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ABSTRACT

The current global momentum for carbon pricing has lately produced innovative hybrids: carbon taxes allowing the use of offsets from emission sources not targeted by the carbon tax for compliance with the tax load. This study aims at filling the knowledge gap in existing literature by exploring the potential impacts of domestic offset components in carbon taxes on mitigation of national emissions, including the country examples Colombia, Mexico and South Africa.

The findings indicate that the use of offsets in carbon taxes may significantly influence mitigation of national emissions both positively and negatively. On the one hand, this model may result in real emission reductions from offset projects and positive spillover effects of efforts to reduce emissions from emission sources covered by the carbon tax to other emission sources. Furthermore, the offsetting component can be used as a bargaining chip in political negotiations facilitating the introduction of mitigation policies and measures and/or strengthening their ambition level. On the other hand, it also entails serious risks: Offsetting could compromise the environmental integrity of the carbon tax through low-quality offsets. Furthermore, offsets reduce incentives to curb emissions in the emission sources covered by the carbon tax, potentially leading to carbon lock-in effects. Moreover, an offsetting component could provoke opposition to further climate policies and measures for emission sources generating offsets, as replacing the offsetting component with mandatory emission reduction policies would eliminate revenues from offset credits. General opposition of stakeholder groups to the introduction of offsets may even hinder the introduction of carbon pricing instruments and offsetting altogether.

The study identifies options that could be employed to increase potential positive effects of introducing an offset component to a carbon tax and mitigate related risks, pointing to the country examples included, where appropriate.

KEYWORDS

Climate policy, emissions mitigation, carbon markets, carbon pricing, carbon tax, offsetting

WORD COUNT

6,738 words

ABBREVIATIONS

AFOLU	Agriculture, forestry and other land use
BAU	Business as usual
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CO_2e	Carbon dioxide equivalent
ETS	Emissions trading scheme
GHG	Greenhouse gas
GS	Gold Standard
MRV	Measuring, reporting and verification
NDC	Nationally determined contribution
NGO	Non-governmental organisation
REDD+	Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of

	forest carbon stocks in developing countries
SDGs	Sustainable Development Goals
UBA	German Federal Environment Agency (Umweltbundesamt)
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard

1. INTRODUCTION

The Sustainable Development Goals (SDGs) are the United Nation's blueprint for a better and more sustainable future for all. Goal 13 is to "(t)ake urgent action to combat climate change and its impacts by regulating emissions and promoting developments in renewable energy" [1]. Contributing to achieving this goal, in 2015, the Paris Agreement has opened a new page for international climate policy: It requires all signatory Parties to undertake "ambitious efforts" to hold the increase in the global average temperature to "well below 2°C above pre-industrial levels" and pursue "efforts to limit the temperature increase to 1.5°C above pre-industrial levels" [2]. Parties are to submit their nationally determined contributions (NDCs) to global mitigation and adaptation efforts to the United Nations Framework Convention on Climate Change (UNFCCC). As of 25th September 2018, 176 Parties have submitted NDCs.
One of the means of mitigating greenhouse gas (GHG) emissions employed by many countries is carbon pricing. As of April 2018, 45 national and 25 subnational jurisdictions are putting a price on carbon by either introducing emissions trading schemes (ETSs) or by pricing carbon through taxation [3]. This momentum for carbon pricing has also produced innovative hybrids: Colombia, Mexico and South Africa have introduced or are planning to introduce carbon taxes that allow taxpayers to use offsets for complying with the tax load to some extent. This allows emission reductions generated in emission sources not covered by the tax to be used for reducing the tax load. While the impact of an offset component on ETSs has already been studied to a wide extent, this new model of using offsets has until now only received little attention in the literature. With a growing number of countries introducing carbon taxes, this can be considered a serious knowledge gap. This study aims to fill this gap with an analysis of the potential impacts of a domestic offset component in a carbon tax on mitigation of national emissions.

For this analysis, this study first introduces the theoretical framework explaining the concepts emission trading, carbon taxes and offsets (chapter 2). The analysis of existing scientific literature regarding ETSs, carbon taxes, and offsets in chapter 3 displays the existing knowledge gap, particularly regarding the impact of domestic offset components in carbon taxes on mitigation of national emissions. The study briefly illustrates the origins of this model and portrays the development and main features of carbon taxes with offset components in Colombia, Mexico, and South Africa in chapter 4 to provide the basis for the subsequent analysis. The analysis differentiates between potential opportunities (chapter 5) and risks (6) regarding mitigation of national emissions resulting from introducing a domestic offset component to a carbon tax. Where appropriate, it points to key features in the design of the carbon taxes and their offset components in Colombia, Mexico, and South Africa and identifies options that may be employed to increase positive impacts and to reduce risks regarding emissions mitigation resulting from this new model. This analysis may support policy makers in designing offset components for carbon taxes.

