Why do some economies benefit more from climate finance than others? A case study on North-to-South financial flows

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ABSTRACT
The Copenhagen and Paris Agreements, in which developed countries committed to mobilise USD 100 billion a year by 2020, indicate that climate finance will continue to grow. Even though economic development is not the aim of climate finance, climate-related disbursements will generate an economic impact on recipient countries’ economies. This impact will also reach other countries (including climate finance donors) through induced international trade. In this paper, we apply a structural decomposition analysis to study why the economic impact of climate finance varies between countries. We focus on specific climate actions and quantify the contribution of four drivers: value-added intensity, domestic multiplier, foreign multiplier and trade structure. The paper helps identifying the factors with the greatest potential to enhance the economic gains of climate finance in each country. This information can be useful for policy-makers trying to design national strategies that exploit the synergies between climate action and economic development.

1. Introduction

For many countries the lack of financial resources is a barrier to the successful implementation of an appropriate mix of policies to mitigate climate change and its impacts. To enable a globally coordinated response to climate change, developed countries committed to jointly mobilise US dollar (USD) 100 billion per year by 2020 from a variety of sources to address developing countries’ needs in terms of climate action at the 15th Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC). The Copenhagen Accord contained this commitment, which is named Long-term Finance (UNFCCC, 2009). The decision 1/CP.21 accompanying the Paris Agreement urges developed countries to increase their level of financial support, with a concrete roadmap for achieving the commitment made in Copenhagen (UNFCCC, 2015). This decision upholds...
the USD 100 billion target from 2020 to 2025, and specifies that it will then review that collective target upwards.

Since the negotiation of the UNFCCC in 1992, the number of climate change funds that channel climate finance has increased rapidly. Today, there are around 100 international public funds, including the Global Environment Facility, the Adaptation Fund, the Climate Investment Funds and the Green Climate Fund (GCF), as well as a great number of private funds. The GCF, whose creation was agreed in the Cancun Agreements of the 16th COP in 2010, was conceived as the main channel for the Long-term Finance commitment (UNFCCC, 2010). As for December 2016, it had mobilised USD 10.3 billion and had started its support activities in developing countries (GCF, 2016). The Organisation for Economic Co-operation and Development, in collaboration with the Climate Policy Initiative (a leading think tank on the subject), estimated that in the period 2013–2014 developed countries mobilised USD 57 billion per year on average for climate action in developing countries (71% from public sources) (OECD and CPI, 2015).

In the academic literature, the concept of climate finance is used to refer to climate-related financial flows within or between countries that are dedicated to both mitigation and adaptation (Glemarec, 2011; van Melle et al., 2011). The growing body of literature on climate finance has already explored different aspects and implications of this topic. Some researchers have focused on tracking the progress towards the quantitative goal of USD 100 billion per year, characterising the landscape of climate finance (sources, channels, instruments, recipients and uses) and analysing climate funds (Amin, 2015; Buchner et al., 2011, 2013, 2014, 2015; Fridahl and Linnér, 2016; Schalatek et al., 2015). Others have provided quantitative estimates of the volume of financial resources required for financing the transition to a low-carbon resilient world (UNEP, 2014a; 2014b).

Using theoretical models of coalition formation, other authors have analysed the role of financial transfers between developed and developing countries as side payments to encourage participation in an international agreement for climate change (Barrett, 2009; Barrett and Stavins, 2003; Benckekroun et al., 2011; Marrouch and Ray Chaudhuri, 2011; de Zeeuw, 2015). Empirical models (e.g. Computable General Equilibrium or Integrated Assessment Models) have also been used to estimate the magnitude of North-to-South transfers that would enable such international climate agreement (Bowen et al., 2015; Tian and Whalley, 2010).

Another stream of the literature deals with the assessment of alternative options for the mobilisation of climate finance. This group includes studies that, from formal and non-formal approaches, analyse welfare effects and fairness implications of different mobilisation schemes (Buchholz and Peters, 2007; Buob and Stephan, 2013; Grasso, 2010; Heuson et al., 2012; Hof et al., 2011; Pickering et al., 2015; Pittel and Rübbelke, 2013; Rübbelke, 2011; Schenker and Stephan, 2014; Urpelainen, 2012a). Finally, other studies have dealt with climate finance effectiveness, studying the conditions required for climate finance to be effective (Bird and Brown, 2010; Chaum et al., 2011; Joffe et al., 2013; Michaeiowa, 2012; Urpelainen, 2012b; Vandeweerd et al., 2012).

The present paper seeks to contribute to this body of literature by studying the factors that determine the size and spatial distribution of the economic benefits of climate finance. Even though it is not its purpose (climate finance aims at enabling climate action in recipient countries), climate finance generates an economic impact inasmuch as disbursements
are used in the implementation of mitigation and adaptation actions. As in developed countries the fight against climate change has been seen as an opportunity for the development of a green economy able to generate economic growth and employment (see, e.g. Mundaca et al., 2016), likewise the disbursements of climate finance can contribute to the economic progress of developing countries (as described in Román et al., 2016).

In this paper, we focus on North-to-South financial flows enabling the implementation of mitigation and/or adaptation actions (including measures, projects or programmes) in the recipient country. Our analysis is centred on the effects of disbursements of climate finance, independent of the channel (bilateral or multilateral) and the source (public or private).

Value-added creation, which reflects the remuneration of primary production factors (i.e. labour and capital), was used in this study as a measure of the economic benefits of a particular intervention. In our case, the intervention studied consists of climate finance disbursements generating new demand for goods and services. In order to respond to this new demand, industries involved in the production of these goods and services pay employees and capital owners, creating value-added. The entire amount of financial resources transferred to the recipient country is finally transformed into value-added in different countries of the world to remunerate the production factors involved. The proportion of the value-added created that is domestically retained is referred to as the local economic impact of climate finance. The remainder constitutes the spillover effect resulting from international trade.1

The geographic distribution of value-added creation differs depending on where climate finance is disbursed. In a previous paper (Román et al., 2016), we quantified the domestic impact and spillovers of different types of climate actions for different countries. The present paper supplements this previous research by explaining the observed differences between countries’ ability to capture economic impacts. In order to do this, we apply the structural decomposition analysis (SDA), a technique that is based on Input–Output tables. This methodology has extensively been used in climate change literature to quantify the contribution of different factors to the growth in greenhouse gas emissions, and to assess the outsourcing of emissions phenomenon and carbon footprints (as Lenzen, 2016 explains). But to the best of our knowledge, it has not been applied to explain the contribution of climate finance to countries’ economies.

With this work we seek to bring to light the relative importance of the factors that determine the scale of the value-added created for both donors and recipients of climate finance disbursements. Our specific research questions are the following: (1) What factors determine the magnitude of the economic impact of climate finance? (2) What is the contribution of each factor to the differences between countries’ ability to capture economic impacts? (3) Which industries offer the highest potential for increasing the economic impact of climate finance in each country?

