FONDAZIONE ENI ENRICO MATTEI

NOTA DI LAVORO

94.2015

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Climate Change and Sustainable Development
Series Editor: Carlo Carraro

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Summary

Introducing a price on greenhouse gas emissions would not only contribute to reducing the risk of dangerous anthropogenic climate change, but would also generate substantial public revenues. Some of these revenues could be used to cover investment needs for infrastructure providing access to water, sanitation, electricity, telecommunications and transport. In this way, emission pricing could promote sustainable socio-economic development by safeguarding the stability of natural systems which constitute the material basis of economies while at the same time providing public goods that are essential for human well-being. An analysis of several climate scenarios with different stabilization targets and technological assumptions reveals that emission pricing has a substantial potential to close existing access gaps.

Keywords: Carbon Pricing, Infrastructure, Economic Development

JEL Classification: Q31, H54

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Using carbon pricing revenues to finance infrastructure access

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Abstract. Introducing a price on greenhouse gas emissions would not only contribute to reducing the risk of dangerous anthropogenic climate change, but would also generate substantial public revenues. Some of these revenues could be used to cover investment needs for infrastructure providing access to water, sanitation, electricity, tele-communications and transport. In this way, emission pricing could promote sustainable socio-economic development by safeguarding the stability of natural systems which constitute the material basis of economies while at the same time providing public goods that are essential for human well- being. An analysis of several climate scenarios with different stabilization targets and technological assumptions reveals that emission pricing has a substantial potential to close existing access gaps.

Keywords: Carbon pricing, infrastructure, economic development

1. Introduction

Recent research has pointed out the dangers of continued global warming (IPCC 2014a). A projected increase of the global mean temperature of 4°C or more in the year 2100 would entail potentially serious consequences for e.g. sea-level rise, water availability, agricultural productivity, and human health (World Bank 2012). In order to achieve reductions of greenhouse gas (GHG) emissions to a level that keeps these risks at a socially acceptable level, a price on emissions is frequently highlighted as the most efficient policy (Edenhofer et al. 2013). Recent literature has furthermore highlighted that countries have multiple incentives to impose a price on emissions, including the possibility to generate revenue in a way that is less distorting than taxing labour or capital (Edenhofer et al. 2015). Popular approaches for emission pricing include emission taxes and tradable permit schemes, as well as hybrid schemes (Goulder and Parry 2008). This paper argues that emission pricing would not only contribute toward climate change mitigation, but could also advance human well-being by providing the financial means to promote access to basic infrastructures, including water, sanitation, electricity, telecommunication, and transport. Access to these infrastructure services is a fundamental underpinning of human development understood as creating the capabilities for individuals to achieve their personal objectives (Drèze and Sen 2013). Even though investments in the respective infrastructures are likely to yield large returns (Calderon and Serven 2014), in the absence of stable institutions and without access to capital markets, many poor people in developing countries will find it difficult to pool the dividends they will thusly receive for these investments (Estache and Fay

2007). Infrastructure gaps are still high with many people lacking access to electricity and water and sanitation. According to the World Development Indicators (World Bank 2014) more than 2.4 billion people world-wide did not have access to sanitation in 2010, for example (see also Table 1 below). In this study we argue that pricing of greenhouse gas emissions constitutes a promising option to finance at least some part of the investments needed to close existing access gaps. Investing revenues from emission pricing in infrastructure could also create synergies between climate change mitigation and adaptation, as areas lacking access to infrastructure services are particularly vulnerable to climate impacts (Malik and Smith 2012).

The rest of the paper is organized as follows: the second section reviews the literature, while the third section explains how we calculate revenues from emission pricing and the costs to close gaps to universal access to the different types of infrastructure. Section 4 presents the results drawing first conclusions on implications of our proposal for different regions. Section 5 carries out a sensitivity analyses in order to test for the robustness of our insights. The final section concludes and presents policy implications.

2. Literature Review

This paper combines three different strands of literature. First, it follows previous studies estimating infrastructure investment needs. Previous studies, on which our analysis builds, have examined the financial needs to provide universal electricity access Pachauri et al. (2013) and the investments in water and sanitation (Hutton et al. 2012) required to achieve the Millennium Development Goals, without focusing on the question of how these investments could be financed.

Second, our paper draws on the literature on emission pricing. Most of this literature is concerned with the optimal choice of policy instrument, i.e. under which conditions it is more favourable to employ a price or a quantity instrument (Goulder and Parry 2008). The revenue raising aspect of emission taxes is at the centre of the 'double-dividend' literature, which discusses how revenues from emission taxes can improve economic performance by lowering other, distortionary taxes, e.g. on labour and capital (Goulder 2013). In a similar vein, recent literature has pointed out the potential welfare improvements by influencing the composition of investors' portfolios in the presence of fixed factors of production (Edenhofer, Mattauch, and Siegmeier 2013). By contrast, using emission pricing to finance infrastructure investment has only received scant attention in the literature. One study in this direction is Mattauch et al. (2013), who point out how taxing fixed factors – such as a given 'carbon budget', i.e. a fixed amount of emissions – eliminates the trade-off between public good provision and the disadvantages of distortionary taxation.

