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Distributional Impacts of Carbon Pricing in Low- and Middle-Income Countries

The climate targets agreed upon in the Paris Agreement will eventually need to be backed by ambitious climate policies. Putting a price on carbon and abolishing subsidies on fossil fuels is usually widely agreed upon by economists to be the economically efficient solution (High-Level Commission on Carbon Prices 2017). An increasing amount of countries, including low- and middle-income economies (LMICs), have already introduced (or plan to do so) carbon pricing schemes. Yet, the introduction of carbon pricing schemes frequently triggers concerns regarding the distributional justice of climate policy. The question of distributional effects relates closely to the political feasibility of reforms. A regressive carbon price would not only be problematic from a perspective of equity and justice, but very likely also be deemed to fail politically.

Yet, as it has usually been developed countries that discuss pricing mechanisms, not much is known regarding the particularities of carbon pricing schemes in LMICS. At the same time, the World Bank reports an increasing number of active and planned carbon pricing instruments (CPI) in LMICs (World Bank 2021). Argentina, Chile, Colombia, Mexico, and South Africa have implemented carbon pricing, although with relatively small effective prices and, with the exception of South Africa, narrow tax bases that cover only a small share of jurisdictional emissions. China, the only Asian country among the LMICs with a CPI in place, has now initiated the world's largest carbon market. Other countries such as Brazil, Indonesia, Vietnam, Thailand, Pakistan, Turkey, Senegal, and Côte d'Ivoire are currently considering the introduction of carbon taxes or emission trading schemes (ETS).

While there is limited real-world experience with the introduction of carbon prices in LMICs, those governments have made ample experiences with reducing fossil fuel subsidies, effectively abolishing (or reducing) a negative tax on carbon. Reforms were frequently followed by protests and sometimes violence, which frequently led to planned reforms being reversed (IMF 2013). Therefore, understanding the distributional consequences of carbon taxes—and how to alleviate them—is key for the societal and political acceptance of carbon pricing in LMICs.

In this article we will first synthesize the existing knowledge on distributional effects of carbon pricing reforms in LMICs. We provide exemplary analyses for nine low- and middle-income countries with differing development status at varying locations. We continue by discussing in detail how distributional effects could be addressed, given economic and administrative realities in LMICs. Finally, we discuss the benefits and challenges of carbon pricing in LMICs.

DISTRIBUTIONAL IMPACTS OF CARBON PRICING IN LMICS

A growing number of studies deals with distributional effects of carbon prices (including fuel taxes and fossil fuel price subsidies) in LMICs. Unlike in high-income countries, the distributional effect of carbon prices in LMICs is often found to be progressive (Ohlendorf et al. 2021).

The majority of available studies focuses on impacts across the income distribution (i.e., vertical effects) using different methodological approaches. The dominating methodology in the scientific literature is to focus on short-run impacts under the assumption

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Table 1
Overview of Key Economic Indicators for Sample of LMICs

	Population (Million)	GDP per capita (constant 2010 USD)	Gini coefficient	Energy use per capita (kgoe)	Share of population with access to clean cooking fuels (%)	Total CO_2 emissions ($MtCO_2$)
Argentina	44	10,050	41.3	2,030	98	177
Bolivia	11	2,560	42.6	778	64	23
Ethiopia	109	571	35	493	4	16
India	1,353	2,090	35.7	637	41	2,435
Indonesia	268	4,285	37.8	884	58	583
Nigeria	196	2,383	35.1	764	5	131
Peru	32	6,453	42.4	790	75	54
South Africa	58	7,432	63	2,696	85	433
Vietnam	96	1,964	35.7	660	67	258

Note: This table displays aggregate statistics for the selection of LMIC in this study. Reference year is 2018. Column "Energy use per capita" displays numbers refers to 2014 (Vietnam: 2013). Column "Share of population with access to clean cooking fuels (%)" refers to 2016. Column "Gini coefficient" refers to 2018 with exception: India (2011), South Africa (2014), Ethiopia (2015).