The rest of the paper is structured as follows: Section 2 describes the methodology; Section 3 contains the results at both aggregated and sectoral levels; and Section 4 discusses the main outcomes and contains some conclusions.

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1 Note that the economic effects referred to in this paper are those generated by the use of climate finance. Other authors have studied the economic consequences of the mobilisation of financial resources (Basu et al., 2011; IMF, 2011; Jones et al., 2013; Parker et al., 2010).
2. Materials and methods

To quantify the contribution of each factor in explaining the differences between countries in the scale of value-added impact, we apply a SDA within a Global Multi-Regional Input–Output (GMRIO) framework. This technique is normally used to decompose changes in a variable over time. For example, Xu and Dietzenbacher (2014) and Arto and Dietzenbacher (2014) used this method to identify the factors driving the change in greenhouse gas emissions by comparing different years. Like Alcántara and Duarte (2004), De Nooij et al. (2003) and Hasegawa (2006) we perform a spatial SDA, which consists on comparing different locations with data for the same year.

The main data source for our analysis is the World Input–Output Database (WIOD) for the year 2011 (Timmer et al., 2012). As regards climate finance recipient countries, we consider the five developing countries for which data are available in the WIOD: India, Brazil, China, Indonesia and Mexico. This set of recipient countries represents around 60% of the emissions as well as GDP of developing countries in 2011, according to the World Bank Indicators. As regards climate finance donor countries, we consider the four main contributors to bilateral and multilateral climate funds for which data are available in the WIOD: Germany, the United Kingdom (UK), Japan and the United States of America (USA). This set of countries represents 62% of the total contributions to climate funds pledged as for October 2016, according to the Climate Funds Update (2016). The information in these tables (transactions between industries, purchases of end products, remuneration of labour and capital and total output of each industry in each country in monetary terms), enables us to trace value-added creation associated with a specific demand shock back to the country where it is created.

Our exercise is based on the assumption that climate finance, once disbursed in a recipient country, results in the expenditures required for a certain intervention with mitigation and/or adaptation purposes. We denote such intervention as ‘climate action’. Mitigation actions are defined as those interventions aimed at reducing the emissions of greenhouse gases. Adaptation actions refer to interventions aimed at lowering the risks posed by the consequences of climatic changes. Each climate action would produce a different demand shock in the economy, depending on the requirements of the specific type of intervention. The demand shock consists in the new purchases of commodities and services required for the implementation of that climate action.

In our Input–Output framework demand shocks are modelled as cost structures. The cost structure of one climate action consists of a specific distribution of the budget between the different industries in the economy. This distribution is different for each climate action, reflecting that the implementation of each climate action requires a different mix of goods and services. We define six categories of climate actions (including the deployment of renewable energy sources, energy efficiency measures and different adaptation options) and use secondary sources of information to determine one cost structure for each of them.

With regards to mitigation actions, we consider the deployment of the most widely used renewable energy technologies worldwide: onshore wind, solar thermal and hydropower. The cost structure of these actions reflects the distribution of the expenditure required for

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2 For a detailed description of the WIOD project, the WIOT (World Input–Output Tables) and main weaknesses see also Dietzenbacher et al. (2013) and Timmer et al. (2015).

3 Another relevant contributor to climate finance is Norway, but it is not included in the WIOD.
the construction of facilities (overnight cost) between industries. Data used in previous studies (Lehr et al., 2008, 2012), reflecting the cost structures of projects in Germany in 2011, are used to define the cost structures of these types of climate action.4

Another mitigation option is the enhancement of energy efficiency. We consider the refurbishment of buildings to minimise the use of energy for heating and air conditioning as an energy efficiency measure. Data for determining the cost structure of building insulation are taken from Markaki et al. (2013).5 Table B.1. in the Supplementary Material describes the cost structures by commodity of mitigation options.6 The correspondence between commodities and industries used is described in Table B.2. in the Supplementary Material. We use the same classification as the WIOD (CPA-NACE) in order to connect this information with the GMRIO framework.7

Regarding adaptation actions, we consider a wide range of options. Table B.3. in the Supplementary Material contains all the adaptation measures considered and the sources of information used for the determination of cost structures, which are specific Priority Project Profile documents from National Adaptation Programmes of Action (NAPAs) (UNFCCC, 2014).8 Next, Table B.4. in the Supplementary Material describes the correspondence used between NAPAs expenditure categories and commodity codes, and Tables B.5–B.13. in the Supplementary Material detail the cost breakdown of the selected projects. For the sake of tractability of results, adaptation options are grouped, according to the relevance of the infrastructure component, into hard and soft adaptation. Hard adaptation comprises interventions in the following areas: coastal protection, disaster risk reduction, water supply and management, human settlements, infrastructure and spatial planning, water and wastewater projects. Soft adaptation comprises actions in the following areas: forestry and land use, terrestrial ecosystems, capacity-building, agriculture, fishing and livestock, and social protection. The cost structure for hard and soft adaptation is the average cost structure of the projects within each group. Again, the correspondence reported in Table B.2. in the Supplementary Material is used to express cost structures in terms of industries.

Figure 1 illustrates the resulting cost structures of climate actions considered in this paper. For example, while 100% of the expenditures in building insulation consist of construction services, when climate finance is spent in wind power generation, expenditures are shared out between several sectors: 49% for machinery, 19% for metals and other minerals, 13% for other business activities, 3% for construction and 16% for other industries. Table B.14. in the Supplementary Material describes the vector of the demand shock for each climate action by industry.

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4 Lehr et al. (2008, 2012) use data gathered by the German Institute for Economic Research (DIW Berlin) of input coefficients for the production of different renewable energy sources facilities including hydropower. Table B.1. in the Supplementary Material contains this data.
5 These authors’ assumption that building insulation projects involve expenditures only in the construction sector is based on information obtained from the literature and actual projects in Greece. We have used the same premise.
6 A more accurate assessment would require country specific cost structure data, which to the best of our knowledge is not available. In the future, as long as climate finance flows increase and information on the specific actions became available, this analysis could be refined.
7 CPA is the statistical classification of products by activity, and each CPA product is related to activities defined by the statistical classification of economic activities in the European Community, abbreviated as NACE.
8 The choice of adaptation actions is based on categorisations of previous studies (Blazejczak et al., 2014; Buchner et al., 2013; OECD/IEA, 2014; Prowse and Snislstveit, 2010; REN21, 2014).
Figure 1. Distribution to industries of expenses per climate action.

The production induced by demand shocks initiates a sequence of requirements of intermediate goods and services, and value-added generation across different industries and countries. All these relations can be captured by a GMRI model as described next.