Third, our paper is related to the sustainable development literature. Imposing a limit on the amount of emissions that can be released to the atmosphere can be regarded as an operationalization of the concept of 'strong sustainability', which states that some natural thresholds that must under no means be violated (Neumayer 2010). Recent literature has proposed to combine these natural boundaries with socio-economic limits to define so-called 'Sustainable Development Goals' (Griggs et al. 2013). An approach to balance environmental and social objectives is exemplified by Jakob and Edenhofer (2014), who identify management of a portfolio of (natural as well as constructed) capital stocks as the overarching goal of policy making and recommend taxing resource use and environmental externalities to finance infrastructure investments (see also Edenhofer et al. 2014).

Our paper is to our knowledge the first to examine the empirical relevance of using the revenues from carbon pricing in order to promote human development by means of providing access to basic infrastructure services, such as water, sanitation, electricity, transport and telecommunication. By focusing on basic services, our paper can perhaps best be regarded as an application of the concept of multi-dimensional deprivation (Alkire 2002) in the spirit of Sen's 'capabilities approach' (Sen 1999).

3. Methodology and Data

This section outlines the data and calculations made to determine to what extent revenues from carbon pricing would be sufficient to close the gaps in access to basic infrastructure across all world regions.[1] Section 3.1 starts by describing the data used to estimate the gaps in access to the different types of infrastructure we chose to focus on. Section 3.2. provides an overview of our cost calculations. Section 3.3. discusses the scenarios used to assess revenues from carbon pricing. As access gaps and cost

[1] Please note that our analysis is based on the extrapolation of empirical trends and does not consider possible feedbacks of carbon pricing on access and infrastructure costs.

estimates are described in detail in the companion paper (Fuss et al. 2015), we only provide some key insights here. All data used are available online[2].

3.1. Access to Infrastructure

The goal of this study is to determine whether revenues from emission would be sufficient to cover investments to an extent that it would enable universal (i.e. 100%) access water, sanitation, electricity and telecommunication, and allow paving of all unpaved roads[3]. Arguably, these infrastructures are essential for human development in the sense of creating the capabilities to allow people to pursue their aims (Drèze and Sen 2013).

Access to water refers to the share of the population using an improved drinking water source, such as piped water, public taps or standpipes, tube wells or boreholes (World Bank 2014). Improved sanitation facilities include piped sewer systems, septic tanks, pit latrines, and composting toilet (World Bank 2014). Electricity access measures the percent of households with an electricity connection (Pachauri et al. 2013). For telecommunication, having a mobile phone plus 10 minutes of airtime per day were taken as a target (ITU 2014). Finally, for transportation, we examine the costs of paving all currently unpaved roads (World Bank 2014).

[2] http://www.mcc-berlin.net/fileadmin/user_upload/Jakob/Data_carbon_pricing_infrastructure_mike.xlsx

[3] Access to roads is essential for e.g. access to markets (Jacoby 2000).We suppose that all unpaved roads are in place because there is an actual need for them. Even though these roads do not necessarily need to be paved to ensure access, paving would substantially ease transportation. Hence, the requirement of paving all unpaved roads considered in this paper can be regarded as an upper limit for the investment needs required to ensure access to transportation services.

Region	% w/o acccess to elec.	% w/o acccess to water	% w/o acccess to sanitation	% w/o acccess to ICT	% of unpaved roads
East Asia & Pacific	4.8	8.8	30.6	29.3	40.1
Europe & Central Asia	0.0	2.0	6.5	14.2	23.1
Latin America & Caribbean	5.2	6.2	18.4	23.0	81.8
Middle East & North Africa	5.3	9.2	11.1	13.8	21.9
North America	0.0	0.8	0.1	1.1	0.0
South Asia	25.6	10.6	61.8	67.9	46.9
Sub-Saharan Africa	68.1	36.7	69.6	59.8	79.6
Global	**16.8**	**11.3**	**36.0**	**37.4**	**31.6**

Table 1: Share of population lacking access to electricity, water, sanitation, telecommunication and share of unpaved roads by region according to World Bank classification. All data are for the year 2010. Source: World Bank (2014), ITU (2014), Pachauri et al. (2013).

Table 1 provides an overview of access gaps aggregated on the regional level. These gaps are in general most pronounced for Sub-Saharan Africa, where more than one third of the population doesn't have access to water, and more than two thirds lacks access to electricity. Likewise, in South Asia, more than 60% lack access to sanitation, and more than two thirds don't have access to telecommunication.

For our analysis, we examine a scenario in which infrastructure investments are undertaken over a horizon of 15 years, corresponding to the 2015-2030 timeframe of the process to extend the Millennium Development Goals (Griggs et al. 2013). We assume that without intervention, the share of the population lacking access to a certain infrastructure in the year 2030 would be the same as in the year 2010 (hence our estimates can be considered conservative, as with economic growth it can be expected that access gaps start to shrink as part of the economy's development process). The access gap for each country is then calculated by multiplying this share with the medium scenario of the population forecast for 2030 from the United Nations World Population Prospects (UN 2013).

