The geographic distribution of the economic impact of climate finance

María Victoria Román, Iñaki Arto and Alberto Ansuategi

July 2016

BC3 WORKING PAPER SERIES

2016-05

The Basque Centre for Climate Change (BC3) is a Research Centre based in the Basque Country, which aims at contributing to long-term research on the causes and consequences of Climate Change in order to foster the creation of knowledge in this multidisciplinary science.

The BC3 promotes a highly-qualified team of researchers with the primary objective of achieving excellence in research, training and dissemination. The Scientific Plan of BC3 is led by the Scientific Director, Prof. María José Sanz Sánchez.

The BC3 Working Paper Series is available on the internet at
http://www.bc3research.org/lits_publications.html

Enquiries (Regarding the BC3 Working Paper Series):

Prof. Sérgio H. Faria

Email: sergio.faria@bc3research.org

www.bc3research.org

The geographic distribution of the economic impact of climate finance

María Victoria Román*[a], Iñaki Arto[a], Alberto Ansuategi[b]

Current estimates at global level put the investments required to address climate change at around 1.3 trillion dollars per year in the coming decades. Most developing countries face financial constraints (public as well as private) and significant additional costs imposed on their development by the impacts of climate change. In the framework of international climate negotiations, industrialised countries have committed to assist financially developing countries in this effort. Indeed, a specific fund (the Green Climate Fund) has been created to channel climate finance from donor to developing countries. This paper contributes to the literature dealing with climate finance allocation. In particular, we study the global distribution of the economic impacts associated with these financial flows linked to 17 different mitigation options and nine adaptation options using a Global Multi-Regional Input-Output model. This methodological framework enables us to broaden the scope of analysis of the economic impacts of climate finance beyond the boundaries of the host country, and to capture the impacts generated in third countries through international trade. The results confirm the relevance of spill-over effects generated by climate finance, which account for (on average) 29% of the total impact. But the volume of spill-overs varies significantly depending on the type of climate action that is financed and the country that receives the funds. Therefore, international spill-overs are an aspect that countries might take into account when making decisions and negotiating about climate finance allocation, because they determine the distribution of economic gains associated to climate action.

Keywords: climate finance, spill-overs, GMRIO, mitigation, adaptation.

Cite as: Román, M.V., I. Arto and A. Ansuategi (2016) The geographic distribution of the economic impact of climate finance. *BC3 Working Paper Series 2016-05.* Basque Centre for Climate Change (BC3). Bilbao, Spain.

---

* Corresponding Author. Email: mavi.roman@bc3research.org

[a] Basque Centre for Climate Change, BC3. Edificio Sede Nº1, Planta 1ª, Parque Científico de UPV/EHU, Barrio Sarriena, s/n, 48940 Leioa (Bizkaia), Spain.

[b] University of the Basque Country (UPV-EHU), Av. Lehendakari Aguirre 83, 48015 Bilbao, Spain

1. Introduction

Financial resources are critical to addressing climate change. Large-scale investments are required to significantly reduce emissions, notably in sectors that emit large quantities of greenhouse gases (GHGs). The International Energy Agency estimates that achieving a low-carbon energy sector will require an average of USD1.2 trillion in additional investments every year to 2050 (IEA, 2014). The global cost of adaptation to climate change is difficult to estimate, largely because climate change adaptation measures will be widespread and heterogeneous. However, the Adaptation Gap Report (Olhoff et al., 2014) states that current estimates, ranging from USD70 to more than 100 billion per year by 2050, probably constitute an underestimate.

Most developing countries face financial constraints (public as well as private) and significant additional costs imposed on their development by the impacts of climate change. Therefore bilateral, multilateral and private financing are all likely to be important sources of funding for their mitigation and adaptation activities. Climate finance (or climate aid)[1] is therefore a critical topic in the United Nations' climate talks. Industrialised countries have committed to such assistance through the United Nations Framework Convention on Climate Change (UNFCCC), the Copenhagen Accord (UNFCCC, 2009) and the Cancun Agreements (UNFCCC, 2010), wherein the higher-income countries have jointly pledged up to USD30 billion in "fast start" financing (FSF) for lower-income countries for the period 2010–2012, and a goal of jointly mobilizing USD100 billion annually by 2020.

Some governments have started to respond to the call to mobilise financial resources to support mitigation and adaptation. However, even with the recent initial capitalisation of the Green Climate Fund (AFP, 2014), most experts agree that climate finance must be sped up and scaled up to put the world on track to climate-neutral development in this century (Gupta et al., 2014).

The UNFCCC (2014) provides estimates of the volume of climate finance flows transferred so far. Considering only public sources of financing, transfers reached between USD35 and 50 billion in 2011. Estimates suggest that developed countries' contributions could reach the FSF goal, especially thanks to those from Germany, Japan, Norway, the United Kingdom and the USA. But these are still far from the goal established for long-term finance (USD100 billion per year).

So far, mitigation projects in the energy sector in Asia and the Pacific have accumulated the largest share of climate finance from developed to developing countries. Another important part of climate finance transfers has been invested in mitigation projects in forests (linked to the REDD+ instrument), especially in the Amazon region. Mitigation in the transport sector has attracted a more modest volume of finance. Adaptation projects have more difficulties attracting funding than mitigation. African countries and the Middle East are the main hosts of this type of projects, which mainly involve adaptation measures in the agriculture sector, water management and sanitation.

A rapidly growing body of literature has emerged that analyses the economic, social and environmental implications of public instruments for climate financing and seeks to identify innovative instruments for raising revenue without burdening developing countries and with limited effects on competitiveness (Parker et al., 2010; Basu et al., 2011; IMF, 2011; Keen et al., 2012). Another branch of literature has focused on the rationale for industrialised countries' involvement in international climate finance. Pickering et al. (2015) depart from the development literature to explore the factors influencing donors' decisions about climate finance allocation. They found both similarities and differences with development aid practices, associated to the agencies involved, economic aspects and political relevance.

[1]: Here the term "climate finance" refers to transfers of public resources from industrialised to developing countries for climate change mitigation and adaptation projects and programmes. This concept has also been called "climate aid".

According to Pickering and Rübbelke (2014), climate finance for mitigation has an allocative rationale: exploiting low-cost options for producing a global public good (i.e. mitigation); while climate finance for adaptation has a distributive rationale: compensation for risks caused by the donor countries[2]. These different rationales may explain why mitigation received much more FSF than adaptation did (Nakhooda et al., 2013). Abadie et al. (2013) discuss further reasons beyond the global public good argument that may explain the bias of climate finance towards mitigation. Halimanjaya (2015) assesses the relationship between amounts of public climate finance allocated to mitigation and the characteristics of developing countries, concluding that high CO_2 intensity, large carbon sinks, high deforestation rates, low per capita incomes and good governance are the factors that explain climate finance disbursements.

This paper contributes to this body of literature by studying the distribution of the economic impacts of cross-border climate finance through international trade, providing useful information for the assessment of alternative investment options for climate finance, and discussing whether those economic impacts could help us understand the observed distribution of climate finance.

It should be noted that, like any other type of demand shock, investments aimed at reducing emissions (mitigation projects) and/or enhancing climate-resilience (adaptation projects) involve the production of goods and services and the creation of value added in economic sectors at different locations. Thus, the general purpose of the analysis in this paper is to study the extent to which the benefits of climate action in terms of value added creation are retained by recipient countries or, by contrast, indirectly captured by companies in other countries (donors included) via international trade.

The specific objective of this paper is to answer these three questions: first, how are the economic impacts of climate actions distributed between countries? Second, how much impact spills over third countries for the different types of climate action? And, finally, for each alternative climate-related investment option (involving a specific location and project), how much impact is captured by each country?

The article is structured in five sections. After this introduction, Section 2 details the methods used. Results are presented in Section 3, with the answers to the questions asked above. Results are discussed in Section 4 and, finally, Section 5 presents conclusions and policy implications.

2. Methods

The impact of public policies has typically been assessed with the static Leontief demand model, based on the information contained in national Input-Output tables. In climate change literature, several studies have assessed the domestic economic impacts associated with climate-related investments, and despite being restricted to a national scale they have pointed out the relevance of international trade. For instance, Lehr et al. (2008) conclude that if low-carbon technologies create employment in Germany, this is due to exports. Other studies also show that the ability to retain gains by recipient countries depends on the share of components that can be manufactured domestically (Ciorba et al., 2004; Markaki et al. 2013; Oliveira et al., 2013). These previous results point to the relative position of economies in international markets as a determining factor in the distribution of economic gains from climate investments. Our study seeks to broaden this line of research by

[2:] However, as Rübbelke (2011) and Pittel and Rübbelke (2013) argue, there may be indirect allocative benefits of adaptation support. First, by improving developing countries' perceptions of the fairness of a global agreement, adaptation support may increase their willingness to contribute to international mitigation efforts. This in turn tends to enhance the total level of the global public good of mitigation that is generated through international negotiations.

studying the economic spill-overs[3] of climate finance. Spill-overs refer to economic impacts somewhere other than the economy where climate finance is disbursed and spent.

The study by Beutel (2003) is a precedent of our work in the context of regional policy. Studying European Structural Funds, his results suggest that for small open economies a substantial part (between 20–30%) of grants leaks to other countries, especially to more developed European regions, due to imports of capital goods required for infrastructure. However, the use of national Input-Output tables does not enable us to distinguish which countries benefit from these spill-overs. Global Multi-regional Input-Output (GMRIO) databases are the most suitable tool for capturing the global impact of climate finance, since they are especially constructed to reflect the current interconnectivity of the world's economies. They comprise information on global supply chains, reflecting the participation of the different sectors and countries in the production process of each single good or service. There are various GMRIO databases (see Tukker and Dietzenbacher (2013) for a comparison of the different databases), from which the World Input-Output Database (WIOD) has been chosen for this exercise. Two important advantages of WIOD are the following: first, it is publicly available and free of charge; and, second, it is based on national Supply and Use Tables, which contain information required for characterising demand shocks. WIOD tables combine information on national production activities for 59 products and 35 industries, and international trade data for 40 countries (27 EU countries and 13 other major countries) for 1995–2011. For a detailed description of the WIOD project and tables see (Timmer et al., 2012; Dietzenbacher et al., 2013).

The analysis focuses on the last available year (i.e. 2011) and on the major economies included in the WIOD. Thus, we consider Brazil (BRA), China (CHN), Indonesia (IDN), India (IND) and Mexico (MEX) as climate finance recipient countries, and the United States of America (USA), the European Union (EU), East Asia (EA: Japan, Korea and Taiwan) and other developed countries (ODC: Australia, Canada, Russia and Turkey) as donors. All these economies together represent approximately 83% of global GDP and 80% of global emissions. The five recipient countries examined represent around 70% of emissions from developing countries, and more than 60% of their GDP (WB, 2010, 2012). We analyse the impact that one monetary unit of investment would generate depending on where and in what type of mitigation or adaptation action it is invested. To that end, data on how that amount of money would be spent are required for each type of climate action. Following the IPCC (2007), we consider three main types of climate action: those with benefits in terms of reducing emissions (mitigation); those which improve the resilience of societies (adaptation) and those with benefits in both aspects (M&A). Table B.1. contains a detailed list of action categories, including 14 renewable energy (RE) technologies and three energy efficiency (EE) measures, six adaptation alternatives and three types of project capable of reducing emissions while also enhancing adaptive capacity. This table also reports the data sources.

