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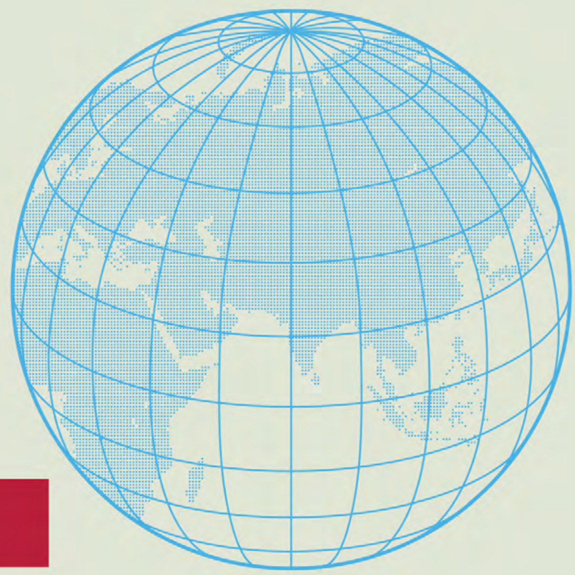
Taxation Alternatives for India's Energy Transition

ESAM Analysis

Rajat Verma
Laveesh Bhandari



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Centre for Social and Economic Progress (CSEP)
CSEP Research Foundation
6, Dr Jose P. Rizal Marg, Chanakyapuri,
New Delhi - 110021, India

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Taxation Alternatives for India's Energy Transition
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Rajat Verma
Associate Fellow
Centre for Social and Economic Progress
New Delhi, India

Laveesh Bhandari
President and Senior Fellow
Centre for Social and Economic Progress
New Delhi, India

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List of Abbreviations

CBAM	Carbon Border Adjusted Mechanism
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CT	Carbon Tax
CSEP	Centre for Social and Economic Progress
CGE	Computable General Equilibrium
DTT	Distance Travelled Tax
E3	Economic Efficiency, Emissions Intensity, and Equity
ESAM	Environmentally-extended Social Accounting Matrix
EU	European Union
GPS	Global Positioning System
GST	Goods and Services Tax
GHG	Greenhouse Gas
GDP	Gross Domestic Product
HHs	Households
I-O	Input-Output
OBC	Other Backward Class
OSG	Other Social Group
SC	Scheduled Caste
ST	Scheduled Tribe
SRTUs	State Road Transport Undertakings
SAM	Social Accounting Matrix
SPSD	Social Policy Simulation Database
UK	United Kingdom
UT	Users Taxes
VAT	Value Added Tax
VMT	Vehicle Miles Travelled

Executive Summary

India has pledged to achieve net zero by 2070, which requires a reduction in CO_2 emissions and a shift towards clean energy. However, this shift will have fiscal implications, as revenue generated by fossil fuels (both tax and non-tax revenue in 2019–20) accounts for 3.2% of India's GDP. This calls for the need to not only find alternative tax options to compensate for potential loss in revenues but also examine how these tax alternatives will impact economic efficiency, emissions intensity, and equity (E3). This study addresses the critical question of how the replacement of existing fossil fuel taxes with various indirect tax options will influence E3.

While previous research has explored the potential impacts of introducing new eco-taxes, this study introduces a novel perspective by evaluating the effects of replacing existing fossil fuel taxes with alternative taxation strategies, particularly within the unique context of India.

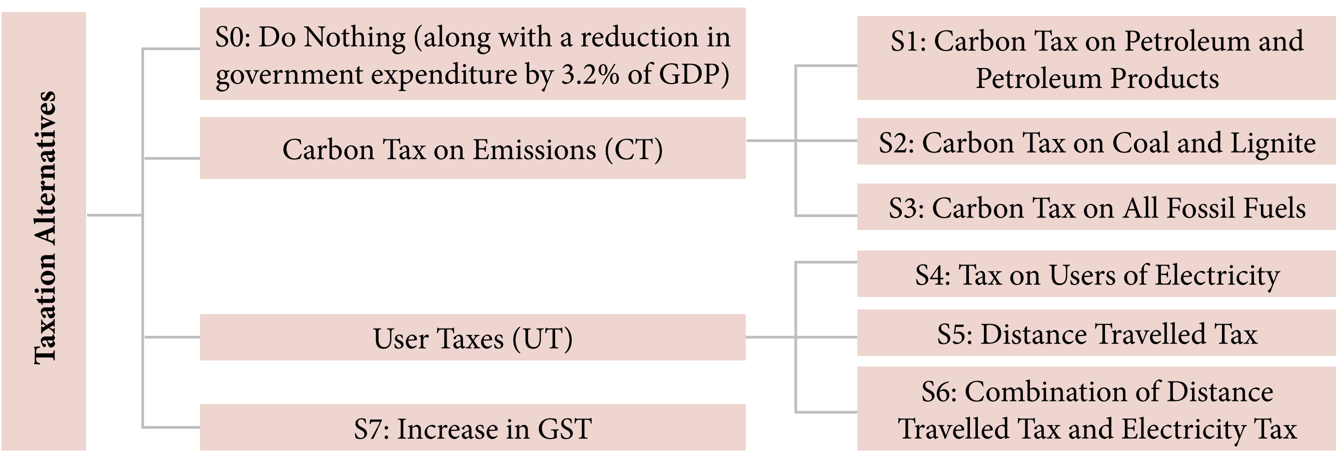
This paper uses the aggregated version of the Environmentally-extended Social Accounting Matrix (ESAM) for India 2019–20, where labour has been aggregated into 32 categories and households into 40 categories. The study has substantially altered the multiplier model and the price vector model. Using these methods, we estimate the potential impacts of replacing existing fossil fuel taxes with seven different tax options, which can be categorised under three sub-heads—Carbon Taxes (CT), User Taxes (UT), and Goods and Services Taxes (GST). These scenarios have been explained below.

The study finds that the restructuring of fossil fuel taxes will impact the welfare of households by marginally impacting their tax burden. The incidence is mildly regressive in almost all the scenarios, except in the case of the distance travelled tax and a combination of electricity and distance travelled tax. The macroeconomic and environmental impacts of these taxes vary across scenarios.

We find three key results. First, a carbon tax on coal emissions has positive impacts on real GDP and reduces emissions. However, it is regressive. Moreover, a carbon tax on coal would only hasten the transition process but not address the long-term fiscal challenge. Second, user taxes (scenarios 5 and 6) may be difficult to levy institutionally and are mild to strongly progressive. However, they are likely to have a strong adverse impact on real GDP and emissions. Third, a proportionate increase in GST results in a strong negative impact on emissions and mild impacts on equity and real GDP.

We can conclude there exists a trade-off in all these scenarios. In the medium term, fossil fuel taxes can be replaced with a carbon tax on emissions from coal; however, this will negatively impact equity. In the long run, replacing fossil fuel taxes with user taxes will negatively impact real GDP, whereas if a proportionate increase in the GST replaces fossil fuel taxes, then this will impact equity. The regressivity concerns can be addressed by providing revenue transfers from the State to the lowest quintiles and can be examined in future studies.

All these taxation alternatives will involve concerns related to institutionalising these in the Indian context, which often involves political economy concerns and addressing structural changes, which are dynamic challenges and hence will require further investigation. There will be intrinsic costs involved in choosing each of these alternatives, which is difficult to factor into the model simulations.



Note: CT stands for Carbon Tax and UT stands for User Taxes. Source: Authors' Representation..

1. Introduction

Countries are transitioning from fossil fuels to clean energy, aiming to reduce their greenhouse gas (GHG) emissions and achieve net-zero targets. India is no exception, as in November 2021, it also pledged to achieve net zero by 2070. To realise this, India aims to aggressively reduce its carbon dioxide (CO_2) emissions and is advancing towards replacing fossil fuel energy production with clean energy. While this shift will play a pivotal role in achieving these targets, it will be accompanied by a decline in government revenues, as in 2019–20, fossil tax revenue accounted for 3.2% of GDP (Bhandari & Dwivedi, 2022). This, thus, necessitates the identification of alternative taxation options that may compensate for the potential loss in revenue.

Considering India's low tax-to-GDP ratio (16.1% in 2019–20), the revenue generated by fossil fuels holds substantial significance. Addressing the potential revenue loss requires implementing compensatory taxation measures. The imposition of any new tax (including environmental taxes) is expected to have distributional impacts, as it may have a disproportionate impact on the welfare of households across different income strata. In addition, there would also be macroeconomic and environmental implications.[1] Thus, it becomes essential to analyse how the introduction of new taxes will impact the welfare of households, the economy and the environment. This paper attempts to examine these effects using the Environmentally-extended Social Accounting Matrix (ESAM) 2019–20 constructed for India by Chadha et al (2023).

The study's major objective is to analyse the implications of closing the fossil fuel revenue gap through taxation options and thus examine scenarios of different taxation alternatives for providing stability of government revenues. It does not intend to capture the health impacts of, say, a carbon tax or any other second-order impacts from the restructuring of the tax structure. Further, the study will not delve into renewable energy targets and any other schemes that are outside the purview of exploring alternative taxation options for closing the revenue gap. It is important to note that the gradual revoking of fossil fuel subsidies by enhancing spending efficiency and eliminating extrabudgetary spending—which has been in the range of 3–5% of State GDP (CRISIL, 2022; Gupta & James, 2023)—could also generate some funds for the Government of India. However, this issue is not considered in this study. Subsequent studies will attempt to examine the former issue, in addition to analysing the implications of utilising these funds to finance renewables in India.

