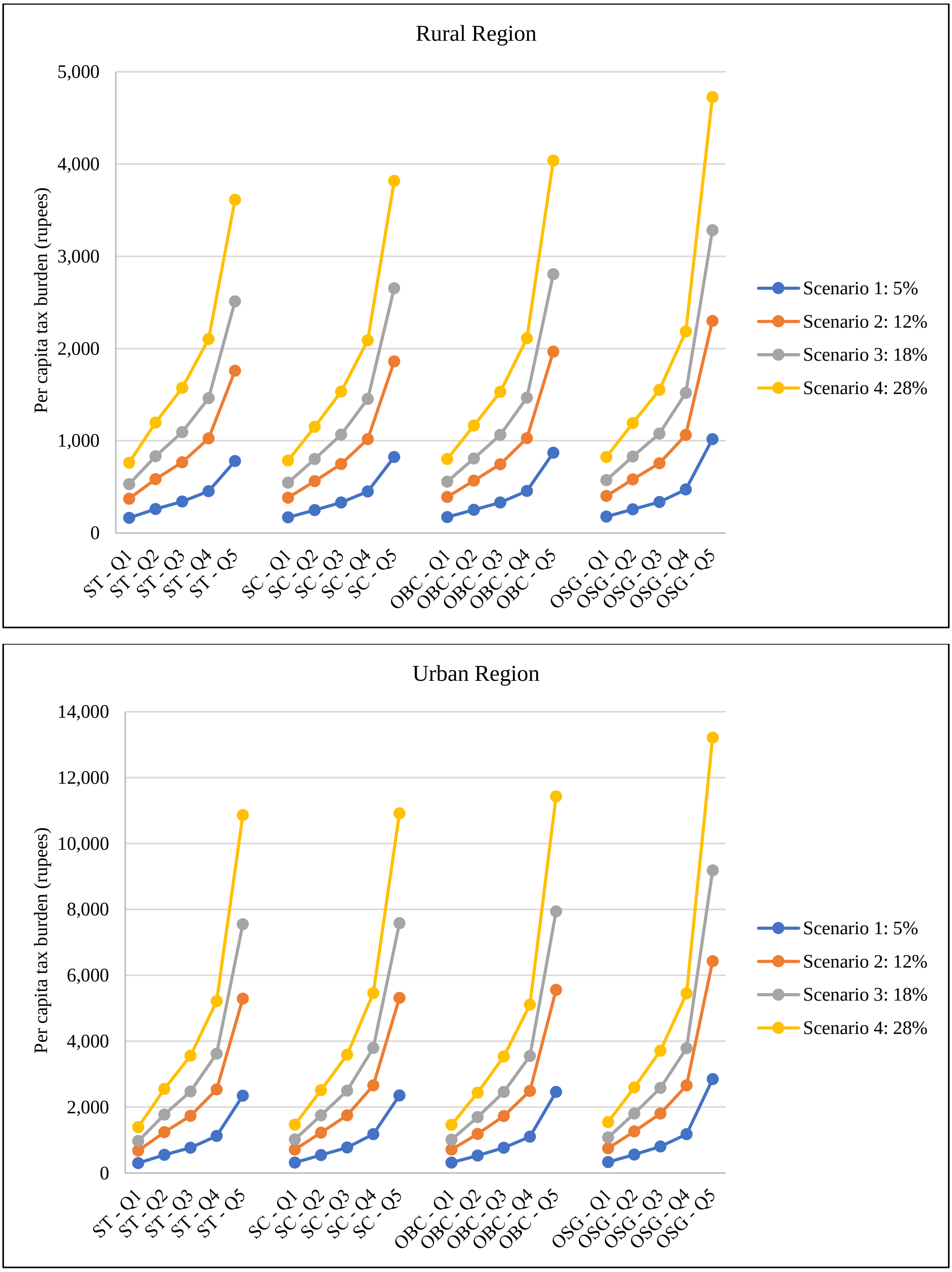
We have applied the ecotax on the gross value of output (Output *minus* Net Indirect Taxes) of the 5 polluting sectors. For each of these cases, we have looked at revenue recycling scenarios. The revenue recycling values come in the form of government transfers to households, and are in proportion to the impact of the taxes on household incomes. For each scenario, taxes are recycled only for Quintiles 1 and 2. These are applied to either all social groups, or only the marginalised social groups (ST/SC/OBC). Further, these are either applied only to the rural sector, rural and urban equally, or slightly higher for the rural sector.