Data for RE projects, provided by the German Institute for Economic Research (DIW Berlin), reflect the cost structures of projects in Germany in 2011. Cost structures of other mitigation measures (ocean energy and EE in buildings, industry and transport) are taken from previous studies in different countries (Allan et al., 2008; Pollin and Garrett-Peltier, 2009; Markaki et al., 2013). National Adaptation Programmes of Action[4] (NAPAs) have provided information for the rest of categories. One specific project has been selected for each investment category and detailed information

[3]: Beutel (2003) includes the analysis of cross-border impacts but calls them "leakage effects" instead of "spill-overs". Here we use the latter term to avoid confusion with another relevant concept in climate change literature, i.e."carbon leakage". The concept of "spill-over effects" has been also used in climate change literature to refer to indirect damage through international trade (Schenker, 2013).

[4]: http://unfccc.int/adaptation/workstreams/national_adaptation_programmes_of_action/items/4585.php

contained in Priority Project Profile documents about the budget allocation has been used to estimate the cost structure of each adaptation project category[5].

Departing from this information, as Fig. 1 illustrates, the first step is to define the shock in terms of commodities according to the classification used in WIOD (i.e. the Statistical Classification of Economic Activities in the European Community or NACE[6]).

Table B.2. in the Appendix, which shows the correspondence between expenditure categories of NAPA projects and NACE commodity categories, is used for this purpose. Table 1 reflects how project budgets are distributed between the different commodities, showing clearly the differences between the types of climate action envisaged. It shows, for example, that almost any type of project requires some construction work, machinery and other business services, whereas only some require agriculture products (such as introducing biofuels in transport).

The shock obtained is expressed, as in the original budgets, in purchaser's prices, which include taxes and trade margins. Thus, the second step consists of transforming the shock into basic prices, which is the amount received by producers. For this operation International Supply and Use

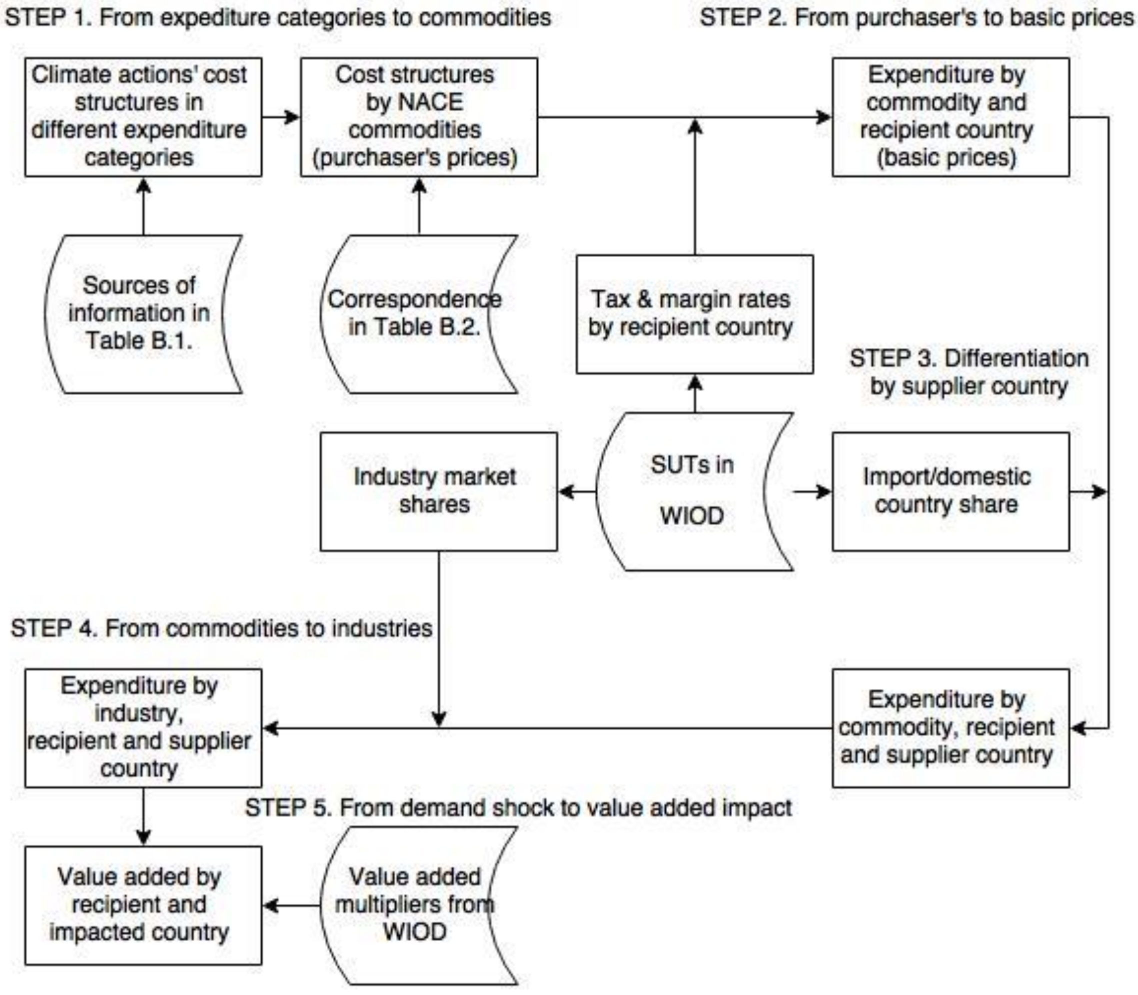

Figure 1: Description of the method

[5]: As Table B.1. shows, each adaptation category comprises different sub-categories. One NAPA project has been selected for each sub-category, taking the average as representative of the category.
[6]: In French: Nomenclature statistique des Activités économiques dans la Communauté Européenne.

Tables (SUTs) for the different recipient countries are used. These contain the information required to calculate the tax rates for each country and commodity[7]. After subtracting the amount corresponding to taxes, the amount corresponding to trade margins is calculated and reallocated to the corresponding commodity categories (i.e. trade and transport services). SUTs also provide information required for this operation.

Table 1: Relative weights of each commodity category for each type of climate action (percentage). Source: Own work based on DIW 2011; Markaki et al. 2013 (a); Allan et al. 2008; (a) some modifications have had to be introduced in the allocation of expenses to commodities given the different aggregation levels of the commodity categories. This is the case of expenses classified as real estate services (70), which have been reclassified as other business services (74) or research and development services (73), as appropriate. Moreover, expenses allocated to trade services have been allocated to the corresponding manufacturing sector. The margins are subsequently discounted and reallocated to trade services as explained in the method. This is the case of retail trade services (52), which correspond to sales of electrical equipment (31), and trade in motor vehicles (50), corresponding to motor vehicles (34). Abbreviations: AG: agriculture, fishing and livestock; BB: biomass big; BE: renewable energy in buildings; BG: biogas; BI: insulation of buildings; BS: biomass small; CB: capacity building; CO: coastal protection; CS: concentrated solar power; DR: disaster risk reduction; FO: forestry and land use/Terrestrial Ecosystems; GD: geothermal deep; GS: geothermal surface; HY: hydropower; ID: energy efficiency in industry; IF: human settlements, infrastructure and spatial planning; OC: ocean power; PV: photovoltaics; SP: social protection; TE: renewable energy in transport; TH: solar thermal; TR: transport infrastructure; WA: water supply and management; WF: offshore wind; WN: onshore wind; WT: waste and wastewater;

NACE code	WN	WF	PV	TH	HY	BB	BS	BG	GD	GS	CS	OC	TE	BE	TR	ID	BI	CO	DR	WA	IF	SP	WT	FO	CB	AG
1	0	0	0	0	0	0	0	0	0	0	0	0	62	0	0	0	0	0	0	4	0	0	0	6	0	13
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	4	13	0	0	0	15	0	0
10	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	1	14	1
23	0	0	0	0	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	4	2	11	3	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	3	8	0	0	0	1
25	2	1	0	1	2	1	3	2	3	4	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	4	18	0	0	14	6	5	0	3	20	0	0	0	0	0	0	0	21	0	0	6	0	0	0
27	16	19	9	3	0	2	11	7	7	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	3	1	1	12	7	9	31	5	6	12	4	14	0	0	0	0	0	0	0	0	0	0	0	6	0	1
29	12	6	0	26	31	16	8	22	12	39	1	51	17	31	1	32	0	0	10	32	22	16	20	8	12	12
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
31	19	9	13	1	16	6	5	11	3	2	31	6	0	27	1	10	0	0	0	0	3	0	0	0	0	0
32	0	0	17	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	4	2	0	9	3	2	5	2	0	2	0	0	0	0	0	0	0	5	26	0	8	0	0	1	0	4
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52	0	0	0	1	0	0	0	0	1	0	0
35	12	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	1	0	1	0	8	0	1	1	1	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
45	3	15	30	20	1	60	3	7	31	23	0	4	11	11	31	49	100	34	21	6	35	5	34	8	0	18
51	3	1	2	2	5	1	6	4	5	3	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	1	0	1	0	1	0	0	0	0	0	10	0	0	0	1	0	0	0	0	3	0	1
62	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	2	0	1	3	0
64	1	0	0	0	1	0	1	1	1	0	1	0	0	0	0	0	0	0	1	0	0	2	0	1	3	0
65	2	3	0	0	1	0	1	2	1	1	1	0	0	0	1	0	0	4	0	0	0	0	0	0	0	0
66	0	4	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	1	1	1	1	2	0	2	7	6	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	1	0	1	2	2	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	30	14	0	0	1	0	2	18	32
74	13	18	4	2	10	2	0	12	10	4	31	5	0	15	3	10	0	18	17	21	27	53	27	42	49	17
75	0	0	0	0	3	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	4	0	0
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	4	4	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	9	0	0	0
92	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

7: Since this information is not available for two recipient countries (China and Indonesia), average values of the other recipient countries (Brazil, India and Mexico) are used instead.

Once the shock is expressed in basic prices, the next step is to differentiate the geographical origins of the commodities. SUTs contain the information required to calculate the share produced by each country for each commodity. Next, the production of each commodity in each country is allocated to the sectors in that country according to the market shares calculated.