Among Adam Smith's four canons of taxation, one is the ability-to-pay principle. According to this, taxpayers' contributions should be in proportion to their respective abilities, which implies the incidence of tax should be equitable. Even if the incidence of a tax replacing the fossil taxes is found to be progressive, it may still have an adverse impact on the welfare of certain sections of society, which would create an additional impact on these households and given their relatively low incomes, would adversely affect them much more than their counterparts. In addition, another equally important objective is to simultaneously optimise economic efficiency—i.e., move away from more to less distortionary taxes. Environmental taxes are considered to be less distortionary when imposed by replacing existing taxes because these taxes serve a dual purpose: environmental protection and revenue generation (see Fullerton & Metcalf, 1997; Goulder, 1995). The tax revenue collected from carbon taxes can be redistributed through revenue recycling policies, which have the potential not just to correct the inequities, but also to improve economic efficiency and environmental quality. It is thus imperative to design a carbon tax alongside necessary revenue recycling policies to ensure a smooth, equitable economic transition while aiming for a clean energy transition. To identify the potential gainers and losers of these policies and their impact on the environment, this study attempts to understand how various taxation alternatives and revenue redistribution policies will impact economic efficiency, emissions intensity and equity (E3) in the Indian economy.

There are various taxation alternatives one could consider. These could be a carbon tax, a change in the overall rates of existing indirect taxes such as Goods and Services Tax (GST) or imposing or increasing

[1] The environmental implications can be further linked to impacts on health and, consequently, worker productivity. While these impacts can be better measured in a Computable General Equilibrium (CGE) model, this study does not attempt to quantify them, as its primary objective lies elsewhere.

taxes such as user-based taxes (electricity duties and distance travelled taxes) to compensate for the revenue loss. These and other fiscal alternatives have been explored in-depth which we will examine in Section 2. Section 3 surveys the literature on the distributional, economic, and environmental impacts of taxes, followed by Section 4, where the data and methods used to simulate the impact of taxation alternatives in India are discussed. Section 5 examines the analyses of the implications of proposed taxation options on E3, followed by Section 6 which provides the concluding remarks for this study.

2. Taxation Alternatives: Institutional Concerns

A transition away from fossil fuels entails a reduction in their consumption and, consequently, government revenue—which has been a critical source of income for both the Centre and State Governments. While identifying alternative taxation options, this study also considers implementation and institutional aspects. Bhandari et al. (2023) examined these issues and identified several taxation alternatives, along with their institutional implications. Table 1 provides this list of taxation options, their potential revenue impacts, and institutional feasibility.

Considering the various taxation instruments in India—which comprise direct and indirect taxes—the potential loss in revenue may be compensated for either by imposing additional taxes or by amending existing ones. In the case of direct taxes—key components of which include personal income tax and corporate income tax—additional revenue may be generated by increasing tax rates, reducing minimum thresholds, or including currently non-taxable income sources, such as those from agriculture. However, while the first two options are unlikely to generate adequate revenues, imposing a tax on non-taxable incomes like agricultural income requires a constitutional amendment and may be infeasible due to political and economic considerations (Bhandari et al., 2023).

Additionally, the share of direct taxes in the overall GDP/tax revenue has historically been significantly low and stagnant (around 6% of GDP presently, up from 2% of GDP from 1950 to 1990). Thus, there is a need to explore other taxation options—a bouquet of options is available under indirect taxes—which are not only institutionally feasible but may also generate adequate revenue to compensate for the potential revenue loss.

One possible option is to expand the base of the already existing Goods and Services Tax (GST) by including more items, such as electricity, liquor, petroleum, and services such as agricultural services, education, banking, etc. While including these goods and services within the ambit of GST may generate significant revenues, doing so requires institutional changes and will shift a substantial source of revenue from states, and is thus unlikely to be implemented (as discussed in Table 1).

Another option is to impose higher user taxes, like a tax on electricity consumed and a tax on distance travelled. These user taxes have the potential to generate significant revenues for the government, as electricity consumption and transportation will only rise in the near future with rising incomes. However, their implementation may involve significant challenges, which include a lack of monitoring and collection infrastructure, a constitutional amendment if revenues previously collected by States are to be shared between the Centre and State governments (as in the case of electricity use), technological challenges, etc. Considering these implementation challenges, it may be difficult for the government to levy such user taxes immediately, but it does provide an interesting revenue generation instrument. The Government of India is already contemplating replacing FASTag with the Global Positioning System (GPS) for toll collection at national highways. This technology, if successfully installed, can be used for implementing distance-travelled taxes (Money Control, 2024).

Considering the institutional challenges associated with amending the existing tax structure—as per the constitution—or introducing user taxes, another taxation alternative could be levying a carbon tax. A carbon tax has the potential to generate significant revenues and can act as a medium-term solution, as in the long run, the overall revenue generated from this option will decrease as emissions decline for complying with the Net Zero target. A carbon tax, compared to the tax alternatives discussed earlier, can in principle not only generate revenues for the government but also address the negative externalities by increasing the cost of emissions. Further, this could also provide the possibility of generating revenue sources domestically.

Table 1: Tax Revenue Options Before India

Taxation Heads	Potential Options Available	Significant Additional Revenue Generation	Long-Term Revenue Potential - Continuity	Institutional Change Required	State Autonomy over Additional Resources	Notes
Personal Income Tax	Increase tax rate at higher income levels	Low to moderate	Yes	No	Low	Revenues less sensitive to higher tax rates.
Personal Income Tax	Reduce minimum threshold	Low	Yes	No	Low	Generally believed to be costly to implement with little returns.
Personal Income Tax	Include agricultural income	High	Yes	Yes	Low	Constitutional amendment required.
Corporate Income Tax	Increase tax rate	No	No	No	Low	Globally comparable rates currently; foreign investment sensitive to tax rates.
Goods and Services Tax	Rate rationalisation	Moderate	Yes	No	Low	Difficulties in building consensus in the GST Council.
Goods and Services Tax	Inclusion of more goods and services, excluding electricity and liquor	Moderate to high	Yes	Yes	Low	Moving from State Value Added Tax (VAT)/sales tax to GST reduces State autonomy.
User Taxes	Distance travelled tax	High	Yes	Perhaps#	Low	#Monitoring of distance travelled required for each vehicle. No constitutional amendment required if imposed by Central Government only (Article 248 applies). Constitutional amendment required if shared by both Central and State Governments.
User Taxes	Electricity duties	High	Yes	Perhaps#	High	#State Governments only – No constitutional amendment required (Electricity duties in the State list). Central + State governments – Yes, Constitutional amendment required.
Carbon Tax	Single national carbon tax (all fuel taxes subsumed)	High	No*	Yes (Constitutional Amendment)	Low#	*Carbon taxes will eventually become negligible. #States will lose autonomy over fuel taxes.
Carbon Tax	Dual carbon tax - separate for Centre and states (all fuel taxes subsumed)	High	No	Yes (Constitutional Amendment)	High#	#States have autonomy, but a double taxation regime will be inefficient.
Carbon Tax	Implemented by the Centre under Article 248 (state-level fuel taxes continue)	High	No	No	Moderate#	#States retain some autonomy as fuel taxes are retained, but a double taxation regime will be inefficient.
Carbon Tax	Subsumed under GST (based on emissions by fossil fuel users)	High	No	Not clear	Low	Emissions monitoring + mapping of emissions to notional output value required.
Carbon Tax	Subsumed under GST (on the basis of potential emissions of fossil fuel seller)	High	No	Not clear	Low	Mechanism to monitor and map potential emissions to tax rate.

Source: Bhandari et al. (2023).[2]

[2] Readers interested in understanding the taxation reforms needed to enhance India's tax capacity may additionally refer to the IMF (2023).

Imposition of carbon taxes also involves certain implementation challenges, including the monitoring of emissions and mapping of emissions to the notional value[3] (if carbon taxes are to be subsumed under GST). Despite these challenges, levying a carbon tax will be pragmatic and politically feasible to compensate for the potential revenue loss, especially considering the worldwide demand for pricing carbon emissions and in response to actions taken by certain countries in this regard, such as the introduction of the Carbon Border Adjusted Mechanism (CBAM) by the EU and UK.

After considering the implementation and institutional challenges—like effectiveness in revenue generation, long-term sustainability, and the requirement of institutional changes while preserving States' autonomy—associated with these taxation options, this study examines the potential distributional, economic, and environmental impacts of certain taxation alternatives that can be broadly classified under carbon taxes, user taxes, and an increase in aggregate GST rates.

Carbon taxes on fossil fuel emissions can generate significant revenues; however, these revenues cannot be sustained long-term. These taxes may hamper States' autonomy, but they need examination because emissions from fossil fuels contribute significantly to overall emissions. User taxes also have the potential to generate significant revenues, which are sustainable in the long run and, when designed appropriately, may also retain States' autonomy over the revenues generated. One taxation option within user taxes that may be considered is a combination of Distance Travelled Tax (DTT) and Electricity Tax, where approximately 60% of revenue can be generated from DTT, with the Centre having autonomy, and the rest being generated from Electricity Tax, which will be collected and utilised by the states to retain their autonomy. The 60:40 proportion is based on the quantum of revenue lost from fossil fuels by the Centre and the States, correspondingly (Bhandari & Dwivedi, 2022).

