Climate Finance for Developing Country Mitigation: Blessing or Curse?

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Abstract

Under the United Framework Convention on Climate Change, industrialized countries have agreed to cover the incremental costs of climate change mitigation in developing countries and recent climate negotiations have reaffirmed the central role of climate finance for global mitigation efforts. We use an integrated energy-economy-climate model to assess the potential magnitude of financial transfers to developing countries that can be expected under non-market transfer mechanisms as well as international emission trading with several allocation schemes. Our results indicate that for the latter, depending on international permit allocation rules financial transfers to developing countries could reach almost USD bln 400 per year in 2020, with Sub-Sahara Africa receiving financial inflows of as much as 14.5% of its GDP. Reviewing the literature on natural resource revenues, official development assistance, and foreign direct investment, we identify three major channels through which such sizable financial inflows may induce harmful effects for recipients: volatility, Dutch disease, and rent-seeking and corruption. We discuss the relevance of these mechanisms for climate finance and identify institutional arrangements which could help to avoid a 'climate finance curse'. We conclude that there is no deterministic relationship between financial inflows and adverse consequences, as the most serious problems could be prevented or at least alleviated by appropriately designed policies and governance provisions.

Keywords: Mitigation scenarios, developing countries, multilateral climate policy frameworks, North-South

1. Introduction

Ambitious climate change mitigation as embodied by the 2°C target affirmed by the UNFCCC conferences at Copenhagen, Cancún and Durban requires significant emission reductions not only in industrialized, but also in developing countries. In view of the costs that these reductions will impose, industrialized countries have pledged to cover the 'agreed full incremental costs' of mitigation measures (UN 1992, Article 4.3), and the Copenhagen Accord calls for the mobilization of USD bln 30 in the period 2010-2012 – to be increased to USD bln 100 annually by 2020 – to support mitigation and adaptation efforts in developing countries (UNFCCC 2009).

Against this background, we use the integrated energy-economy-climate model ReMIND-R (Leimbach et al. 2010) to assess the magnitude of potential financial transfers to developing countries under several scenarios. Without appropriate institutions and governance mechanisms, sizable financial inflows such as resource rents or foreign aid could potentially be harmful for economic development. We discuss the possibility of such detrimental impacts arising as a consequence of large-scale climate finance transfers to developing countries (i.e. a 'climate finance curse') and discuss institutional frameworks to avoid them.

This paper is not the first to address the issue of climate finance and its potential adverse impacts. On the one hand, the vast literature on the so-called 'natural resource curse' (Sachs and Warner 1995; see van der Ploeg 2011 for a review), which is briefly reviewed in Section 3, is essential for the understanding of the mechanisms that could result in a 'climate finance curse', but does not focus on climate finance. On the other hand, several contributions have tried to quantify financial transfers or transfer needs under several scenarios and transfer mechanisms without considering the related adverse impacts on receiving countries' economic performance (e.g. UNFCCC 2007, 2008; Jacoby 2008; Russ et al. 2009; World Bank 2010; Bastianin et al. 2010).

One of the few studies to assess the macroeconomic impacts of climate finance is Mattoo et al. (2009), who use a computable general equilibrium model to analyze a scenario in which developing countries cut their emissions by 30 per cent by 2020 relative to projected business-as-usual (BAU) levels. They find that the manufacturing sector in developing countries with a highly carbon intensive energy system could be seriously affected by the inflow of climate finance[1], potentially harming long-term growth prospects. Strand (2009), the paper closest to this study, presents an overview of the development economics literature related to financial transfers and discusses implications for climate finance. The author points out that current financial flows delivered through offset-schemes (such as the CDM) are manageable, but that climate finance transfers in a global cap-and-trade or carbon tax scheme could by large exceed receiving countries' absorptive capacity. However,

[1] For instance, for China and India manufacturing output declines by 6-7 percent, and manufacturing exports by 9-11 percent.

he does not systematically discuss options for dealing with sources of a potential 'climate finance curse'. Jones et al. (2012) provide an overview of financial flows under a global carbon market under different stabilization targets drawing on the MiniCAM model, considering allocation of emission permits in proportion to initial emissions (i.e. grandfathering) and to population, respectively. Their study also provides an extensive discussion of how carbon pricing can be implemented and coordinated internationally and analyses the fiscal implications of tackling deforestation and adaption, but they do not consider potentially detrimental economic effects from climate finance and response options for alleviating these.

Our paper contributes to the literature by considering a broader range of scenarios and approaches to disburse climate finance than previous studies. These approaches include coverage of incremental investment costs, and coverage of total mitigation costs, as well as international emissions trading for a variety of allocation schemes. This study is the first to compare these transfers within in a consistent modeling framework. Previous studies have compiled estimates from different sources using different models and assumptions, which makes them hard to compare. We derive estimates for market-based and non-market based financial flows using one single model in which all other assumptions (such as energy system costs, economic mechanisms, discount rates etc.) are held constant while only the mode of allocation changes between scenarios. Further, we go beyond previous studies by systematically discussing the possible channels through which a 'climate finance curse' could arise and identifying possible governance options through which these adverse macroeconomic impacts might be mitigated or avoided.

The paper proceeds as follows: Section 2 presents modeling results for international finance flows related to climate change mitigation. Section 3 reviews analyses of potential adverse impacts of large-scale financial flows from resource sales, ODA and FDI on the receiving country's development prospects. Section 4 discusses potential detrimental consequences of large-scale climate finance flows to developing countries and policies to address them. Section 5 concludes.

2. Climate finance for mitigation: orders of magnitude

Climate finance can be delivered by means of *non-market approaches* based on direct transfers, either to recipient governments or the private sector. They can be implemented in various ways, including public budget support, subsidies to specific projects such as feed-in tariff schemes, or grant elements in loan contracts; within existing frameworks of official development assistance; or in public-private partnerships (e.g. High Level Advisory Group 2010; Buchner et al. 2013).[2] A recent

[2] While climate finance may be sourced from both public and private sources, we do not analyze this aspect in more detail as for the potential adverse economic impacts of climate finance identified in this paper the source of transfers is not relevant. Where it might matter for implementing response options (such as conditionality rules), we raise the issue in Section 4.

proposal for organizing direct funding for mitigation activities are so-called 'nationally appropriate mitigation actions' (NAMAs; UNFCCC 2009). While the precise definition of the concept of NAMAs remains contested (Sterk 2010), one option for implementation is that recipient countries assess their financing needs, possible barriers, and policy measures towards a low-carbon growth strategy that is in line with overall development objectives. Direct transfers may then be deployed by the international community (e.g. via the Green Climate Fund) to support implementation (Röser et al. 2011).