After these steps, the demand shock for each recipient country contains additional demands for different sectors in different countries at basic prices. World Input-Output Tables are used to calculate value added coefficients, which express the value added per unit of output in each sector and country. Value added reflects the contribution of an industry to an economy (Miller and Blair, 2009). Using value added coefficients, it is possible to differentiate the contribution of each country to the value added embodied in climate investments. As detailed in Dietzenbacher et al. (2013), the product of value added coefficients and the Leontief inverse gives the magnitude of the impact of climate finance on the different countries involved in the value chain of the required goods and services. Since impacts at sector level are not the focus of this research, results are aggregated to obtain the impacts at country level triggered by the additional demand of the recipient countries. For a detailed explanation of the methodology, see Appendix A.

3. Results

Using this multi-regional framework we obtain figures for the amount of value added in all industries directly or indirectly linked to the interventions examined, including those located in countries other than the recipient country. In this section, the research questions listed in the introduction are answered in turn.

3.1 Geographic distribution of the value added impact

The first question is how the economic impacts caused by the implementation of climate actions are distributed between countries. Figure 2 displays the geographic distribution of the value added impact, depending on where climate finance is disbursed.

On the one hand, the figure shows the differences in the ability of the economies of recipient countries to hold on to the value added: in India and Brazil around 80% of the impact remains within the domestic economy, but Mexico and Indonesia retain no more than two thirds. China is in an intermediate position among recipient countries, retaining 72% of the impact of its climate actions. On average, spill-overs account for 28.6% of the total impact.

On the other hand, the ability of countries to attract these spill-over effects also varies. The EU is the region that benefits most from international spill-overs. It captures 9% of the impacts generated when investments take place in China and 7% in the cases of Brazil, Indonesia and Mexico. It is also the donor that captures the highest share of spill-overs in India, where spill-overs are in any case very low for all donors. Note that the USA captures 15% of the impacts when investments are placed in Mexico but less than 3% with other recipient countries. The EA countries capture 6% of the impacts generated by investments in China and 5% in the case of Indonesia. In fact, EA captures more spill-overs than the USA in these two countries. China also substantially benefits from spill-overs independently of the destination of climate finance. Spill-overs attracted by China are among the largest when climate finance goes to India, Brazil and Indonesia. For example, China attracts more spill-overs from India and Indonesia than the USA does, and a similar level of spill-overs from Brazil.

Figure 3 illustrates how impacts generated by climate finance are distributed among countries. It clearly shows that international trade redirects the value added impacts from recipient countries to the countries that produce the inputs required for the deployment of climate actions.

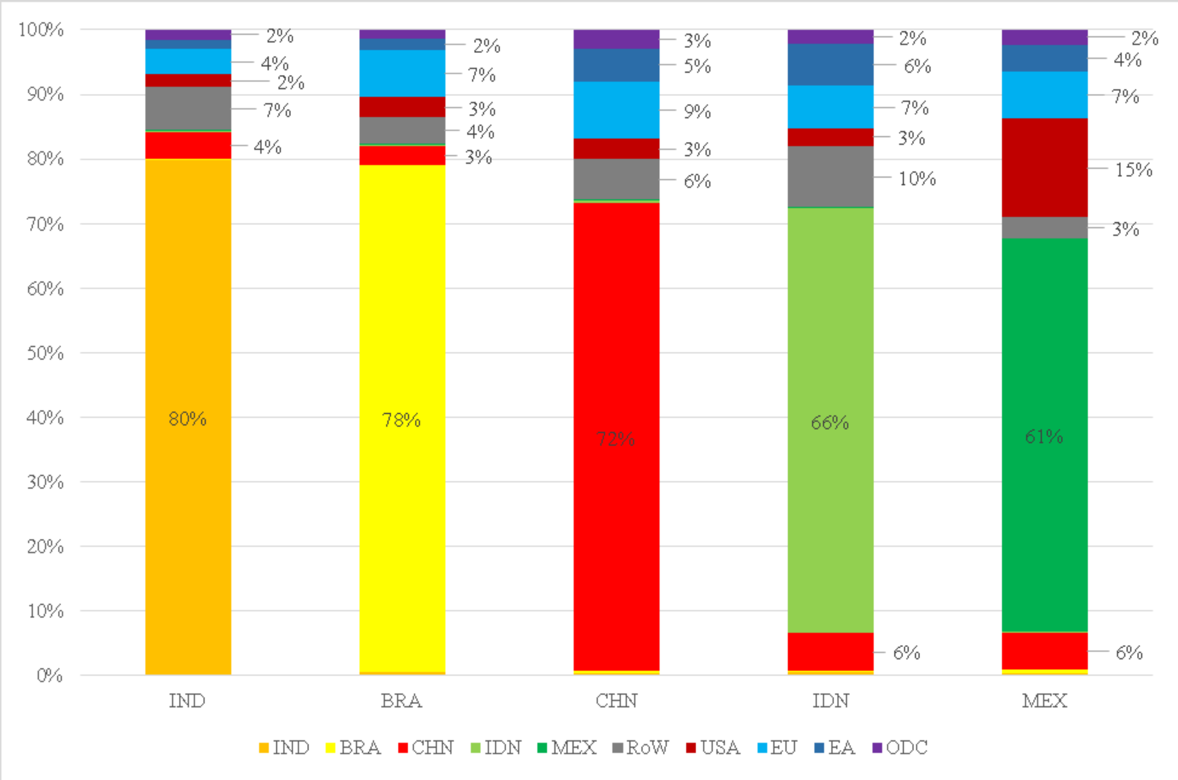

Figure 2: Geographic distribution of the value added impact depending on the recipient country. Abbreviations: BRA: Brazil; CHN: China; EA: East Asia; EU: European Union; IDN: Indonesia; IND: India; MEX: Mexico; ODC: Other developed countries; USA: United States;

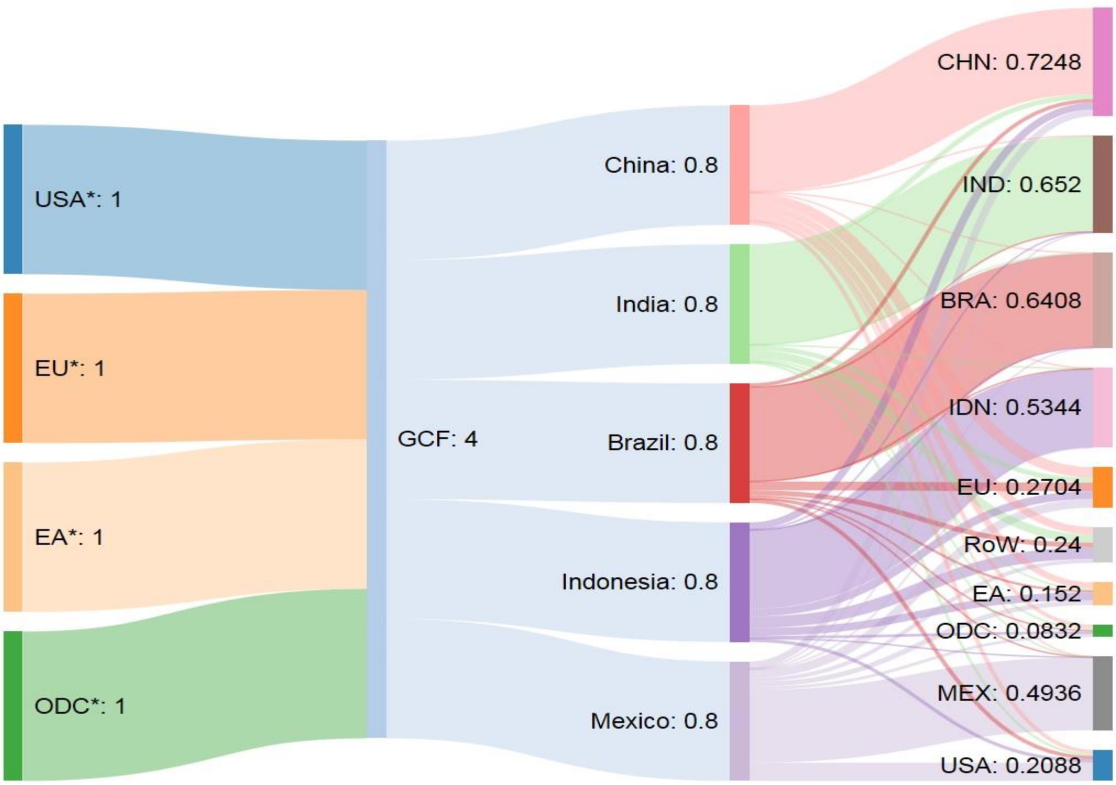

Figure 3: Spill-over flows from recipient countries to third countries via trade. Abbreviations: BRA: Brazil; CHN: China; EA: East Asia; EU: European Union; GCF: Green Climate Fund; IDN: Indonesia; IND: India; MEX: Mexico; ODC: Other developed countries; USA: United States;

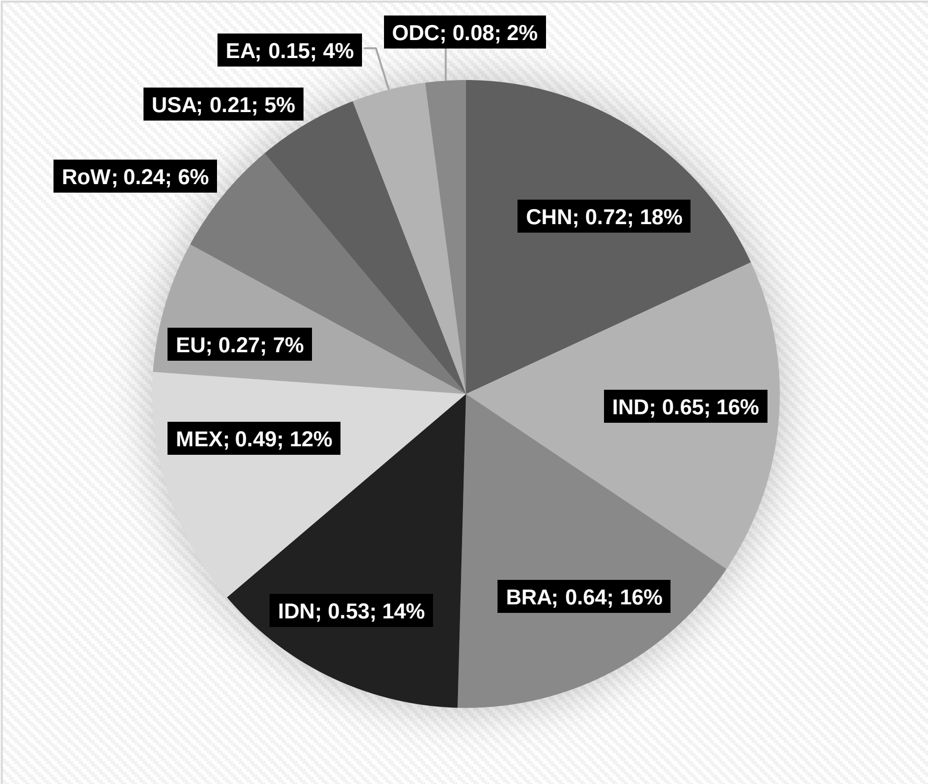

Figure 4: Distribution of the value added impacts of a hypothetical GCF. Abbreviations: BRA: Brazil; CHN: China; EA: East Asia; EU: European Union; IDN: Indonesia; IND: India; MEX: Mexico; ODC: Other developed countries; USA: United States;

For instance, if each of the four donor countries transferred one USD to a hypothetical Green Climate Fund (GCF) and this four USD fund was equally distributed among the five recipient countries, each of the donors would recover the following amounts in the form of spill-overs: USD0.27 for the EU, USD0.21 for the USA, USD0.15 for EA and USD0.08 for ODC. The amounts obtained by recipient countries would be USD0.72 for China, USD0.65 for India, USD0.64 for Brazil, USD0.53 for Indonesia and USD0.49 for Mexico. Figure 4 summarises the distribution of the value added impacts of this hypothetical climate finance architecture.