4 Results

4.1 Incidence on Households

The tax burden is measured as the ratio of the increase in household expenditure due to a tax to the original household expenditure. The per capita tax burden of each of the four ecotax scenarios (5%, 12%, 18%, and 28%) on each household categories are shown in *Figure 4*. These results show that the per capita tax burden increases progressively for households in India, irrespective of the regions. In fact, the impact of ecotaxes on the top most quintile increases steeply both in the rural and urban areas. Therefore, the incidence of ecotaxes in India is in accordance with the equity aspect of the Adam Smith's cannons of taxation.

Figure 4: Per Capita Tax Burden of Four Ecotax Scenarios



Source: Authors' computations

4.2 Impact of Ecotaxes

The results from the preceding section depict that the incidence of ecotaxes with varying rates are similar in terms of the progressivity. Therefore, we have analysed the impact of the 18% ecotax levied on the five polluting sectors on the economy and emissions, shown in *Table 2*. The GDP drops by 1.63% due to the additional tax, and the price changes cause household expenditure to fall by 1.73%. Greenhouse gas emissions reduce, as well, by 3.06%, which results in a 1.46% reduction of the air emissions intensity of GDP.

Table 2: Impact of Ecotax on Economy and Emissions

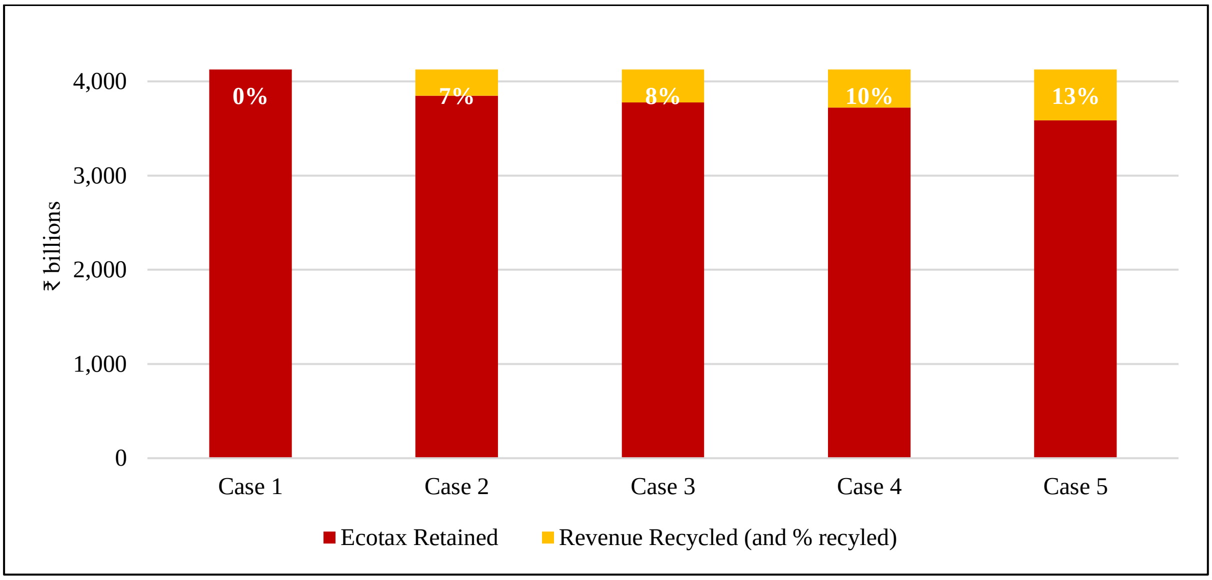
Parameters	**% Change**
Gross Domestic Product	-1.63
Household Expenditure	-1.73
Air Emissions	-3.06
Air Emissions Intensity of GDP	-1.46

Source: Authors' computations

4.3 Effects of Revenue Recycling

The five revenue recycling cases have been highlighted in Section 2.2, with the first case being the no recycling scenario. Each revenue recycling case has been computed using the 18% ecotax scenario, where the government raises an additional ₹4,127 billion in ecotaxes. *Figure 5* shows the value of revenue recycled (including the percentage share) and the remaining amount of the raised ecotax for each revenue recycling case. The share of revenues recycled through ecotaxes range from 0%, in the no recycling scenario, to 13%, in the scenario where revenues are recycled to all households in the first three quintiles of annual consumption expenditure.