Another option for delivering climate finance are market-based instruments, in particular international emission trading (IET) on the level of either (i) governments as exemplified by the Kyoto Protocol's provision for trading of Assigned Amount Units (AAUs) among Annex-I nations which included free allocation to governments, or (ii) on the level of companies. The latter structure of international company-level emission trading might emerge with developing countries adopting domestic emissions trading systems such as the EU ETS, with subsequent linking of these systems (e.g. Flachsland et al. 2009). In case of company-level international emission trading, one design feature relevant for climate finance impacts and the scope of management options is whether permits in developing countries' ETS are freely allocated to companies, or if they are auctioned. With free allocation, the value of international permit sales is captured by companies. In case of auctioning, the international permit sales value is transferred to governments. This enables different options for managing international emission trading revenue flows, as discussed in Section 4.

2.1. Abatement costs, transfers, and rents

While the main motivation for the provision of climate finance is to cover the costs of mitigation actions in developing countries, it may also involve the transfer of rents. Figure 1a provides a stylized representation of the costs of mitigating e units of emissions[3], given by the area under the marginal abatement cost curve, i.e. area $A + B$. With an appropriate non-market funding instrument, such as the Green Climate Fund, it would ï at least in theory ï be possible to cover these costs by means of a direct financial transfer. With a market-based instrument, such as IET, a country that participates in emission trading commits to a reduction target $\bar{e}$. The actual abatement performed (e) is determined by the market price p. For a net seller of emission permits, trading allowances results in revenues $p(e-\bar{e})$. If these exceed the costs of abating the $(e-\bar{e})$ traded units of emissions, a rent arises as indicated by area C (the magnitude of this rent of course depends on the shape of the marginal abatement cost curve; yet, it is always strictly positive as long as the curve is upward sloping). This óRicardianô rent represents the scarcity value of low-cost mitigation options. As a consequence, the net rent received by a country via emissions trading is determined by the area C ï A, i.e. the rents accruing from emission trading minus the costs of meeting the domestic reduction target.

[Figure 1 about here]

Figure 1a assumes a rough balance between the costs of meeting the domestic reduction target and the rents accruing from permit trade. By contrast, Figure 1b depicts a case in which the initial allocation of emission permits is close to the business-as-usual level, such that a considerable net rent, again given by area C ï A, arises. It is even conceivable that a countryôs allocation of permits is above its business-as-usual level of emissions. Such an óover-allocationô would then result in windfall profits, i.e. financial transfers that do not result in mitigation in the receiving country, as was the case with so-called óHot Airô allocated to Russia under the Kyoto protocol.

2.2. Model and scenarios

ReMIND-R combines a Ramsey-type optimal growth model with a technology-rich energy system model, incorporating a detailed description of energy carriers and conversion technologies that include a wide range of carbon free energy sources (Leimbach et al. 2010a, b)[4]. Macro-economic output is determined by a constant elasticity of substitution (CES) production function with labor, capital and final energy as input factors. This output can be used for consumption, capital accumulation, all expenditures in the energy system (fuel costs, investment costs and operation and maintenance costs) and exports. The energy system module (ESM)

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[3] In order to provide an appropriate picture of macro-economic abatement costs, the marginal abatement costs would not only need to include technology costs, but also cost of e.g. overcoming market barriers (Staub-Kaminski et al. in press).

[4] In its structure the ReMIND-R model is comparable to other integrated assessment models, e.g. RICE (Nordhaus and Yang 1996) or MERGE (Manne et al. 1995), but features a detailed resolution of the energy sector.

comprises a detailed description of energy carriers and conversion technologies. It is embedded into the macroeconomic growth model through the techno-economic characteristics and the system of balance equations that set up the energy system. Each region is modeled as a representative household maximizing an inter-temporal utility function that depends on instantaneous utility in each time-step (discounted at a pure rate of time preference of 3%), which is derived from per capita consumption[5]. The present version of ReMIND-R distinguishes 11 world regions, linked by trade relations. Note that analyses presented in this paper builds on model version 1.3 (Luderer et al. 2012).

The baseline scenario describes plausible future developments in a world without climate policy[6]. Global population is expected to keep growing and reach roughly 9 billion in 2050. GDP is assumed to grow at rates close to historical values in industrial regions but more rapidly in newly industrializing and most (but not all) developing and least developed countries. The US, Europe, and Japan are expected to remain the regions with the highest incomes in 2050, with other countries, especially China and India, closing the gap. The model assumes continuous improvements in energy efficiency due to technological progress, resulting in an average annual decline in energy consumed per unit of GDP of about 1.5%. Nevertheless, in the baseline ReMIND-R projects strong growth of energy use (especially in developing regions), and fossil fuels are expected to account for almost 90% of total primary consumption in 2050.

The policy scenarios are designed to project financial flows for the mitigation of energy-related CO_2-emissions. Due to major uncertainties with regard to the associated costs, abatement of non-CO_2 greenhouse emissions or emission reductions from deforestation or forest degradation as well as adaptation finance are excluded from the analysis. The scenarios differ in several dimensions. First, two different levels of stabilized atmospheric concentration are considered, namely 450 ppm CO_2-eq and 550 ppm CO_2-eq. Second, we calculate regional mitigation costs and incremental energy investment costs in scenarios with a globally efficient harmonized carbon tax to obtain the financing need of developing countries. Due to the inter-temporal optimization framework applied to generate these scenarios, the transfer scheme (and – in the case of emission trading – the distribution of emission permits) only affects the incidence of mitigation costs, while the distribution of physical emission reductions remains independent of allocation (Manne and Stephan 2005; Lüken et al. 2011), i.e., the amount of mitigation actually carried out in each region is identical in all scenarios. Third, we simulate the adoption of international emissions trading with three different permit allocation schemes.

[5] Due to the modelôs optimizing behavior and the assumption of perfect foresight, the resulting stabilization scenarios should not be interpreted as forecasts but rather as first-best scenarios regarding a cost-optimal transition towards a low-carbon energy system.

[6] Economic damages caused by climate change are not taken into account in this version of ReMIND-R.

2.3. Results: non-market approaches

Non-market approaches to climate finance for mitigation would foresee transfers that cover the cost of abatement in developing countries. Even though there is no commonly accepted definition of incremental costs, we consider the two most commonly used indicators for these costs: (i) total mitigation costs and (ii) incremental energy system investment costs. In ReMIND, *total mitigation costs* are measured as consumption losses relative to the business-as-usual case. They reflect, inter alia, additional investment costs, revaluation of resource endowments, and fuel cost savings. A major practical challenge to this metric is the difficulty of monitoring in the real world, so models are required for policy application. As different models vary in their assessment of regional mitigation costs (e.g. Knopf et al. 2010, Luderer et al. 2011), applying this metric in political negotiations – despite its appeal in terms of relating directly to the overall distributional implications of policy – is challenging. By contrast, *incremental investment costs* (i.e. additional investment to restructure the energy sector) relative to business-as-usual may be evaluated at the level of projects in the real world. As a drawback, indirect costs and benefits captured by the total mitigation cost approach are ignored.