Rationalisation of rates within the GST may also be considered as another taxation alternative, as it would be easy to implement, requiring no institutional amendments, but requires a common agreement within the GST Council. This option has the potential to generate significant revenues but might leave States with less autonomy over additional resources.

3. Distributional Impacts of Taxation Alternatives: Lessons from the Literature

The discussion on the implications of environmental policies and taxes has become extremely important in the era of changing climate. Assessing the potential impacts on households' welfare, emissions, and economic efficiency helps in examining the costs vis-à-vis benefits for various taxation alternatives and, hence, is a useful analytical exercise.[4]

In the preceding section, we examined several possibilities for designing indirect taxes to compensate for the revenue loss in India due to the energy transition. It is a well-established fact that indirect taxes tend to be more regressive than direct taxes, as the burden of taxation can be easily shifted. The incidence of a tax is said to be regressive when its impact is proportionally higher on low-income households than on high-income households.

The analysis of the incidence of a carbon tax and its distributional impacts has been discussed extensively in the existing literature; however, there is no definitive answer to its potential incidence in the context of carbon taxes, possibly because the burden of any tax depends on a multitude of factors, such as the existing tax structure, the prevalence of distortionary taxes, and expenditure patterns. Wang et al. (2016) comprehensively review the existing literature on the distributional effects of a carbon tax and conclude that in the absence of revenue recycling, the carbon tax is regressive in developed countries, while no general conclusion can be drawn for developing countries.

Hamilton & Cameron (1994) used an Input-Output (I-O) model, coupled with a detailed energy disposition account and a micro-simulation model of household expenditures, and found the distributional consequences of a carbon tax of $101.56 per tonne of carbon to be moderately regressive in Canada. De Bruin & Yakut (2018) also found the impact of increasing an already existing carbon tax to be regressive in

3 Notional value in this context is defined as "proportional to the emissions or the amount of 'bad' being caused by the emissions" (Bhandari et al., 2023).

4 Understanding the political economy of introducing such taxes is also pertinent as it analyses questions concerning their design, utilisation, and distribution, and that of their associated proceeds. However, we do not delve into this currently.

Ireland. They utilised an ESAM multiplier analysis and estimated that an increase in carbon tax by €20 (i.e., double the existing tax rate) in the Irish economy would result in the poorest households losing a higher share of their income (0.67%) compared to the richest households (0.28%), as the natural gas supply, transport, and energy sectors are the most affected production sectors because they experienced the highest increase in producers' prices, which account for a relatively higher share in the consumption basket of poorer households. This is expected to reduce economy-wide emissions by just 5%, indicating the need for more stringent measures to reduce emissions.

Johne et al. (2023) assessed the potential incidence of a nitrogen tax on different households in Germany using the I-O model along with household expenditure data. They found the incidence of a nitrogen tax to be regressive, as the resulting price hike would have a substantial adverse impact on the budgets of low-income households.

Literature shows evidence of progressive impacts for developed countries as well. Beck et al. (2015) found the incidence of the existing carbon tax of \$30/t CO_2 in British Columbia to be highly progressive, as its adverse impact falls more on high-income households than low-income households. Compared to the no-carbon-tax scenario, its imposition worsened households' welfare by 0.53% in aggregate but, at the same time, also reduced emissions by 9.2%. In the case of Australia, by employing a Computable General Equilibrium (CGE) model using the Social Accounting Matrix (SAM) database, Sajeewani et al. (2015) found carbon taxes to have a mildly progressive impact on households' income. In addition to income distributional impacts, carbon taxes also resulted in a fall in real GDP and decreased emissions by 11.94%.

Metcalf (2023) analysed the distributional impacts of a new Vehicle Miles Travelled (VMT) tax and Gasoline Tax swap. Using the 2017 National Household Travel Survey data and estimated income elasticity of fuel intensity, he found the incidence of a tax swap to be mildly progressive for all households with incomes below \$200,000—i.e., progressive at all but the highest income levels.

The literature, we find, surmises that the distributional impacts of environmental taxes are inconclusive for developing countries as well. Brenner et al. (2007) found the impact of a carbon charge of 300 yuan/tCO_2 to be progressive in China, whereas Datta (2010) used an input-output approach to analyse the impact of fuel tax in India and found that its incidence would be progressive, except for kerosene, for which the incidence would be regressive. Using the Suits Index of tax progressivity, Agostini & Jiménez (2015) found the distributional impact of the gasoline tax to be slightly progressive. They also estimated that the incidence of a 25% reduction in the gasoline tax implemented in 2008 made the tax less progressive, as it benefitted the households in the higher income deciles more because the fraction of expenditure incurred by households on gasoline increases with an increase in income.

The policy simulation scenario for Mexico, as studied by Renner (2018) and based on the I-O model coupled with household survey data, found regressive effects of a carbon tax of \$50 per tonne of CO_2/CO_2e emissions, as it resulted in relative welfare losses of 4.2% and 3.4% of total expenditures for the poorest and richest households, respectively, highlighting the regressive nature of the tax.

Moz-Christofoletti & Pereda (2021) examined the short-run welfare and emission effects of an economy-wide carbon tax using the Hybrid Input-Output approach and the Brazilian Household Expenditure Survey of 2008–09. They found that while the imposed tax led to an improvement in environmental emissions, it also led to welfare losses of 0.06% and 0.10% in total expenditures for the richest and poorest households, respectively, highlighting the regressive nature of the tax. The study also found that the resulting regressivity may be reduced if the tax is imposed on targeted products,[5] rather than having an economy-wide carbon tax.

Dissou & Siddiqui (2014) argued that assessing the impact of a carbon tax on households is incomplete and misleading if it only considers changes in commodity prices. Using a general equilibrium analysis built on the SAM and household survey data from the Social Policy Simulation Database (SPSD), the authors found that while the carbon tax led to a fall in CO_2 emissions, GDP, exports, imports, and total consumption in the economy, it also led to a fall in returns to labour and capital. While the change in commodity prices has regressive welfare effects, the incidence of the changes in factor prices is progressive. They found a U-shaped relationship between carbon tax rates and inequality: a carbon tax can reduce inequality (and the resultant incidence is pro-

[5] Targeted sectors include products with high carbon content, such as commuting and transportation, and food and beverages.

gressive) at lower tax levels, and the reverse is the case at high tax rates, suggesting that the positive impact of changes in factor prices on inequality outweighs the negative impact of changes in commodity prices at low levels of carbon tax and vice versa.

The literature indicates ambiguity regarding the distributional impacts of environmental taxes. While assessing the impacts of carbon taxes on households, studies have argued that it mainly depends on the impacts of price changes and household expenditures (Moz-Christofoletti & Pereda, 2021; Shang, 2021). Expenditure shares of households have been considered a better parameter than households' income (as consumption expenditure is a proxy for permanent income)[6] for examining distributional effects (Poterba, 1989). Fullerton (2011) stresses that the overall distributional impact—and thus the incidence—of environmental policy is influenced by several factors, including consumption expenditure of households, production structure and factors of production, benefits of environmental protection, costs of adjustments and transition, and government transfers, among others, which may have a disproportionate impact on poor households. It may be complex and require multiple analyses to model all the distributional impacts of a policy. The surveyed literature underscores that the introduction of a new tax in the economy has ramifications across equity, the economy, and the environment, a comprehensive analysis of which is contingent upon the multifaceted forces at play.

4. Simulating the Implications: Method and Materials

4.1 CSEP ESAM

This study uses the Centre for Social and Economic Progress–Environmentally extended Social Accounting Matrix (CSEP-ESAM) for India 2019–20, which comprises 45 production sectors. Labour and households are disaggregated into 318 and 80 categories, respectively. Households are classified based on region (rural or urban), social groups (Scheduled Caste (SC), Scheduled Tribe (ST), Other Backward Class (OBC), and Other Social Groups (OSG)), and annual consumption expenditure, which allows us to analyse how different categories of households will be impacted due to an exogenous change/shock in the economy (Chadha et al., 2023). It also provides information on three categories of environmental impacts: air, water, and land.

For this study, we will utilise the aggregated CSEP-ESAM, where labour has been aggregated into 32 categories and households into 40 categories.[7] It will allow us to analyse the equity implications of taxation options across different categories of households for bridging the fossil fuel revenues gap in a meaningful way. All these categories of labour and households are important for understanding the potential differential impacts of exogenous changes in taxation policy due to the varying socio-economic categories.

The impact on emissions due to the levying of new environmental taxes will be assessed using only the impact on air emissions for this study. The impact of alternative taxes on economic efficiency will be examined through changes in certain macroeconomic variables such as GDP and prices, using the ESAM by adopting the methods discussed in the following sections.

4.2 Taxation Alternatives

The primary objective of this study is to estimate the implications of identified taxation alternatives for bridging the fossil fuel revenue gap. To this end, it is important to understand how to determine the level of such taxes and where to levy them.