The value-added created in country \( r \) as a consequence of the implementation of climate action \( a \) in the recipient country \( t \) can be calculated as the product of a series of factors, as shown in Equation 1:

\[
w_{ra} = \sum_s v_r^r L^{rs} t^{st} \otimes e^a,
\]  

where

- \( v_r^r \): transpose of the vector of value-added coefficients obtained as multiplication of the inverse of the diagonal matrix of the column vector of gross outputs in country \( r \), \((\hat{x}_r)^{-1}\), and the column vector of value-added in country \( r \), \( w_r^r \), with elements \( w_{ri}^r \) indicating the value-added created in each sector \( i \) of that country;
- \( L^{rs} \): submatrix of the Leontief inverse matrix defined as \( L = (I - A)^{-1} \), where \( I \) is an identity matrix of the appropriate dimension and \( A = Z(\hat{x})^{-1} \) is the matrix of input coefficients; \( Z \) is the matrix of intermediate inputs, with elements \( z_{rs}^{ij} \) indicating the sales of sector \( i \) in country \( r \) to sector \( j \) in country \( s \);
- \( t^{st} \): column vector that indicates the trade structure of country \( t \). It is derived from \( f^t \), the column vector with final demand, with elements \( f_{j}^{st} \) indicating the final demand in country \( t \) for products of sector \( j \) produced by country \( s \). Each element of the trade structure vector indicates the fraction of the total final demand in country \( t \) for commodities of sector \( j \) imported from country \( s \) (when \( s \neq t \)) or domestically produced (when \( s = t \) ) and is obtained as \( f_{j}^{st} = f_{j}^{st} / \sum_s f_{j}^{st} \).
- \( e^a \): column vector of demand shock, with elements \( e^a_j \) indicating the proportion of the total expenditure on a specific climate action \( a \) spent in sector \( j \). The symbol \( \otimes \) denotes the Hadamard product, that is, the element by element multiplication.
- \( w^{ra} \): resulting value-added created in country \( r \) as a consequence of the implementation of climate action \( a \) in the recipient country \( t \).

Once the local value-added derived from climate finance in each country is calculated, the country with the greatest impact is identified as the benchmark against which other countries are compared. Within the recipient countries group, the benchmark is the country that is able to retain the largest part of the total value-added created. Donor countries are compared to the country able to attract the largest proportion of spillover effects. Thus, the difference in the value-added created by the implementation of climate action \( a \) in country \( t \) between country \( B \) (the benchmark) and country \( C \) (each of the rest of countries in the group) is given in Equation 2. The difference in the value-added captured by recipient and donor countries is given by Equations 3 and 4, respectively.

\[
\Delta w^{ta} = \sum_s v^{B'} L^{Bst} \otimes e^a - \sum_s v^{C'} L^{Cst} \otimes e^a,
\]

\[
\Delta w^a = \sum_s v^{B'} L^{Bst} \otimes e^a - \sum_s v^{C'} L^{CstC} \otimes e^a,
\]

\[
\Delta w^{ta} = \sum_s v^{B'} L^{Bst} \otimes e^a - \sum_s v^{C'} L^{Cst} \otimes e^a \quad t \neq B, C.
\]

Next, we illustrate the functioning of the SDA with the case of two factors (as explained by Arto and Dietzenbacher, 2014). Let \( a^x \) represent the value of a variable \( a \) in country \( x \). Let us assume that \( a \) is defined as the product of two exogenous parameters: \( a^x = b^x c^x \).

The difference in \( a \) between country \( A \) and country \( B \) is expressed in Equation 5. Following Dietzenbacher and Los (1998), this difference can be decomposed in two different ways shown in Equations 6 and 7. Dietzenbacher and Los (1998), also discuss that \( \Delta a \) can be expressed as the average of these two decompositions, as shown in Equation 8. In this expression the difference in \( a \) is the sum of the contribution of each factor (\( b \) and \( c \)) to the difference in \( a \).

\[
\Delta a = a^A - a^B,
\]

\[
\Delta a = (b^A - b^B)c^A + b^B(c^A - c^B) = \Delta b c^A + b^B \Delta c,
\]

\[
\Delta a = (b^A - b^B)c^B + b^A(c^A - c^B) = \Delta b c^B + b^A \Delta c,
\]

\[
\Delta a = \frac{1}{2} \Delta b (c^A + c^B) + \frac{1}{2} (b^A + b^B) \Delta c.
\]

Following this procedure, we can operate in Equations 3 and 4 in order to decompose the differences in the value-added as the sum of a series of factors. For the case of recipients, Equation 3 can be decomposed as the average of the two polar decompositions, \( \Delta w^a = 1/2(\Delta w^{a1} + \Delta w^{a2}) \).\(^9\)

\(^9\) For the sake of simplicity we just show the differences in recipient countries; the procedure to compare donor countries is very similar (see Appendix A in the Supplementary Material).
with

\[
\Delta w_1^a = \sum_s (\Delta v') L^{Bs} t_s^B \otimes e^a + \sum_s v^{C'} (\Delta L^s) t_s^B \otimes e^a + \sum_s v^{C'} L^{Cs} (\Delta t^s) \otimes e^a,
\]

\[
\Delta w_2^a = \sum_s (\Delta v') L^{Cs} t_s^C \otimes e^a + \sum_s v^{B'} (\Delta L^s) t_s^C \otimes e^a + \sum_s v^{B'} L^{Bs} (\Delta t^s) \otimes e^a,
\]

and

\[
(\Delta v') = (v^{B'} - v^{C'}),
\]

\[
(\Delta L^s) = (L^{BB} - L^{CC}) + (L^{BC} - L^{CB}) + \sum_{s \neq B, s \neq C} (L^{Bs} - L^{Cs}),
\]

\[
\Delta t^s = (t^{BB} - t^{CC}) + (t^{CB} - t^{BC}) + \sum_{s \neq B, s \neq C} (t^{sB} - t^{sC}),
\]

The average of the polar decomposition is shown in Equation 14. The second and third terms of Equation 14 can be further decomposed. The resulting expression, Equation 15, decomposes the difference in the value-added generated in donor countries into four factors that are described in Equations 16–19.