Regardless which of these two metrics is chosen as a basis for determining financial transfers, we assume that mitigation costs or incremental investments would be fully compensated. This is in line with the principle agreed under the UNFCCC that developed countries should cover the 'agreed full incremental costs' of mitigation measures (UN 1992, Article 4.3).

[Figure 2 about here]

Figure 2 shows results from the ReMIND-R model for total mitigation costs (a, b) and incremental investments to restructure the energy system (c, d) in percent of regional GDP. For example, in the 450ppm scenario financial transfers to cover total mitigation costs in the considered developing countries amount to roughly USD bln 220 in the year 2020[7], while for incremental investments, the respective figure is USD bln 125[8]. First, we note that the differences between total mitigation costs and incremental investments are relatively small:[9] In all cases AFR displays the highest costs among all regions, with a maximum of about 2.5% of GDP losses if mitigation

[7] In the future, significant additional inflows for adaptation and REDD+, which currently account for a rather small share of climate finance, could materialize (Buchner et al. 2013). As the finance needs as well as the associated burden sharing are subject to substantial uncertainty, we refrain from quantification of potential financial flows in these areas.

[8] This compares to an aggregated GDP of developed countries (i.e. USA, EU27, Japan, Russia and other Annex I countries) of approximately USD trln 50 in the year 2020, depending on the scenario. For a comparison to financial flows from other sources see also Section 3.

[9] Bottom-up studies estimating costs on the level of specific technologies (e.g. Olbrisch et al. 2010) usually find incremental investment costs to be higher than mitigation costs due to higher investment but lower operation costs of low-carbon technologies relative to conventional energy sources. As our approach assesses mitigation costs as macro-economic consumption losses that include all general equilibrium changes, no such general relationship can be posited *a priori*.

costs are considered. For the other regions, by contrast, total mitigation costs are well below 2.5%, and incremental investment costs rarely exceed 1%. Second, while mitigation costs seem to be relatively constant over time with only minor differences between 2020 and 2050, incremental investments in 2020 are considerably higher in all regions compared to 2050. This reflects the substantial up-front investments required to incite the transformation of energy systems. Third, incremental investments are not very sensitive to variations of the stabilization target, whereas for some regions mitigation costs for the 450ppm target are about twice those observed for 550ppm.[10] This observation can be explained by the fact that even with a less ambitious climate target, high investments are needed in the short and medium run in order to restructure the energy system. Consumption losses, in turn, capture the increased costs of a more ambitious climate target, not only in terms of additional investments, but also reduced output, for instance due to lower energy consumption.

2.4. Results: market-based approaches

With IET, the magnitude of financial transfers is determined by the deviation of the permit allocation from the cost-optimal allocation of abatement across regions (Manne and Stephan 2005). In the following, we consider three schemes to allocate emission permits: (i) equal per capita emissions (i.e. proportional to a region's population in the respective year), i.e. the global budget of emission permits is equally distributed across the global population, (ii) the Contraction and Convergence (C&C) scheme (Meyer 2004), which envisages a linear transition of emission shares from status quo to equal per capita emissions in 2050, and (iii) GDP shares, where emission allowances are allocated according to countries' share of the gross world product, thus favoring richer countries.

While an equal per-capita allocation of emission permits might seem unlikely from the perspective of political feasibility, it figures prominently in international negotiations (Mattoo and Subramanian 2012), such that it deserves serious evaluation. Furthermore, other popular schemes which assign rights for future emissions in inverse proportion to historical responsibility would result in even larger allocations for developing countries (WBGU 2009).

[Figure 3 about here]

[10] ReMIND-R projects lower mitigation costs for Sub-Sahara Africa in the more stringent 450ppm mitigation target in 2020 and 2050 (but not over the 2nd half of the 21st century) as compared to the less ambitious 550ppm scenario. This can mainly be explained by technology spill-overs through learning-by-doing. That is, while more abatement is required in the more ambitious scenario, the marginal abatement cost curve shifts down due to a higher abatement level in other regions. Unlike other regions, for Sub-Saharan Africa the cost reductions associated with the latter effect dominate the rising costs related to the former (but note that in later time steps, mitigation costs in this region are significantly higher in the 450ppm scenario).

Figure 3 shows annual financial flows in percent of GDP to developing regions for the years 2020 and 2050 for three different allocation schemes. The results are in general very similar for the two atmospheric stabilization targets under consideration.[11] The most striking observation is that – depending on the permit allocation scheme – transfer volumes can become very significant. In the 450ppm scenario overall financial transfers to developing countries range from USD bln 40 to almost USD bln 400 in the year 2020[12]. The per-capita allocation favors developing countries relative to industrial countries, leading to substantial permit sales of up to 14.5% of GDP for AFR and 6% for IND. Significantly lower transfers of 1% to 1.3% of GDP flow to LAM and OAS, respectively, in 2020. The GDP shares allocation is more favorable to industrialized countries and can even imply permit purchase expenditures by developing countries, e.g. 1% of GDP for India in 2020. The C&C allocation as a mix of the rationale of the other two allocations lies in between.

While the precise results are driven by specific model dynamics, the plausibility of the order of magnitudes of transfers can be illustrated by the following back-of-the envelope calculation for the year 2008: 755 million people (11% of the global population) live in Sub-Saharan Africa (excluding South Africa) today, while the region's share in global CO_2 emissions was less than 1% (266 Mt). A global equal per capita allocation of emissions permits (4.6 t CO_2 per person) would imply a permit allocation of 3.5 Gt CO_2 to Sub-Sahara Africa, of which more than 90% (3.2 Gt) could then be sold even with zero mitigation. With a carbon price of about USD 35 as calculated by ReMIND for the year 2020, financial flows from selling emission permits would yield revenues of about USD bln 112, i.e. roughly 15.5% of current GDP. This compares with 14.5% calculated by ReMIND-R for the year 2020.

Summing up, a market-based approach to climate finance might trigger substantial transfers to developing countries, depending on the chosen permit trading scheme. This is in line with previous findings. For instance, Jacoby et al (2008), using the EPPA model and calculating the costs of cutting global emissions by 50% in 2050 relative to the year 2000, find that - depending on the allocation scheme - in the year 2020 financial transfers to developing countries could range from USD bln 14 to almost USD bln 900. Olbrisch et al. (2011) comparing estimates by the UNFCCC, McKinsey and the IEA report global incremental mitigation investments to developing countries to be in the range between USD bln 177 to USD bln 695. Jones et al. (2013) find regional net inflows from a global cap and trade scheme to reach a maximum (in Sub-Sahara Africa) of 11% of regional GDP building on MiniCAM scenarios. More recently, Bowen et al. (2013) comparing the ReMIND-R and WITCH

[11] With a stricter abatement target, the carbon price will be higher, but the amount of permits allocated to each region and hence the amount of permits sold by net exporters will be lower. Hence, it is ambiguous whether financial inflows will be higher or lower under a more ambitious mitigation scenario.