3.2. Costs of Providing Infrastructure

The costs for infrastructure access and paving roads were collected from the literature. Where data for individual countries was not available, we used regional averages. For recurrent costs, we assumed that infrastructure built-up is distributed equally over the considered 15-year horizon, which yields an average time of 7.5 years for which these expenses need to be met.

For the cost estimate of enabling universal access to clean water and sanitation, we rely on the World Health Organization (WHO) study by Hutton (2012). For costs of electricity access, which can be achieved by means of grid expansion or decentralized sources, we employ cost projections from an energy systems model (Pachauri et al. 2013) as the basis for our calculation. Concerning the costs of paving those unpaved roads, we use data from the International Energy Agency (2013). Finally, cost for providing access to mobile connections is assumed to be 150 US$ fixed costs per connection, which is line with the range of different studies reported in Rothman et al. (2014). For the cost of usage, we assume that 10 minutes of air time per day are to be covered, at a price of 2 cents per minute.

At global scale, our cost calculations indicate that universal access to water could be achieved by investing US$ 190 bn per year, US$ 370 bn could cover universal access to sanitation, and US$ 430 bn could finance universal access to electricity. Providing universal access to telecommunication would amount to US$ 2.6 trn annually, and paving all unpaved roads to US$ 8.7 trn.

The next sub-section examines the potential revenues of emission pricing under different scenarios. These are then compared to infrastructure investment needs on the country- level in Section 4.

3.3. Revenues from Emission Pricing

Estimating potential revenues requires the use of scenarios of future emissions and emission levels. Integrated Assessment Models (IAMs) constitute the most frequently employed tool to generate such scenarios (Luderer et al. 2011), which are inter alia used as a basis for the assessment of the Intergovernmental Panel on Climate Change of technological transformation pathways and mitigation costs to achieve a certain stabilization target (i.e. an atmospheric concentration of greenhouse gases or temperature increase not to be exceeded) (IPCC 2014b).

Figure 1 provides an overview of carbon prices and emissions in the year 2020 for the RCP2.6 stabilization scenario, which has a high probability of achieving the 2°C target. Scenario data include seven models used in the EMF-27 model comparison (Blanford, Kriegler, and Tavoni 2014; Krey et al. 2014; Kriegler et al. 2014)[4]. The scenarios assume a globally harmonized carbon price and full availability of low-carbon energy technologies (such as renewables, nuclear, and carbon capture and storage (CCS)). As can be clearly

[4] Scenarios were obtained from IIASA's AR5 scenario database (https://secure.iiasa.ac.at/web-apps/ene/AR5DB). The models included in EMF-27 are AIM-Enduse 12.1, GCAM 3.1, IMAGE 2.4, MESSAGE V.4, POLES EMF27, REMIND 1.5, and WITCH EMF27.

seen, models project roughly similar year 2020 emissions[5] (x-axis) for a certain region (with the exception of negative emissions in two regions for the GCAM model[6]), but a large variation in carbon prices (y-axis), which range from less than US$ 20 to more than US$ 120 per ton of CO_2. This broad span is mostly explained by differences in technological assumptions (e.g. on the availability of certain low-carbon energy sources, or technology costs) and economic mechanisms across models.