2. EMISSIONS TRADING, CARBON TAXES AND OFFSETS

Externalities occur from an economic activity (production, consumption) and affect third parties not directly related to this transaction. They lead to market failure, i.e. a situation in which the allocation of goods and services by a free market is not efficient, because they

cause an activity's price equilibrium to not accurately reflect the true costs and benefits of that activity. Policies can internalise externalities in order to redistribute costs and benefits to the causer of the externality.
GHG emissions have a negative effect on parties not directly involved in their emissions, thus constituting negative externalities. The idea behind carbon pricing is to charge GHG emitters for their emissions, shifting fiscal burdens to emitters, thus correcting a market failure while at the same time generating public revenue.
Generally, there are two approaches to create an explicit carbon price: ETSs and carbon taxes. An ETS sets a cap on GHG emissions for specific emission sources and allows capped entities to trade allocated permits (allowances) for their emissions with each other (cap and trade). The price of the allowances, i.e. the tradable permits, depends largely on the level of ambition applied when setting the cap of the ETS and on the entities' abatement costs. For each tonne of GHG emitted, allowances have to be surrendered.
GHG or carbon taxation levies, on the other hand, determine a tax rate for each tonne of GHG emitted (carbon tax). Taxation of this kind also sends a price signal to covered entities, which is determined by the government, and incentivises emission reductions. In contrast to ETSs, however, there is no trading involved. While an ETS provides certainty in terms of the amount of GHG emissions that can be emitted, a carbon tax ensures a stable carbon price.
With both ETSs and carbon taxes, emission reductions are becoming an asset since each tonne of GHG emitted represents a financial burden for the emitter. Thus, carbon pricing instruments trigger investments in low-carbon technologies including energy efficiency and renewable energy. Emitters can choose how to reduce their GHG emissions in the most cost-effective way to reduce the burden caused by the carbon pricing system.

Cost-effectiveness can be intensified by linking carbon pricing systems, thus increasing the number of GHG abatement options that can be used for compliance with the policy instrument. Linking can be permitted across national borders, to emission sources not covered by the carbon pricing system, but also between different instruments, i.e. between ETSs and carbon taxes. Links can either be direct, or indirect via market mechanisms that generate offsets.
Offsets are emission reductions generated in emission sources not covered by the main carbon pricing system that can be used for compliance in a carbon pricing system. In an ETS, participants can submit these offsets for their emissions instead of, or in addition to allocated permits. An offsetting component in a carbon tax allows regulated entities to fulfil (part of) their compliance obligations by surrendering mitigation certificates generated outside the scope of the carbon tax. These credits can be generated within or outside the jurisdiction of a country (domestic vs. international offsetting). A domestic offsetting component is only possible when a carbon pricing instrument is not applied to the overall economy (existence of emissions not covered by the instrument) or when offsets are generated from negative emissions (e.g. via afforestation).
The main reason for introducing an offset component to a carbon tax usually consists in lowering costs for covered entities. Offset components not only increase the political feasibility of a carbon tax. By reducing costs for (some of) the entities targeted by the tax, concerns regarding carbon leakage – i.e. the geographic or temporal dislocation of emissions – as well as potential distributional impacts can be addressed. Depending on its design, offset components can have far-reaching impacts on mitigation of national emissions that will be illustrated in chapters 5 and 6. There are, however, alternative pathways to reduce the costs for entities covered by a carbon tax and address concerns regarding leakage and distributional impacts:

- Full or partial exemption from tax obligations: Full exemptions completely exclude some emitters from the direct tax obligation (e.g. small emitters), while partial exemptions exclude a portion of a companies' emissions. Both approaches can be operationalized through thresholds.

- Reducing the tax rates for (some) emitters.
- Rebates on carbon tax payments: Repayment of all or part of the carbon tax paid by the liable entity.
- In-kind support, such as subsidies, for liable entities [4].

3. LITERATURE REVIEW

The proliferation of carbon pricing has led to numerous scientific publications on this topic. There is extensive literature about the merits of putting a price on carbon [e.g. 5], about the benefits of introducing a carbon tax and design options [e.g. 4, 6-11], and on how to develop an ETS [e.g. 12, 13]. Recent research has also evaluated the practical experiences made with both instruments [e.g. 14-19].

A specific area that has been explored in more detail is the linking of ETSs [20-28]. In recognition of the fact that government's "tastes differ" [29] when it comes to choosing the right policy instrument, research on linking non-ETS policies is gaining increasing relevance [29, 30]. Policy linking has received increased attention with the adoption of the Paris Agreement and its Article 6, which could provide a basis for international linkages between domestic climate policy instruments [31-33]. Further research has focused on hybrid systems combining carbon taxation and carbon trading [e.g. 34, 35].