\[
\Delta w^a = \frac{1}{2} \sum_s \Delta v' (L^{Bs} t_s^B \otimes e^a + L^{Cs} t_s^C \otimes e^a) + \frac{1}{2} \sum_s v^{C'} \Delta L^s t_s^B \otimes e^a
\]

\[
+ \frac{1}{2} \sum_s v^{B'} \Delta L^s t_s^C \otimes e^a + \frac{1}{2} \sum_s (v^{C'} L^{Cs} + v^{B'} L^{Bs}) \Delta t^s \otimes e^a,
\]

\[
\Delta w^a = \frac{1}{2} \sum_s \Delta v' (L^{Bs} t_s^B \otimes e^a + L^{Cs} t_s^C \otimes e^a)
\]

\[
+ \frac{1}{2} v^{B'} (L^{BB} - L^{CC}) t^{CC} \otimes e^a + \frac{1}{2} v^{C'} (L^{BB} - L^{CC}) t^{BB} \otimes e^a
\]

\[
+ \frac{1}{2} v^{B'} (L^{BC} - L^{CB}) t^{CC} \otimes e^a + \frac{1}{2} v^{C'} (L^{BC} - L^{CB}) t^{BB} \otimes e^a
\]

\[
+ \frac{1}{2} \sum_{s \neq B, C} v^{B'} (L^{Bs} - L^{Cs}) t_s^C \otimes e^a + \frac{1}{2} \sum_{s \neq B, C} v^{C'} (L^{Bs} - L^{Cs}) t_s^B \otimes e^a
\]

\[
+ \frac{1}{2} \sum_s (v^{C'} L^{Cs} + v^{B'} L^{Bs}) \Delta t^s \otimes e^a,
\]

\[
VAiE \equiv \frac{1}{2} \sum_s \Delta v' (L^{Bs} t_s^B \otimes e^a + L^{Cs} t_s^C \otimes e^a),
\]

\[
DME \equiv \frac{1}{2} v^{B'} (L^{BB} - L^{CC}) t^{CC} \otimes e^a + \frac{1}{2} v^{C'} (L^{BB} - L^{CC}) t^{BB} \otimes e^a,
\]
\[ \text{FME} \equiv \frac{1}{2} v^B (L^{BC} - L^{CB}) t^{CC} \otimes e^a + \frac{1}{2} v^C (L^{BC} - L^{CB}) t^{BB} \otimes e^a + \frac{1}{2} \sum_{s \neq B,C} v^B (L^{Bs} - L^{Cs}) t^sC \otimes e^a + \frac{1}{2} \sum_{s \neq B,C} v^C (L^{Bs} - L^{Cs}) t^sB \otimes e^a, \]  

\[ \text{TSE} \equiv \frac{1}{2} \sum_s (v^C L^{Cs} + v^B L^{Bs}) \Delta t^s \otimes e^a. \]  

- **VAiE** is the value-added intensity effect, which reflects differences in value-added per unit of domestic output. A positive (negative) VAiE means that the benchmark country (B) produces more (less) value-added per unit of output than the studied country (C). High value-added intensities are typical in countries specialised in the production of high technology commodities that require high-skilled labour.

- **DME** is the domestic multiplier effect, which reflects differences in domestic production per unit of domestic demand. A positive (negative) DME means that the amount of production generated in B per unit of demand of goods/services produced in B is bigger (smaller) than the amount of production generated in C per unit of demand of goods/services produced in C. High domestic multipliers are typical of highly integrated economies, characterised by the presence of industrial clusters for different commodities that are relatively independent of foreign production.

- **FME** is the foreign multiplier effect, which reflects differences in domestic production per unit of demand of foreign products. A positive (negative) FME means that the amount of production generated in B per unit of goods/services produced in other countries is bigger (smaller) than the amount of production generated in C per unit of goods/services produced in other countries. High foreign multiplier effects are typical of countries that participate in global supply chains for many products and services.

- **TSE** is the trade structure effect, which reflects differences in the demand of domestic products generated by a climate action. We assume that the demand shock generated by each type of climate action is similar for all recipient countries in terms of level and composition of commodities. But we take into account that the origin of the commodities varies depending on the recipient country. A positive (negative) TSE means that the demand of goods/services produced in B generated by the implementation of a particular climate action is larger (smaller) than the demand of goods/services produced in C generated by the implementation of the same action in C. In the case of recipient countries, this is the effect of the degree of dependency on final goods and services produced abroad, something that is related to the size of the country. In the case of donors, this is the effect of the penetration of their final products on the recipient countries’ markets.

### 3. Results

This section includes general considerations that apply to all the results. Results are then grouped into two subsections according to their level of detail. Aggregated results for each economy are presented first, followed by results at industry level. Results for climate finance recipient countries distinguish between the types of climate action implemented. In the case of donor countries the focus is exclusively on renewable energy technologies, since these are the climate actions that yield the largest spillover effects (Român et al., 2016).
Table 1. Local economic impacts, spillovers and benchmark countries.

| Climate action | BRA | CHN | IDN | IND | MEX |
|----------------|-----|-----|-----|-----|-----|
| Wind           | 70% | 68% | 59% | 72% | 44% |
| Solar          | 73% | 71% | 55% | 70% | 52% |
| Hydropower     | 71% | 71% | 49% | 72% | 42% |
| B. insul.      | 91% | 82% | 81% | 83% | 82% |
| Soft A.        | 87% | 79% | 76% | 85% | 76% |
| Hard A.        | 82% | 77% | 70% | 79% | 67% |

| Recipient country | CHN | DEU | UK | JPN | USA |
|-------------------|-----|-----|----|-----|-----|
| BRA               | 6%  | 3%  | 1% | 1%  | 4%  |
| CHN               | –   | 3%  | 1% | 4%  | 4%  |
| IDN               | 9%  | 3%  | 1% | 6%  | 4%  |
| IND               | 7%  | 2%  | 1% | 2%  | 4%  |
| MEX               | 9%  | 3%  | 1% | 3%  | 20% |

Source: Own work. Abbreviations: BRA, Brazil; CHN, China; IDN, Indonesia; IND, India; MEX, Mexico; DEU, Germany; UK, United Kingdom; JPN, Japan; USA, United States of America; B. insul., building insulation; Soft A., soft adaptation; Hard A., hard adaptation. Benchmark countries are indicated in grey.

However, since the volume of spillovers varies widely depending on the country receiving climate finance, results distinguish between the destinations of climate finance.\(^{10}\)

Results reflect the comparison between the benchmark country and each of the other countries in the group. Amongst recipient countries, the benchmark varies depending on the climate action implemented. Amongst countries benefiting from spillovers, the benchmark varies depending on the country receiving climate finance. Table 1 shows the proportion of the impact retained by each recipient country, the proportion attracted by each donor country and the benchmark country in each case.\(^{11}\)

For example, we see that out of every USD 100 spent in wind energy in India, USD 72 stay within the country (in the form of wages or benefits of Indian companies). The rest goes to other countries participating in the production of final goods/services or intermediate inputs required for the wind power project. However, the same expenditure in Mexico would leave in the country only USD 44. The decomposition explains what drives the difference of USD 28 between India and Mexico. In the case of donors, we see that out of every USD 100 spent in mitigation projects in Mexico, USD 20 end up in the USA as wages or companies’ profits, due to their participation in the production of the inputs of the project. Japan, however, only receives three dollars. The decomposition shows the contribution of each of the four factors considered to this USD 17 difference.