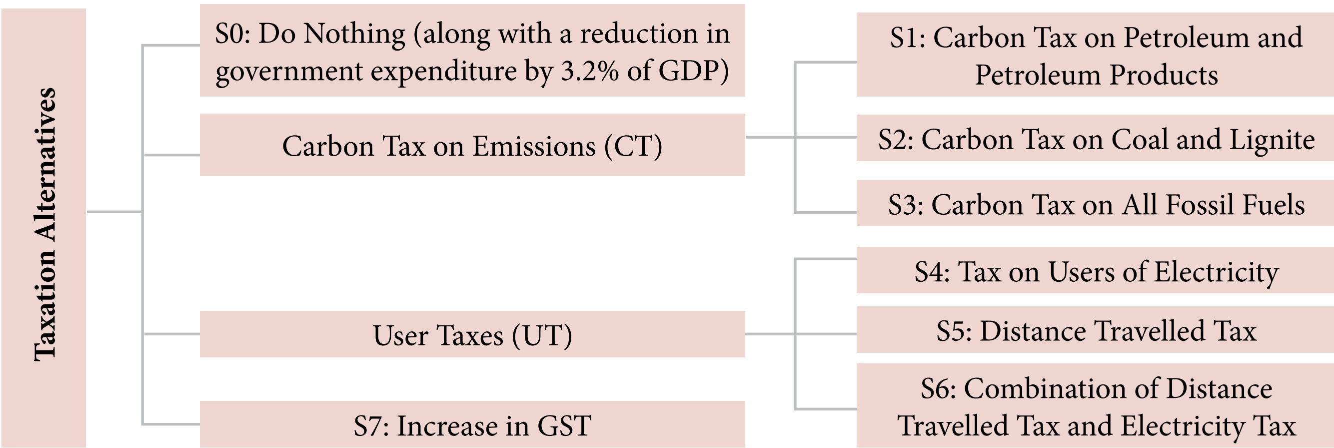
In this study, we analyse the potential implications of various taxation options, which fall into three categories: a carbon tax on fossil fuels, user taxes, and an increase in GST. These are summarised in Figure 1. To understand what would happen to E3 if taxation alternatives did not replace the removal of existing taxes, but rather government expenditure was reduced by the same amount as the government's revenue receipts due to the removal of existing fossil fuel taxes, we also considered an alternative scenario (S0). Table 2 provides details on how existing taxes are replaced by various taxation alternatives.

[6] This assumes that households base their consumption behaviour on long-term expected incomes rather than their current income.

[7] The 318 labour categories—defined based on two regions (rural and urban), four social groups, six employment types (rural) and four employment types (urban), four education levels, and two genders—have been aggregated into 32 categories (categorised by two regions, four social groups, two education levels, and two genders). Data are based on the Periodic Labour Force Survey, which considers transgenders under the male category. 80 household categories, initially categorised based on two regions, four social groups, and 10 annual consumption categories, have been aggregated into 40 household categories (two regions, four social groups, and five annual consumption categories).

The tax base in the case of carbon taxes (S1, S2, S3) is CO_2e emitted by the targeted fossil fuels. In the case of user taxes, the tax base is electricity consumption by all users in the economy (S4), distance travelled by various vehicle categories for both commercial and non-commercial purposes (S5), and a combination of both electricity consumption and distance travelled (S6). However, in S7, when existing taxes are replaced with an increase in GST, the tax base is assumed to be the same as the existing tax base within the GST framework—i.e., the value of output of the currently included sectors. Besides the tax base, the tax rate in each case will be estimated based on the total revenue (3.2% of India's GDP) that must be generated to compensate for the potential revenue loss, as estimated by Bhandari & Dwivedi (2022) for 2019–20.

Figure 1: Scenarios of Taxation Alternatives



Note: CT stands for Carbon Tax and UT stands for User Taxes.

Source: Authors' Representation.

Table 2: Details of Exogenous Shocks Across Scenarios

Scenario	Existing Revenue Generated by Fossil Fuels (3.2% of GDP)	Levy a New Tax to Generate 3.2% of GDP
Scenario 0: Do Nothing (along with a reduction in government expenditure by 3.2% of GDP)	Removed on the basis of consumption	No new levy of tax but a reduction in government spending
Scenario 1: Carbon Tax—Crude Oil, Petroleum Products, Natural Gas Consumers		Carbon tax on emissions from crude oil, petroleum products (combustible and non-combustible), and natural gas (consumed in the economy)
Scenario 2: Carbon Tax—Coal and Lignite Consumers		Carbon tax on emissions from coal and lignite (consumed in the economy)
Scenario 3: Carbon Tax on All Fossil Fuel Consumers		Carbon tax on emissions from coal and lignite, and petroleum (including petroleum products and natural gas consumed in the economy)
Scenario 4: Tax on Users of Electricity		User-based tax: on consumption of electricity
Scenario 5: Distance Travelled Tax		User-based tax: on distance travelled by different vehicle categories[8]
Scenario 6: User Tax (Electricity Tax and Distance Travelled Tax)		User-based tax: distance travelled by different vehicle categories and electricity consumed
Scenario 7: Increase in GST		A proportionate increase in GST paid by all endogenous sectors (production sectors, households, and the Rest of the World account) as simulated through the ESAM

Source: Authors.

[8] Appendix A provides details on how distance travelled tax has been calculated in this study.

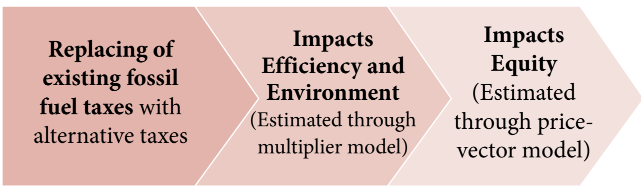
4.3 Modelling the Implications of Taxation Alternatives

A tax will not only have implications for emissions but will also impact equity and economic efficiency. This is because levying a tax will lead to an increase in the price of targeted sectors, which will also impact associated sectors that use these sectors as inputs or for final consumption. This interlinkage can be comprehensively explained through an ESAM, which computes direct, indirect, and induced effects (Miller & Blair, 2009).

Indirect taxes, such as carbon taxes or any other taxes levied on outputs/inputs, are considered regressive, as the tax burden can be shifted (see Section 3). This could be modelled through an ESAM—albeit a bit strongly, as it considers perfect elasticity of the supply curve (i.e., the entire burden of the tax is borne by the consumers). However, the impact of the overall reduction in demand is also seen through the reduced outputs of the sectors.

The relative incidence of any tax on a household primarily depends on two parameters: changes in the relative prices of goods and services consumed and the share of total expenditure on the taxed and other affected products. For instance, if a low-income household spends a sizeable portion of its income on carbon-intensive products, the incidence of the carbon tax is expected to be relatively regressive. In addition to incidence, a tax will also negatively impact macroeconomic variables such as GDP, price level, and wages of workers, thus affecting overall economic efficiency. All these effects can be simulated in an ESAM framework, as shown in Figure 2, and explained in detail next.

Figure 2: Methods Used for Analysis in the Study



Source: Authors' Representation.

Impact on the Economy

The impact of a new tax on the economy and emissions can be estimated using the methodology of Grottera et al. (2017), as modified by Verma & Sivamani (2022). We know that the imposition of any new tax—say, a carbon tax on emissions of fossil fuels—would generate tax revenue for the government. This is a transfer to the government and hence needs to be removed from the computations of the net value of output.

Since, in this study, carbon tax has been simulated on the emissions of fossil fuels, tax revenue generated from, say, the coal and lignite sector (i[th] sector) is calculated as a product of CO_2e emissions of this sector (***Ei***) and the rate of carbon tax (***t***). Thus, the total tax revenue (TR) generated from taxing the sector ***i*** is calculated by Equation (1) mentioned below.

$$\boldsymbol{TR_i = t \times E_i} \quad (1)$$

The tax base ***Ei*** in Equation (1) is CO_2e emissions of taxed sector ***i*** in the case of a carbon tax. However, in the case of user taxes and an increase in GST, ***Ei*** will represent the total value of the output of the respective sector.

Since this additional tax revenue has been now transferred to the government, it needs to be factored out of the total value of all those sectors that are consuming these fossil fuels (in this instance, coal and lignite) to calculate the new effective output. This is represented by Equation (2).

The calculation of new output requires us to first compute the proportion of new output to initial output due to the levy of any tax. The effective output is computed by subtracting the tax revenue (TR) from the initial output (Y) of the taxed sector(s). Thus, the proportion of effective output to the initial output is represented in the diagonal elements of the O matrix,[9] as depicted by Equation (2) below.

$$\boldsymbol{O_{120*120} = \left[1 - \frac{TR}{Y}\right]} \quad (2)$$

Since the imposition of a carbon tax has changed the effective output of the sectors, it will lead to a change in technical coefficients which has been represented by the effective coefficient matrix A_{eff}. This is described below using Equation (3), which is computed by multiplying the matrix O with the initial coefficient matrix A.

$$\boldsymbol{A_{eff\,120*120} = O_{120*120} \times A_{120*120}} \quad (3)$$

[9] The 120-order matrix comprises 45 production sectors, 32 labour categories, one category of capital, 40 categories of households, one Private Corporate Sector, and one Rest of the World sector of the aggregated ESAM used in this study.

This change in the coefficient matrix will thus bring a change in the multiplier matrix, which, along with a change in the exogenous demand vector (X_{eff}), will lead to a change in the output of the sectors. Thus, the impact of an exogenous policy shock—such as restructuring a fossil tax with a carbon tax on emissions of fossil fuels—on the outputs can be represented using Equation (4).

$$Y_{eff_{120*1}} = \left(I - A_{eff}\right)^{-1}{}_{120*120} \times X_{eff_{120*1}} \quad (4)$$

After calculating the effective output of the sectors (Y_{eff}), the effect of the carbon tax on various macroeconomic indicators can also be computed.