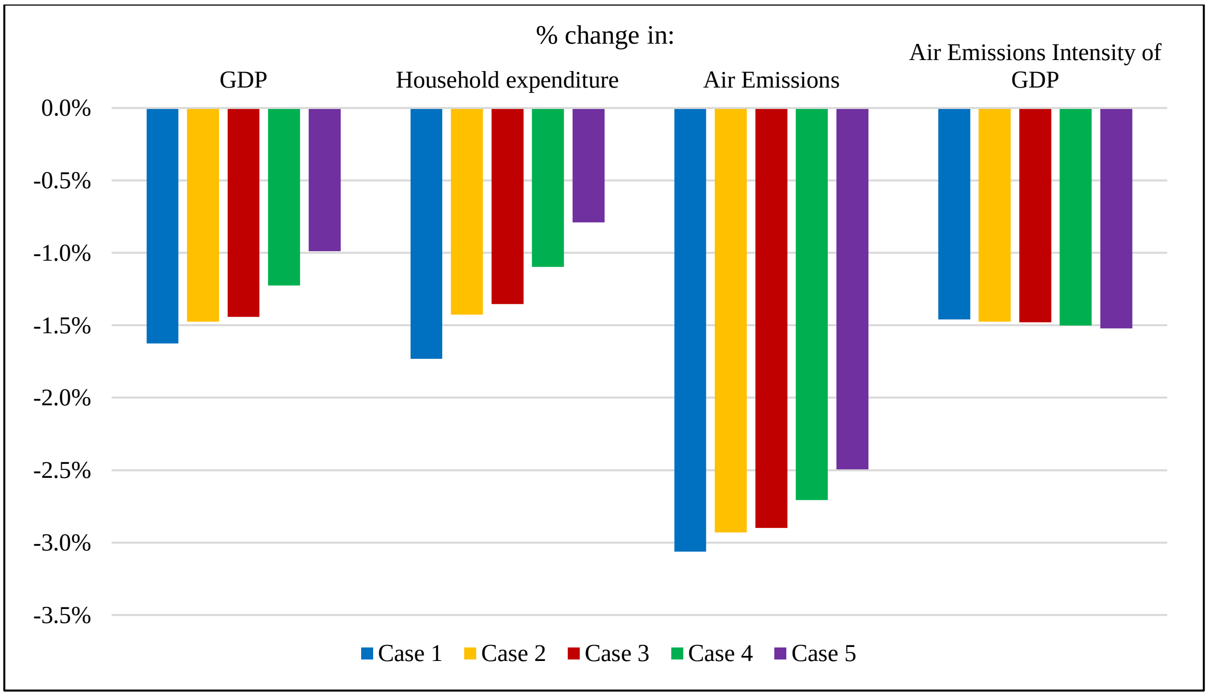
Figure 5: Revenue Recycling Cases



Source: Authors' computations

Once the revenues have been recycled in the form of transfer payments of the entire tax burden faced by the relevant household category, the new impacts on the economy and emissions have been computed (*Figure 6*).

Figure 6: Impacts of Revenue Recycling Cases on Economy and Emissions



Source: Authors' computations

5 Conclusions

We find that ecotax policy scenarios appear to be progressive for both rural and urban India, depicting that the costs of these policies are not disproportionate across region or social categories. These findings suggest that revenue recycling can help reduce the impact of the ecotax on GDP and household expenditure, and further reduces the air emissions intensity compared to a no-recycling scenario. The implementation of revenue recycling through transfer payments can be done through the Direct Benefit Transfer (DBT) programme of the Indian government – this is currently being done for various schemes through the *Aadhaar* system, which helps identify the targeted beneficiaries of welfare schemes (Unique Identification Authority of India, 2023). The revenue recycling brings benefits to the economy and environment in the form of dampened reductions in GDP and household expenditure, and a greater reduction in the emissions intensity of GDP. This underscores the importance of revenue recycling in the economy.

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