\(^{10}\) The SDA of spillovers depends on which country is the donor, which one is the recipient and what type of climate action is implemented. This three-fold dependency complicates the presentation and interpretation of results. We therefore concentrate on renewable energy technologies, because they are the actions that yield the largest spillovers for donors, and present average results for wind energy, hydropower and solar energy.

\(^{11}\) Note that China is the benchmark country against which donor countries are compared in the case of climate finance disbursed in Brazil, Indonesia and India because in those cases China is the country that benefits from the largest spillovers.
Since benchmark countries are determined based on the economic impact at country level, aggregated results show always positive differences between the benchmark and other countries. This is not necessarily the case for results at industry level, where both positive and negative differences might appear. At both levels, the sign of the different effects (i.e. VAiE, DME, FME and TSE) can be either positive or negative, depending on whether they contribute positively to the dominant effect or counteract it. In other words, positive effects help explaining why benchmarks are benchmarks, and negative effects explain why differences between benchmarks and other countries are not even larger.

### 3.1. Aggregated results

In this section, the results for each climate finance recipient country are shown first, followed by results for each donor country. Figures 2 and 3 illustrate the results for recipient and donor countries. To explain the content of Figure 2 we continue with the previous example: the USD 28 of difference between the domestic impact of a wind energy project in India and Mexico is because the trade structure generates USD 19 more in India (Figure 2(b)) than in Mexico (Figure 2(e)), the domestic multiplier generates USD 12 more in India than in Mexico and the value-added intensity generates three dollars more in Mexico than in India.

Brazil (Figure 2(a)) is the benchmark for all types of climate action except wind power and hydropower, for which the largest local economic benefits happen in India. However, Brazil is very close to the benchmark even there, with a local impact that is only one percentage point (pp) lower in the case of hydropower and two percentage points lower in the case of wind power. In both cases, the effects that contribute positively to the difference are the domestic multiplier and the trade structure effects. Counteracting these two factors is the effect of the value-added intensity.

India (Figure 2(b)) is the benchmark for wind power and hydropower but is surpassed by Brazil in the rest of climate actions, with a difference of two percentage points for soft adaptation, three percentage points for solar energy and hard adaptation and eight percentage points for building insulation. In most cases (with the exception of soft adaptation), the effect of value-added intensity contributes to the difference while the effect of the domestic multiplier acts in the opposite direction.

China (Figure 2(c)) is between one and nine percentage points from the benchmark countries, depending on the climate action. The largest differences are for building insulation and soft adaptation (nine and eight percentage points, respectively). But we see as a common pattern for all climate actions that differences with the benchmark are the result of two contrary and sizeable forces: a positive value-added intensity effect (that surpasses 20 pp) and a negative domestic multiplier effect (almost of the same magnitude).

Indonesia (Figure 2(d)) is farther from the benchmarks (between 10 and 23 pp), with the largest differences being found in renewable energy technologies (13–23 pp). In these cases, three factors contribute positively to the difference: mainly the effect of the trade structure, but also those of the domestic multiplier and the value-added intensity. The difference for building insulation (10 pp) results from the effect of the value-added intensity, which is partially offset by the domestic multiplier effect. In the case of adaptation actions, the dominant effects are the value-added intensity and the trade structure effects.
Figure 2. Results by recipient country and climate action. (a) Brazil, (b) India, (c) China, (d) Indonesia and (e) Mexico.

Source: Own work. Abbreviations: VAIE, valueadded intensity effect; DME, domestic multiplier effect; FME, foreign multiplier effect; TSE, trade structure effect; B. insul, building insulation; Soft A., soft adaptation; Hard A., hard adaptation.

Mexico (Figure 2(e)) is the farthest from benchmark countries: between 9 and 30 pp. Again, the largest differences are for renewable energy technologies (21–30 pp), and the lowest for building insulation (9 pp). This time the dominant effect in most cases is the
Figure 3. Results by donor and recipient country. (a) Germany, (b) UK, (c) Japan and (d) USA.

trade structure, with the domestic multiplier as the other factor that contributes to the difference. In most cases, the value-added intensity also counteracts these former effects. The case of building insulation is different, with the trade structure having no influence, and both the domestic multiplier and the value-added intensity contributing positively to the difference. Note that the effect of the foreign multiplier does not appear as a relevant factor in explaining the differences in the domestic economic impact of climate finance between recipient countries.

To explain the results contained in Figure 3, we continue with the previous example: the USD 17 of difference between spillovers captured by the USA and Japan from a mitigation project in Mexico are because the trade structure generates USD 12 more for the USA (Figure 3(d)) than for Japan (Figure 3(c)), the foreign multiplier creates four dollars more in the USA than in Japan, the higher value-added intensity of American production produces two dollars of difference, and the domestic multiplier generates one dollar more in Japan than in the USA.

Spillovers attracted by Germany (Figure 3(a)) are only one percentage point lower than those attracted by the benchmark country (Japan) when the recipient country is China.

Source: Own work. Abbreviations: VAiE, value-added intensity effect; DME, domestic multiplier effect; FME, foreign multiplier effect; TSE, trade structure effect; BRA, Brazil; CHN, China; IDN, Indonesia; IND, India; MEX, Mexico.
The difference rises to 17 pp when the recipient country is Mexico (the benchmark country is the USA in this case). In general, the dominant factor is the trade structure. Two other factors that also contribute positively to the difference are the domestic and foreign multipliers. Finally, the only factor that counteracts those effects is the value-added intensity, showing that this is generally larger in the German production than in benchmark countries (with the exception of the USA). The same happens with the UK (Figure 3(b)), whose results are very similar. Differences are slightly larger in the case of the UK (between 3 and 19 pp), but the signs and relative magnitude of the different factors are the same than for Germany.

Japan (Figure 3(c)) is the benchmark country when China receives funding for deploying renewable energy technologies. In other cases, spillovers captured by Japan are between 3 and 17 pp lower than those captured by the benchmark country: the average is four percentage points when then benchmark country is China and 17 pp when it is the USA. Again, the dominant factor is the trade structure. The foreign multiplier also contributes positively to the difference. The signs of the other two factors differ depending on the benchmark country: when it is China, the effect of the domestic multiplier increases the difference and the value-added intensity effect decreases it; when it is the USA, the opposite occurs.

The USA (Figure 3(d)) is the benchmark when Mexico is the recipient country. In other cases differences with the benchmark countries do not exceed five percentage points. The most relevant factors are the trade structure and value-added intensity. This latter counteracting the rest of the effects, something which indicates that value-added per unit of output is greater in the USA than in benchmark countries.