[12] Note that developing countries here refer to the four ReMIND-R model regions IND, AFR, OAS and LAM. Also note that only financial inflows are regarded.

(Bosetti et al. 2007) models find regional inflows to reach a maximum of ca. 19% for ReMIND and up to 41% for WITCH (both maxima are found in Sub-Sahara Africa).

3. Lessons from large-scale financial flows to developing countries

Experience shows that large-scale financial inflows to developing countries can have both beneficial and adverse effects on development. In view of beneficial effects resource exports, foreign aid, and foreign direct investment (FDI) provide financial inflows that have the potential to promote economic growth by enabling to increase investment, implement measures that raise factor productivity, and reduce distortionary taxation (e.g. Collier et al. 2009). Empirical research shows, however, that results are mixed and suggests that there are mechanisms at work that can offset some of these positive effects. This section reviews this literature and draws lessons for the deployment of climate finance.

Figure 4 provides an overview of the current magnitude of resource exports, foreign aid, and FDI for selected world regions in comparison to inflows expected by ReMIND scenario calculations. Scenario results are shown by white bars, indicating minimum and maximum inflows as well as the median over all scenario runs. Scenario analyses include two different levels of climate stabilization (450 and 550 ppm CO_2 only) and three different allocation schemes for each stabilization level (equal per capita, per GDP and conditional convergence). Evidently, the Middle-East and North Africa as well as Sub-Saharan Africa receive the highest revenues from resource exports (especially oil and gas), amounting to more than 30% of these regions' GDP. With regard to foreign aid, it is of little surprise that the poorest regions in Sub-Sahara Africa receive the largest inflows, which account for about 4% of GDP. Finally, all regions receive inflows from FDI in the range between 3% and 5% of their GDP. Regarding potential inflows from international carbon finance, Sub-Saharan Africa would receive the highest transfers relative to its GDP (up to almost 15%, median over all considered scenarios 5%), followed by South Asia and LAM. The MEA region would not receive positive transfers according to our model calculations. For the SSA and LAM regions, the maximum of expected transfers would be lower than what has been witnessed by resource exports in the past, but in the range of FDI and aid.

In absolute terms (not shown in Figure 4), all four regions received approximately USD bln 1400 from resource exports (with approximately 40% received by the MENA region), USD bln 80 by foreign aid (with 45% received by SSA) and over USD bln 260 by FDI (with 45% being received by LAM). By contrast, current transfers related to climate finance from carbon markets and public sources are comparatively small: transaction volumes of CDM credits peaked at USD bln 7.4 in 2007 (World Bank 2011). Bilateral or multilateral development assistance and dedicated climate funds account for about USD bln 9 (Olbrisch et al. 2011). However, it is well recognized that the largest share of climate finance is currently deployed by private sources, such as FDI and asset finance. For this reason, Clapp et al. (2013) estimate total financial flows to developing countries to fund climate-related activities to amount to USD bln 70-120, and Buchner et al. (2013) give a number of USD bln 39-62. These figures are of the same order of magnitude as foreign aid, but one order of magnitude below revenues from total natural resource exports accruing to developing countries.

[Figure 4 about here]

3.1 Natural resource exports

The literature on resource exports from developing countries suggests three channels through which resource revenues can result in lower growth rates. First, fluctuations of resource prices expose countries that are highly dependent on resource exports to macroeconomic volatility (Deaton 1999)[13]. Several empirical studies find volatility to have negative effects on growth (Ramey and Ramey 1995; van der Ploeg and Poelhekke 2010). Plausible reason for this observation include that in the face of uncertainty, investments are delayed (Aizenman and Marion 1999), or that the realisation of unforeseen macroeconomic shocks triggers distributive conflicts, which entail social costs (Rodrik 1998).

The second is the so-called 'Dutch Disease': as a boom in the natural resource sector provides additional income for resource owners, it increases demand for non-tradable goods. The resulting upward pressure on the price of non-tradable goods raises the economy's overall price level (Balassa-Samuelson effect), causing an appreciation of the real exchange rate, which crowds out exports of manufactured goods (Corden and Neary 1982). If endogenous economic growth occurs primarily through productivity spillovers between firms (e.g. through R&D or learning-by-doing) in the exportable manufacturing sector, this has adverse effects on industrial structure and leads to lower growth rates in the long run (Van Wijnbergen 1984; Matsuyama 1992).

Third, large resource rents can give rise to rent-seeking behaviour and corruption. The term 'rent-seeking' refers to engagements in 'directly unproductive, profit-seeking activities' (Bhagwati 1982) to influence the distribution of rents in a zero-sum game (Krueger 1974). It has repeatedly been argued that rent-seeking and corruption can seriously affect growth by undermining an economy's institutions (Tornell and Lane 1999; Ross 2001).

[13] For instance, Collier (2003) estimates that for Africa a typical large export shock can decrease GPD by as much as 20% in the long run.

With regard to empirical evidence, the finding that there is a general 'natural resource curse' (Sachs and Warner 1995) has repeatedly been challenged by studies that use different empirical methods (Lederman and Maloney 2002 and 2003) and indicators to measure natural resource abundance (Stijns 2005; Brunnschweiler and Bulte 2009), finding zero or positive growth effects of resource wealth. A plausible explanation for these findings is that the positive effects of resource revenues discussed above are at least as pronounced as the negative effects. The observation that natural resource revenues do not necessarily result in adverse impacts also suggests that the latter can be mitigated by appropriately designed policies and institutional arrangements. Section 3.4. reviews some of the measures discussed in this context.

3.2 Foreign Aid

The major problems that are most frequently discussed in the context of foreign aid are very similar to those associated to resource revenues, namely Dutch disease effects (Rajan and Subramanian 2010), and rent seeking behaviour (Svensson 2000). Further, donor volatility – i.e. a political decisions to re-adjust aid budgets – has repeatedly been found to expose recipient countries' economies to volatile aid inflows (Heller 2005). De Renzio (2006) argues that reduced incentives of recipient countries' governments to raise alternative sources of revenues (e.g. via a broadened tax base, or measures to increase the economy's productive capacity) can prolong poor countries' dependency instead of facilitating the growth process.

One further strand of literature emphasizes that foreign aid is only likely to be effective if the receiving country has implemented "good fiscal, monetary, and trade policies" (Burnside and Dollar 2000, p.847). However, this result appears to be sensitive to the countries and years included in the sample and to the definition of foreign aid (Easterly 2003). Finally, some authors maintain that aid is subject to diminishing returns such that its overall effect is only positive as long as it does not exceed the so-called 'absorptive capacity' of an economy (Collier and Dollar 2002). In a meta-analysis of previous studies, Feeny and McGillivray (2011) estimate that aid exhibits negative growth effects if it exceeds 20% of GDP.