3.2 Spill-overs per type of climate action

So far, average impacts of a wide variety of climate actions have been presented. But the geographical distribution of the generation of value added is different for each type of climate action: some produce mainly domestic impacts whereas others generate a large proportion of spill-overs. Figure 5 shows the spill-overs associated with each type of investment on average for all recipient countries.

Spill-overs range from 17% to 45%. Several actions related to renewable energy sources (ocean power, solar thermal power, onshore wind, geothermal surface, hydropower and the introduction of renewables in buildings) produce spill-overs in excess of 35%. The spill-overs from other renewable energy technologies (photovoltaics, small biomass, biogas and offshore wind), energy efficiency measures in industry, construction of infrastructures for transport and adaptation, disaster risk reduction actions and adaptation measures in the water sector range from 30% to 35%. The spill-overs from some actions related to renewable energies (CSP, large biomass, deep geothermal and biofuels), adaptation measures (waste management and social protection) and M&A actions (agriculture and capacity building) range from 20% to 30%. Finally, spill-overs of less than 20% are generated in the forestry sector, insulation of buildings and protection of coasts.

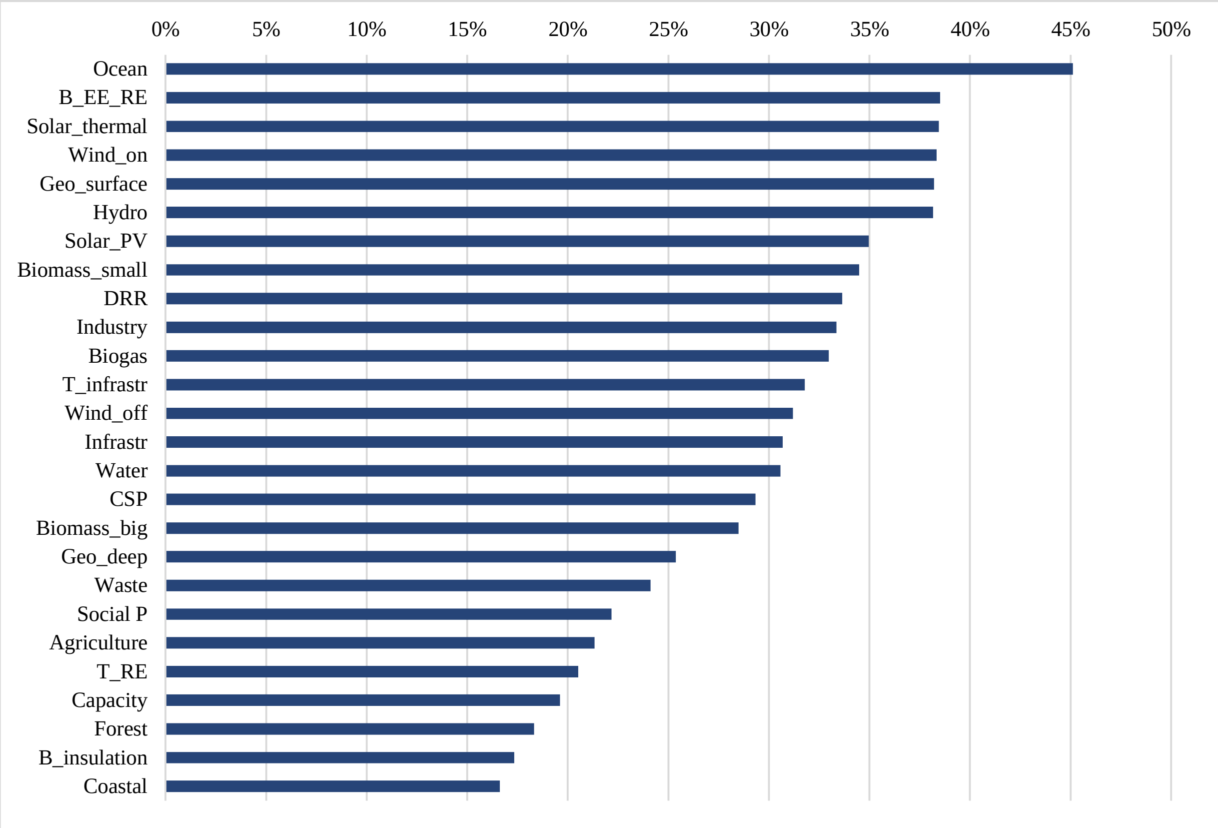

Figure 5: Average spill-overs per type of climate action. Abbreviations: Agriculture: Agriculture, fishing and livestock; B_insulation: Building insulation; B_RE: Renewable energy in buildings; Biogas: Biogas power; Biomass_big: biomass energy large scale; Biomass_small: Biomass energy small scale; Capacity: Capacity building; Coastal: Coastal protection; CSP: Concentrated solar power; DRR: Disaster risk reduction; Forest: Forestry and land use/ Terrestrial Ecosystems; Geo_deep: Deep geothermal energy; Geo_surface: surface geothermal power; Hydro: Hydropower; Industry: Energy efficiency in industry; Infrastr: Human settlements, infrastructure and spatial planning; Ocean: Ocean power; Social P.: Social protection; Solar PV: Photovoltaics; Solar_thermal: solar thermal energy; T_infrastr: Infrastructures for transport; T_RE: Renewable energy in transport (biofuels); Waste: Waste and wastewater; Water: Water supply and management; Wind_off: Offshore wind power; Wind_on: Onshore wind power;

Table 2 presents the proportion of the impact that occurs in each country for each type of action separately. Figures for recipient countries reflect the percentage of impact that each one holds on to when it receives climate finance. Figures for donor countries reflect the percentage of impact that each donor country attracts in average when climate finance is disbursed to the recipient countries considered. Thus the figures do not add up to 100%, since spill-overs captured by countries other than donors are not included. Recall that a significant share of the impact of investments in different recipient countries ends up in China, a fact that is not reflected in Table 2. This table clearly illustrates that measures with larger impacts on the economies of recipients offer more limited benefits for donor countries in terms of spill-over effects. Depending on the type of action, the domestic share of the impact ranges from 57% to 84% (see column 6 in Table 2). Differences exist depending on the regions where actions are implemented. Brazil and India retain between 68% and 88% of the relevant impacts, while Mexico holds on to between 39% and 83%, depending on the type of action.

Table 2: Proportion of impact captured by each country/group of countries for each type of climate action. Notes: Figures for recipient countries (columns 1-5) reflect the percentage of impact that is retained by each country when it receives climate finance. Figures for donor countries (columns 7-10) reflect the percentage of impact that each donor country attracts on average when climate finance is disbursed to the recipient countries considered. The green-yellow-red color scale reflects the attractiveness of each climate action for each country (from the point of view of its potential for creating domestic impacts in the case of recipient countries, and spill-overs in the case of donors). The most attractive options are in green and the least attractive ones in red. The table is sorted by the value of column 6 (Average Recipient) in descending order. Abbreviations: BRA: Brazil; CHN: China; EA: East Asia; EU: European Union; IDN: Indonesia; IND: India; MEX: Mexico; ODC: Other developed countries;USA: United States; A: Adaptation; Agriculture.: Agriculture; fishing and livestock; B_insulation: Building insulation; B_RE: Renewable energy in buildings; Biogas: Biogas power; Biomass_big: biomass energy large scale; Biomass_small: Biomass energy small scale; Capacity: Capacity building; Coastal: Coastal protection; CSP: Concentrated solar power; DRR: Disaster risk reduction; Forest: Forestry and land use/ Terrestrial Ecosystems; EE: Energy efficiency; Geo_deep: Deep geothermal energy; Geo_surface: surface geothermal power; Hydro: Hydropower; Industry: Energy efficiency in industry; Infrastr: Human settlements, infrastructure and spatial planning; M&A: Mitigation and adaptation; Ocean: Ocean power; RE: Renewable energy; Social P.: Social protection; Solar PV: Photovoltaics; Solar_thermal: solar thermal energy; T_infrastr: Infrastructures for transport; T_RE: Renewable energy in transport (biofuels); Waste: Waste and wastewater; Water: Water supply and management; Wind_off: offshore wind power; Wind_on: onshore wind power;

	1	2	3	4	5	6	7	8	9	10	11
	IND	BRA	CHN	IDN	MEX	**Average Recipient**	EU	USA	EA	ODC	**Average Donor**
Coastal (A)	86%	88%	80%	83%	82%	84%	4%	3%	2%	1%	2%
B_insulation (EE)	82%	89%	81%	81%	83%	83%	3%	3%	2%	2%	2%
Forest (M&A)	87%	87%	80%	79%	78%	82%	4%	4%	2%	1%	3%
Capacity (M&A)	86%	87%	78%	78%	76%	81%	5%	4%	2%	1%	3%
T_RE (RE)	89%	84%	83%	77%	68%	80%	4%	4%	2%	1%	3%
Social P (A)	84%	85%	73%	75%	74%	79%	6%	4%	2%	1%	3%
Agriculture (M&A)	85%	84%	78%	76%	74%	79%	5%	4%	2%	1%	3%
Waste (A)	81%	84%	77%	72%	72%	77%	6%	4%	3%	2%	4%
Geo_deep (RE)	81%	83%	76%	67%	71%	76%	5%	4%	3%	2%	4%
Biomass_big (RE)	80%	80%	74%	66%	63%	73%	6%	5%	4%	2%	4%
CSP (RE)	83%	77%	72%	70%	60%	72%	6%	5%	5%	2%	4%
Water (A)	75%	78%	73%	65%	62%	71%	8%	5%	3%	2%	5%
Infrastr (A)	80%	78%	70%	65%	60%	70%	8%	5%	4%	2%	5%
Wind_off (RE)	81%	77%	71%	65%	57%	70%	7%	6%	4%	3%	5%
T_infrastr (EE)	79%	74%	70%	70%	53%	69%	8%	6%	4%	2%	5%
Biogas (RE)	80%	76%	71%	58%	57%	68%	7%	6%	4%	2%	5%
Industry (EE)	79%	76%	72%	60%	53%	68%	8%	6%	4%	2%	5%
DRR (A)	78%	76%	67%	63%	55%	68%	8%	6%	4%	2%	5%
Biomass_small (RE)	75%	77%	68%	56%	59%	67%	7%	5%	5%	3%	5%
Solar_PV (RE)	73%	75%	65%	67%	55%	67%	6%	5%	5%	2%	5%
Hydro (RE)	80%	71%	68%	54%	44%	63%	9%	7%	5%	2%	6%
Wind_on (RE)	79%	71%	65%	57%	45%	63%	8%	7%	5%	3%	6%
Geo_surface (RE)	77%	74%	68%	50%	47%	63%	9%	7%	5%	3%	6%
B_RE (RE)	79%	69%	68%	57%	42%	63%	9%	7%	6%	2%	6%
Solar_thermal (RE)	70%	73%	66%	54%	52%	63%	9%	6%	5%	3%	6%
Ocean (RE)	68%	68%	65%	44%	39%	57%	11%	8%	6%	3%	7%
Average M&A	86%	86%	79%	78%	76%	81%	5%	4%	2%	1%	3%
Average A	80%	81%	73%	70%	66%	75%	7%	5%	3%	2%	4%
Average EE	82%	81%	77%	72%	64%	73%	6%	5%	3%	2%	4%
Average RE	77%	75%	69%	59%	53%	68%	8%	6%	5%	2%	5%