### 3.2. Sectoral results

A small group of sectors concentrates the main effects in the countries analysed: ‘Mining and Quarrying’, ‘Basic Metals and Fabricated Metal’, ‘Machinery n.e.c.’, ‘Electrical and Optical Equipment’, ‘Electricity, Gas and Water Supply’, ‘Construction’, ‘Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles’, ‘Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods’, ‘Inland Transport’, ‘Financial Intermediation’ and ‘Other Business Activities’.12 Figure B.1 in the Supplementary Material illustrates the results for recipients and donor countries.

In Brazil (Figure B.1(a)), the largest positive differences with the benchmark (India) appear in trade sectors (due to the effect of value-added intensity, the domestic multiplier and the trade structure) and the transport sector (especially due to the domestic multiplier). The sectors with the largest negative differences (around −2 pp) are metals and electricity, gas and water supply (in wind and hydropower, respectively), especially due to the negative effect of the value-added intensity.

When comparing India (Figure B.1(b)) to the benchmark (Brazil), the most relevant difference at aggregated level is found in building insulation projects. This result can be explained by the large difference (16 pp) in the construction sector, associated with the value-added intensity. This effect in the construction sector may also explain the differences in solar energy and hard adaptation. Negative differences appear in metals,

12 N.e.c. is the abbreviation of “not elsewhere classified”.
retail trade and transport for building insulation projects. These negative differences are generally driven by the domestic multiplier.

Sectoral results for China (Figure B.1(c)) show that the differences observed in building insulation projects are associated with the construction sector (34 pp). The differences in soft adaptation are due to the other business activities sector (13 pp), and those observed in hard adaptation are due to both the construction and other business activities sectors (around 8 pp each). These differences are a consequence of a positive effect of the value-added intensity. Also noteworthy is the positive domestic multiplier effect in the retail trade sector regardless of the type of action. This effect is negative at the aggregated level due to sectors such as metals and equipment.

In Indonesia (Figure B.1(d)), metals and machinery sectors contribute to the large difference in renewable energy projects, especially due to the effect of the domestic multiplier in the former and the effect of the trade structure in the latter. The difference observed in building insulation projects might be explained in part by the value-added intensity in the construction sector. This effect in this sector might also influence the aggregated results in solar energy and hard adaptation projects. The value-added intensity in other business activities and the trade structure in machinery influence the differences in adaptation projects. This latter effect in the machinery sector contributes to the positive difference in all types of action except for building insulation. Notable negative differences are observed in the mining sector (up to 9 pp) regardless of the type of action, as a consequence of the effects of the domestic multiplier and the value-added intensity.

According to the sectoral results, the trade structure in the machinery sector contributes to the differences observed for renewable energy projects in Mexico (Figure B.1(e)). Actually, this effect in this sector contributes to the difference in all types of project except for building insulation. Other sectors, such as metals, equipment and financial intermediation, also contribute to the difference in renewable energy actions due to the trade structure and the domestic multiplier. In this type of action, the role of the value-added intensity is negative with the exception of the equipment sector. In adaptation actions, the most influential effect is the trade structure in machinery. Regarding negative differences, the other business activities sector stands out, especially due to the value-added intensity in adaptation projects.

Three sectors concentrate the most significant effects in explaining differences between donor countries: ‘Basic Metals and Fabricated Metal’, ‘Machinery n.e.c’ and ‘Electrical and Optical Equipment’. In the case of Germany (Figure B.1(f)), the trade structure of these three sectors is especially influential, particularly when the benchmark countries are China and the USA. The UK (Figure B.1(g)) and Japan (Figure B.1(h)) present very similar results regarding the relative importance of sectors and the signs of effects. The case of the USA (Figure B.1(i)) is also similar, but with some noteworthy features such as the negative effect of the value-added intensity on the equipment and machinery sector, especially when the benchmark country is China.

4. Discussion

One of the reasons why Brazil, out of all the recipient countries considered in the analysis, is the one where climate finance produces the largest domestic impact in most cases
(i.e. for solar energy, building insulation and adaptation projects) is the value-added intensity. According to the sectoral results, this effect makes the impact of mitigation actions especially larger in the Brazilian metals, electricity, gas and water supply, and construction sectors. Table 2, which shows value-added coefficients by country and sector, confirms that these sectors are relatively more intensive in primary inputs in Brazil than in the other recipient countries, which might be due to a higher level of sophistication in the production and the use of high technology and skilled labour. An alternative (or complementary) explanation for higher value-added per unit of output is a higher degree of protectionism in the economy. In fact, Brazil ranks at the bottom of the ICC open markets index for the year of study (ICC, 2011), behind the other recipient countries. Thus, the high values of value-added per unit of output might also be due to a lack of competition with foreign producers, who find barriers to entry into Brazilian markets. The high value-added coefficient in the Brazilian electricity, gas and water supply sector may be associated with the large share of hydropower in the Brazilian energy mix, an energy source with low requirements for intermediate inputs.

When climate finance is spent on wind or hydropower projects, India is the recipient country with the largest domestic impact. According to our results, this is mainly due to the fact that India imports less final products than other recipient countries for undertaking such projects. According to the sectoral results, this effect means that the impact of these projects in the machinery industry is larger in India than in other recipient countries. Table 3, which shows the share of domestic production per industry in the final demand of recipient countries, confirms that India is, on average, the recipient country with the largest share of domestic production in its final demand. India has also a high level of self-sufficiency in machinery, equipment and transport equipment, the main components of this type of projects. Moreover, demand for Indian products triggers greater domestic production (especially in the metals and transport sectors) than in other countries. Both effects reflect the high level of self-sufficiency and integration of the Indian economy, a relatively well-developed, independent industrial base and the existence of intraregional communication and transport networks.

China is the other side of the coin compared to Brazil: a lower weight of labour and capital in the total production costs of Chinese industries is the main reason why China is not able to retain a larger proportion of the impact of climate finance. According to sectoral results, the value-added intensity makes the impact of climate actions in the Chinese metals, construction and other business activities sectors lower than in the benchmark cases. Table 2 confirms that China is the recipient country with the smallest value-added coefficients in almost all industries, including these three.