The empirical evidence regarding the impact of aid on economic growth is rather mixed: while for instance Rajan and Subramanian (2010) find little robust evidence of positive or negative growth effects, Clemens et al. (2004) argue for a positive effect once emergency and humanitarian aid as well as development assistance that can expected to affect growth over very long horizons only are excluded from the definition of aid. As for natural resource revenues, this evidence suggests that the relationship between aid inflows and growth crucially depends on specific circumstances and raises the question of how policies and institutions should be designed in order to ensure that aid has benign effects.

3.3 Foreign Direct Investment

The literature identifies several channels through which FDI can have positive impacts. These include imitation of production processes and management practices by local firms, an increased motivation for workers to invest in skills, increased competition in the domestic market, and promoting export-led growth (Görg and Greenway 2004). Even though some studies find that FDI has positive effects on individual firms' productivity (e.g. Aitken and Harrison 1999; Javorcik 2004), the empirical evidence is mixed (see Crespo and Fontoura 2006 for a recent review). For instance, Rodriguez-Clare (1996) points out that multinationals are more likely to have a positive effect on the host country if home and host countries are not too different, and Alfaro et al. (2004) highlight that FDI inflows have only proved to be beneficial for countries with well-developed financial markets.

One possible explanation why empirical studies have not found unambiguously positive effects of FDI is that it could (similar to resource revenues) also lead to an appreciation of the real exchange rate and crowd out manufacturing activity, undermining long-run growth (Prasad et al. 2007). As the positive effects of technology spillovers and the negative effects à la Dutch disease work in opposite directions, there is no reason to expect that increased FDI inflows should *per se* spur growth (Kose et al. 2009), and the observation that on average welfare effects of FDI are 'negligible' (Gourinchas and Jeanne 2006) seems plausible. Hence, the challenge for policy-makers is not only to attract FDI, but also to create an environment which promotes technology transfer while keeping potential negative effects associated with FDI in check (Javorcik 2008).

3.4 How to deal with financial inflows

From the above observations, three adverse processes that may be relevant in the context of climate finance emerge. First, large-scale financial inflows can result in Dutch disease: as an appreciated real exchange rate leads to a crowding-out of manufacturing exports, endogenous growth in the industrial sector (through learning-by-doing or R&D spillovers) can be reduced. Second, volatility of financial flows can hamper economic development, as the implied uncertainty deters investments or triggers distributive conflicts. Third, rents from climate finance could spur unproductive or even politically destabilizing rent-seeking activities that are profitable on the private level – such as lobbying or corruption – but turn out to harm the economy by undermining its institution and deteriorating the business environment.

A number of policy responses have been developed to manage these challenges, which can be useful starting points to develop policies for minimizing the adverse effects of climate finance absorption in developing countries.

In order to ensure long-term predictability of aid flows, donor-recipient contracts could reduce uncertainty for recipients by specifying the terms of cooperation

(Heller 2005). If based on the principle of conditionality, such contracts could also serve as an instrument to address rent-seeking by reducing the incentive to accept a transfer payment without adhering to a previously established commitment (Azam and Laffont 2003). Yet, recent experience has made clear that conditionality in the absence of domestic ownership is insufficient to ensure the success of aid projects. Hence, donors increasingly focus on supporting activities that are in line with recipients' development objectives instead of aiming to induce policy change (Morrison 2012).

A recurrent theme in the literature is that countries with good institutions (characterized by e.g. democratic freedoms and low levels of corruption) are less likely to be adversely affected by financial inflows (Robinson et al. 2006). Institutional quality is frequently cited as the reason why countries such as Norway, Chile, and Botswana have experienced continued economic growth despite their significant revenues from natural resources (Mehlum et al. 2006). To tackle the challenge of rent-seeking in the natural resource sector, transparency-oriented programs such as the Extractive Industries Transparency Initiative (EITI) have been devised to strengthen governance of resource revenues (EITI 2012).

Furthermore, it has been suggested that investing revenues from natural resource exports into well-governed sovereign wealth funds (SWF) could be beneficial on several accounts. Transparent management could help to circumvent rent-seeking. Investing parts of the proceeds in foreign assets could also – as the money is not fully spent – dampen inflationary pressures and create a buffer to smooth out volatility over time (Sala-i-Martin and Subramanian 2003; Collier et al. 2009).

Other proposals focus on the role of fiscal and monetary policies to tame inflationary pressures (Heller 2005). For instance, price hikes in the non-traded goods sector could be addressed by either increasing the interest rate, or reducing government spending, or a combination of both. Such interventions need to strike a middle ground between reining in inflation and preventing excessive interest rate hikes, which would crowd out the private sector (Hussain et al. 2009). In addition, the government's ability to cut spending may be severely limited by the social implications of e.g. reducing the budget for healthcare or education.

Finally, it has been pointed out that Dutch Disease effects are mitigated substantially if revenues are used in a way that increased the productivity of the non-traded goods sector (Bulir and Lane 2002). If the increased productivity lowers the prices of non-traded goods, it can offset some of the price rise exerted by financial inflows, and Dutch disease will be less of an issue.

4. How to avoid a climate finance curse

Analogous to the types of financial transfers discussed in the previous section, a number of positive macroeconomic impacts of climate finance can materialize beyond the benefit of emission reductions. Climate finance may induce enhanced productivity spillovers if state-of-the-art mitigation technologies are adopted by developing countries, increased investment may trigger macro-economic multiplier effects, and distortionary taxation may be reduced. However, there may be detrimental consequences as well. In the following, we discuss the question if there may be a climate finance curse and how it could be managed.

4.1 Volatility

In an international emission trading system, permit prices will fluctuate and correspondingly impact the magnitude of financial flows. Permit price volatility can already be observed in the EU ETS: while the permit price in January 2011 was about € 14, it dropped to € 7 one year later (EEX 2012). Underlying reasons can be macroeconomic shocks such as the recent financial crisis, new information about technologies and their costs, policy changes like renewable and efficiency policies, or accession of new regions and sectors to an international permit trading system. In case of non-market instruments, there is the possibility that changing governments, new information, or unforeseen fiscal pressures lead to fluctuations in financial transfer volumes, similar to donor volatility in development aid.

Analogical to resource price volatility (Section 3.1), abrupt changes in significant financial flows from unfettered permit trading could hamper the long-term growth prospects for developing countries. The result may not only be 'boom and bust' mitigation cycles with inefficiencies in planning and deploying mitigation projects, but also wider detrimental macro-economic impacts.