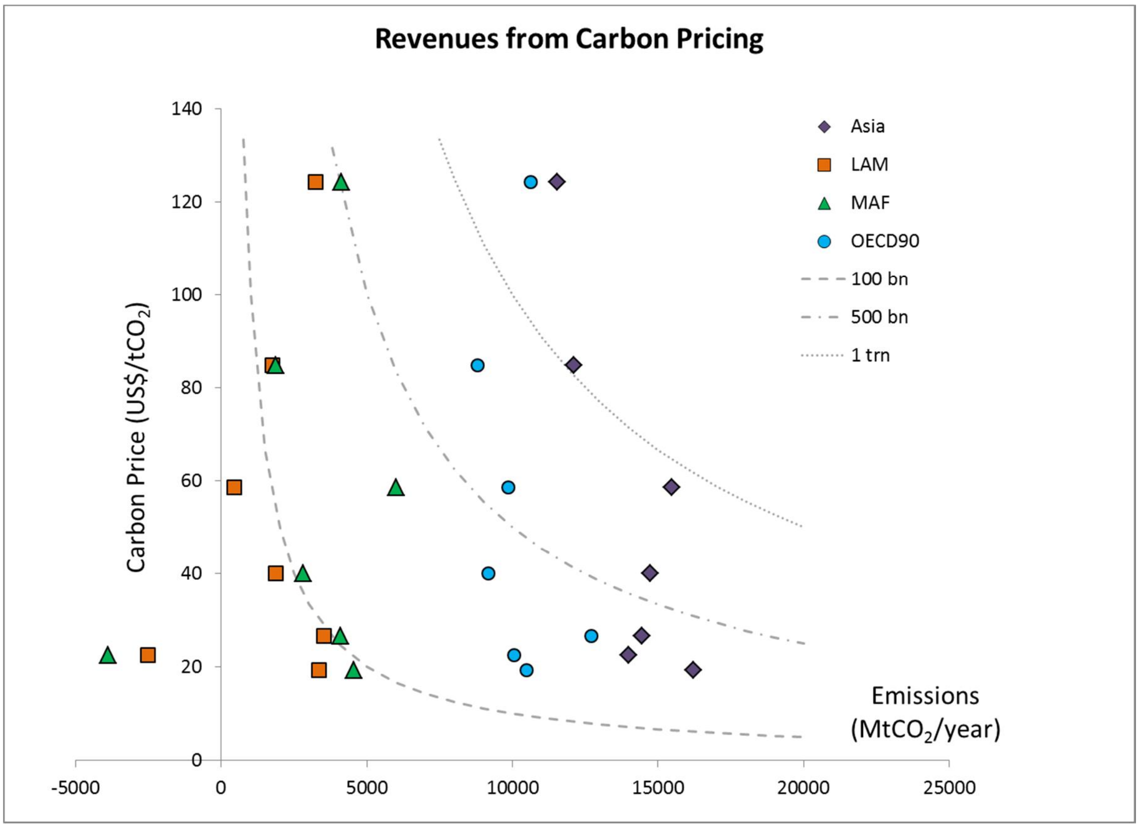

Figure 1: Emissions and carbon prices in the year 2020 for the 450ppm scenario, which exhibits a high probability to limit global warming in the year 2100 to below 2°C compared to the pre-industrial level. Data are from the EMF-27 model comparison (Blanford, Kriegler, and Tavoni 2014; Krey et al. 2014; Kriegler et al. 2014) for four regions: Asia (blue), Latin America (red), Middle East and Africa (green) and the OECD (black). Negative emissions imply removal

[5] All emissions referred to in this study are total CO_2 emissions, i.e. including CO_2 emissions from land use change and industrial processes, but excluding non-CO_2 GHGs, such as methane.

[6] Negative emissions occur if more emissions are taken out of the atmosphere by e.g. afforestation or use of biomass in combination with CCS than are released by e.g. the combustion of fossil fuels.

of emissions from the atmosphere from e.g. biomass and CCS (BECCS) or afforestation. The dashed iso-revenue curves indicate all points that correspond to revenues of US$ 100 bn, 500 bn, and 1 trn, respectively.

Besides differences between models, different stabilization targets as well as restricted availability of certain technologies influence the carbon price. That is, a less ambitious mitigation target will result in a lower carbon price, whereas foregoing the use of CCS, or restricting biomass use, will raise it. In order to get a better understanding for the determinants of carbon prices, we perform a simple regression analysis, in which the year 2020 carbon price in a stabilization scenario (for 450ppm and 550ppm, and with full technological availability, limited biomass, as well as without CCS) is the dependent variable. We regress these prices on dummy variables for the stabilization target (with 550ppm as the lower-bound benchmark), technological availability (with full-tech as the benchmark) and a model-specific dummy variable (which gives the ceteris paribus difference to the average) using OLS. As the results reported in Table 2 should not be regarded as a draw from a random sample, standard errors and significance levels are uninformative; rather, the results should be interpreted as conditional means.

VARIABLES	(1) p2020	(2) p2020	(3) p2020	(4) p2020
ppm450	27.79	62.56**	27.79	63.67**
	(37.99)	(23.77)	(39.34)	(24.15)
noccs	8.422	52.08*	8.422	53.44*
	(37.99)	(28.94)	(39.34)	(29.57)
limbio	2.996	11.51	2.996	11.79
	(37.99)	(28.18)	(39.34)	(28.90)
ppm450_noccs	99.77*		100.9*	
	(56.90)		(58.36)	
ppm450_limbio	16.27		16.07	
	(55.10)		(56.79)	
aim	15.23	-0.213		
	(38.19)	(36.36)		
gcam	-8.103	-23.54		
	(38.19)	(36.36)		

image	22.79	1.050		
	(42.47)	(39.01)		
message	-2.054	-17.49		
	(38.19)	(36.36)		
poles	12.96	-2.475		
	(38.19)	(36.36)		
remind	95.60**	80.16**		
	(38.19)	(36.36)		
witch	14.87	-7.919		
	(39.92)	(37.31)		
Constant			21.61	3.673
			(27.82)	(23.40)
Observations	39	39	39	39
R-squared	0.625	0.577	0.292	0.220

Table 2: Results of regression analysis to explain carbon prices in the year 2020 in different stabilization scenarios. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

For our preferred specification that includes model-specific dummies as well as interaction terms for stabilization target and technology availability (first column), the results indicate the following: first, for the case of full availability of technologies, mitigation costs in the 450ppm scenario are on average about US$ 28 higher than for the 550ppm scenario. Second, for the 550ppm scenario, excluding CCS and limiting biomass use raises the carbon price moderately, by roughly US$ 8 and US$ 3, respectively. Third, these technologies are significantly more important for the more ambitious 450ppm scenario. That is, not having CCS available would then raise carbon prices by more than US$ 108, and limiting biomass use by almost US$ 20. Finally, as already highlighted in Figure 1, the difference of carbon prices between models is significant, with the lowest values for GCAM, and the highest for REMIND.