While the impacts of credits from international offsetting schemes on ETSs have been explored broadly [e.g. 36, 37], research on how offsetting schemes might impact carbon taxes is still limited [e.g. 38-43], and there have so far not been any publications focusing on the impact of introducing an offset component in a carbon tax on emissions mitigation.

Countries considering introducing an offset component to their carbon tax can therefore build on only limited experiences and studies. This study examines potential impacts of the use of domestic offsets in carbon taxes on mitigation of national emissions to bridge a key part of the existing knowledge gap.

4. ORIGINS AND DEVELOPMENT OF OFFSET COMPONENTS IN CARBON TAXES IN DIFFERENT COUNTRIES

While carbon taxes were first proposed in the early 1970s, the origins of real-world offset components in a carbon tax can be traced back to July 2012 when Australia's Clean Energy Act 2011 came into effect [44]. Australia's carbon price scheme covered about 60% of Australia's total emissions and started with a fixed carbon price similar to a tax of 23 AUD $ (19,23 EUR[1]). It was to transition to an ETS by July 2015 but was repealed in July 2014 [45]. From the start, covered entities were allowed to use offsets for up to 5 per cent of their obligations under the scheme [44]. This example induced interest in offset components in other countries considering the introduction of a carbon tax in the following years.

Thus, South Africa has been preparing an offsetting component for its carbon tax since 2012 and both Mexico and Colombia have already introduced such a component for their carbon taxes. The following provides an overview of the development and key features of the (envisaged) carbon taxes and their offsetting components in these three countries. Chapters 5 and 6 on the opportunities and risk arising from the use of offset in carbon taxes will refer to the country examples, where appropriate.

4.1 South Africa

[1] Amounts in Euro are calculated on the basis of the exchange rate of 1 July 2012.

Since being mooted in 2010 [46], the introduction of a carbon tax in South Africa has been postponed several times and is now envisaged for 1 January 2019. In the first phase of the tax up until 2022, the tax rate is envisaged to amount to 120 R (7.46 EUR[2]) per tCO_2e. However, the government proposes a number of options to reduce the tax liability with tax-free thresholds, leaving the effective tax rate between 6 and 48 R (between 0.37 and 2.98 EUR) per tCO_2e. In the first phase, the waste and land use sectors have been excluded from the tax [47].
After South Africa's Tax Proposal Budget 2012 mentioned offsets as a design feature for the proposed carbon tax [48], stakeholders engaged in developing a framework for carbon offset opportunities in South Africa [e.g. 49]. According to South Africa's latest carbon tax proposal, offsets are envisaged to be allowed to be used for 5 or 10% of the carbon tax, depending on the sector, and will have to come from domestic projects that generate offsets outside the scope of activities covered by the carbon tax. Renewable energy projects have been excluded from the carbon offset scheme and the indicative positive list includes projects in energy efficiency projects (except projects claiming South Africa's energy efficiency tax incentive), transport, waste, and agriculture, forestry and other land use (AFOLU). The scheme will rely on the Clean Development Mechanism (CDM), the Verified Carbon Standard (VCS) and the Gold Standard (GS) [50].

4.2 Mexico

The tax on fossil fuels (impuesto a los combustibles fósiles) in Mexico entered into force in January 2014 and is imposed on the sale and import of fossil fuels, except for natural gas, which is exempted from the tax. For each of the other fossil fuels, a tax rate is calculated based on the additional amount of CO_2 that would be generated if the respective fossil fuel were used instead of natural gas [51]. In 2017, the tax ranged from between 6.50 USD (5.69 EUR[2]) per litre for Propane to 17.15 USD (15.01 EUR) per litre for fuel oil [52]. The fact that no uniform carbon price is defined for the carbon content of the different fuels hinders the connection of the tax to Mexico's ETS, which is to launch its pilot phase in 2019.
With the adoption of the tax on fossil fuels, the option to use credits from climate change mitigation projects was introduced. Rules for the use of credits came into force in December 2017. Eligibility is restricted to Certified Emission Reductions (CERs) from projects of the CDM hosted in Mexico, and CERs eligible under the Emissions Trading Scheme of the European Union (EU ETS). Notably, it will not be possible to use CERs directly to reduce the overall volume of taxed carbon. Instead, the taxpayer can pay part of the tax amount using CERs. According to the law, the value of the CERs is to correspond to the market value at the moment of paying the tax. For the first year, up to 20% of the tax on fossil fuels can be paid with credits [53].