Source: World Development Indicators (World Bank 2021).

of full price pass-through to final demand in environmentally extended input-output models. Solely focusing on energy related emissions from fossil fuels, Renner (2018, for Mexico), Saelim (2019, for Thailand) and Malerba (2021, for Peru) find slightly progressive impacts of carbon taxes. For the removal of energy subsidies, a comparable policy to fossil fuel carbon emissions, the literature also finds progressive impacts (Coady et al. 2015 and 2018; Schaffitzel 2020).

The main reason for differing distributional outcomes in LMICs compared to high-income countries (where studies usually find regressive results) are differing energy use patterns. In poor countries, the expenditure share for formal energy items increases with income, leading to progressive results of carbon pricing as long as other important consumption items are not exceptionally carbon intensive. In high-income countries, by contrast, richer households spend relatively less on energy items leading to regressive results of a carbon price. These results are confirmed empirically on a global level by Dorband et al. (2019) in an analysis covering 87 LMICs; however, using relatively coarse data. In a detailed and comparative approach for eight countries in developing Asia (Bangladesh, India, Indonesia, Pakistan, Philippines, Thailand, Turkey, and Vietnam), Steckel et al. (2021) confirm the progressive findings of single-country studies with few notable exceptions. For example, in India the fossil fuel-intensive agricultural sector (based on diesel-run water pumps) would be responsible for higher food prices and therefore result in regressive outcomes. They also highlight that the exact carbon pricing design (e.g., covering only specific sectors or the full economy) can lead to very different distributional outcomes.

There are also a few numerical simulation studies involving computable general equilibrium (CGE) models, theoretically superior to simpler IO models due to the possibility of distinguishing between income (source) and consumption (use) side impacts on household welfare (Goulder et al. 2019). Only very few CGE studies are available for LMICs that also tackle distributional questions of carbon pricing (e.g., Garaffa et al. 2021 for Brazil), given methodological and conceptual difficulties. Generally, looking into the full spectrum of the literature, Ohlendorf et al. (2021) find that CGE studies are systematically more progressive than other forms of study. Goulder et al. (2019) argue that carbon pricing reduces returns to capital more than returns to labor due to higher than average capital labor ratios in carbon intensive sectors. A carbon price would then reduce the demand for capital relative to labor and subsequently capital returns. Since in LMICs the capital income is concentrated in the very top of the income distribution, a similar tendency towards progressivity would be expected, but evidence is largely missing. Studies that focus on the short-run incidence might be perceived as an upper bound with regard to regressive outcomes of carbon pricing.