For our revenue projections, we take the 450ppm scenario with full technology available as a benchmark scenario (alternative scenarios are explored in the sensitivity analysis). We take emissions and carbon prices from the POLES model, as this model yields the median revenues of the seven EMF-27 models (listed in footnote 3). As we require revenues on country level for our analysis, we apply annual regional emission growth rates in the period 2010-2030 from POLES to extrapolate from emissions in the year 2010. Further, as the model scenarios provide emission prices in 10-year intervals only, we estimate annual prices by assuming a constant growth rate from 2010 to 2030. Finally, we examine four different ways how revenues from a global carbon price could be distributed across countries: (i) we analyze the case in which all countries apply a (globally uniform) domestic carbon price, without redistribution of revenues between countries. Following (Raupach et al. 2014), we also look at a scenario in which the share of revenues is determined (ii) in proportion to actual emissions (w=0), (iii) in proportion to population (w=1), and (iv) the average (w=0.5) of the former two schemes. These schemes for revenue sharing (or burden sharing, respectively) can be regarded as reflecting different notions of justice and political feasibility, similar to the equal-per-capita allocation, grandfathering, and contraction-and-convergence schemes frequently discussed for the allocation of emission permits.

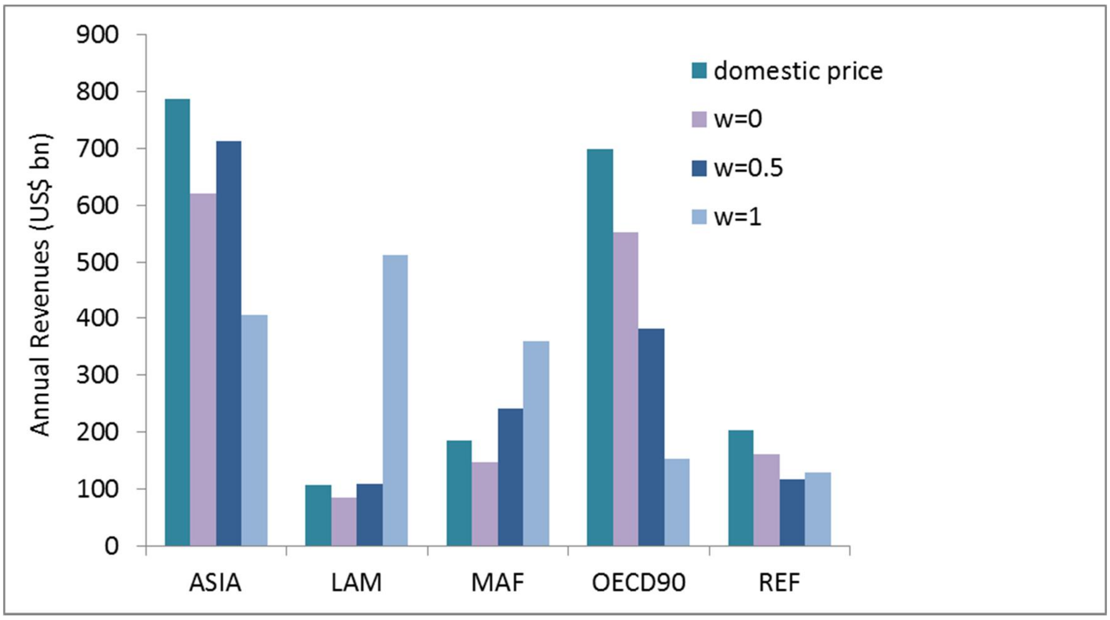

Figure 2: Annual average revenues from emission pricing during the period 2015-2030 in US$ bn for the 450ppm scenario with full availability of technologies. Model regions include developing Asia (ASIA), Latin America and the Caribbean (LAM), Middle East and Africa (MAF), countries that were OECD members in 1990 (OECD90) and transition economies (REF).

The results – which will form the basis for our analysis – are displayed on a regional aggregation in Figure 2. The figure reveals that revenues from carbon pricing would be sizable. For instance, depending on the scheme according to which revenues are distributed, funds raised by means of carbon pricing range from about US$ 400 bn to US$ 800 bn for Asia, and US$ 150 bn to US$ 360 bn for the Middle East and Africa, thereby significantly exceeding current levels of official development assistance (ODA), which amounted to about US$ 135 in the year 2013 (OECD 2014). The extent to which these revenues could contribute towards existing infrastructure access gaps will be the subject of the following section. For the analysis we focus on the 450ppm scenario, and the scheme in which revenues are shared as an average between a country's share in global population and global emissions (i.e. w=0.5). Other scenarios are considered in the sensitivity analysis (Section 5).