Impact on Emissions

The impact of a carbon tax (user tax and increase in GST rates) on emissions can be computed using the method detailed by Kohn (1975), which allows us to assess the impacts of changes in the output of the sectors on emissions, as shown by Equation (5). The CSEP-ESAM provides information on the sectoral emissions level; matrix P is thus computed using the same. This is analogous to the technical coefficient matrix, which implies the emissions from one unit of output (one lakh rupees since all values in the SAM are in lakhs) produced in value terms.

$$E_{1*1} = P_{1*120} \times Y_{eff_{120*1}} \quad (5)$$

Distributional Effects on Households

The implications of restructuring fossil fuel taxes on equity can be modelled by altering the methodology of Datta (2010), as done by Verma (2021). This method has been used to assess the distributional effects of the proposed taxes on household quintiles across rural and urban regions using a price-vector model. The initial and impacted relative prices of production sectors, factors of production, and households due to the substitution of existing fossil fuel taxes with a new tax could be seen through Equations (6) and (7), respectively.

$$P_{120*1} = \left(I - A_{eff}^{T}\right)^{-1}{}_{120*120} \times V_{120*1} \quad (6)$$

$$P'_{120*1} = \left(I - A_{eff}^{T}\right)^{-1}{}_{120*120} \times V'_{120*1} \quad (7)$$

Where,

P is the vector of initial relative prices of 120 endogenous sectors.

P' is the vector of new relative prices of 120 sectors after the simulation of the new tax.

A_{eff}^{T} is the transpose of the new input coefficient matrix A obtained from Equation (3).

V is the vector of the cost of inputs per unit of output.

V' is the vector of the new cost of inputs per unit of output after the simulation of the new tax.

These new relative prices () and the matrix of the share of expenditure (X_k/Y_k) incurred by the k^th^ households in these sectors are used to calculate the tax incidence of each household group (Equation (8) below).

$$(Tax\ Burden_k)_{1*1} = (X_k/Y_k)_{1*120} \times P'_{120*1} \quad (8)$$

The incidence of restructuring of tax in all scenarios has been computed using two approaches: first, a change in per capita tax burden using Equation (9) and second, by also estimating the change in tax burden borne by each household category as a share of their initial income using Equation (10). This gives us a comprehensive understanding of how different approaches can measure the distributional effects of restructuring taxes.

$$Change\ in\ Per\ capita\ tax\ burden = \frac{Initial\ expenditure \times Tax\ Burden_k - Initial\ Expenditure}{Population_k} \quad (9)$$

$$Tax\ burden\ as\ a\ share\ of\ initial\ income = \frac{Initial\ expenditure \times Tax\ Burden_k - Initial\ Expenditure}{Initial\ Income_k} \quad (10)$$

4.4 Qualifiers of the Model

We now discuss the assumptions and, therefore, the limitations of this model. ESAM allows us to assess the wider economic impacts of a policy change or exogenous shock, but it focuses on short-term impacts. In this study, while ESAM helps us estimate the direct, indirect, and induced impacts of a tax on the Indian economy, the resultant impacts should be inferred as immediate or short-run impacts. This is because the dynamics of the changing behaviour of economic agents—such as producers shifting to cleaner sources of energy in the medium to long run—cannot be modelled using ESAM alone. This is better assessed by simulating these effects through dynamic or recursive dynamic Computable General Equilibrium (CGE) models, which we will examine in subsequent studies. Such models can also incorporate the dynamic nature of the transition, where the structure of the Indian economy, especially in the energy sector, is expected to change.

Another important assumption of the SAM/ESAM framework is perfectly elastic supply curves. Because of this, the entire burden of the proposed tax is shifted to consumers—i.e., a complete pass-through of prices has been assumed. However, as explained above, some of the incidence is also borne by producers due to the effect on their profitability through altered prices. Issues relating to state/district-level impacts cannot be addressed using ESAM analysis, as the database provides interrelationships of various sectors of the economy from a macroeconomic standpoint. Further, the simulation scenarios have not incorporated the institutional challenges that would arise when the tax structure is altered. These have been studied in depth in our earlier publication (see Bhandari et al., 2023).

Considering these qualifiers of the model, we analyse the impacts of proposed taxation alternatives on the efficiency, emissions, and equity of the Indian economy.

5. Analysing the Distributional Effects

5.1 Impact on Economic Efficiency

The efficiency of a tax swap depends on how it is implemented. A tax cut, on the one hand, leaves households and businesses with more disposable income, thereby increasing spending and investment in the economy, which results in higher economic growth. On the other hand, it may lead to an increased fiscal deficit if not coupled with a reduction in government spending.

We first seek to understand how the removal of existing taxes on fossil fuels, coupled with a reduction in government consumption expenditure, will impact the economy. Thus, with Scenario 0 (S0), we intend to analyse the impact of eliminating existing taxes on fossil fuels (S0B) while concurrently decreasing government consumption expenditure[10] by an equivalent amount (S0A), thereby maintaining a constant fiscal deficit. In this scenario, a decline in government consumption expenditure creates a contractionary effect in the economy, as it reduces aggregate demand and thus output and economic activity.

The results in Table 3 show a significant decline in real GDP when the removal of existing taxes is coupled with a reduction in government spending (S0), which is in line with the anticipated effects—i.e., a contractionary impact of the reduction of government spending, as in S0A, and an expansionary impact on the economy due to the removal of existing fossil fuel taxes, as in S0B. Additionally, emissions intensity has also increased, which is detrimental to the environment, coupled with a significant adverse impact on household (HH) welfare. This can be explained by the increase in the relative prices of most consumed sectors due to an increase in the disposable incomes of households.

Table 3: Base Case: An Illustrative Scenario

Change in the Base Case	S0A: Impact of reduction in government expenditure	S0B: Removal of existing fossil fuel taxes and consequent increase in household expenditure	S0: Removal of existing fossil fuel taxes along with the reduction in government expenditure
Change in Nominal GDP (at market price)	-6.27%	4.37%	-2.12%
Change in CO_2e emissions intensity[11]	1.05%	0.83%	1.87%

Note: The five most consumed sectors in the aforementioned table are Commerce and Public Services; Food and Tobacco; Agriculture; Textile and Leather; and Land Transport. These are mentioned in decreasing order of their average aggregate consumption by the 40 categories of households. Second-order effects of the impacts have not been considered.

Source: Authors' Computations.

[10] While reducing government expenditure in S0, only the expenditure incurred on 45 production sectors has been reduced, maintaining their existing share of total expenditure.

[11] Emission intensity has been defined as Total emissions in the economy as a share of GDP_{MP}, and

$$\text{Change in emission intensity} = \frac{Emission\ Intensity_{New} - Emission\ Intensity_{Initial}}{Emission\ Intensity_{Initial}}$$

However, government expenditure,[12] which plays a major role in driving any country's social and economic development, is unlikely to be reduced and need not be curtailed when existing taxes on fossil fuels are replaced with alternative taxes. We study this in Scenarios 1 to 7. This replacement of existing taxes with new taxes will offset the potential revenue loss as India transitions away from fossil fuels to green energy. Existing government expenditure is thus maintained in Scenarios 1 to 7, where we simulate the impact of alternative taxes on the E3.

The impact of replacing existing fossil fuel taxes with various taxation alternatives on the economy has been assessed by analysing their likely impacts on key macroeconomic indicators: nominal GDP at market price and price level in the economy (these two impacts have also been studied using real GDP). Since different types of taxes have different implications, the alternative taxes proposed in this study are expected to have varying impacts on the economy and households, depending on the tax base and their interlinkages with different sectors of the Indian economy. When the existing taxes on fossil fuels are replaced by a new tax on other production sectors, the output of these taxed sectors and the downstream sectors could be negatively impacted. This is because the newly taxed sectors may be more deeply linked with the rest of the economy than fossil fuels are. If this happens, it will further extend to other downstream sectors that rely on the newly taxed sectors for their inputs. Consequently, the output of certain sectors would contract, leading to a negative impact on GDP. However, if the interlinkages of the newly taxed sectors are lower than those of the sectors from which the fossil fuel taxes were removed, this is expected to cause an expansionary impact on the economy. The differences between sectoral interrelationships, therefore, drive the different outcomes in our scenarios.

The impact on economic efficiency due to the imposition of taxes (vis-à-vis the current state of the economy in 2019–20 as reflected by ESAM) is presented in Figure 3. The removal of existing fossil fuel taxes leads to increased demand for fossil fuels and downstream sectors because of the increase in the disposable incomes of households, thereby creating an expansionary impact on the economy. However, as the results show, when the removal of these taxes is coupled with the imposition of new taxes on other production sectors, which relatively have higher forward linkages (here, Scenario 1 and Scenario 7, as in these cases sectors with high forward linkages bear more of the burden of the tax), it creates a contractionary impact on the economy. This is because the reduced output of taxed sectors is distributed across the other sectors more profoundly than the positive impact of the removal of taxes on fossil fuels, thereby reducing economic activity and nominal GDP. Conversely, in the cases of the carbon tax on coal and lignite and the distance travelled tax scenarios (Scenarios 5 and 6), there is a slight increase in nominal GDP, as in these scenarios there are fewer forward linkages for the sectors that bear the most tax burden compared to the sectors from which the fossil fuel taxes were removed.