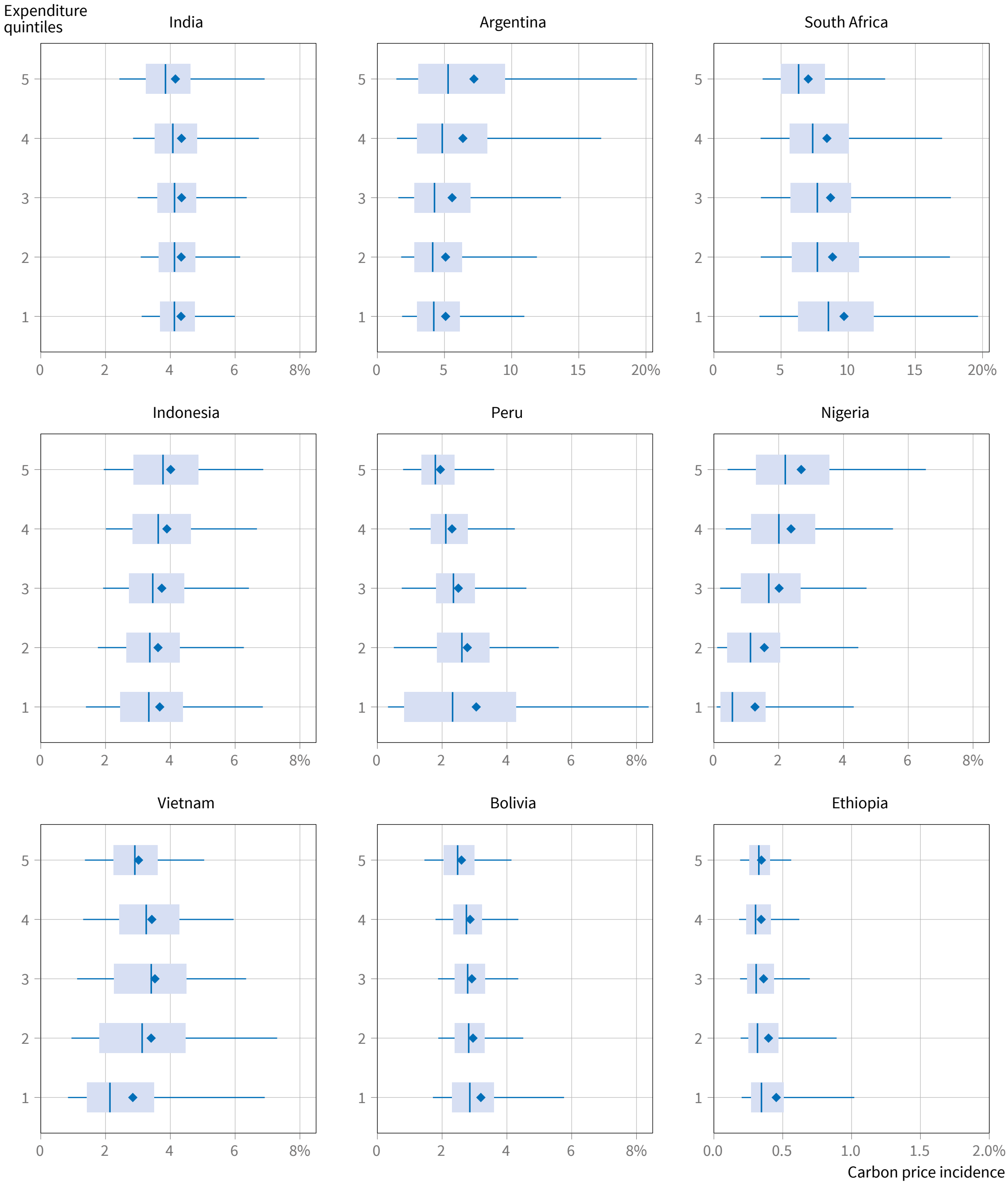
We present a more detailed analysis of short-run distributional implications of implementing a USD 40 carbon price per tCO_2 for a selective sample of LMICs, including three examples from Latin America (Argentina, Bolivia, Peru), Sub-Sahara Africa (Ethiopia, Nigeria, South Africa) and Asia (India, Indonesia and Vietnam), respectively. Table 1 presents an overview of key economic indicators for those countries.

Figure 1 shows both the vertical dimension of distributional incidences (i.e., inter-quintile differences of distributional incidences) as well the horizontal dimension (within-quintile differences) in percent of household income, proxied by total household expenditures.

Three basic observations emerge from this analysis: first, distributional effects are highly country-specific. While results are progressive in some countries (including Argentina, Nigeria, Indonesia, and Vietnam), they are regressive (Bolivia, Ethiopia,

Figure 1

Carbon Pricing Incidence over Expenditure Quintiles



Note: Additional costs to households induced by a carbon price of USD 40/t CO_2 as a share of total household expenditures (X-axis) for each expenditure quintile (Y-axis). Carbon price incidence of 1% indicates that a household would require an additional 1% of its expenditure budget to buy the same amount of goods and services, which they bought prior to the implementation of a carbon price, while observing price increases equivalent to carbon intensity of products. The first expenditure quintile (1) comprises those 20% of households with least total expenditures per capita. Boxes show the 25th to 75th percentile, whiskers display the 5th to 95th percentile. Blue vertical line indicates the median. Dots represent the mean.

Source: Own microsimulation using nationally representative household survey data (see below) and an environmentally extended input-output-model based on data from Global Trade Analysis Project (GTAP) 10 (Aguiar et al. 2019) – see Steckel et al. (2021) more in detail.