4. Results

This section discusses the extent to which existing infrastructure access gaps could be covered by carbon pricing. Figure 3 displays the share of carbon pricing revenues that would need to be invested in a particular infrastructure over a period of 15 years to achieve universal access. A darker color denotes that a larger share of the revenues would be required, i.e. a lower potential of carbon pricing to close access gaps. Light blue indicates shares greater than one, which means that revenues would be insufficient to fully close existing access gaps.

For water (panel a), the results indicate that carbon pricing revenues would be more than sufficient to cover the costs of universal access for all countries for which data are available. For most countries, the required share is relatively low (<5%). However, the Yemen would require about 10% of the revenues, and Ecuador almost 20%, which is due to the rather large access gap in the former of almost 50% of the population, and relatively low emissions in the latter (which under our baseline assumption on revenue sharing results in lower revenues than for countries displaying higher emissions). For sanitation (panel b), carbon pricing revenues would also be more than sufficient to cover investment needs, with only few countries requiring more than 5%. This holds even for many countries with very low rates of access, such as India, which displays an access gap of 66% of the population. Countries with higher requirements are located mostly in Sub-Saharan Africa (with a maximum of 17% for the Chad) and Latin America and the Caribbean (Haiti, Nicaragua and Bolivia). For investment in electricity infrastructure (panel c), the highest shares of revenues are required for countries in Sub-Saharan Africa, with ranges from 10-20% of carbon pricing revenues needed for universal access. On the other hand, practically all countries in Latin America and Asia could achieve universal access at 5% or less of their carbon pricing revenues, owing to the lower access gaps as well as lower costs per connection (which are due to higher population densities in these areas compared to Africa)[7]. For telecommunication (panel d), many African countries would require rather large shares of 20-40% to achieve universal access, whereas investment needs for most parts of Asia and Latin America are below 20% of carbon pricing revenues (a notable exception is Myanmar, where access to telecommunication is well below the regional average, such that a larger share of revenues would be required for universal access). This suggests that at least some countries might face limitations in terms of achieving universal access to telecommunications when taking into account that some fraction of their revenues will also be required to finance the other infrastructures under consideration. Finally, the investment needed to pave all unpaved roads (panel e) would exceed carbon pricing revenues several-fold for a number of countries. Interestingly, there is no clear regional pattern for these countries, as they include the middle-income Lithuania, Hungary, and Latvia, whereas for Africa, the required share only exceeds 100% for Guinea. This result

[7] Note that providing universal electricity access would only have a small impact on emissions and hence not contradict the goal of safeguarding environmental quality (Pachauri 2014; Rao, Riahi, and Grubler 2014).

is due to the relatively high absolute amount of unpaved roads in the former countries (i.e. the gap in percent of unpaved roads is lower there, but the absolute amount higher). Revenues would also be insufficient for several Latin American countries (Nicaragua, Colombia, Brazil, Bolivia, and Paraguay) as well as New Zealand.

In summary, our results indicate that for all countries in our study universal access to water, sanitation and electricity could be achieved during the period 2015-2030 by using in total less than half of emission pricing revenues. For telecommunications, however, the potential of our approach may face limitations for some countries, and for paving all existing unpaved roads potential revenues from emission pricing are insufficient in several cases.

In the next section, we assess the robustness of our results by testing for the impact of different assumptions regarding the stabilization target and availability of low-carbon technologies, which both have important consequences for the emission price. In addition, we examine different schemes how the revenues of emission pricing are shared across countries.