Average figures are included for broader categories of climate action (last four rows in Table 2). Depending on the recipient country, between 76% and 86% of the impacts can be retained locally by investing in M&A actions. Other adaptation measures and EE actions enable countries to hold on to between 64% and 82% of the impacts. Deployment of renewable sources of energy retains only between 53% and 77% of the impacts.

According to our results, the climate actions with highest impact for recipient countries are the following: forestry sector and capacity building actions in the case of M&A; coastal protection, social protection and waste management actions in the case of adaptation; building insulation in the case of EE; and the use of biofuels, deep geothermal, large biomass and CSP generation in the case of RE.

Depending on the type of action, the average spill-overs that accrue for donor countries range from 2% to 7%, with substantial differences between them (last column in Table 2). Hence, depending on the donor country, RE investments may provide spill-overs of between 2% and 8%, EE measures and adaptation between 2% and 7% and M&A actions between 1% and 5% (last four rows in Table 2). From the point of view of donor countries, the types of climate action that result in a significant proportion of impacts taking place in their economies are as follows: ocean, wind, solar and hydropower for RE sources; those in the industry sector and transport infrastructures for EE projects; actions in the water sector, infrastructures and DRR measures for adaptation; and finally actions in the agriculture sector for M&A.

Although there is a common pattern for all countries included on the same side of the climate finance transfer (i.e. recipients or donors) regarding the effects of each type of action, there are slight variations. For example, India experiences a larger impact than the average recipient country from the introduction of biofuels and water supply and management investments. China also stands out because of the size of the local impact of biofuels and photovoltaics. The same occurs with donors. For instance the EU stands out because of the size of the spill-overs received from ocean power investments.

3.3 Impact captured per donor country and investment option

Table B.3 in the Appendix gathers the results relative to the average volume of spill-overs that each donor country can expect from climate-related investments in the different recipient countries. If the donor countries rank climate finance alternatives according to potential of value added spill-overs, this table helps to identify the best options for each donor country.

The USA benefits especially from climate projects in Mexico, regardless of their type, as it recoups from 7% (coastal protection) to 24% (ocean energy) of its investment in the form of spill-overs. Other investment options that offer good returns to the USA are ocean energy projects in Brazil and Indonesia and onshore wind projects in Brazil (5% each). China is the country that generates the largest spill-overs for the EU and ODC. The action that offers the largest spill-overs for the EU is ocean power in China and in Mexico (13%). Indonesia, Mexico and Brazil offer spill-overs of 7% on average for the EU. ODC’s best options are small biomass projects in China (5%), ocean power and onshore wind in Mexico (4%) and ocean power in Indonesia (4%). EA benefit especially from ocean energy and surface geothermal investments in Indonesia (11%), but also from several types of project in China and Mexico (7%).

The content of Table B.3 is rearranged in Table B.4 to better identify the least attractive options (in terms of spill-overs) for donors in each recipient country.

Several combinations of location/type of action have a very limited potential to generate spill-overs for donors. Cases in point include building insulation in China and Indonesia and coastal protection in Indonesia. Other combinations generate more spill-overs but only for one donor, e.g. deep geothermal, M&A actions, biofuels and coastal protection in all recipient countries; building insulation in Mexico and Brazil; biogas, CSP, EE in industry in India; and social protection in Mexico and Indonesia.

4. Discussion

Our results confirm that climate finance stimulates economic sectors and creates value added in economies other than the recipient country, including donor countries, through international trade. This may have implications for both donors and recipients when making decisions about climate finance allocation.

From the point of view of a potential donor, as long as its ability to capture spill-overs is substantial, contributing to climate finance might be a way to stimulate exports and growth. Since the size of potential indirect benefits differs from one donor to another, as results on spill-overs show, the strength of this argument for climate finance decisions might also vary. Currently, the group of major donors of climate finance (UK, Germany, USA, Norway and Japan) comprises countries that are able to benefit from significant spill-overs[8]. The great ability of China to capture spill-overs may also be related to China's position in favouring South-South cooperation for expanding international trade and building consensus on climate negotiation issues (The Climate Group, 2012; Minas, 2014).

If donor countries considered spill-overs as a criterion for the allocation of climate finance, they might be interested to know the potential of each type of project and alternative recipients for generating value added impacts via demand for products for their industries. The group of measures that produce the largest spill-overs includes several RE technologies, EE measures and adaptation options that have something in common: they mainly require machinery and other capital assets (precision instruments or motor vehicles). These are goods with high technology content that are not usually produced domestically in many recipient countries (see Table 1).

According to past climate finance data in UNFCCC (2014), investments in the energy sector have been a priority. According to our results, this may have produced substantial spill-overs for donors. Agriculture and water, the main sectors receiving climate finance for adaptation, are also associated with the generation of substantial spill-overs, which may be associated with imports of machinery and R&D services (see Table 1). Between 38% and 53% of climate finance went to the Asia and Pacific region, which includes two of the destinations associated with large spill-overs: China and Indonesia. This suggests that the search for spill-overs may have been one of the factors determining the international allocation of climate finance. However, another significant proportion of funds (10–41%) have been used for mitigation in the forestry sector (REDD+ projects) in Latin America, a fact that cannot be explained by the prospects of spill-over effects.

On the other hand, recipient countries might also be interested in hosting those projects that are most able to stimulate their own economies. According to our results, this is the case of climate actions that are intensive in construction work and locally produced goods and services, i.e. various RE technologies (i.e. biofuels and deep geothermal) and EE measures (i.e. building insulation), and in particular most adaptation and M&A options. Allocating the same priority to support for adaptation as to mitigation has recently become a core element rather than a peripheral issue in the adoption of a post-2012 climate agreement (Galarraga and Román, 2013, 2015; GCF, 2014).

[8]: http://www.climatefundsupdate.org/global-trends/donor-countries

To sum up, our results offer another possible explanation for the bias towards mitigation projects in the energy sector, and for the demand by developing countries for greater support for adaptation measures. Our study also contributes to climate finance literature by informing about an additional aspect that should be borne in mind when assessing alternative investment options from the point of view of both donors and recipients of climate finance. Since the results of economic impacts are quantitative, this study provides useful inputs of information for modelling or assessment exercises (e.g. Agent-Based Models, Cost-Benefit Analysis, Multi-criteria Analysis, etc.).

Our results reinforce the idea that the impacts of international climate finance are best assessed on a global scale, and demonstrate the potential of GMRIO databases as tools for analysing economy-wide impacts of climate finance. However, the shortcomings of the Input-Output method apply here too: time lag, homogeneity of outputs, absence of economies of scale, invariance of technological coefficients, linearity of technological coefficients and missing interactions between prices and quantities (see Murray and Lenzen, 2013 for specific limitations of GMRIO models).

It should also be noted that our assessment is incomplete, given that only the positive effects associated with the measures implemented are considered. We do not account for the impacts associated with investments avoided, or with changes in prices or income. Since the aim of this exercise is to further understanding of the role of international trade in climate finance impacts, we focus on the short-term effects of interventions.

There are several ways to extend the present research: first, by broadening the scope of analysis to include additional countries. Our analysis only considers five major recipient countries. This might lead to an underestimation of the size of spill-over effects, since it has already been argued that small countries generate more spill-overs (see for example, Dietzenbacher et al., 2013a). This connects with a second possible extension of our research: identifying factors that can explain the magnitude of spill-overs. Despite the fact that all recipient countries considered are big economies, Table 2 shows differences in the abilities of these countries to retain the impacts of similar types of investment. Apart from size, Dietzenbacher et al. (2013) point to the openness of economies to explain the size of spill-overs. The small spill-overs generated by Brazil could thus be a consequence of the big size and low dependency on imports of its economy (a result that the said authors corroborate in the paper cited). Beutel (2003) points to two more factors: development level and competitiveness. In fact, competitiveness might provide an explanation of results for Mexico: despite the big size of the Mexican economy, its weaker competitive position in relation to the US economy could explain the size of the spill-overs between the two countries. Competitiveness might also help us understand why EU countries and the USA, among the donors, and China, among the recipients, are where most relevant spill-overs occur[9]. Other factors that could be included in research into the determinants of the size of spill-overs are the specialization of production and geographical location.

Other extensions could include ex-post and ex-ante analysis of climate finance flows, based on existing data or hypothetical scenarios of climate finance, the study of the dynamic impacts on macroeconomic and environmental impacts of international climate finance and the extension of empirical exercises to determine the drivers of climate finance transfers (following the line of Halimanjaya (2015) including the prospects of capturing spill-overs from climate actions financed).

[9]: Six European countries, the USA and Japan are in the top-ten global competitiveness ranking. China occupies the highest position among the BRICS, and Mexico is in 61st place out of 144 in the global ranking (see http://www.weforum.org/reports/global-competitiveness-report-2014-2015).

5. Conclusion and policy implications

Our results show that a significant share (29% on average) of the value added generated by climate finance spills over to third countries and that spill-overs accruing to donor countries range from 10% to 28% of the resources transferred, depending on the climate actions in which they are invested.

Taking into account that the long-term finance commitments of higher-income countries in United Nations' Climate talks entails reaching USD100 billion per year by 2020, spill-over effects may add up to several billion dollars per year. Thus, our results constitute valuable information for governments to help them understand the economic consequences of decisions about climate finance mobilisation and allocation, and can be used by Parties in the negotiations under the UNFCCC.