Data from the national household survey include: Encuesta Nacional de Gastos de los Hogares 2017-2018 (Argentina), Encuesta de Hogares 2018 (Bolivia), Ethiopian Socio-economic Survey 2018 (Ethiopia), National Sample Survey 2012 (India), Survei Sosial Ekonomi Nasional 2018 (Indonesia), General Household Survey 2015-2016 (Nigeria), Encuesta Nacional de Hogares 2016 (Peru), Living Conditions Survey 2014-2015 (South Africa), and Vietnam Household Living Standard Survey 2012 (Vietnam). Calculation of carbon intensities is based on the data from Global Trade Analysis Project (GTAP) 10.

South Africa) or nearly neutral (India, Peru) in others. Second, no matter the direction of the distributional impact, households suffer an effective welfare loss resulting from carbon pricing in the absence of compensatory measures that can be substantial. Among the poorest households, additional costs range from 0.5 percent in Nigeria to 8.5 percent of household expenditure in South Africa for the median household. Third, inter-quintile variation of effects is generally smaller than the within-quintile variation. That is, some households—independent of their income—are notably more affected than the median household in a specific quintile. Exemplarily, that can be well illustrated for Asian countries in the sample, where the difference of average effects between the first and the fifth quintile range between 0.2 and 0.3 percentage points, whereas the difference between the 20th and the 80th percentile within the first quintile is 1.4 (India), 2.5 (Indonesia), and 2.8 percentage points (Vietnam), respectively.

The large variation of horizontal effects is also confirmed by the literature, e.g., for the US (Cronin et al. 2018) and France (Douenne 2020), or multiple Asian countries (Steckel et al. 2021). This yields important consequences for the political economy of carbon pricing reforms. While it is generally believed that progressive outcomes might facilitate implementation, some highly affected interest groups might—in light of high horizontal inequality—still oppose reforms.

Further, regarding LMICs it is important to understand the full spectrum of welfare effects. Carbon pricing, for example, would not include the use of traditional biomass. Yet, the relative price increase of fossil fuels compared to tradition fuels would still foster the use of firewood and charcoal, which are related to negative health implications (Cameron et al. 2016). In addition, higher prices on fossil fuels provide larger incentives to women and children to spend time collecting firewood, diverting them from participation in the paid labor market or education (Dinkelman 2011). The literature highlights potential substitution effects in various countries, including Ghana (Greve and Lay 2020 evaluating a fossil fuel subsidy reform ex-post), Tanzania (Olabisi et al. 2019), and Senegal (Yaméogo 2015). Aggarwal et al. (2021) also highlight that carbon pricing (in the case of Uganda) could additionally trigger adoptions in the food baskets, leading to lower nutrition and calorie intakes for the poorest parts of the population.

OPTIONS FOR CARBON PRICING REVENUE RECYCLING IN LMICS

Distributional effects can theoretically be alleviated by recycling revenues from carbon pricing along different channels (Klenert et al. 2018), but the practical implementation and administrative feasibility in LMICs' institutional contexts need to be examined carefully.

When considering revenue recycling directly to households, two options are generally conceivable: cutting existing taxes and deploying transfers to households. Compensation via cuts in direct taxes, e.g., reduced income taxes, would be strongly regressive due to high income tax exemption thresholds as well as informality and misreporting (Besley and Persson 2009; Jensen 2019). Reductions in other indirect taxes such as consumption taxes might also be less promising for lower-income households due to already small tax rates for essential goods such as food and the high share of informal businesses. The latter often supply essential goods to low-income but not high-income households, resulting in effective higher consumption tax rates for richer households (Bachas et al. 2020). Overall, cutting direct and indirect taxes appear to offer little opportunities for progressive recycling of carbon pricing revenues in LMICs.

The second option is to compensate households directly, either through targeted or universal transfer schemes. Targeted transfers comprise a broad group of diverse social assistance programs such as subsidized health insurance, noncontributory pensions, or conditional and unconditional cash transfers. LMIC governments have repeatedly demonstrated the ability to redistribute resources via social assistance programs, but existing challenges require special attention in the carbon pricing debate. In LMICs, transfers are not straightforward to implement.