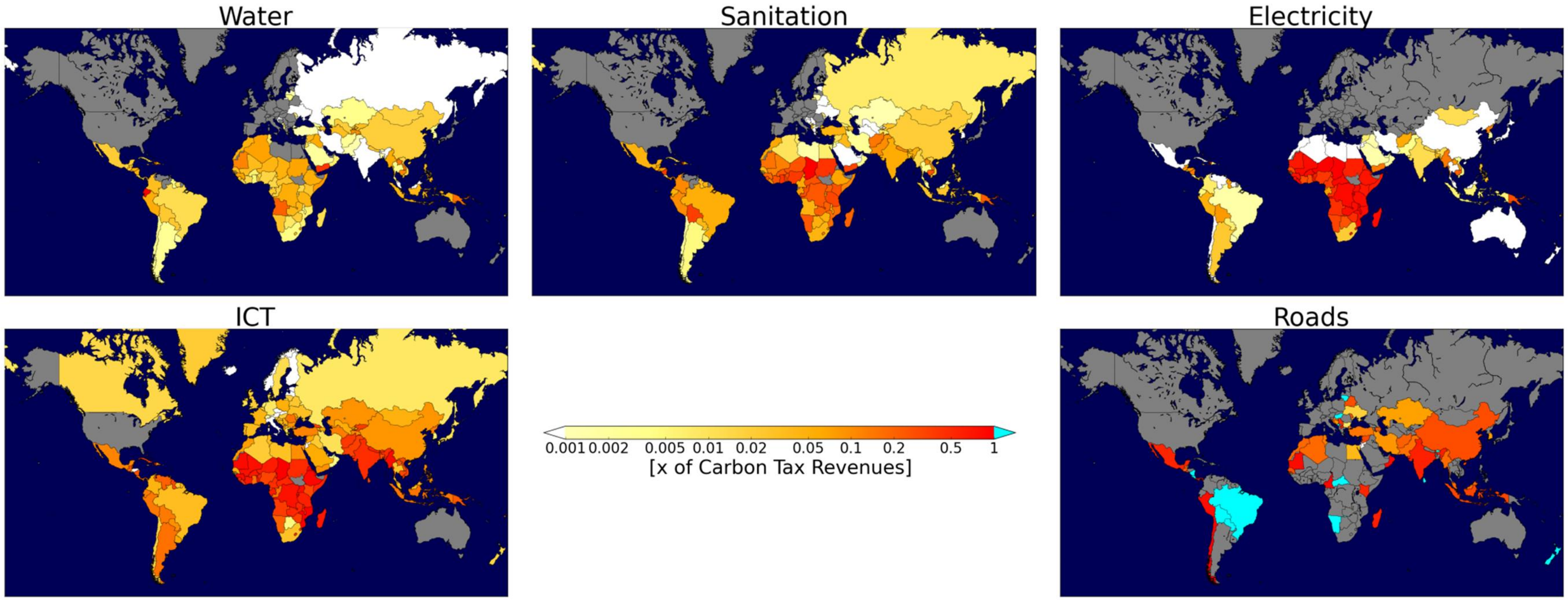

Figure 3: Share of carbon pricing revenues required to finance universal access to infrastructure. (a) Water, (b) Sanitation, (c) Electricity, (d) Telecommunication, and (e) costs of paving all unpaved roads. For description of data and sources see Section 3. Darker colors indicate higher shares, and light blue shares exceeding one. Grey areas denote countries for which data are not available. Please note logarithmic scale.

5. Sensitivity Analysis

The results presented above were derived for a scenario that assumes stabilization of the atmospheric GHG concentration at 450ppm CO_2-eq. with a full portfolio of technology options. As the use of some technologies might be restricted either because they might not be socially acceptable, more costly than expected, technologically infeasible or associated with unforeseen risks or unacceptable trade-offs, we also examine two alternative settings, in which the use of biomass is limited (low bio), and in which CCS is assumed to be unavailable. Furthermore, we also examine scenarios aiming at less ambitious climate targets, namely 550ppm CO_2-eq. Finally, we analyse the four different schemes to share global carbon pricing revenues described in Section 3.3. This leaves us with a total 24 scenarios (3x2x4 for different assumptions on technologies, the stabilization target, and the revenue sharing scheme). The required shares of carbon pricing revenues for each infrastructure are shown on a regional aggregation that corresponds to the POLES model regions from EMF27 (see Figure 3).