The magnitude of the impact varies with the location and nature of the investment. The type of actions that offer recipient countries the best opportunities to grow do not coincide with those that benefit donor countries in the form of spill-overs. Nevertheless, there are some types of actions that involve substantial benefits in terms of value added in both donor and recipient countries.

At the same time, several climate actions have been identified that might be unlikely to find funding opportunities if donors made their decisions exclusively based on the prospects of capturing value added impacts. This is the case of coastal protection in Indonesia, where two million people are exposed to rising sea level rise[10]. In these specific situations the international community should implement alternative mechanisms other than trade-related economic incentives to ensure that sufficient climate financial flows reach the most vulnerable regions.

Finally, our results also suggest that some recipient countries have significant room for manoeuvre for improving their ability to retain the value added generated by capital-intensive projects, such as those involving RE technologies. Such projects require machinery, transportation and communication equipment and mineral and metal inputs that must typically be brought from abroad. Thus, in order to maximise the domestic impact of climate finance, recipient countries could pursue strategies aimed at improving the competitiveness of their industrial sectors. Technology transfer programmes may also enhance the ability of these countries to decrease their dependency on imports of capital goods that generate relevant spill-overs. As long as such programmes help to build up competitive industries that can provide substitutes for the imported goods, the domestic impact of climate finance may multiply.

Acknowledgements

Maria Victoria Román is funded by CICEP (Strategic Challenges in International Climate and Energy Policy), one of three centres for social science based research on environment-friendly energy established by the Research Council of Norway in 2011 (http://www.cicep.uio.no/). The authors would like to thank Ulrike Lehr and Dietmar Edler for providing the data on input coefficients for renewable energy sources (DIW 2011).

References

Abadie, L.M., Galarraga, I., Rübbelke, D., 2013. An analysis of the causes of the mitigation bias in international climate finance. Mitig. Adapt. Strateg. Glob. Change 1–13.

AFP, 2014. Countries pledge $9.3bn for Green Climate Fund, the Guardian. URL http://www.theguardian.com/environment/2014/nov/20/countries-pledge-93bn-for-green-climate-fund (accessed 4.10.15).

10: http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=446

Allan, G.J., Bryden, I., McGregor, P.G., Stallard, T., Swales, J.K., Turner, K., Wallace, R., 2008. Concurrent and legacy economic and environmental impacts from establishing a marine energy sector in Scotland. Energy Policy 36, 2734–2753.

Basu, P., Finneran, L., Bishop, V., Sundararaman, T., 2011. The Scope for MDB Leverage and Innovation in Climate Finance. A background paper for ―Mobilizing Climate Finance,‖ prepared at the request of G20 Finance Ministers.

Beutel, J., 2003. The economic impact of objective 1 inteventions for the period 2000-2006. Fachhochschule Konstanz/Wirtschafts-und Sozialwissenschaften (WS).

Ciorba, U., Pauli, F., Menna, P., 2004. Technical and economical analysis of an induced demand in the photovoltaic sector. Energy Policy 32, 949–960.

Dietzenbacher, E., Guilhoto, J., Imori, D., 2013a. The role of Brazilian regions in the global value chain (Working Paper Series No 2013-15). Department of Economics-FEA/USP.

Dietzenbacher, E., Los, B., Stehrer, R., Timmer, M., De Vries, G., 2013b. The construction of world input–output tables in the WIOD project. Econ. Syst. Res. 25, 71–98.

Galarraga, I., Román, M.V., 2015. Lima COP20: Another small step on the long road to Paris (No. 2015–1). BC3 Basque Centre for Climate Change.

Galarraga, I., Román, M.V., 2013. Warsaw Conference: "Small steps forward while awaiting major decisions at the 2015 Paris Conference" (No. PB 2013/ Special Issue-01). BC3 Basque Centre for Climate Change.

GCF, 2014. Policies and Procedures for the Initial Allocation of Fund Resources. Green Climate Fund.

Gupta, S., Harnisch, J., Barua, D.C., Chingambo, L., Frankel, P., Garrido Vázquez, R.J., Gómez-Echeverri, L., Haites, E., Huang, Y., Kopp, R., Lefèvre, B., Machado-Filho, H., Massetti, E., 2014. Cross-cutting Investment and Finance Issues., in: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (Eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Halimanjaya, A., 2015. Climate mitigation finance across developing countries: what are the major determinants? Clim. Policy 15, 223–252.

IEA, 2014. Energy Technology Perspectives 2014. Harnessing Electricity's Potential. Executive Summary. International Energy Agency.

IMF, 2011. Promising Domestic Fiscal Instruments for Climate Finance. International Monetary Fund.

IPCC, 2007. Climate Change 2007 - Impacts, Adaptation and Vulnerability. Cambridge University Press, Cambridge.

Keen, M., Perry, I., Strand, J., 2012. Market-based instruments for international aviation and shipping as a source of climate finance. World Bank Policy Res. Work. Pap. Ser. Vol.

Lehr, U., Nitsch, J., Kratzat, M., Lutz, C., Edler, D., 2008. Renewable energy and employment in Germany. Energy Policy 36, 108–117.

Markaki, M., Belegri-Roboli, A., Michaelides, P., Mirasgedis, S., Lalas, D.P., 2013. The impact of clean energy investments on the Greek economy: An input-output analysis (2010-2020). Energy Policy 57, 263–275. doi:10.1016/j.enpol.2013.01.047

Miller, R.E., Blair, P.D., 2009. Input-output analysis: foundations and extensions. Cambridge University Press.

Minas, S., 2014. FPC Briefing: Climate change cooperation within the Global South: Finance, policy and institutions. The Foreign Policy Centre.

Murray, J., Lenzen, M., 2013. The Sustainability Practitioner's Guide to Multi-Regional Input-Output Analysis. Champaign IL Common Ground Publ.

Nakhooda, S., Fransen, T., Kuramochi, T., Caravani, A., 2013. Mobilising International Climate Finance: Lessons from the Fast-Start Finance Period. ODI, WRI, IGES, OCN, UKAid.

Olhoff, A., Alverson, K., Puig, D., Olhoff, A., Noble, I., Watkiss, P., Baarsch, F., Trabacchi, C., Caravani, A., Tr\a erup, S.L. erke M., others, 2014. The Adaptation Gap Report-a Preliminary Assessment. United Nations Environment Programme.

Oliveira, C., Coelho, D., da Silva, P.P., Antunes, C.H., 2013. How many jobs can the RES-E sectors generate in the Portuguese context? Renew. Sustain. Energy Rev. 21, 444–455.

Parker, C., Brown, J., Pickering, J., Roynestad, E., Mardas, N., Mitchell, A., 2010. The little climate finance book: A guide to financing options for forests and climate change. Global Canopy Foundation.

Pickering, J., Rübbelke, D., 2014. International Cooperation on Adaptation to Climate Change, in: Markandya, A., Galarraga, I., Sainz de Murieta, E. (Eds.), Handbook of the Economics of Climate Change Adaptation. Routledge, Abingdon (UK), pp. 86–106.

Pickering, J., Skovgaard, J., Kim, S., Reich, H., Roberts, J.T., Rosatti, D., Stadelmann, M., 2015. Acting on Climate Finance Pledges: Inter-Agency Dynamics in Contributor States. World Dev. 68, 149–162.

Pittel, K., Rübbelke, D., 2013. International climate finance and its influence on fairness and policy. World Econ. 36, 419–436. doi:10.1111/twec.12029

Pollin, R., Garrett-Peltier, H., 2009. Building a green economy: employment effects of green energy investments for Ontario. Political Economy Research Institute, University of Massachusetts at Amherst.

Rübbelke, D.T.G., 2011. International support of climate change policies in developing countries: Strategic, moral and fairness aspects. Ecol. Econ. 70, 1470–1480. doi:10.1016/j.ecolecon.2011.03.007

Schenker, O., 2013. Exchanging Goods and Damages: The Role of Trade on the Distribution of Climate Change Costs. Environ. Resour. Econ. 54, 261–282.

The Climate Group, 2012. Shaping China's Climate Finance Policy. Executive summary.

Timmer, M., Erumban, A.A., Gouma, R., Los, B., Temurshoev, U., de Vries, G.J., Arto, I. -ak., Genty, V.A.A., Neuwahl, F., Francois, J., others, 2012. The world input-output database (WIOD): contents, sources and methods (Working Paper No. 10). Institute for International and Development Economics.

Tukker, A., Dietzenbacher, E., 2013. Global multiregional input–output frameworks: an introduction and outlook. Econ. Syst. Res. 25, 1–19.

UNFCCC, 2010. UNFCCC Decision 1/CP.16. The Cancun Agreements.

UNFCCC, 2009. FCCC/CP/2009/L.7. Copenhagen Accord.

UNFCCC-SCF, 2014. Biennial Assessment and Overview of Climate Finance Flows Report. UNFCCC Standing Committee on Finance.

WB, 2012. GDP (current US$).

WB, 2010. CO2 emissions (kt).

Appendix A. Methodology

In this appendix we show the methodology for the calculation of the economic impact of climate actions using a Global Multi-Regional Input-Output (GMRIO) model. The starting point is the information on the average expenditure composition of each climate action. We compute cost structures by climate action (e.g. coastal protection), calculating the percentages of the total budget corresponding to each expenditure category (e.g. infrastructures). In order to connect this information with the GMRIO model we have to make some transformations using information contained in International Supply and Use Tables of the input-output framework.

The first transformation consists of using the correspondence reported in Table B.2. to express the cost structures in terms of the NACE classification of commodities. The resulting parameter ($Expenditure\_pp_{ia}$) shows for each unit worth of expenditure in one specific climate action (denoted by subscript a), how many cents are expended in each commodity category (denoted by subscript i). This expenditure by commodity is reported at purchaser's prices (pp), i.e. including taxes and transport and trade margins.

The second transformation consists of expressing the expenditure at basic prices, something that requires the reallocation of trade and transport margins to the transport and trade commodities respectively, and the reallocation of taxes collected in each recipient country according to the public expenditure of that country. For that purpose, first we calculate the taxes by recipient country (r), commodity (i) and climate action (a) as follows:

$$Tax_{ia}^{r} = \tau_{i}^{r} \times Expenditure\_pp_{ia} \quad (1)$$

where τ_{i}^{r} is the tax rate by commodity and recipient country calculated form the International Supply Table of each recipient country.