First, general coverages rates of social assistance are low. The share of the population covered by social transfer programs in LMICs is on average only 44 percent (World Bank 2018). Second, coverage is in particular low for poor low-income households, averaging 56 percent for the poorest 20 percent of the population (World Bank 2018). Third, adding to the general coverage issue, not all social assistance programs are suitable to compensate households for carbon-pricing-induced changes in household income and the cost of living. For such an economy-wide shock, many governments in LMICs would likely consider unconditional cash transfers as an administratively simple and suitable tool. The coverage of the poor is only reaching about 23 percent in the bottom quintile of the income distribution on average, with particularly low coverage rates of the poor in low-income countries.

Those in need are often targeted on the basis of proxy means testing (PMT), estimating household income based on assets and household characteristics collected from a short survey. The estimation procedure and subsequent ranking has been demonstrated to lead to severe targeting errors, excluding a substantial share of the population while including others who are not in need (Bah et al. 2019; Brown et al. 2018; Hanna and Olken 2018). For some well-documented cases, like the energy subsidy removal in Indonesia from 2005, targeting errors are associated with social unrest and erosion of local social capital (Cameron and Shah 2014). Such experiences should be a cautionary tale that redistribution in carbon pricing necessitates thoughtful implementation strategies to avoid politically jeopardizing reform success by creating inequality and a lack of transparency.

Administratively, the prior existence of large transfer programs is not necessarily a prerequisite for introducing carbon pricing. More important is the general ability, i.e., the institutional capacities of countries to redistribute government revenues. This can theoretically be done based on social registries, which an increasing number of middle-income countries operate, however with largely differing covering rates. Some examples include Indonesia (covering around 40 percent of the population), Colombia (73 percent), or the Philippines (75 percent) (Leite et al. 2017). On the other end of the spectrum, low-income or lower-middle-income countries often have no social registry or a very limited coverage, which renders their use for revenue recycling of carbon pricing practically challenging. Difficulties regarding targeting also apply to social registries given the limited information in these databases. Alternatives that are applied by some countries include community-based targeting (Alatas et al. 2012), self-targeting (Alatas et al. 2016), and a mix of targeting methods. Since targeting segments of the population is most often imperfect, universal transfers to every household or citizen may also be considered. A permanent institutional solution to this, universal basic income is now also discussed in the context of LMICs (Banerjee et al. 2019), but has not been linked to carbon pricing yet.

In addition to revenue recycling at the household level, compensation schemes could also tackle firms or generally increase government spending. Compensation for firms is usually executed either through corporate tax cuts or direct compensation schemes. Corporate taxes tend to be progressive in theory, but the incidence eventually depends on the relative mobility of capital and labor (Auerbach 2006). Evidence from high-income countries suggests that a large share of the tax burden from corporate taxes falls on wages (Arulampalam et al. 2012; Fuest et al. 2018; Suárez Serrato and Zidar 2016), but there is no evidence that corporate tax cuts in LMICs would lead to higher wages. In the case of direct compensation, such as grandfathering in an emissions trading scheme, the distributional effect will also likely be regressive in LMICs. Since the capital ownership structure in LMICs is highly concentrated at the very top of the income distribution, only few individuals would benefit.

The second alternative to revenue recycling at the household level consists of the government's spending items for health, education, and infrastructure. Dorband et al. (2021) found that using revenues of a carbon price to facilitate access to key infrastructures would be more progressive than lump-sum transfers in Nigeria. Generally, for infrastructure spending the incidence measurement is complex and empirically challenging. Yet, the existing literature suggests a range from strongly (Gonzalez-Navarro and Quintana-Domeque 2016; McIntosh et al. 2018) to modestly (Asher and Novosad 2020; Lee et al. 2020) positive impacts on the welfare of poor households. Due to the wide range of different infrastructure investments, the incidence is clearly case-specific. Adding to this complexity, infrastructure investments also come with an intertemporal complication. While low-income households may benefit from the investment in the future, it does not increase current disposable income. If the goal is to compensate short-run welfare losses, then revenue recycling via infrastructure spending is harder to justify politically, even when the long-run impacts are favorable.