The introduction of new taxes in place of existing fossil fuel taxes has also led to a change in average price levels[13] in the economy, thereby impacting real GDP, which has increased only for Scenario 2, suggesting the most preferred taxation alternative as far as real GDP is concerned.

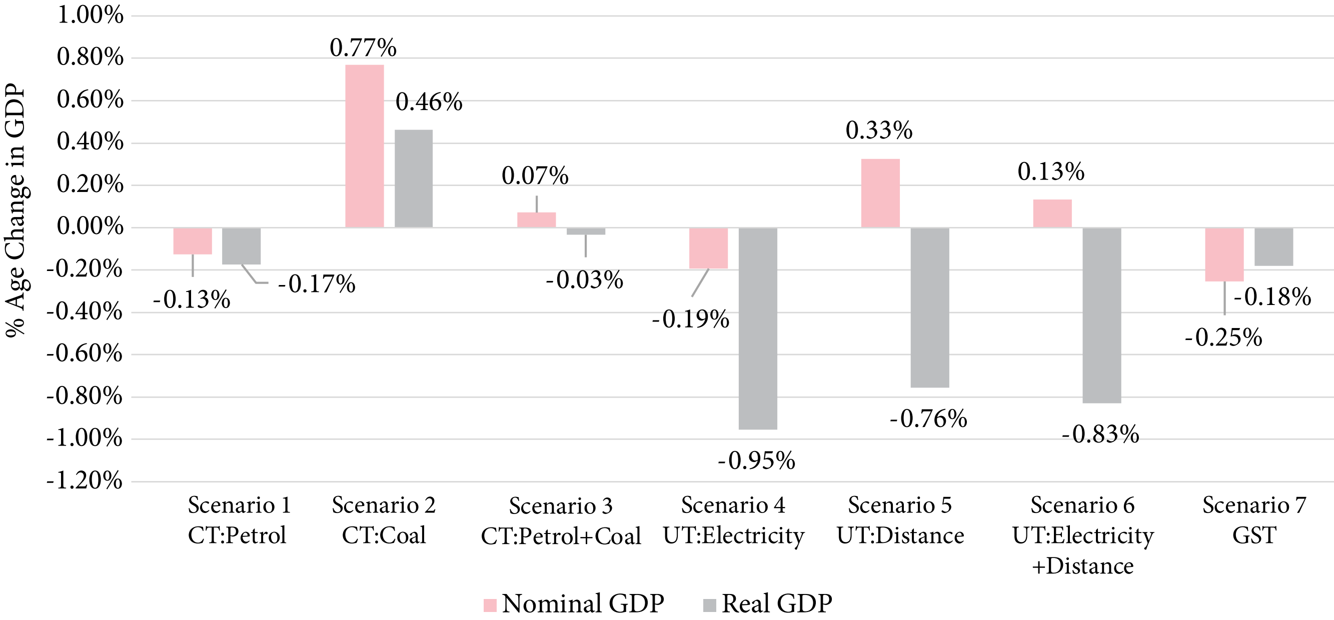
5.2 Impact on Environment

Given the linear relationship between carbon emissions and output in the economy, as depicted in Equation 5 above, a decline in output due to tax imposition is anticipated to result in reduced emissions, and vice versa. The potential impact of all the tax alternatives on the environment (CO_2e emissions intensity) is presented in Figure 4. These results show that CO_2e emissions intensity decreased for all tax options except for Scenarios 5 and 6 (S6 witnesses a slight increase), indicating an improvement in environmental quality relative to economic output.

[12] Here, government expenditure refers largely to the revenue expenditure incurred by the government on various sectors. Since the government's expenditure on health and education as a proportion of GDP is abysmal when compared to other countries, it is unlikely that such expenditure will be reduced any further, hence the assumption.

[13] A change in the price level in the economy is assessed by looking at the change in the average of all 120 endogenous sectors as simulated using Equation 7.

Figure 3: Impact on Economic Efficiency

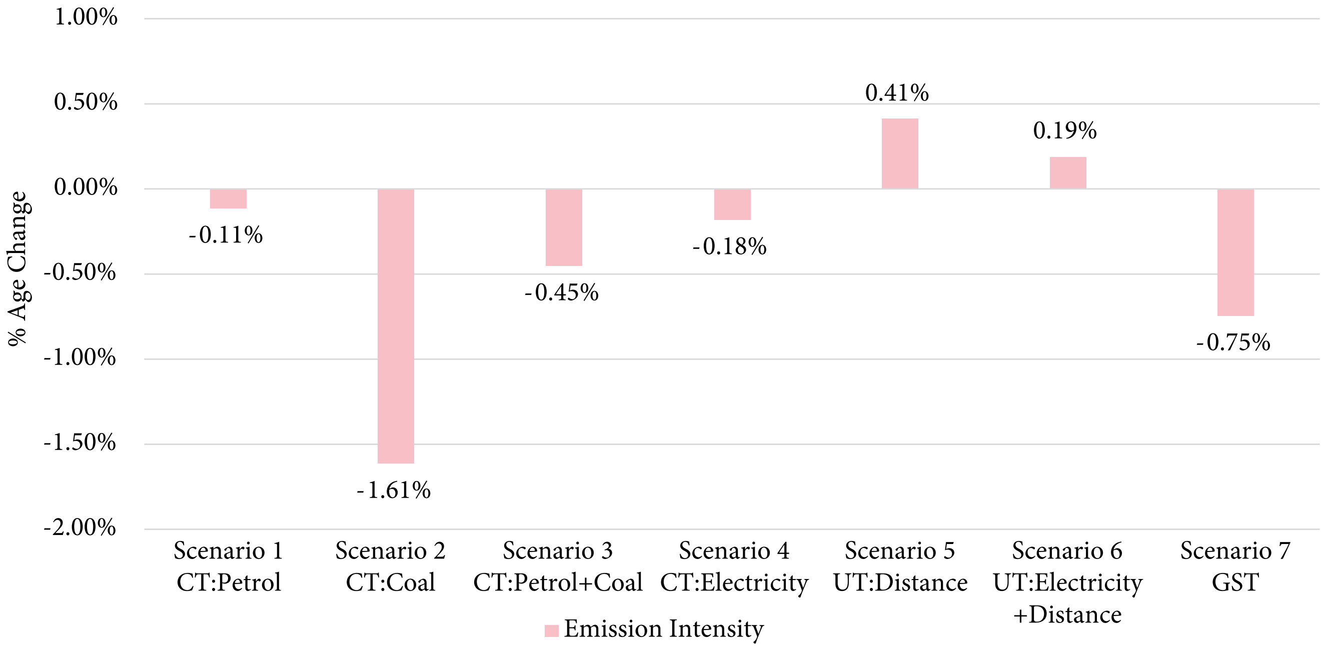


Note: CT stands for Carbon Tax and UT stands for User Tax.

Source: Authors' Computations.

The decline in emissions intensity is highest when existing fossil fuel taxes are replaced with a new tax on carbon emissions from coal and lignite. This is because the coal and lignite sector is not only one of the most carbon-intensive sectors but is also a major input to other major carbon-intensive sectors in India, such as thermal electricity, cement, iron and steel, and aluminium. This tax on emissions results in an increase in the cost of production for these sectors, which leads to a decline in their production. It highlights that taxes, when designed appropriately, may result in a significant environmental benefit, but they will also have an output impact, as discussed earlier.

Figure 4: Impact on Emissions Intensity



Source: Authors' Computations.

5.3 Distributional Effects on Households

The impact of any net increase in taxes creates an additional burden on households if the share of expenditure on the newly taxed and associated sectors is more than the tax on the fossil fuel sectors. This incidence could be either regressive or progressive. The tax burden on each household is measured as the change in the consumption expenditure of the respective household due to the imposition of the net change in the tax.

Given that the tax burden is contingent on the share of household expenditure on the targeted sectors and the new relative prices of the production sectors (as illustrated in Equation 8 above), one might anticipate that households with a greater proportion of spending on impacted sectors would bear a higher tax burden. Additionally, a relatively greater increase in prices would result in a higher tax burden.

In this study, the tax bases differ across the proposed taxation options, leading to varied impacts on relative prices. A net change in tax on targeted sectors will not only directly impact the prices of these sectors but will also impact the prices of deeply interlinked goods and services. For example, if coal emissions are taxed, this will impact the prices of sectors such as thermal power and iron and steel more than it would, for example, agriculture.

The changes in per capita tax burden and in tax burden as a share of initial income for each household category are shown in Tables 4 and 5. Table 4 shows that, when incidence is measured as a change in per capita tax burden, it is progressive for almost all scenarios (except S7). Table 5 shows that the impact of alternative taxes on HH welfare is almost negligible for most scenarios, as the increase in tax burden as a share of income is broadly less than 1% (except for S5). Thus, the incidence results depend on the choice of method, which shows that different methods reflect varying impacts.

It can also be inferred from Table 5 that the incidence of tax for most scenarios is mildly regressive, as the adverse impact on HH welfare is greater for higher quintiles. Moreover, for Scenario 6, where an increase in HH tax burden as a share of their respective income is still less than 1%, the overall incidence is mildly progressive (although for rural households the incidence is regressive for the first three quintiles and then progressive; for urban households, it is progressive across all quintiles).