Indonesia and Mexico are even farther away from the benchmarks than China, as a result of a combination of factors. First, both countries import a large part of their final demand. Sectoral results show relevant differences in the impact of renewable energy and adaptation projects in the metals and machinery sectors due to this effect. Table 3 confirms that these two countries are (on average and also in these two sectors) the recipient countries which depend most on others countries’ end products. Another factor that contributes to the lower impact of renewable energy projects is the fact that domestic demand generates less

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13 The position of recipient countries in ascending order is: Indonesia (54), China (57), Mexico (58), India (66), and Brazil (68).
Table 2. Value-added per unit of output by country and sector.

| Sector                        | Brazil | China | Indonesia | India | Mexico | Germany | UK   | Japan | USA  |
|-------------------------------|--------|-------|-----------|-------|--------|---------|------|-------|------|
| Agriculture                   | 61%    | 59%   | 77%       | 78%   | 58%    | 44%     | 54%  | 50%   | 43%  |
| Mining                        | 44%    | 47%   | 82%       | 79%   | 82%    | 47%     | 71%  | 20%   | 57%  |
| Pulp                          | 46%    | 25%   | 37%       | 29%   | 46%    | 40%     | 48%  | 45%   | 38%  |
| Coke                          | 26%    | 19%   | 59%       | 17%   | 16%    | 19%     | 18%  | 38%   | 28%  |
| Chemicals                     | 36%    | 21%   | 31%       | 31%   | 31%    | 39%     | 40%  | 28%   | 35%  |
| Rubber                        | 40%    | 19%   | 35%       | 19%   | 33%    | 41%     | 44%  | 25%   | 37%  |
| Non-metallic mineral          | 44%    | 28%   | 46%       | 37%   | 54%    | 40%     | 49%  | 33%   | 39%  |
| Metals                        | 41%    | 21%   | 31%       | 26%   | 37%    | 35%     | 40%  | 27%   | 33%  |
| Machinery n.e.c.              | 38%    | 24%   | 30%       | 31%   | 38%    | 40%     | 43%  | 36%   | 44%  |
| Equipment                     | 37%    | 17%   | 37%       | 30%   | 20%    | 42%     | 42%  | 32%   | 64%  |
| Transport equip.              | 29%    | 20%   | 41%       | 29%   | 35%    | 27%     | 32%  | 24%   | 22%  |
| Electricity, gas and water    | 57%    | 29%   | 31%       | 36%   | 36%    | 52%     | 38%  | 44%   | 72%  |
| Construction                  | 56%    | 23%   | 36%       | 39%   | 50%    | 45%     | 43%  | 46%   | 52%  |
| Wholesale trade               | 73%    | 60%   | 59%       | 89%   | 75%    | 61%     | 56%  | 69%   | 67%  |
| Inland transport              | 57%    | 52%   | 39%       | 41%   | 66%    | 50%     | 53%  | 63%   | 49%  |
| Other transport               | 57%    | 39%   | 78%       | 54%   | 73%    | 42%     | 49%  | 58%   | 65%  |
| Post                          | 50%    | 59%   | 65%       | 70%   | 63%    | 50%     | 51%  | 65%   | 58%  |
| Financial                     | 68%    | 69%   | 79%       | 77%   | 69%    | 44%     | 54%  | 61%   | 55%  |
| Real Estate                   | 93%    | 83%   | 55%       | 92%   | 91%    | 81%     | 67%  | 87%   | 70%  |
| Other business activities      | 64%    | 41%   | 58%       | 70%   | 73%    | 67%     | 68%  | 51%   | 68%  |
| Public admin                  | 68%    | 55%   | 56%       | 100%  | 71%    | 68%     | 53%  | 69%   | 60%  |
| Health                        | 62%    | 35%   | 55%       | 66%   | 74%    | 72%     | 44%  | 62%   | 63%  |
| Personal services             | 65%    | 45%   | 54%       | 83%   | 71%    | 62%     | 56%  | 60%   | 54%  |
| Average                       | 53%    | 39%   | 51%       | 53%   | 55%    | 48%     | 48%  | 47%   | 51%  |

Source: Own work. Note: Colour gradients are used to compare values within the same row in order to help distinguish the countries with higher value-added intensities (in darker tones) from those with lower ones (in lighter tones).

domestic production in the metals industry (i.e. metals required for domestic production are also more frequently imported).

The salient feature of Indonesia is the domestic multiplier effect of the mining sector, which reduces the difference with the benchmark in the cases of renewable energy and energy efficiency projects. This reflects the fact that Indonesia is relatively self-sufficient in this sector. According to PwC (2014), the mining sector was very important in the Indonesian economy in 2011, accounting for 19.5% of the GDP. In Mexico, the salient feature is value-added per unit of output, especially in the metals and other business activities sectors (see Table 2). This factor reduces the difference with the benchmark for renewable energy and adaptation projects.

Major differences in the distribution of spillovers of renewable energy projects appear when other donors are compared with the USA, the benchmark country when climate finance is disbursed in Mexico. According to our results, the main driver of these large differences is trade in both final and intermediate commodities. As Table 3 shows, Mexico is relatively dependent on others countries’ production to meet its final demand, something that, together with the geographic proximity and accessibility of the American market,
Table 3. Proportion of domestic production in final demand per country and sector.

| Sector          | Brazil | China | Indonesia | India | Mexico |
|-----------------|--------|-------|-----------|-------|--------|
| Agriculture     | 98%    | 98%   | 97%       | 99%   | 96%    |
| Mining          | 96%    | 98%   | 98%       | 97%   | 97%    |
| Pulp            | 97%    | 83%   | 91%       | 94%   | 85%    |
| Coke            | 88%    | 85%   | 40%       | 97%   | 57%    |
| Chemicals       | 88%    | 62%   | 89%       | 88%   | 80%    |
| Rubber          | 72%    | 85%   | 86%       | 88%   | 47%    |
| Non-metallic mineral | 83%  | 94%   | 93%       | 75%   | 97%    |
| Metals          | 90%    | 93%   | 66%       | 94%   | 78%    |
| Machinery n.e.c. | 74%  | 85%   | 18%       | 78%   | 18%    |
| Equipment       | 60%    | 74%   | 72%       | 66%   | 23%    |
| Transport equip. | 84%  | 85%   | 81%       | 94%   | 40%    |
| EGW             | 99%    | 99%   | 100%      | 100%  | 100%   |
| Construction    | 100%   | 100%  | 100%      | 100%  | 100%   |
| Wholesale trade | 100%   | 99%   | 100%      | 99%   | 100%   |
| Inland transport| 99%    | 98%   | 96%       | 100%  | 100%   |
| Other transport | 99%    | 98%   | 94%       | 100%  | 99%    |
| Post            | 97%    | 98%   | 99%       | 99%   | 100%   |
| Financial       | 99%    | 99%   | 99%       | 98%   | 97%    |
| Real estate     | 97%    | 100%  | 77%       | 100%  | 100%   |
| Other business activities | 99%  | 95%   | 100%      | 97%   | 99%    |
| Public admin    | 100%   | 100%  | 99%       | 100%  | 97%    |
| Health          | 100%   | 100%  | 99%       | 100%  | 100%   |
| Personal services | 99%  | 98%   | 98%       | 99%   | 98%    |
| Average         | 92%    | 92%   | 87%       | 94%   | 83%    |

Source: Own work. Note: Colour gradients are used to compare values within the same row, in order to help distinguish countries with higher proportions of domestic production in their final demand (in darker tones) from lower ones (in lighter tones).

explains the significance of trade in end products (i.e. the effect of the trade structure). The relevance of trade in intermediate inputs (i.e. the effect of the foreign multiplier) is due to two facts: first, regional trade facilitated by proximity and trade treaties (i.e. North American Free Trade Agreement) also benefits the USA indirectly (i.e. via Mexican imports of Canadian products that require American intermediate inputs); and second, American industries are well positioned in global markets, which enables them to participate in global supply chains and capture a share of the economic benefits generated from consumption in many parts of the world.14 According to the World Bank, in 2011 the USA was the top market for world exports and the second exporting country (World Bank, 2011). Results also show that the USA is the donor that creates most value-added per unit of output, followed by Germany and the UK. Japan is in the last place in this aspect. Note that this ranking is in line with the average value-added coefficients contained in Table 2.