4.3 Colombia

Since 2017, Colombia levies an economy-wide carbon tax on sales and imports of all liquid and gaseous fossil fuels used for combustion, except for natural gas in the generation of electricity. The tax was introduced with 29 COP (0.0087 EUR[2]) per cubic metre of natural gas and between 95 and 177 COP (between 0.028 and 0.053 EUR) per gallon of liquid fuels, depending on the fuel, resulting in about 5 USD (4.37 EUR) per t CO_2 [54].
Instead of paying the tax, taxpayers may surrender offsets for 100% of their tax obligations and become certified carbon neutral [55]. Regulation for carbon neutral certification was established on 1 June 2017. It limits offset eligibility to specific methodologies:

1. CDM methodologies.

[2] Amounts in Euro are calculated on the basis of the exchange rate of 12 August 2018.

2. Methodologies from specific certification programmes and carbon standards. These methodologies either have to
   - be verified by a third party accredited by specific entities using specified methodologies,
   - be issued by the UNFCCC,
   - be recognized through Colombia's National Normalization Body, or
   - meet the REDD+ (Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries) registry's registration requirements for initiatives.

While offsets generated using CDM methodologies have to originate from mitigation activities on national territory, until 31st December 2017, offsets generated under the specified certification programmes and carbon standards were allowed to stem from mitigation activities outside of Colombia. Since the beginning of 2018, only offsets developed on national territory are eligible under the specified certification programmes and carbon standards, too [56].

5 OPPORTUNITIES ARISING FROM A DOMESTIC OFFSET COMPONENT IN A CARBON TAX ON MITIGATION OF NATIONAL EMISSIONS

The introduction of offsets in carbon taxes opens up several opportunities regarding emissions mitigation that are introduced in this chapter. Where available, options to increase these opportunities are presented.

5.1 Cost reductions

The key reason for introducing an offset component to a carbon tax usually consists in reducing costs for covered entities (see chapter 2) by increasing the number of GHG abatement options that can be used for compliance with the policy instrument. Cost reductions, however, depend on the design of the carbon tax's offsetting option. Thus, for example, current provisions regarding the use of offsets in Mexico's tax on fossil fuels do not necessarily entail cost reductions for the taxpayer: they allow submitting a limited amount of CERs from CDM projects hosted in Mexico or eligible under the EU ETS, and having the tax bill reduced according to the CERs' global market value at the moment of paying the tax. This option will, however, only impact transaction costs of taxpayers who already own offsets and would rather use them for tax compliance than sell them on the international market. As taxpayers will continue to have the possibility to sell CERs at international market price, there is no additional incentive to use them for paying the tax. Taxpayers who are willing to use this option but have no certificates would have to acquire them. With the value of CERs being set at market price levels, those taxpayers will not even be able to cover the additional transaction costs required for the acquisition. In South Africa, in contrast, where offsets are envisaged to reduce the amount of CO_2e taxpayers have to pay the carbon tax for, cheap credits may well reduce the costs of GHG mitigation once the carbon tax is in place. In Colombia, many taxpayers use the option to reduce their costs by becoming carbon neutral with offsets instead of paying the carbon tax.

Increasing the scope of emission sources eligible for offset generation and the amount to which offsets may be used can boost the opportunity to reduce costs with an offset component. Also, expanding the scale of eligible offset activities from projects to programmes and sectors may make offsets cheaper, thus reducing costs for liable entities.

5.2 Emission reductions in emission sources generating offsets

Offsets represent verified emission reductions. The use of domestic offsets for compliance with a carbon tax thus substitutes tax payments with emission reductions in domestic emission sources not covered by the carbon tax, leading to increased mitigation of national emissions.

The more offsets (i.e. additional emission reductions) are traded in for tax revenue, the higher the additional mitigation achieved through the offset component. All options increasing the opportunity to reduce costs with an offset component included in chapter 5.1 (increasing the scope of eligible emission sources for offsetting, raising the amount to which offsets may be used, expanding the scale of eligible offset activities) may increase the use of offsets for compliance with the tax and thus boost additional mitigation.

Furthermore, the level of the carbon tax may influence the impact the introduction of a domestic offset component may have on mitigation of national emissions. Thus, low tax rates may not be able to incentivise substantial emission reductions – neither in the emission sources covered by the carbon tax nor in the (potential) emission sources generating offsets – as emitters may prefer to just pay the tax instead of investing in low-carbon alternatives or buying offsets. In this case, the impact of offsets on emissions mitigation would be marginal, just as the tax would have a very limited impact. Higher tax rates, on the other hand, would not only incentivise taxable entities to identify and use own mitigation options but also encourage the use of offsets and the corresponding reduction of emissions from emission sources generating offsets.