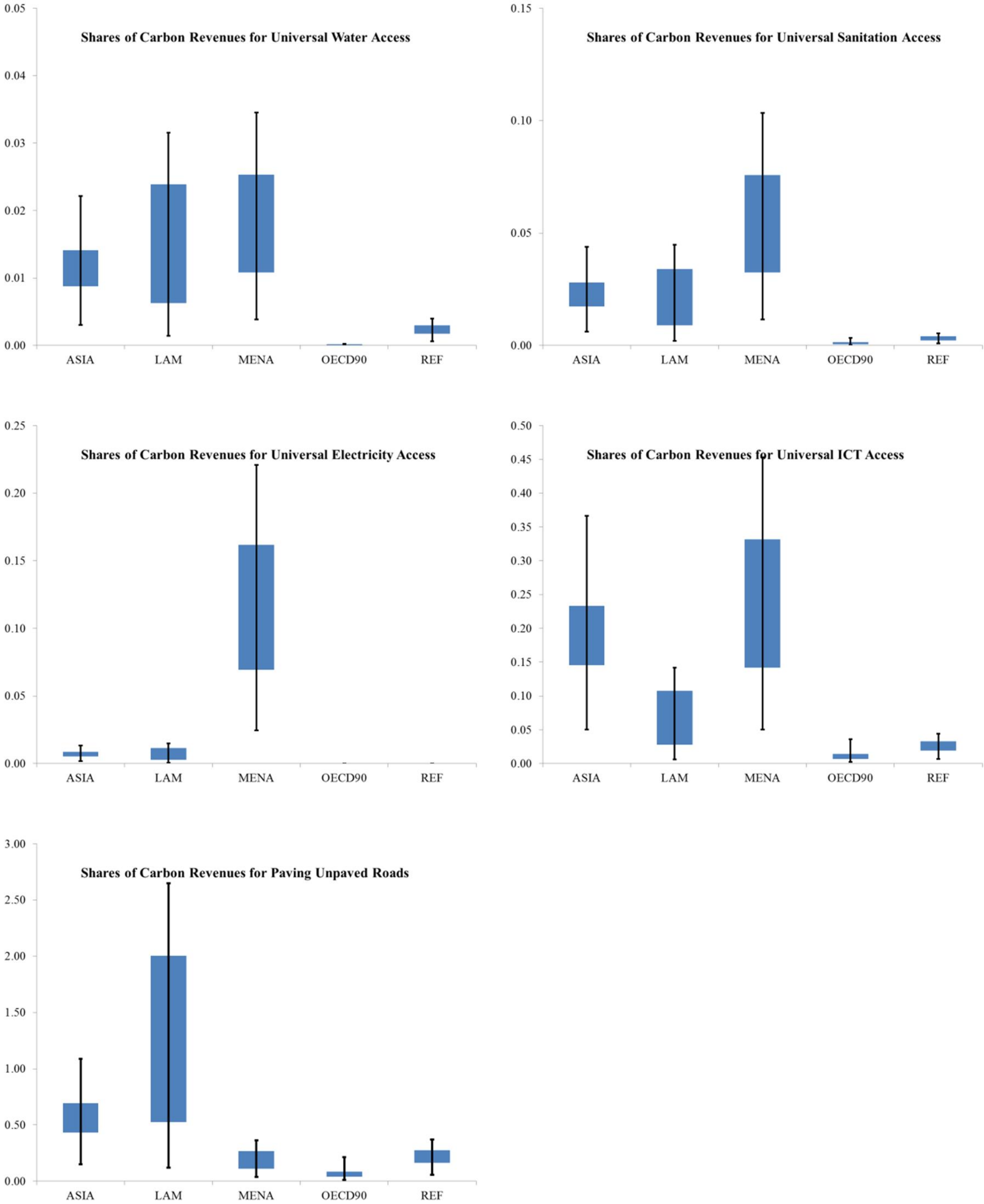

Figure 4: Results of sensitivity analysis showing minimum and maximum investment requirements (whiskers) as well as 25% and 75% quartiles for the infrastructures under consideration. Please note different scales.

This analysis confirms that for water, sanitation and electricity, investment needs would be significantly lower than revenues from carbon pricing even under scenarios in which relatively low revenues are generated for regions with large access gaps, that is, under scenarios in which revenues are either raised without redistribution (i.e. domestic pricing) or in which high emitters receive a high share of those revenues (i.e. proportional to actual emissions). For telecommunication, however, a large share of almost 40% would be required for Asia in this case, and about 45% for Middle-East and Africa, and investment requirements for paving all unpaved roads would exceed the revenues from emission pricing for Asia as well as Latin America. On the other hand, under scenarios in which a large share of the global revenues accrue to poor regions (i.e. equal per-capita allocation of emission rights), even the costs of universal telecommunication access as well as for paving roads would only amount to a moderate fraction of carbon pricing revenues. For instance, only about 10% of revenues would be required to pave all unpaved roads in Asia, and about 15% for Latin America.

6. Discussion and Conclusions

Access to basic infrastructures, such as water, sanitation, electricity, telecommunication and transport, is an essential feature of human well-being. For this reason, these services play an important role in existing development policies, such as the Millennium Development Goals (MDGs) and their extensions beyond 2015. In this paper we have examined how these considerations can be combined with a broader perspective of sustainable development, which includes the stability of natural systems, such as the atmosphere, as a policy target. In particular, we have focused on the question of how emission pricing – which constitutes the most frequently discussed policy to mitigate climate change – can generate revenues to meet infrastructure investment needs.

In a companion paper (Fuss et al. 2015), we examine the potential to raise finance for infrastructure investment by means of taxing natural resource rents. There, we find that resource rents could cover a large share of these investment requirements, especially for water, sanitation, and electricity.

Resource rents and carbon pricing revenues can be expected to be of a comparable order of magnitude: the former about US$ 3 trn in the year 2011, the latter on average about US$ 1.9 trn per year in our baseline scenario in the period 2015-2030. However, in most of our scenarios, carbon pricing goes further in closing access gaps, even if no revenues from carbon pricing are redistributed across countries. The reason is that those countries with the highest resource endowments in many instances display relatively small access gaps, whereas emissions are distributed more evenly, such that proportionally higher revenues would accrue to countries with large access gaps.

In addition, whereas some parts of resource rents is already captured by governments, e.g. by means of taxes, royalties, and state ownership. By contrast, emission pricing would by and large constitute new funds. Hence, we conclude that at least in scenarios aiming at ambitious climate stabilization with a high emission price, and under schemes in which a sufficient share of global revenues goes to countries with high access gaps, emission pricing holds even more promise than resource rent taxation as a funding source for infrastructure investment needs[8]. In summary, taking both contributions together points to the fact that fiscal reform that acknowledges the natural environment as an economic factor offers significant potential to promote sustainable development.

Acknowledgements

The authors have benefitted from discussions with Paul Segal at a workshop on resource rent taxation at the Mercator Research Institute on Global Commons and Climate Change (MCC) in Berlin in 2014 and to Christian Flachsland and Jan Steckel of the MCC and Shonali Pachauri from IIASA for useful comments and constructive criticism.

[8] However, emission pricing schemes need to be designed in a way that avoids negative impacts on the poorest members of a society (Rao 2012), and appropriate institutions and policies need to be in place to avoid negative impacts of large financial transfer between countries (Jakob et al. 2014).

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