Likewise, the total trade and transport margins paid by recipient country, commodity and climate action are calculated as:

$$Margin_{ia}^{r} = \mu_{i}^{r} \times \left(Expenditure\_pp_{ia} - Tax_{ia}^{r} \right) \quad (2)$$

where μ_{i}^{r} is the trade and transport margins by commodity and recipient country also from the International Supply Table. The expenditure net of taxes and margins is calculated by subtracting taxes and margins to the expenditure at purchaser's prices:

$$Expenditure\_netTM_{ia}^{r} = Expenditure\_pp_{ia} - Tax_{ia}^{r} - Margin_{ia}^{r} \quad (3)$$

Now, we allocate the margins to the corresponding commodities (i.e. trade and transport services) denoted by h, which is a subset of i. The part of the expenditure corresponding to trade and transport margins by recipient country, trade and transport service and climate action is:

$$Expenditure\_M_{ha}^{r} = \lambda_{h}^{r} \times \sum_{i} Margin_{ia}^{r} \quad (4)$$

where λ_{h}^{r} is the share of the total margins corresponding to each trade and transport service by recipient country calculated form the International Supply Table. The part of the expenditure corresponding to taxes is allocated among the commodities according to the government expenditure structure in the International Use Table.

$$Expenditure\_G_{ia}^{r} = \gamma_i^r \times \sum_i Tax_{ia}^{r} \quad (5)$$

where γ_i^r is the share public expenditure corresponding to each commodity, by recipient country. From (3), (4) and (5) we can derive the expenditure by recipient country, commodity and action at basic prices as:

$$Expenditure\_bp_{ia}^{r} = Expenditure\_netTM_{ia}^{r} + Expenditure\_M_{ia}^{r} + Expenditure\_G_{ia}^{r} \quad (6)$$

Next we use the information reported by the International Use Table on the origin of each commodity to split the expenditure according to the supplier country (s):

$$Expenditure\_bp\_ctr_{ia}^{sr} = country\_shares_i^{sr} \times Expenditure\_bp_{ia}^{r} \quad (7)$$

where $country\_shares_i^{sr}$ is the share of the expenditure in commodity i by country r that is supplied by country s. Note that when $s = r$ it refers to the demand for domestically produced goods and otherwise it refers to imports.

The next step is to transform the expenditure by commodity into expenditure by industry according to the market shares of each industry derived from the International Supply Tables:

$$Expenditure\_bp\_ctr\_ind_{ja}^{sr} = \sum_i market\_share_{ij}^{s} \times Expenditure\_bp\_ctr_{ia}^{sr} \quad (8)$$

where $market\_share_{ij}^{s}$ denotes the share of the total demand of the commodity i in country s that is produced by industry j.

Finally, the economic impact in a country t of a specific action a in the recipient country r is calculated by multiplying the expenditure by industry, climate action, supplier and recipient country times the corresponding value added multiplier:

$$va_a^{tr} = \sum_k \sum_j \sum_s va\_multiplier_{kj}^{ts} \times Expenditure\_bp\_ctr\_ind_{ja}^{sr} \quad (9)$$

where $va\_multiplier_{kj}^{ts}$ represents the total value added generated in sector k of country t due to the final demand of commodities produced by sector j of country s. This value added multiplier is calculated as the product of the value added coefficients and the output multipliers obtained from the GMRIO model, as follows:

$$va\_multiplier_{kj}^{ts} = va\_coef_k^{\,t} \times output\_multiplier_{kj}^{ts} \quad (10)$$

Appendix B. Additional tables

Table B.1: List of project categories and sources of information. [a]
http://unfccc.int/adaptation/workstreams/national_adaptation_programmes_of_action/items/4585.php

Mitigation (M)		**Source**
Renewable energy generation (RE)	Onshore wind	(DIW, 2011)
	Offshore wind	(DIW, 2011)
	Photovoltaics	(DIW, 2011)
	Solar thermal	(DIW, 2011)
	Hydropower	(DIW, 2011)
	Biomass large	(DIW, 2011)
	Biomass small	(DIW, 2011)
	Biogas	(DIW, 2011)
	Geothermal deep	(DIW, 2011)
	Geothermal surface	(DIW, 2011)
	Concentrated solar power	(DIW, 2011)
	Ocean power	(Allan et al., 2008)
	Renewable energy in transport	(Markaki et al., 2013)
	Renewable energy in buildings	(Markaki et al., 2013)
Energy efficiency (EE)	Insulation of buildings	(Markaki et al., 2013)
	Industry	(Markaki et al., 2013)
	Transport infrastructure	(Markaki et al., 2013)
Adaptation (A)		NAPAs[a]
Coastal protection (Coastal)	Beach nourishment	GAMBIA #9
	Coastal protection structures	CAPE VERDE #3
	Rehabilitation of coastal areas	SIERRE LEONE #18
Disaster risk reduction (DRR)	Early warning or emergency response systems	GAMBIA #1
	Construction or improvement of drainage systems	BHUTAN #5
	Flood protection	BHUTAN #7
	Hazard mapping and monitoring technologies	BHUTAN #9
	Improved climate services	SIERRE LEONE #2
Water supply and management (Water)	Rainwater harvesting and storage	SUDAN #2
	Rehabilitation of water distribution networks	SIERRE LEONE #12
	Desalinization, water recycling and water conservation	TUVALU #3
Human settlements, infrastructure and spatial planning (Infrastr)	Energy security (hydropower)	TANZANIA #5
	Energy security (solar energy)	SIERRE LEONE #8
	Energy security (biomass)	GAMBIA #6
	Transport and road infrastructure adaptation	MALDIVES #10
	Protection of infrastructure	BHUTAN #6
	Zoning	SAMOA #6
	Improving the resilience of existing infrastructures/buildings	MALDIVES #8
Social protection (Social P.)	Livelihood diversification	MALAWI #1
	Food storage and preservation facilities	LESOTHO #8
	Health, vaccination programs	SIERRE LEONE #23
Waste and wastewater (Waste)	Sanitation	SIERRE LEONE #22
	Storm and wastewater	MALDIVES #5
Mitigation and Adaptation (M&A)		**NAPAs**
Forestry and land use/ Terrestrial Ecosystems (Forest)	Afforestation and reforestation	ERITREA #3
	Ecological restoration and soil conservation	LESOTHO #6
	Protection of biodiversity	TUVALU #5
	Forest management, management of slopes and basins	BURUNDI #3
	Forest fires reduction	BHUTAN #11
Capacity-building (Capacity)	Awareness raising and integrating into education	BURUNDI #11
	Technical assistance	MALAWI #5
	Planning, policy development and implementation	SIERRE LEONE #19
Agriculture, fishing and livestock (Agriculture)	Crop / animal diversification	SIERRE LEONE #5
	Crop, grazing land, livestock and fisheries enhanced management	ERITREA #2
	Research	MALDIVES #9
	Irrigation and drainage system	SIERRE LEONE #7

Table B.2: Correspondence between NAPA expenditure categories and NACE commodities.

Expenditure categories	NACE commodities
Breeding animals, forage seeds, planting, crop management	1
Forest nurseries, re/afforestation, rehabilitation, beach stabilization, plantations	2
Materials, reporting, communication, awareness creation, training	22
Chemicals, drugs, raw materials	24
Materials for construction and rehabilitation	26
Tools	28
Machinery and installation	29
Office equipment	30
Transmission and distribution network	31
Laboratory/field/data processing equipment, hydrology/meteorology stations, telecommunication, remote sensing	33
Vehicles	34
Construction, rehabilitation, beach stabilisation, improve facilities/infrastructure	45
Logistics	60
Communication (campaign, networks, workshops)	63
Communication (telephone, internet and postal charges)	64
Micro-credit fund	65
Vehicle hiring charges	71
Research, experimentation, mapping	73
Technical support, design, management, planning, training	74
Institutionalisation of policies, support to collaborating agencies	75
Sanitary inspections, vector control measures, medical/veterinary services	85
Waste collection, sanitation	90

Table B.3: Proportion of impact captured by donor countries per location and type of action (arranged by donor) BRA: Brazil; CHN: China; EA: East Asia; EU: European Union; IDN: Indonesia; IND: India; MEX: Mexico; ODC: Other developed countries; USA: United States; Agriculture: agriculture; fishing and livestock; B_insulation: insulation of buildings; B_RE: renewable energy in buildings; Capacity B.: capacity building; Coastal: coastal protection; CSP: concentrated solar power; DRR: disaster risk reduction; Forestry: forestry and land use/ Terrestrial Ecosystems; Geo_deep: geothermal deep; Geo_surface: geothermal surface; Hydro: hydropower; Infrastr: human settlements; infrastructure and spatial planning; Ocean: ocean power; Social P.: social protection; Solar PV: photovoltaics; T_infrastr: transport infrastructure; T_RE: renewable energy in transport; Waste: waste and wastewater; Water: water supply and management; Wind_off: offshore wind; Wind_on: onshore wind.

		Wind_on	Wind_off	Solar_PV	Solar_thermal	Hydro	Biomass_big	Biomass_small	Biogas	Geo_deep	Geo_surface	CSP	Ocean	T_RE	B_RE	T_infrastr	Industry	B_insulation	Coastal	DRR	Water	Infrastr	Social P	Waste	Forest	Capacity	Agriculture	Average
USA	IND	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	1%	2%	2%	2%	1%	1%	3%	2%	2%	2%	2%	2%	2%	2%	2%
	BRA	5%	4%	3%	4%	4%	3%	3%	3%	2%	4%	3%	5%	2%	4%	4%	3%	1%	2%	4%	3%	3%	2%	2%	2%	2%	2%	3%
	CHN	4%	3%	4%	3%	3%	3%	3%	3%	3%	3%	3%	3%	2%	3%	3%	3%	2%	2%	4%	3%	3%	4%	3%	3%	4%	3%	3%
	IDN	4%	3%	2%	4%	4%	2%	3%	3%	2%	4%	2%	5%	2%	4%	2%	3%	1%	1%	3%	3%	3%	2%	2%	2%	2%	2%	3%
	MEX	19%	16%	14%	18%	21%	14%	15%	17%	12%	22%	14%	24%	15%	22%	21%	19%	7%	7%	15%	16%	15%	11%	12%	10%	12%	11%	15%
EU	IND	4%	4%	5%	6%	4%	4%	5%	4%	3%	5%	3%	7%	2%	4%	4%	4%	3%	3%	5%	5%	4%	3%	4%	2%	3%	3%	4%
	BRA	9%	8%	6%	9%	9%	7%	7%	8%	6%	9%	7%	11%	5%	10%	10%	9%	4%	5%	9%	8%	8%	6%	6%	4%	5%	6%	7%
	CHN	11%	9%	10%	12%	11%	7%	10%	10%	7%	11%	8%	13%	5%	11%	11%	9%	4%	5%	11%	10%	10%	9%	7%	6%	7%	7%	9%
	IDN	7%	5%	5%	9%	9%	6%	7%	8%	5%	10%	4%	12%	4%	9%	5%	8%	3%	3%	8%	8%	8%	5%	6%	4%	4%	5%	7%
	MEX	10%	8%	6%	10%	11%	7%	7%	8%	5%	11%	6%	13%	5%	11%	8%	9%	3%	3%	8%	8%	8%	6%	6%	4%	5%	5%	7%
EA	IND	2%	2%	2%	2%	2%	1%	2%	2%	1%	2%	1%	2%	1%	2%	2%	2%	1%	1%	2%	2%	1%	1%	1%	1%	1%	1%	1%
	BRA	3%	2%	3%	2%	3%	2%	2%	2%	1%	2%	3%	3%	1%	4%	3%	2%	1%	1%	2%	1%	2%	1%	1%	1%	1%	1%	2%
	CHN	7%	5%	7%	6%	7%	5%	5%	5%	4%	6%	6%	6%	2%	7%	5%	5%	3%	4%	7%	4%	6%	4%	4%	3%	3%	4%	5%
	IDN	9%	7%	6%	9%	9%	7%	10%	8%	6%	11%	6%	11%	4%	9%	6%	8%	3%	2%	6%	6%	6%	4%	5%	4%	4%	4%	6%
	MEX	6%	4%	6%	5%	6%	4%	4%	5%	3%	5%	6%	6%	2%	7%	7%	5%	2%	2%	5%	3%	4%	2%	2%	2%	2%	2%	4%
ODC	IND	2%	2%	2%	2%	1%	2%	2%	1%	2%	2%	1%	2%	1%	1%	2%	2%	2%	1%	1%	2%	2%	1%	2%	1%	1%	1%	2%
	BRA	2%	2%	2%	2%	1%	1%	2%	1%	1%	2%	1%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
	CHN	4%	4%	4%	4%	3%	3%	5%	3%	3%	4%	3%	4%	2%	3%	3%	3%	3%	2%	3%	2%	3%	2%	3%	2%	2%	2%	3%
	IDN	3%	2%	2%	3%	3%	2%	3%	3%	2%	3%	2%	4%	2%	3%	2%	3%	2%	1%	2%	2%	2%	2%	2%	2%	2%	2%	2%
	MEX	4%	3%	2%	3%	3%	2%	3%	2%	2%	3%	2%	4%	2%	3%	3%	3%	1%	1%	2%	2%	2%	1%	2%	1%	1%	2%	2%
Average		6%	5%	5%	6%	6%	4%	5%	5%	4%	6%	4%	7%	3%	6%	5%	5%	2%	2%	5%	5%	5%	3%	4%	3%	3%	3%	