5.3 Positive spillover effects

Spillover effects are events in one context that lead to something else in an unrelated context. They can be both negative (e.g. carbon leakage) and positive. Regarding mitigation, positive spillover effects refer to the inducement and diffusion of low-carbon technologies or mitigation policies and measures outside of the main pricing instrument. Introducing an offset component to a carbon tax may provoke positive spillover effects from the emission sources covered by the tax to other emission sources, in particular those that may generate offsets. This may lead to emission reductions well beyond those used to offset emissions in the carbon tax.

The impact of this spillover effect depends highly on the extent to which offsets are used. Thus, the options to reduce costs resulting in higher use of offsets presented in chapter 5.1 (increasing the scope of eligible emission sources for offsetting, raising the amount to which offsets may be used, expanding the scale of eligible offset activities) as well as higher tax rates would increase positive spillover effects of the offset component and lead to additional mitigation outside the scope of the carbon tax.

5.4 Additional regulation

Additional regulation can further increase the positive impact of an offset component in a carbon tax on mitigation of national emissions, in particular through:

1. Cancellation of a certain percentage of emission reductions from the emission sources generating offsets, reducing the amount of offsets generated.
2. Discounting of emission reductions from the emission sources generating offsets, which means that only part of the emission reductions that have taken place are able to generate offsets.
3. Limited crediting periods beyond which emission reductions continue.
4. The use of stringent baselines that set crediting baselines below business as usual (BAU) emission levels.

All of these options can either be applied equally to all mitigation activities or they can be differentiated, for example by specific (sub)sectors and/or project types. Equal application to all activities implies the same percentage of emission reductions to be cancelled, the same discount, equal crediting periods, or the reduction of the same percentage of emissions from BAU baselines, respectively, for all emission reducing activities. In contrast, lower discounts and percentages of emission reductions to be cancelled, as well as longer crediting periods and less stringent baselines for particularly desired emission reducing activities could boost desired emission reducing activities, or prevent specific activities entirely. This way countries could give preference to offsets that are particularly favourable in the eyes of the government, e.g. offsets generated in the transport sector or renewable energy projects [57-60].

Neither Colombia nor Mexico or South Africa have introduced or are currently planning to introduce rules to achieve additional mitigation benefits with their offset schemes through such regulation.

Intensifying the options presented (i.e. increasing the percentage of emission reductions to be cancelled/discounted, further reducing crediting periods, making baselines more stringent) would increase these options' positive impact on mitigation of national emissions.

5.5 Bargaining chip in political negotiations

Allowing for the use of offsets may lead to additional momentum for increased climate action. Thus, offsets may be used as a bargaining chip in political discussions, inter alia, with opponents of the introduction of a carbon tax who fear high burdens for emitters. This has been the case both in Mexico and South Africa, where opposition against the introduction of the carbon taxes has been reduced significantly with the option to allow for the use of offsets. Also, allowing offsets may increase the willingness as well as the ability of a government to enhance its climate commitments. This would indeed have a positive impact on mitigation of national emissions.

Comprehensive stakeholder involvement can increase this option. It has been used and is being used intensively in designing the South African carbon tax.

6 RISKS ARISING FROM A DOMESTIC OFFSET COMPONENT IN A CARBON TAX ON MITIGATION OF NATIONAL EMISSIONS

Allowing offsets also entails a couple of serious risks that the following chapter analyses. Where available, options to reduce these risks are presented.

6.1 Compromising environmental integrity

One of the risks arising from the introduction of a domestic offset component in a carbon tax on mitigation of national emissions is the undermining of environmental integrity. In this study, the term "environmental integrity" is used to describe a situation in which the individual elements and processes of an overarching instrument do not undermine the (environmental) goals of this instrument. In the context of this study, environmental integrity is considered to be ensured if the use of offsets does not undermine the environmental goal of the carbon tax.

The environmental integrity of a carbon tax can be jeopardised when offsets with low quality are used for compliance. Experience with international offset standards, in particular with the CDM, has highlighted some of the risks that offsetting might entail.

One of these risks is non-additionality of the mitigation activity. Broadly speaking, a mitigation activity can only be deemed additional if it would not have been implemented in the absence of the overarching policy intervention [61]. In the context of the subject of this study, the mitigation activity generates the offset credits to be used under the carbon tax while the policy intervention can be defined as the certification standard that triggers the implementation of the mitigation project. A key challenge associated with the assessment of additionality is its counter-factual nature, as project proponents must describe what would happen in the absence of the overarching policy intervention. Under the CDM, non-additionality has been a concern in particular regarding the first projects registered under the mechanism [62-65]. Despite important reforms, non-additionality continues being an issue in