DISCUSSION AND CONCLUSION

An increasing amount of LMICs discuss the possibility of implementing a carbon price. Carbon pricing indeed holds some advantages specifically for LMICs. Besides the theoretical economic argument that it is the most efficient instrument to reduce emissions, the administrative simplicity of, e.g., a CO_2 price for LMICs is a compelling practical argument. Administratively, a carbon price can be as easily implemented (at least when levied as a tax; an emissions trading scheme is connected to additional administrative challenges) as fuel excise taxes and therefore cost-efficiently contribute to domestic revenue mobilization. Hence, carbon pricing can be an effective means to increase the tax base in LMICs, which are usually facing difficulties to raise revenues (Besley and Persson 2014). In addition, it can also be expected that a carbon price—in contrast to many other taxes—has the potential to cover informal markets. A carbon price can further lead to incentives for informal activities to shift back to the formal sector, leading to welfare gains (Bento et al. 2018).

The barriers to introducing carbon pricing, and more importantly schemes with an effectively high incentive structure, are therefore not necessarily of administrative nature. Most often, in domestic climate and energy policy debates, equity concerns loom large and undermine public support. Policies that raise the price of fossil fuels, and thus the price of essential energy services used by households, often meet with fierce resistance from the public. Ecuador and Iran in 2019 or Nigeria in 2020 are only a few recent examples of large scale and violent protests that followed fuel price increases. Understanding which parts of the population are affected in which way is therefore not only essential from an ethical equity perspective, it is also key for the political success of carbon pricing and hence climate policy. For poor countries, understanding the distributional consequences of carbon pricing in detail is hence pivotal for their political success.

It is important to note that both distributional effects as well as absolute effects seem to be less severe when countries have not yet developed carbon-intensive energy systems (Dorband et al. 2019). Introducing carbon pricing might hence be politically easier in countries that are less developed. While countries have usually low emissions, carbon pricing could serve as an important means to ensure low-carbon development and avoiding building up emissions-intensive capital stocks. However, important caveats, e.g., how to deal with potential negative effects on other development goals, such as providing clean cooking alternatives, need to be taken very seriously. In addition, progressive results of carbon pricing in parts hinge on ignoring other greenhouse-gases but CO_2 emissions. Arguably, other emissions, e.g., from land use and land use changes might be relatively more important in LMICs. Extending the definition of carbon emission to carbon equivalent emissions, including other greenhouse gases, Vogt-Schilb et al. (2019) in a comparative analysis for countries from Latin America and the Caribbean as well as Renner (2018) found regressive impacts of carbon equivalent pricing. This result mainly mirrors food price increases that result from pricing other greenhouse gases but CO_2. These studies, however, do not explicitly deal with the technical problem of how to administratively put a price on other GHG emissions than CO_2.

Progressive effects still lead to absolute welfare implications, which can be severe for some parts of the population, in particular in poor countries. In order to make carbon pricing socially and politically acceptable, the expected revenues could be used (at least partly) to alleviate negative distributional effects. Eventually, it is of utmost importance to take into account the institutional limitations of LMICs when considering revenue recycling from carbon pricing. Targeting particular segments of the population has proven to be challenging and administrative progress is needed in building social assistance programs covering the entire poor and vulnerable population. Such programs must be in place before carbon pricing is introduced, which could be a case for bilateral and multilateral development cooperation if the international community wants to include more LMICs in the worldwide effort to price carbon. On the positive end, many countries have some form of social transfer schemes in place. For example, in Ecuador (where a reform of fossil fuel subsidies without any revenue recycling ended in violent protests in 2019), Schaffitzel et al. (2020) show that extending the existing social transfer schemes could have been used to alleviate the most severe effects for most households at the bottom 40 percent of the income distribution.

Yet, political acceptance hinges on more factors but income, as is increasingly understood. Maestre-Andrés et al. (2019) highlight the important role of perceived fairness based on a review of the literature. Regarding the French Yellow Vest movement, Douenne and Fabre (2020) highlight the role of lacking trust in the government and wrong beliefs of how individuals would exactly be affected. In the German context, Sommer et al. (2020) highlight the need to take into account different fairness perceptions in the population when designing revenue recycling schemes. Yet, only limited evidence is available for LMICs. However, it can be expected that trust in governments to handle the distributional effects and recycle revenue in an acceptable way is even more limited than in developed economies. Understanding those challenges in detail for LMICs will require additional research.

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