Table B.4: Proportion of impact captured by donor countries per location and type of action (arranged by recipient) BRA: Brazil; CHN: China; EA: East Asia; EU: European Union; IDN: Indonesia; IND: India; MEX: Mexico; ODC: Other developed countries; USA: United States; Agriculture: agriculture; fishing and livestock; B_insulation: insulation of buildings; B_RE: renewable energy in buildings; Capacity B.: capacity building; Coastal: coastal protection; CSP: concentrated solar power; DRR: disaster risk reduction; Forestry: forestry and land use/ Terrestrial Ecosystems; Geo_deep: geothermal deep; Geo_surface: geothermal surface; Hydro: hydropower; Infrastr: human settlements; infrastructure and spatial planning; Ocean: ocean power; Social P.: social protection; Solar PV: photovoltaics; T_infrastr: transport infrastructure; T_RE: renewable energy in transport; Waste: waste and wastewater; Water: water supply and management; Wind_off: offshore wind; Wind_on: onshore wind.

		Wind_on	Wind_off	Solar_PV	Solar_thermal	Hydro	Biomass_big	Biomass_small	Biogas	Geo_deep	Geo_surface	CSP	Ocean	T_RE	B_RE	T_infrastr	Industry	B_insulation	Coastal	DRR	Water	Infrastr	Social P	Waste	Forest	Capacity	Agriculture	Average
MEX	USA	19%	16%	14%	18%	21%	14%	15%	17%	12%	22%	14%	24%	15%	22%	21%	19%	7%	7%	15%	16%	15%	11%	12%	10%	12%	11%	15%
	EU	10%	8%	6%	10%	11%	7%	7%	8%	5%	11%	6%	13%	5%	11%	8%	9%	3%	3%	8%	8%	8%	6%	6%	4%	5%	5%	7%
	EA	6%	4%	6%	5%	6%	4%	4%	5%	3%	5%	6%	6%	2%	7%	7%	5%	2%	2%	5%	3%	4%	2%	2%	2%	2%	2%	4%
	ODC	4%	3%	2%	3%	3%	2%	3%	2%	2%	3%	2%	4%	2%	3%	3%	3%	1%	1%	2%	2%	2%	1%	2%	1%	1%	2%	2%
CHN	USA	4%	3%	4%	3%	3%	3%	3%	3%	3%	3%	3%	3%	2%	3%	3%	3%	2%	2%	4%	3%	3%	4%	3%	3%	4%	3%	3%
	EU	11%	9%	10%	12%	11%	7%	10%	10%	7%	11%	8%	13%	5%	11%	11%	9%	4%	5%	11%	10%	10%	9%	7%	6%	7%	7%	9%
	EA	7%	5%	7%	6%	7%	5%	5%	5%	4%	6%	6%	6%	2%	7%	5%	5%	3%	4%	7%	4%	6%	4%	4%	3%	3%	4%	5%
	ODC	4%	4%	4%	4%	3%	3%	5%	3%	3%	4%	3%	4%	2%	3%	3%	3%	3%	2%	3%	2%	3%	2%	3%	2%	2%	2%	3%
BRA	USA	5%	4%	3%	4%	4%	3%	3%	3%	2%	4%	3%	5%	2%	4%	4%	3%	1%	2%	4%	3%	3%	4%	2%	2%	2%	2%	3%
	EU	9%	8%	6%	9%	9%	7%	7%	8%	6%	9%	7%	11%	5%	10%	10%	9%	4%	5%	9%	8%	8%	5%	6%	4%	5%	6%	7%
	EA	3%	2%	3%	2%	3%	2%	2%	2%	1%	2%	3%	3%	1%	4%	3%	2%	1%	1%	2%	1%	2%	2%	1%	1%	1%	1%	2%
	ODC	2%	2%	2%	2%	1%	1%	2%	1%	1%	2%	1%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	1%	1%	1%	1%	1%
IDN	USA	4%	3%	2%	4%	4%	2%	3%	3%	2%	4%	2%	5%	2%	4%	2%	3%	1%	1%	3%	3%	3%	1%	2%	2%	2%	2%	3%
	EU	7%	5%	5%	9%	9%	6%	7%	8%	5%	10%	4%	12%	4%	9%	5%	8%	3%	3%	8%	8%	8%	6%	6%	4%	4%	5%	7%
	EA	9%	7%	6%	9%	9%	7%	10%	8%	6%	11%	6%	11%	4%	9%	6%	8%	3%	2%	6%	6%	6%	2%	5%	4%	4%	4%	6%
	ODC	3%	2%	2%	3%	3%	2%	3%	3%	2%	3%	2%	4%	2%	3%	2%	3%	2%	1%	2%	2%	2%	1%	2%	2%	2%	2%	2%
IND	USA	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	3%	1%	2%	2%	2%	1%	1%	3%	2%	2%	2%	2%	2%	2%	2%	2%
	EU	4%	4%	5%	6%	4%	4%	5%	4%	3%	5%	3%	7%	2%	4%	4%	4%	3%	3%	5%	5%	4%	3%	4%	2%	3%	3%	4%
	EA	2%	2%	2%	2%	2%	1%	2%	2%	1%	2%	1%	2%	1%	2%	2%	2%	1%	1%	2%	2%	1%	1%	1%	1%	1%	1%	1%
	ODC	2%	2%	2%	2%	1%	2%	2%	1%	2%	2%	1%	2%	1%	1%	2%	2%	2%	1%	1%	2%	2%	1%	2%	1%	1%	1%	2%
Average		6%	5%	5%	6%	6%	4%	5%	5%	4%	6%	4%	7%	3%	6%	5%	5%	2%	3%	5%	5%	5%	4%	4%	3%	3%	3%	

BC3 WORKING PAPER SERIES

Basque Centre for Climate Change (BC3), Leioa, Basque Country, Spain

The BC3 Working Paper Series is available on the internet at the following addresses:

http://www.bc3research.org/lits_publications.html

http://ideas.repec.org/s/bcc/wpaper.html

BC3 Working Papers recently available:

2014-03 Marta Olazabal, Sonia De Gregorio Hurtado, Eduardo Olazabal, Filomena Pietrapertosa, Monica Salvia, Davide Geneletti, Valentina D'Alonzo, Efrén Feliú, Senatro Di Leo and Diana Reckien: *How are Italian and Spanish cities tackling climate change? A local comparative study*.

2014-04 Iñigo Capellán-Pérez, Mikel González-Eguino, Iñaki Arto, Alberto Ansuategi, Kishore Dhavala, Pralit Patel, Anil Markandya: *New climate scenario framework implementation in the GCAM integrated assessment model.*

2014-05 Alessandro Antimiani, Valeria Costantini, Anil Markandya, Chiara Martini, Alessandro Palma, and Maria Cristina Tommasino: *A dynamic CGE modelling approach for analysing trade-offs in climate change policy options: the case of Green Climate Fund.*

2014-06 Ibon Galarraga and Luis M. Abadie: *The use of "Bonus-Malus" schemes for promoting energy-efficient household appliances: a case study for Spain.*

2014-07 Josué M. Polanco-Martínez and Sérgio H. Faria: *Hunting spectro-temporal information in unevenly spaced paleoclimate time series.*

2014-08 Mikel González-Eguino: *La pobreza energética y sus implicaciones.*

2015-01 Pablo Martinez-Juarez, Aline Chiabai, Sonia Quiroga Gómez and Tim Taylor: *Ecosystems and human health: towards a conceptual framework for assessing the co-benefits of climate change adaptation*.

2015-02 Amaia de Ayala, Ibon Galarraga and Joseph V. Spadaro: *The price of energy efficiency in the Spanish housing market.*

2015-03 Leif Vogel, Joshua Vande Hey, Sérgio H. Faria and Joseph V. Spadaro: *Health impacts of atmospheric pollution in a changing climate.*

2015-04 Christoph Böhringer, Xaquin Garcia-Muros, Mikel Gonzalez-Eguino and Luis Rey: *US Climate Policy: a critical assessment of intensity standards.*

2016-01 María Victoria Román, Iñaki Arto and Alberto Ansuategi: *What determines the magnitude of the economic impact of climate finance in recipient countries? A structural decomposition of value-added creation between countries.*

2016-02 Mikel González-Eguino, Iñigo Capellán-Pérez, Iñaki Arto, Alberto Ansuategi and Anil Markandya: *Industrial and terrestrial carbon leakage under climate policy fragmentation*.

2016-03 Anil Markandya, Kishore Dhavala and Alessandro Palma: *The role of flexible biofuel policies in meeting biofuel mandates.*

2016-04 Stefano Balbi and Ferdinando Villa: *Beyond ecosystem services: a food security perspective.*

2016-05 María Victoria Román, Iñaki Arto and Alberto Ansuategi: *The geographic distribution of the economic impact of climate finance.*