the current, second commitment period of the Kyoto Protocol: a recent analysis of a representative random sample of CDM projects has found that about 85% of the projects have a low likelihood of their emission reductions being additional [66].
In light of this, Mexico allowing for the use of CERs from CDM projects hosted in Mexico or eligible under the EU ETS is highly problematic and may threaten the environmental integrity of its carbon tax. In Colombia, offsets from a list of standards/methodologies are accepted to be certified carbon neutral and not pay the carbon tax. Their quality determines the risk posed to the environmental integrity of Colombia's carbon tax. Public information online suggests that so far, at least a large share of offsets used to achieve carbon neutrality have been CERs [67-69]. This may pose significant risks to the environmental integrity of Colombia's carbon tax. In South Africa, the carbon offset scheme is envisaged to rely on the CDM, VCS and GS with the latter two standards generally assumed to result in credits of higher quality. However, additionality is not tested separately in either one of these standards, resulting in potential problems regarding environmental integrity in South Africa's offset scheme, too. Renewable energy projects and some energy efficiency projects are, however, not eligible under the proposed carbon offset scheme, preventing the use of offsets from projects whose additionality is frequently highly in question, thus reducing the risk of low-quality projects to some extent.

Other effects that adversely impact the quality of offsets and may undermine the environmental integrity of the system in which they are used relate to the determination of the emission reductions. The emission reduction of a mitigation activity is calculated by comparing the project emissions with the emissions from a reference scenario (baseline emissions). In case baseline emissions are overestimated (inflated baselines) or the mitigation activity's emissions are underestimated, the certificates the activity will obtain are higher than the mitigation outcomes actually generated. In order to properly calculate the emission reductions of a mitigation activity, other effects such as carbon leakage and rebound effects must be taken into consideration. Carbon leakage refers to the temporal or geographic dislocation of emissions outside the scope of the mitigation activity. A rebound effect describes the situation in which the implementation of a mitigation activity leads to a reduction of GHG emissions associated to a specific activity, which are, however, countered by changes in behaviour and consumption. In addition, the permanence of the emission reductions must be ensured [70].

Environmental integrity can also be compromised after the mitigation effect of the credits has been robustly estimated: Double counting refers to a set of risks (such as: double issuance, double claiming, double use) that lead to a situation in which one mitigation outcome is used more than once. Ensuring robust accounting and avoiding double counting of mitigation outcomes will be particularly challenging under the Paris Agreement, as the new climate regime leads to a new diversity in terms of national mitigation targets in NDCs and uncoordinated coexistence of certification standards [71-74].

When deciding on the eligibility of offset credits under a carbon tax, policy makers must take these environmental integrity risks into consideration and design regulations in order to reduce them. Otherwise, low-quality credits and flawed accounting processes can put at risk the environmental integrity of the carbon tax. In this regard, an important difference to the impact of low-quality offsets on the environmental integrity of ETSs can be observed: In the case of ETSs, the use of low-quality credits will undermine the cap of the trading system. With a carbon tax lacking such a pre-defined emissions cap, the impact of low-quality offsets would be somewhat different: While low-quality offsets will not directly reduce the mitigation impact of the carbon tax, their use will, however, undermine the overarching environmental goal of the carbon tax, which is climate change mitigation.

6.2 Reduced emission reductions in main carbon pricing system

Another risk of allowing the use of offsets in a carbon tax entails that offsets shift efforts to reduce emissions to other emission sources. Thus, with offsets, emission reductions do not occur in the emission sources the carbon pricing instrument was originally designed for. Remedy can be offered

- by limiting the amount of offsets that may be used,
- by setting the value of offsets for compliance purposes based on their market value rather than their carbon content, thus preventing market flooding with cheap credits, or
- by tying the option to use offsets to increased levels of ambition in the main carbon pricing system.

Depending on both the scale to which offsets are allowed and the increase of ambition, these measures could even have a significant positive impact on emissions mitigation. The larger the increase of ambition in the main carbon pricing system relative to the scale to which offsets may be used, the bigger the net benefit for the atmosphere. The Paris Agreement requires all of its Parties to notify NDCs and to implement measures to achieve them. Increasing the level of ambition in NDCs should be a prerequisite for the introduction of an offsetting component in order to reach a carbon tax's full potential regarding the redirection of investment towards low-carbon options.

With Colombia allowing taxpayers to use offsets for 100% of their tax obligations to become carbon neutral instead of paying the tax, the use of this option has been popular [67-69]. Instead of reducing emissions covered by the carbon tax or paying the tax, this could result in a complete transfer of mitigation efforts to emission sources able to generate offsets, counteracting the main intentions behind the introduction of the carbon tax.

In Mexico, in contrast, the value of the CERs that may be used to pay the tax is to correspond to the market value at the moment of paying the tax. This discourages the use of emission reductions instead of paying the tax or reducing emissions covered by the tax. Furthermore, at least for the first year, the use of CERs is limited to a maximum of 20% of the tax bill, ensuring that the largest share of the tax will be paid without the use of credits, leaving high incentives to reduce emissions covered by the tax.