Arguably, the best approach to manage climate finance volatility is to smooth the flow of finance over time, e.g. by allowing for banking and borrowing (Fankhauser and Hepburn 2010a) and maximizing the geographical scope of an ETS (Fankhauser and Hepburn 2010b). Van der Ploeg and Poelhekke (2009) additionally highlight the role of functioning financial markets for dealing with volatility. In the presence of perfect financial markets, smoothing the flow of finance over time could be managed by the private sector e.g. with governments and companies purchasing mid- to long-term permit put options from intermediaries who evaluate and insure the risk of permit price volatility. However, the presence of perfectly functioning financial markets is debatable in general, and in particular developing country governments or companies may lack access to low-cost insurance schemes.

With international emission trading, allocations that limit the volume of financial transfers may be the most apparent solution to contain risks resulting from volatility. But this is in conflict with other goals when determining permit allocations, in particular certain notions of fairness or strategic side-payments.

Direct permit price controls are another approach to manage price volatility in international permit trading. A permit price corridor with upper and lower bounds implemented by carbon market regulators contains the risk of extreme price volatility (Murray et al. 2009). However, close regulatory coordination is required to implement this approach at the international level (Tuerk et al. 2009). It raises burden- and profit-sharing challenges as managing a permit price corridor can induce costs (e.g. foregone revenues from not selling permits) or revenues (e.g. from issuing additional allowances).

A perhaps more promising approach to deal with permit price volatility could be to draw on experiences and proposals for managing volatile resource export revenues (Section 3.4). A sovereign wealth fund (SWF) could be established by the recipient government (or perhaps multilaterally) to absorb permit sales revenues. This would require government control of the international permit sales revenue either through direct government trading or auctioning of permits in a company-level trading system. Such an SWF would adopt an intertemporally smoothened and periodically updated payout schedule e.g. for financing mitigation projects, compensating regressive impacts of climate policy, and beneficial infrastructure projects. To the extent that the permit sales revenues imply a transfer of pure rents that cannot be productively invested domestically, the fund may also manage international investment of these assets. Operational guidelines for the fund could build on experiences and rules developed in the context of resource revenue management.

4.2 Dutch disease

In view of the experiences with resource revenues, but also ODA and FDI, it can be expected that significant flows of climate finance will analogically result in appreciation of the real exchange rate and corresponding contraction of export sectors. It is not clear, however, that this will necessarily result in an adverse 'Dutch disease' that hampers long-term economic growth prospects.

In fact, if climate finance inflows are allocated to sectors and technologies exhibiting productivity spillovers that are comparable (or superior) to those of the contracting export sector, or increase the productivity of the non-traded goods sector sufficiently, there would be no negative (or even a positive) impact on economic growth. For example, climate finance may be used to import state-of-the-art energy technologies in the power or transport sector, the adoption of which may significantly improve infrastructure conditions and, correspondingly, growth prospects. Thus, an important empirical question arising regards the relative magnitude of spillover rates of mitigation measures versus standard goods production. Climate finance arrangements may exploit these dynamics by including deliberate provisions for preferable treatment of technology imports meeting this requirement. In view of the lack of literature on this issue, one interesting topic for future research is to analyze sector- and technology-specific macro-economic productivity spillovers of mitigation measures and related technology transfers.

No matter which mechanisms for delivering climate finance is adopted, in case there is a climate finance-induced Dutch disease effect, governments can resort to adjusting macro policies, such as raising the interest rate, or fiscal adjustments, such as reducing government spending. Clearly, these may bear costs of their own (Section 3.4; see also Strand 2009).

4.3 Rent-seeking

If international emission trading leads to the transfer of substantial rents, the theory of rent seeking (e.g. Tullock 1967) suggests that developing countries will invest heavily into international negotiations, up to the level where a significant fraction of the rent is dissipated, making all countries worse off. In this perspective, climate finance transfer schemes that minimize rents – e.g. non-market based transfers covering incremental costs – appear preferable.

At the domestic level, climate finance transfers raise the risk of inducing various types of rent-seeking activities well-known from the literature on resource extraction and development aid (Sections 3.1 and 3.2). All climate finance mechanisms that channel climate finance through the government budget (auctioned permits, government permit trading, direct transfers) introduce a number of incentives for rent-seeking. These become salient for example when government officials are entrusted with selecting mitigation projects eligible for funding, or if there are difficulties in monitoring private sector mitigation performance.

The challenges involved are not unlike those experienced in extractive industries and aid disbursement. Some lessons may be transferred to the climate finance context, including ensuring transparency about processing of the funds, developing shared best practice norms on how to spend climate finance, and building capacity to monitor and sanction agents involved in climate finance management. Taken together, these measures can facilitate the identification and sanctioning of misconduct (e.g. via public shaming, legal action, and elections). A framework analogical to the Extractive Industries Transparency Initiative may be set up in the climate finance context, and first steps in this direction have already been undertaken e.g. by Transparency International (2011).

Drawing from experiences in development aid, clear conditionality rules combined with domestic ownership and a shared understanding over best practice is another option to ensure sound climate finance management. Conditionality on a basic set of rules for managing climate finance (e.g. transparency, performance review) could be useful to avoid misuse of international climate finance and to ensure legitimacy in countries sourcing the funds. Experiences from development cooperation highlight the importance of establishing shared ownership between donors and recipients and avoiding competition between individual donors for conditional support programs (Sippel and Neuhoff 2009). These principles have for instance proved rather successful for the funding procedures employed by the Global Fund to Fight AIDS, Tuberculosis and Malaria (McCarthy 2007): local country coordinating mechanisms develop and submit independent grant proposals, whose performance is reviewed by an independent Local Fund Agent (Radelet and Siddiqi 2007). In a similar vein, randomized field trials have recently been employed to assess the performance of funded activities (Banerjee and Duflo 2011). Arguably, a similar approach could be employed in the context of climate finance to determine individual programs' additionality and cost-efficiency (Donner et al. 2011).

In a more innovative vein, a global 'carbon contracting' market might be set up as a new type of market-based instrument.[14] Private and public sector agents could offer emission reduction projects – e.g. in the context of NAMAs – thus bidding for financial support in an auctioning process. Project plans would be reviewed and selected by an international board in a transparent manner, followed by monitoring of project performance in the project implementation phase and clear conditionality rules. This would shift the non-transparent task of project selection and supervision from government bureaucracy to a more open approach.

5. Conclusions

Climate Finance could result in sizable financial inflows in developing countries. Previous research on natural resource revenues, foreign aid, and FDI has highlighted that such inflows can have adverse impacts on the receiving countries' development prospects by exposing the economy to volatility, inciting Dutch disease, and promoting rent-seeking and corruption. This raises concerns that financial flows to support mitigation in developing countries could result in a 'climate finance curse'.