These results also show stark differences in the burden of tax on each household across different taxation options. The tax burden on households is highest—yet still a very small proportion of total income—when existing taxes are replaced with a distance travelled tax. This can be explained by the fact that, when levying a tax on distance travelled by different vehicle categories, the largest part of tax revenue is generated by taxing passenger vehicles (which is passed on directly to HHs, thus adversely impacting their welfare).

Table 4: Distributional Impacts on HHs: Changes in Average Per-capita Tax Burden (Rs.) on Each Household Category

Regions/ Quintiles of Household Groups		Scenario 1 CT: Petrol	Scenario 2 CT: Coal	Scenario 3 CT: Petrol+ Coal	Scenario 4 UT: Electricity	Scenario 5 UT: Distance	Scenario 6 UT: Electricity +Distance	Scenario 7 GST
Rural	Q1	40	123	58	268	379	337	20
	Q2	59	180	86	391	542	486	30
	Q3	78	229	111	507	711	636	34
	Q4	111	291	150	699	1016	899	26
	Q5	232	394	266	1358	2228	1906	-77
Urban	Q1	67	227	102	449	635	565	42
	Q2	118	371	173	774	1129	997	52
	Q3	174	500	245	1122	1702	1485	43
	Q4	265	671	352	1675	2666	2296	4
	Q5	611	1094	712	3674	6407	5383	-259

Source: Authors' Computations.

Table 5: Distributional Impacts on HHs: Changes in Tax Burden as a Share of Initial Income of each HH category

Regions/ Quintiles of Household Groups		Scenario 1 CT: Petrol	Scenario 2 CT: Coal	Scenario 3 CT: Petrol + Coal	Scenario 4 UT: Electricity	Scenario 5 UT: Distance	Scenario 6 UT: Electricity + Distance	Scenario 7 GST
Rural	Q1	0.11%	0.33%	0.16%	0.72%	1.02%	0.91%	0.05%
	Q2	0.11%	0.33%	0.16%	0.71%	0.98%	0.88%	0.05%
	Q3	0.11%	0.31%	0.15%	0.70%	0.98%	0.87%	0.05%
	Q4	0.11%	0.29%	0.15%	0.70%	1.01%	0.90%	0.02%
	Q5	0.11%	0.18%	0.13%	0.66%	1.09%	0.93%	-0.04%
Urban	Q1	0.09%	0.30%	0.13%	0.58%	0.82%	0.73%	0.06%
	Q2	0.09%	0.28%	0.13%	0.58%	0.85%	0.75%	0.04%
	Q3	0.09%	0.26%	0.13%	0.59%	0.89%	0.78%	0.02%
	Q4	0.09%	0.24%	0.12%	0.59%	0.93%	0.80%	0.00%
	Q5	0.10%	0.19%	0.12%	0.60%	1.05%	0.88%	-0.04%

Source: Authors' Computations

This wide variance in tax burden across different scenarios can also be explained by the change in relative prices and the share of household expenditure in those sectors. The data from the ESAM show that, on average, five sectors—agriculture, food and tobacco, textiles and leather, land transport, and commerce and public services—account for around 75% of total household consumption expenditure. This highlights that any change in the prices of these five sectors will have a substantial impact on household expenditure and thus result in a high tax burden. Table 6 summarises the impact of different taxation options on households and the relative prices of these four sectors.

Table 6: Impact of Taxes on Households' Tax Burden and Relative Prices of Most Consumed Sectors

	Scenario 1 CT: Petrol	Scenario 2 CT: Coal	Scenario 3 CT: Petrol + Coal	Scenario 4 UT: Electricity	Scenario 5 UT: Distance	Scenario 6 UT: Electricity + Distance	Scenario 7 GST
Average change in Tax burden as a share of Initial Income (%) of households	0.10%	0.27%	0.14%	0.64%	0.96%	0.84%	0.02%
Average Change in Price of 5 most consumed sectors (%) by households	0.12%	0.45%	0.19%	0.86%	1.17%	1.06%	0.11%

Source: Authors' Computations.

The highest tax burden in the case of a distance travelled tax (i.e., Scenario 5) can also be explained by the fact that the rise in prices (1.17%) of the five sectors accounting for a major part of the household budget is highest in this taxation option. Meanwhile, the rise in the relative prices of these four sectors is lowest in Scenario 7 (an increase in GST), reflecting the smallest impact on HH welfare, as reflected by the average change in tax incidence (only 0.02%).

In summary, we have three key findings. First, a carbon tax on coal emissions has a positive impact on real GDP and reduces emissions. However, it is somewhat regressive. Moreover, a carbon tax on coal would only hasten the transition process but not address the long-term fiscal challenge. Second, user taxes (Scenarios 5 and 6) may be difficult to levy institutionally but are more progressive. However, they are likely to have a strongly adverse impact on real GDP and emissions. Third, a proportionate increase in GST results in a strongly negative impact on emissions, along with mild impacts on equity and real GDP.

We can conclude that a trade-off exists in all these scenarios. In the medium term, fossil fuel taxes can be replaced with a carbon tax on emissions from coal; however, this is likely to negatively impact equity. We find that in the long run, replacing fossil fuel taxes with user taxes will significantly impact real GDP adversely, whereas if fossil fuel taxes are replaced by a proportionate increase in GST, the impact on GDP would be minor but this will impact equity adversely. The regressivity concerns can of course be addressed by providing revenue transfers from the State to the lowest quintiles; this can be examined in future studies.

6. Conclusion

This study examines the potential impacts of select taxation alternatives on economic efficiency, emissions intensity, and equity to close the revenue gap from fossil fuels that will emerge as India shifts away from fossil fuels. Seven taxation scenarios classified under carbon taxes, user taxes, and GST rates were simulated using the ESAM 2019–20 database for India. Our results show that replacing fossil fuel taxes with any other tax will affect at least one of these criteria adversely.

The study finds that there is no single tax alternative that can address multiple objectives. Therefore, a better understanding of the objective of transition can help identify which tax alternative to choose. At the same time, this is a static exercise, which can be extended to a more dynamic frame using CGE analysis. However, several institutional and political-economic challenges will also play a critical role in identifying the policies best suited for India. An important criterion, as mentioned above, is that of state autonomy over its own tax revenues, with the advent of GST this has been compromised somewhat, and a consensus may require allocating at least some revenues where this can be maintained. Further, the challenge of revenue continuity is another important parameter to consider. These can be resolved either by replacing the fossil fuel taxes with a combination of electricity and distance travelled tax or through a proportionate increase in the GST rates. The challenges in each of these alternatives prevail, and the equity issues concerning the latter can be addressed using revenue transfers.

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Appendix A: Method Used to Calculate Distance Travelled Tax

1. Estimation of Total Distance Travelled by Each Vehicle Category:

Total distance travelled$_i$ (km/year) = Number of registered vehicles * Average distance travelled (km/day) * 365

Note: The average distance travelled by buses (km/day) has been estimated based on the number of buses operated by State Road Transport Undertakings (SRTUs) and the effective distance travelled by them, whereas for all other vehicle categories, it has been sourced from the literature.

2. Estimation of Total Revenue to be Generated from Usage of Each Vehicle Category:

First, we determine the total revenue to be generated from goods vehicles and passenger vehicles using the following equation:

Revenue to be generated from goods (passenger) vehicles

$$= \frac{\text{Total Distance Travelled by all Goods (Passenger) Vehicles}}{\text{Total Distance Travelled by all Vehicles}} * (\text{Total Revenue to be generated})$$

Since, within goods vehicles, we have only one category, i.e., trucks and lorries, the revenue to be generated from goods vehicles is the revenue to be generated from trucks and lorries. Passenger vehicles, however, are further categorised into cars, taxis, and buses. The revenue to be generated from each of these sub-categories has to be further determined using the passenger load factor and average selling price of each of these vehicle categories.

3. Revenue to be Generated from Passenger Vehicle Type:

$$\text{Revenue to be generated}_i = \frac{\text{Passenger load factor}_i * \text{Average selling price}_i}{\sum_i^n \text{Passenger load factor}_i * \text{Average selling price}_i} * (\text{Total Revenue to be generated from all passenger vehicles})$$

4. Distance Travelled Tax rate:

$$\text{Tax Rate}_i = \frac{\text{Revenue to be generated}_i}{\text{Total Distance Travelled}_i}$$

where, i – category of vehicle (car, 2-wheeler etc.)