In South Africa, current proposals indicate that offsets may be used for 5 or 10% of the carbon tax depending on the sector, thus capping the offsets' negative effect on incentives for mitigation in emission sources covered by carbon tax.

6.3 Lock-in effects

Allowing for the use of offsets reduces a carbon pricing instrument's price signal. Depending on the scale to which offsets are allowed and used, this reduction may be significant and may divert investors from shifting long-term investment in the emission sources covered by the carbon pricing instrument to low-carbon alternatives. Mitigation efforts instead shift to other emission sources, leaving emission sources covered by the main carbon pricing instrument at risk of a carbon lock-in. Lock-in effects result from existing technologies, institutions, and behavioural norms that hinder the adoption and/or diffusion of low-carbon alternatives.

Regarding this risk, making offsets conditional on additional ambition in the central carbon pricing system could, again, be a solution, as well as limiting the amount to which offsets may be used, and setting the value of offsets based on their market value, thus reducing their use.

6.4 Opposition to further climate policies and measures

Furthermore, introducing an offset component to a carbon tax entails the risk to reduce incentives for mitigation policies and measures in the emission sources generating offsets.

With the perspective loss of additional income, opposition to further climate policies in emission sources (potentially) generating offsets may increase significantly. An option to reduce this risk is the strong involvement of all stakeholders, which is being practiced intensively in South Africa.

6.5 Opposition to introduction of offsets

While offsets may lower opposition to the introduction of carbon pricing instruments of stakeholder groups fearing high burdens for emitters, the risks described may also cause substantial opposition to allowing the use of offsets in a carbon pricing system, e.g. from environmental non-governmental organisations (NGOs), politicians and the general public. This opposition may significantly complicate the introduction and/or use of offsets or even carbon pricing mechanisms in general. Comprehensive stakeholder involvement is key to reduce this risk and is strongly employed in South Africa.

The following tables provide an overview of the aspects discussed in this chapter.

Table 1. Opportunities arising from a domestic offset component and options to increase them (own compilation)

Area	Opportunities	Options to increase opportunities
Economy	Cost reductions	Increasing the scope of emission sources generating offsets Increasing the amount to which offsets may be used Expanding the scale of offset activities
Environment	Emissions reductions in emission sources generating offsets	Increasing the scope of emission sources generating offsets Increasing the amount to which offsets may be used Expanding the scale of offset activities Higher tax rates
Environment	Positive spillover effects	Increasing the scope of emission sources generating offsets Increasing the amount to which offsets may be used Expanding the scale of offset activities Higher tax rates
Environment	Additional regulation (cancellation or discounting of emissions reductions, limited crediting periods, stringent baselines)	Increasing the percentage or emission reductions to be cancelled/discounted, further reducing crediting periods, making baselines more stringent
Politics	Bargaining chip in political negotiations	Stakeholder involvement

Table 2. Risks arising from a domestic offset component and options to reduce them (own compilation)

Area	Risks	Options to reduce risks
Environment	Compromising environmental integrity	Design of regulation

Environment	Reduced emission reductions in main carbon pricing system	Limiting the amount to which offsets may be used Setting the value of offsets based on their market value Tying option to use offsets to increased levels of ambition in main carbon pricing system
Technology	Lock-in effects in emission sources covered by the carbon pricing system	Limiting the amount to which offsets may be used Setting the value of offsets based on their market value Tying option to use offsets to increased levels of ambition in main carbon pricing system
Politics	Opposition to further climate policies and measures in emission sources generating offsets	Stakeholder involvement
Politics	Opposition to introduction of offsets may hinder introduction of carbon pricing instruments and/or offsets	Stakeholder involvement

7. CONCLUSIONS

Even though a growing number of countries and sub-national jurisdictions is introducing carbon taxes and some countries are exploring ways to add an offset component to their tax, these new hybrids have until now only received little attention in the literature. This study fills part of this void by analysing the potential impacts of a domestic offset component in a carbon tax on mitigation of national emissions.
For this purpose, after identifying the existing knowledge gap with an analysis of existing literature, this study provided an overview of the origins and developments of the model. On this basis, it discussed risks and opportunities regarding mitigation of national emissions resulting from introducing a domestic offset component to a carbon tax. It portrayed design options to increase opportunities and reduce risks, pointing to key features in the design of the carbon taxes and their offset components in Colombia, Mexico, and South Africa, where appropriate.