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14 In the comparison of recipient countries, the foreign multiplier represents a feedback effect: the recipient country imports final goods and services that require intermediate inputs from the recipient country. According to our results, and in line with previous empirical evidence, feedback effects are negligible (Meng and Chao, 2007).
The fact that the largest spillover effects when the recipient is China take place in Japan also reflects the effect of proximity in trade. However, the fact that China attracts spillovers between three and eight percentage points larger than any donor country when finance is disbursed in Brazil, Indonesia and India cannot be explained by geographic proximity. However, the prominent position of China in global trade – in 2011 it was the world’s number one exporter and number two importer, according to the World Bank (2011) – might provide an explanation for this result.

5. Concluding remarks

Previous research has suggested that there is a need to align finance for climate action and development, in order to promote synergies between climate and development goals (Andreoni and Miola, 2014; Chambwera et al., 2014; Fankhauser and McDermott, 2014; Halsnæs and Verhagen, 2007). By disentangling the factors explaining the economic benefits derived from climate finance, this paper supports the idea of complementarity between climate and development objectives and identifies areas of action where governments can focus in order to exploit the potential synergies.

Regarding developing countries, our results show that in those countries where the industries involved in mitigation and adaptation projects are well developed and connected, and offer competitive products and services with a high content of value-added, climate actions deliver larger benefits to the local economy. This finding indicates that active policies to facilitate the local development of such industries would deliver climate and development benefits at the same time. This means that for developing countries we identify three areas of action: (1) the value-added content (skilled labour and high technology) of production; (2) the integration of the economy; and (3) the degree of self-sufficiency in climate-related industries.

In the case of donor countries, the first two areas of action also apply and a third one would be related to international trade. Our analysis shows that trade interconnections with recipient countries increase the ability of donor countries to capture economic benefits from climate finance. Based on these findings, the recommendation for donors might be to concentrate climate aid on recipient countries within their specific commercial area. Another strategy would be to increase their participation in global supply chains of high-value-added products and services related to the fight against climate change. This alternative approach has the advantage that it would enable donor countries to profit from the economic benefits of climate action regardless of where it takes place, and regardless of who mobilises climate finance. This means that the promotion of globally competitive industries in the sectors involved in climate action is also a mean for donor countries to benefit from the economic benefits of climate finance.

Summarising, this analysis provides some evidence on the compatibility of climate action with economic gains. Our results suggest that both donors and recipient countries could strategically enhance the competitiveness and/or support the development of climate-related industries with high value-added and thus benefit from larger shares of the economic impact of climate finance. In this sense, it is important to highlight that the search for short-term economic co-benefits of climate action could boost the development of technologies and innovative solutions to adapt and mitigate climate change.
Our paper also shows that the study of the economic impact of climate finance provides useful insights for the consecution of one of the objectives of the Paris Agreement regarding climate finance: the design of country-driven strategies, having into account the priorities and needs of developing countries. Given that development is one of the priorities of these countries, information on the potential economic co-benefits of alternative climate-related measures (and guidance about how to improve those co-benefits) facilitates the design of such country-driven strategies.

With enhanced country ownership of climate-related plans, effectiveness of climate finance would also improve, as recognised by the Intergovernmental Panel for Climate Change (2014). Developed countries have also recently stressed that it is more efficient and effective to integrate climate action in programmes that generate wider development results (UK Government, and Australian Government, 2016). For that reason, they have committed to support developing countries in the preparation of National Adaptation Plans and Nationally Determined Contributions consistent with their national development plans. Our findings might be used in the design of such plans, with the objective of aligning mitigation and adaptation to climate change with development objectives.

We conclude that Global Multiregional Input–Output models have the potential to contribute to discussions on the global climate regime. So far they have provided interesting insights on the topic of responsibility with evidences of carbon footprint and leakage. With this paper we explore a different avenue of research that focuses on the opportunities of the transition towards decarbonised and resilient societies. In future studies, these models could be used to complement this assessment of economic benefits with the estimation of the mitigation potential of financed climate actions.

Finally, a remark is required on the main limitation of this exercise, which lies on the assumptions required to determine the demands of goods and services associated to climate mitigation and adaptation actions. Profiles for expenditure on mitigation actions are taken from the existing literature, and the characterisation of adaptation actions is the result of an ad hoc selection process from the actual programmes of action submitted by developing countries. The subsequent grouping into two main categories of adaptation (soft and hard) via the calculation of the corresponding averages means neglecting some degree of variation. In particular, the largest standard deviations are associated with expenses in the construction and machinery sectors (34% and 18% for construction in hard and soft adaptation, respectively; 27% and 17% for machinery in hard and soft adaptation, respectively). Bearing in mind that adaptation actions are as varied as countries’ adaptation needs, the results of this study provide an estimate of the impact of the ‘typical’ or ‘average’ soft and hard adaptation actions.

Besides, the profiles for expenditure used in this exercise may differ from the real ones depending on where and when climate actions are implemented. This happens because many factors determining the expenditures in climate action vary over time and space (i.e. the price of raw materials, the labour costs and the maturity of technologies, amongst others). Nevertheless, and given that the ultimate objective of the present study is to provide general policy advice, extrapolating the profiles for expenditures of projects in certain

15 Note that the local content is site specific in our analysis. Trade structures representing the origin of the products purchased by each recipient country are obtained from the World Input–Output Database, which is based on official trade statistics.
countries may constitute a first step. For specific case studies, detailed data at project level should be used in future applications of this methodology.

We are also aware of the remarkable differences between the countries considered. The comparison we propose, based on the national accounts and international trade statistics, brings to light their differences in terms of size, trade liberalisation, economic integration, productive specialisation, competitiveness, etc. Results reflect the consequences of these differences and serve to identify where the largest improvement potentials lie. Future studies could elaborate further on the concrete strategies that each country could pursue taking into account limiting factors such as institutional or cultural conditions, natural resources availability or geographical location.

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