Market-based approaches, such as international emission trading, appear especially prone to these challenges. As we have shown in Section 2, the rents transferred through carbon trading could result in financial inflows to developing regions that by far exceed mitigation costs. For instance, under equal per-capita allocation of emission permits, revenues from emissions trading are projected to amount to about 14.5% of GDP for Sub-Saharan Africa in the year 2020. This would be comparable to revenues from natural resource exports, which have repeatedly been cited as a major factor contributing to under-development.

The likelihood of a 'climate finance curse' could be reduced by an appropriate choice of emission permit allocation among countries both under a government- or company-level trading scheme. Yet, schemes which limit the international transfer of rents might require a departure from notions of distributional fairness embodied by these allocation schemes On the other hand, such an approach could possibly be

[14] This approach elaborates on the carbon contracting idea developed by Helm and Hepburn (2007) for the UK domestic context. It also bears some resemblance with the proposal to invest more public resources in facilitating international donor-receiver bargaining over large-scale mitigation deals suggested by Victor (2011).

defended by the argument that by covering the 'full incremental costs' of climate change mitigation, industrialized countries meet their moral obligation, without bearing a responsibility to provide additional windfall gains to the recipients of climate finance.

Non-market financing mechanisms aiming to cover either incremental investment costs or total mitigation costs, respectively, are found to involve relatively modest financial transfers that do not exceed 2.5% of recipients' GDP. This finding could well be regarded as an argument in favor of non-market approaches to climate finance, as these can avoid the international transfer of rents from mitigation activities. However, non-market approaches face at least two important challenges: first, how to raise the necessary financial resources (Bowen 2011), and second, how to provide the right incentives to guarantee that they are allocated in the most cost-efficient way.

In general, while numerical model results presented in this paper are in line with estimates from other models, the precise values are sensitive to specific model assumptions. Thus, a more systematic analysis building on a broader set of models, e.g. in form of a model intercomparison exercise would be desirable in the future

In summary, if international emission trading is used for delivering climate finance, initial allocations that contain the transfer of rents to developing countries should be considered, and emissions trading should be phased in gradually in order to prevent sudden surges of financial inflows and detrimental macro-economic shocks. Furthermore, as discussed in Section 4, there is no deterministic relationship between financial inflows and adverse consequences. Rather, the most serious problems could be prevented or at least alleviated by appropriately designed policies and governance provisions. Previous experiences with the management of resource revenues, official development assistance, and FDI offer valuable insights in this regard.

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Figures

(a) Low transfer of rents **(b) High transfer of rents**

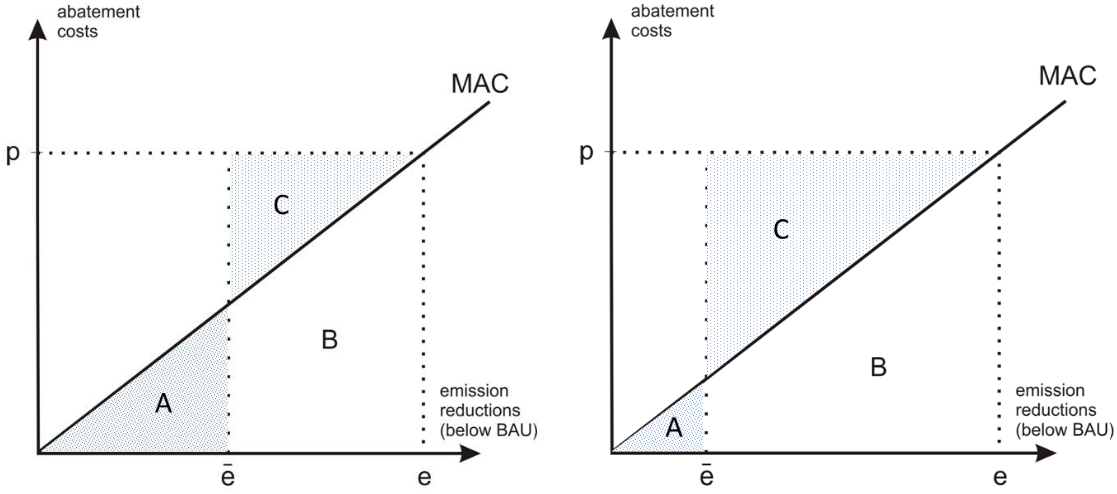

Figure 1: Illustration of rents and incremental costs. In panel (a) the allocation of emission permits is selected in a way that keeps the transfer of net rents (area C-A) low, while panel (b) depicts a case in which emission trading involves considerable rent transfers due to the less ambitious cap of the country. Note that for the illustration the country is assumed to be a carbon-exporter in both cases.