The findings indicate that the use of offsets in carbon taxes may significantly influence mitigation of national emissions. This influence may be both positive and negative.
Thus, on the one hand, an offset component may reduce costs for liable entities, in particular when tax reductions are calculated based on the offsets' carbon content (Colombia, South Africa) and not on the offsets' market value (Mexico). Options to increase cost reductions include increasing the scope of eligible emission sources generating offsets, the amount to which these offsets may be used, and the scale of offset activities.
Furthermore, an offset component in a carbon tax can incentivise emission reductions in emission sources generating offsets and cause positive spillover effects inducing mitigation outside of the main carbon pricing instrument. Both of these opportunities can be boosted by higher tax rates and, again, increasing the scope of emission sources generating offsets, the amount to which offsets may be used, and the scale of offset activities.

Additional regulation can be employed to increase the positive impact of an offset component in a carbon tax on mitigation, in particular cancellation of a percentage or discounting of emission reductions from the emission sources generating offsets, limiting crediting periods, and the use of stringent baselines. Neither Colombia nor Mexico nor South Africa have introduced, or are currently planning to introduce, rules to achieve such an atmospheric benefit with their offset scheme.
Furthermore, the introduction of offsets can be used as a bargaining chip in political negotiations with stakeholder groups who fear high burdens from the introduction of a carbon pricing instrument. This opportunity can be boosted using comprehensive stakeholder involvement, as is being done in South Africa.

However, on the other hand, the analysis has shown that the (planned) introduction of an offset component may also cause substantial opposition, e.g. from environmental NGOs, politicians and the general public. Moreover, the use of offsets could provoke opposition to further climate policies and measures in emission sources generating offsets as these could reduce potential income via offsets. Opposition to the introduction of offsets may even hinder the introduction of carbon pricing instruments and/or offsets altogether. Stakeholder involvement as being exercised in South Africa may help overcoming risks revolving around opposition.
Furthermore, the use of poor-quality offsets may put the environmental integrity of the entire carbon tax at risk. With the high likelihood of many CDM projects not being additional, all countries employing CERs face this risk – including this study's country examples Colombia, Mexico and South Africa. While banning offsets from projects with questionable additionality (like renewable energy projects in emerging economies) reduces this risk, there still remains a serious threat to the environmental integrity of the carbon tax.
Another risk arising from a domestic offset component in a carbon tax consists in reduced emission reductions in the main carbon pricing system and lock-in effects. Remedies include limiting the amount of offsets that may be used, setting the value of offsets for compliance purposes based on their market value instead of their carbon content, thus preventing market flooding with cheap credits, or tying the option to use offsets to increased levels of ambition in the main carbon pricing system. As demonstrated in this study, the three countries analysed have chosen different options in this regard, with South Africa and Mexico having imposed limits on the use of offsets and Colombia allowing taxpayers to use offsets for 100% of their tax obligations. It remains to be seen how these differences in design will impact the operation of the carbon taxes and the use of their offsetting components.

When deciding on the introduction and design of an offset component for a carbon tax, the identified opportunities and risks should be considered carefully in order to reach a balance between different policy goals. Policy makers should also keep in mind that the use of offsets may seriously affect the amount of revenues to be obtained from the carbon tax. The findings indicate that meaningful and comprehensive stakeholder involvement is key for both increasing support and reducing potential opposition to the introduction of an offset component. This will not only be relevant for achieving a well-developed carbon tax but may also support political negotiations on the introduction of other mitigation policies, as well as on stronger mitigation commitments in general. First and foremost, however, the study has demonstrated the importance of designing offset regulations in a way that ensures the environmental integrity of the carbon tax system. Otherwise, the tax will not be able to reach its main goals, the mitigation of climate change, seriously putting the entire instrument into question.

In the years to come, the model of complementing a carbon tax with an offset component may be modified. Introducing a carbon tax with an offset component is sometimes seen as a stepping stone for the introduction of an ETS at a later stage. This builds on the idea of the carbon tax and its offset component assisting the government and the private sector in developing capacities that could be used for the development and operation of an ETS. In this process, the carbon tax could either be transitioned into an ETS or both carbon pricing instruments could coexist in order to arrive at a smart carbon pricing mix that addresses the peculiarities of the different sectors involved. Emission sources not targeted by these instruments could hence act as providers of carbon offsets, further increasing the reach of the carbon pricing signal. As has been demonstrated in this study, a domestic offsetting component's impact on mitigation of national emissions in a carbon tax, however, differs significantly from the one in an ETS where offsetting is at best a zero-sum-game. This observation leads to future research questions on the impact of coexisting ETSs and carbon taxes with domestic offset components on mitigation of national emissions.
Increasing the reach of the carbon pricing signal must not stop at country borders: While today, the offset components in all three countries analysed in this study limit eligibility to domestic offsets, future development paths could as well allow for the use of international credits for compliance with a carbon tax. Such a system would constitute an indirect link of carbon pricing instruments across national borders. Policy makers will, however, have to carefully weigh the risks and opportunities of this option.

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