Table 7: Calculation of Distance Travelled Tax Rates

Vehicle category	Average Selling Price (Rs.) (A)	Passenger Load Factor (B)	Average Distance Travelled (km/ day) (C)	No. of Registered Vehicles (D)	Annual Distance Travelled (Billion km) (E)= C*D*365	Revenue to be Generated (Rs. Lakhs) (F)	Tax Rate (Rs/ km) (G)= (F*10^5)/ (E*10^9)	Data Sources
Non-commercial: Cars, Jeeps, Vans – for Work	8,20,000[1a]	5	25[1b]	4,01,91,270[1c]	366.75	2,15,34,355	5.87	1a: Das (2024). https://www.business-standard.com/industry/auto/average-selling-price-of-passenger-vehicles-rises-by-50-in-last-5-years-124012100104_1.html 1b: Gupta (2018). https://timesofindia.indiatimes.com/business/india-business/indian-commuters-travel-35-km/day-says-survey/articleshow/63140954.cms?from=mdr 1c: MoRTH (2020, 2021)
Taxis – for Passenger Transport	8,20,000[2a]	5	200[2b]	34,58,917[2c]	252.50	2,15,34,355	8.53	2a: Das (2024). https://www.business-standard.com/industry/auto/average-selling-price-of-passenger-vehicles-rises-by-50-in-last-5-years-124012100104_1.html 2b: Rao (2023). https://www.hindustantimes.com/cities/mumbai-news/shortage-of-cabs-on-mumbai-roads-as-drivers-switch-professions-ola-and-uber-passengers-face-long-waiting-times-101685300495802.html 2c: MoRTH (2020, 2021)
Buses	30,00,000[3a]	52	336[3b]	17,23,423[3c]	211.66	75,75,406	3.58	3a: Kidiyoor (2023). https://timesofindia.indiatimes.com/city/bengaluru/to-overcome-shortage-ksrtc-to-buy-200-used-buses-from-bmtc/articleshow/103097331.cms 3b: Estimated based on the number of buses operated by SRTUs and the effective distance travelled by them. 3c: MoRTH (2020, 2021)
Two-Wheelers	40,000[4a]	2	24[4b]	24,36,82,000[4c]	2,134.65	26,26,141	0.12	4a: Sharma (2023). https://www.indiatoday.in/diu/story/high-cost-expensive-emis-applying-brakes-on-2-wheeler-sales-in-india-2357069-2023-04-07 4b: Sati et al. (2021). https://www.orfonline.org/expert-speak/road-emission-control-electrifying-personal-mobility-in-india 4c: MoRTH (2020, 2021)
Trucks & Lorries	NA*	NA*	300[5a]	58,26,471[5b]	638	1,14,60,344	1.80	5a: Niti Aayog et al. (2021). https://www.niti.gov.in/sites/default/files/2021-06/FreightReportNationalLevel.pdf 5b: MoRTH (2020, 2021)

**Estimation of total revenue to be generated from trucks and lorries is determined based on the total distance travelled by them as a share of the total distance travelled by goods and passenger vehicles, and thus the information on their average selling price and passenger load factor is not required.*

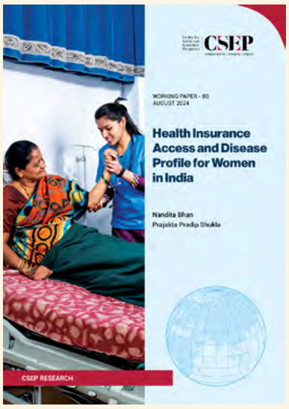
Source: Authors' Computations.

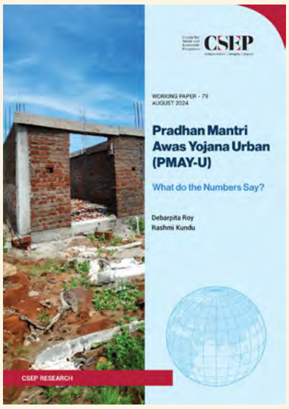
About the authors

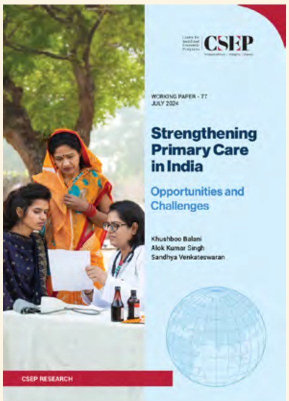
Laveesh Bhandari is President and a Senior Fellow at CSEP. Dr Bhandari has published widely on subjects related to sustainable livelihoods, industrial, economic, and social reforms in India, economic geography, and financial inclusion. He received his PhD in economics from Boston University for which he was awarded the Best Thesis in International Economics. He has taught economics at Boston University and IIT Delhi. Apart from applied economics research, Dr Bhandari has built, seeded, and exited from three companies in the research, analytics, and digital domains, including Indicus Analytics, a leading economic research firm. Currently, he is conducting research on issues of inclusion, India's energy transition, and how it will impact the government as well as the economy.

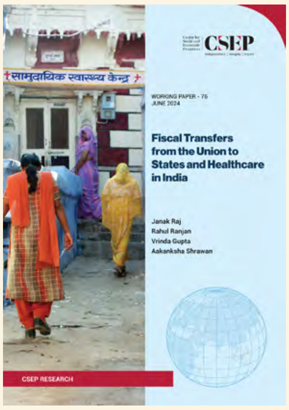
Rajat Verma is an Associate Fellow in CSEP. He specialises in Input-Output/SAM Modelling and ecological taxation. He recently published a book titled "Fiscal Control of Pollution: Application of Ecotaxes in India", wherein he critically examined the theoretical and pragmatic application of optimal rates of ecotaxation and their distributional impacts on households in India. In addition to his interest in Public Finance, he has also published innovative research papers on environmental taxes and international trade. He received PhD in Economics with a specialisation in Environmental Economics from the Institute for Social and Economic Change (ISEC), Bangalore which is affiliated with the University of Mysore.

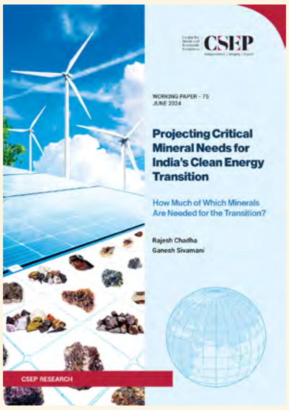
Other publications

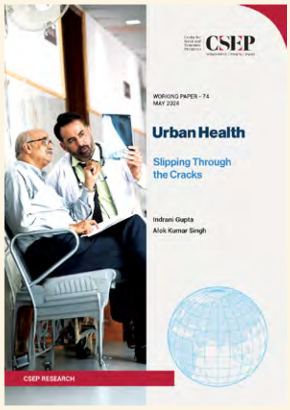


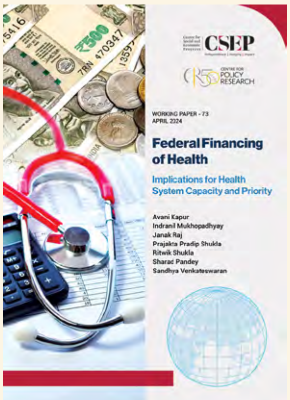


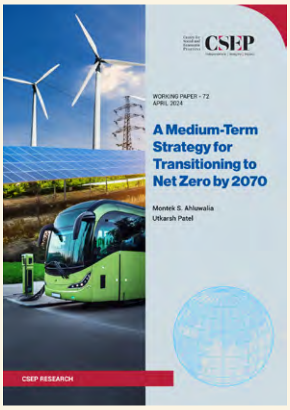


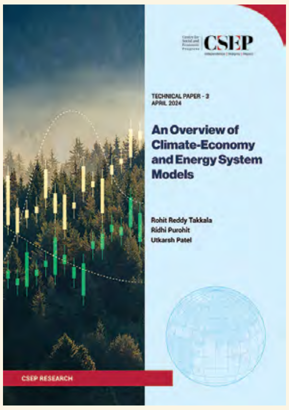


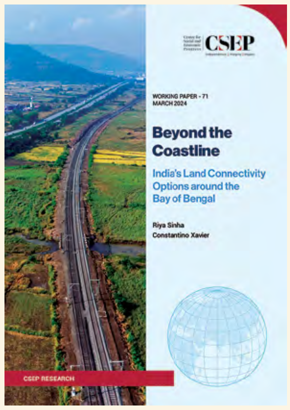


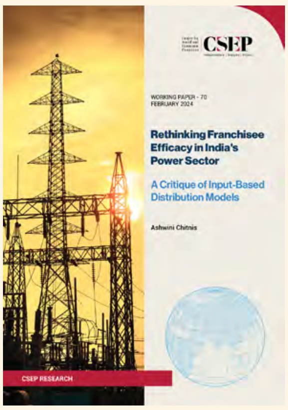


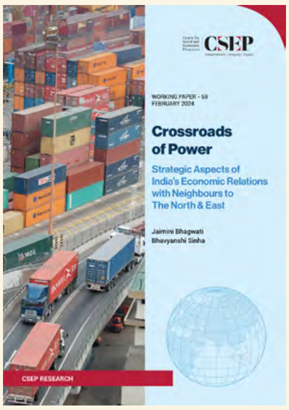


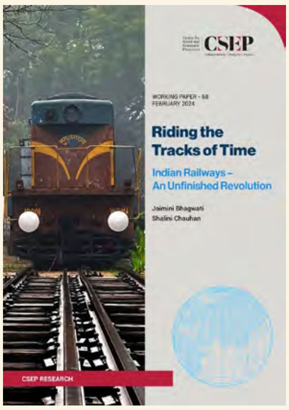


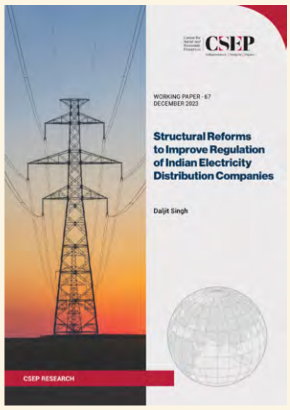












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