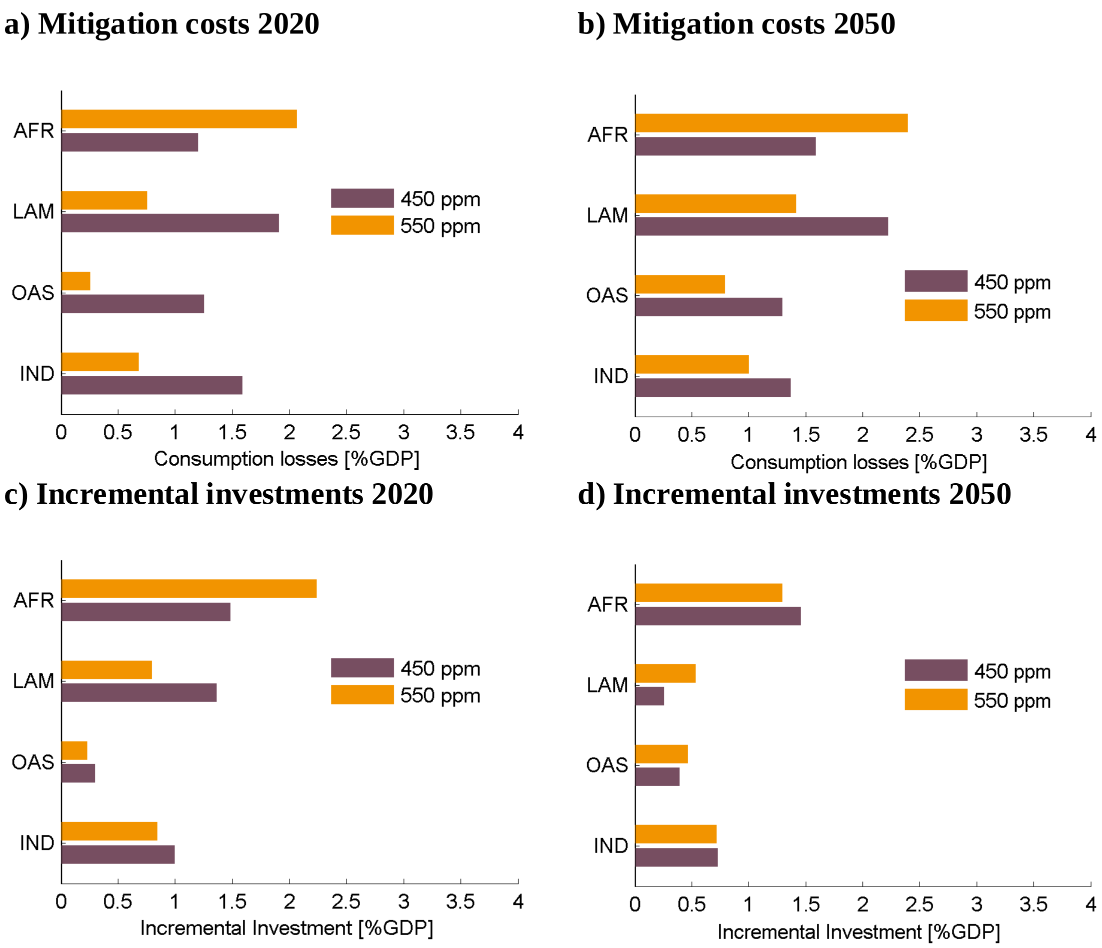

Figure 2: Total mitigation costs measured in consumption losses for (a) 2020 and (b) 2050 and incremental investments in the energy sector for (c) 2020 and (d) 2050 in percent of GDP according to the ReMIND-R model for two different stabilization targets (450 ppm and 550 ppm CO2-eq) in selected developing regions: Sub-Saharan Africa excluding South Africa (AFR), Latin America (LAM), Other Asia [15] (OAS), and India (IND). Please see supplementary material for the intertemporal dynamics and additional years.

[15] The ReMIND-R model region ñOther Asiaò is a composite of South Asian countries except India, South-East Asian countries, the Korean peninsula, Mongolia, Nepal and Afghanistan.

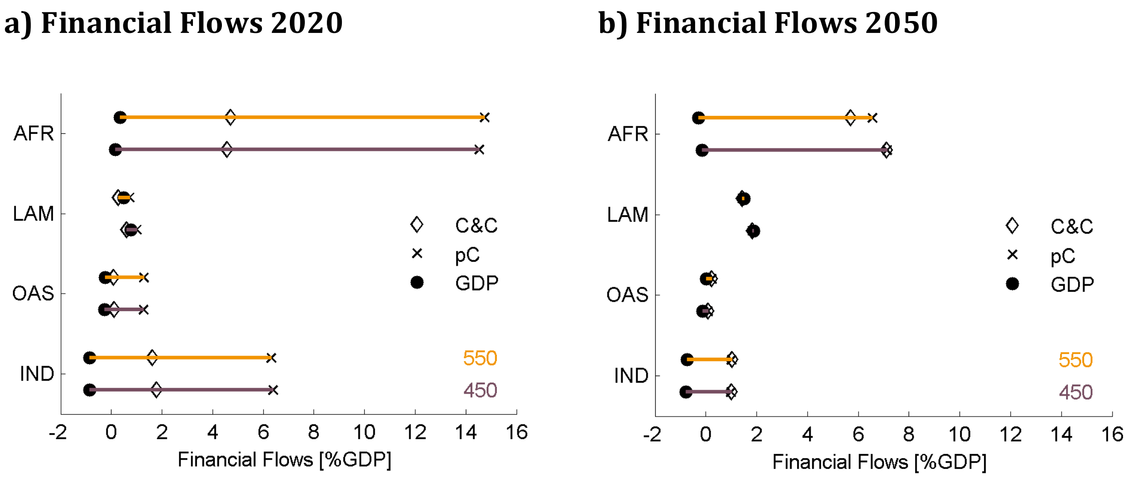

Figure 3: Financial flows induced by different permit allocation schemes calculated by the ReMIND-R model for selected developing regions. Different climate stabilization targets (550 and 450 ppm CO2-eq) are indicated by different colors, while different allocation schemes are denoted by different markers. Please see supplementary material for information on additional time steps between 2005 and 2100.

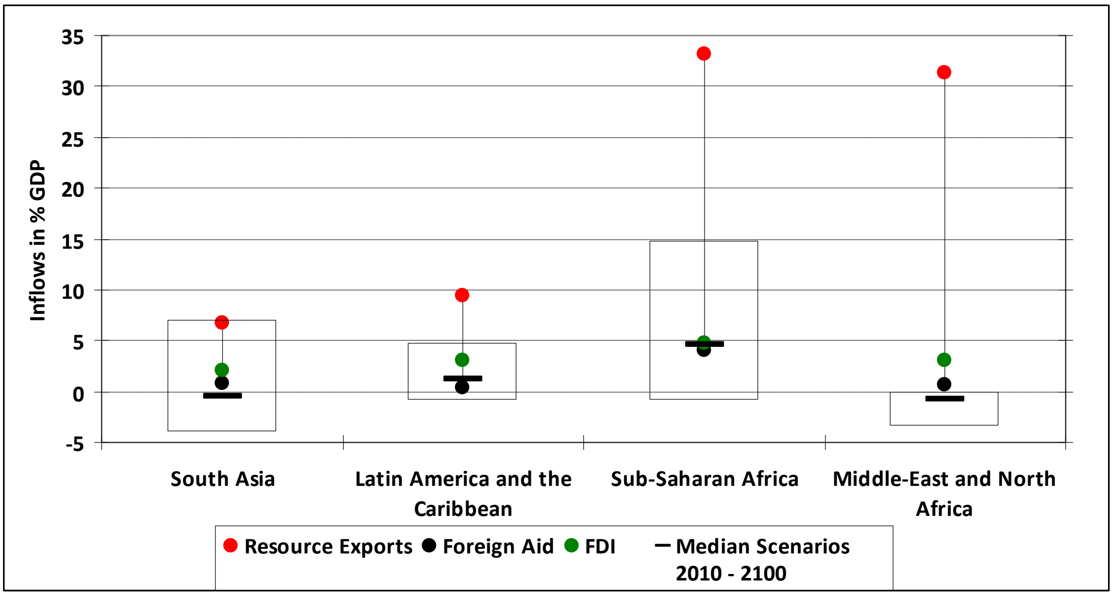

Figure 4: Annual resource Revenues, Foreign Aid, and Foreign Direct Investment for selected world regions in % of GDP compared to ranges of regional financial inflows calculated by the ReMIND-R model. The lower end of the boxes shows the minimum for all scenarios considered from 2010 to 2100, including different allocation schemes (equal per capita, per-GDP and conditional convergence) and different stabilization levels (450 and 550 ppm CO2 in 2100), Most recent data on Resource Exports and FDI are for 2009, on foreign aid for 2008. Source: UNCTAD (2012), World Bank (2012). Note that scenarios calculated for "South Asia" show results for India only. For data on single years please see also supplementary material.