Methodology for estimating the impact of the Sustainability Bond 2018

The impact assessment of the CDP's 2019 Sustainability is based on four specific targets:

1) employment;
2) water use efficiency;
3) beneficiaries of interventions for the prevention of hydrogeological instability and land protection;
4) wastewater treatment management.

Regarding the last three targets (2-4), the perimeter of analysis has been defined as follow. Investments financed through the CDP's Bond emission have been categorized in three different main objectives:

- Category A – water supply network;
- Category B – sewerage and wastewater;
- Category C – prevention of hydrogeological instability and territorial protection.

Investments in Category A have been used to evaluate impacts in water use efficiency. Those in Category B for quantifying potential beneficiaries of interventions in the prevention of hydrogeological instability and territorial protection. Finally, investments in Category C has been analyzed in order to estimate impacts on wastewater treatment management.

1. Methodology used to estimate the employment impact of CDP Sustainability Bond

Methodological aspects. The approach used to analyze the employment impact of the CDP's financing linked to the Sustainability Bond involves input-output models that measure the effects generated in terms of added value and employment by changes in one or more components of the final demand.

This takes account not just of how the sector in question is directly affected by the additional demand
generated by the funds raised through the Sustainability Bond, but also of all those effects caused when each sector relies on another for purchasing the intermediate and semi-finished goods required in the production process.
Using this method, the estimated impact is the result of three types of effects:

- **direct effects**, i.e. those impacting only the sector affected by the change in demand and its first intermediate inputs;
- **indirect effects**, i.e. those arising when each sector relies on another (the Leontief multiplier);
- **induced effects**, i.e. those deriving from the additional income flows that stimulate greater spending by end consumers (the Keynesian multiplier).

As this is a simple mechanical description of how the different sections of an economy are connected, it does not provide any explanation regarding the economic behavior of operators but it does take into account how external factors affect the economy, especially in the short term and assuming like-for-like conditions. It does not make spending distinctions based on who is doing the spending (there is no difference, for example, if the outlay comes from the private or the public sector), nor does it allow us to assess how the impact is affected by changes in the short-term economic environment.
Conceived by Wassily Leontief, input-output analysis is an economic statistics technique involving analysis of the relationships resulting from the production and circulation of goods and services between the different economic sectors. The main feature of input-output analysis is the double-entry intersectoral table, in which you can imagine the national economy as a set of sectors, each of which carries out two types of transaction:

- purchases from other sectors of goods and services that they use for their own production activity (branches of use);
- sales of goods they produce to other sectors and end consumers (branches of origin).

The sectors are grouped in branches, i.e. groupings of production units characterized by similar cost structures, production processes and products.

The input-output table makes it possible to quantify the many effects that a change in demand (consumption, investments, public spending, exports) can have on domestic production, added value and foreign-trade accounts in the country in question. This is possible by providing an overview of inter-industry relationships and the economic structure of a country and by determining the value of the intermediate goods and services produced by one sector and used by another.

By establishing the output that each sector must produce in order to satisfy a given sectoral demand, the input-output model makes it possible to estimate how particular economic policy decisions affect the future performance of the economy, especially in the short term (which is when the assumptions of the input-output model are more realistic). In this static model, the technological relationships remain fixed at a given moment in time, assuming a linear production technology and with fixed coefficients, so that the quantities requested adapt to the demand and not to the prices.

The input-output table is a system of equations that describe the relationships between production and respective usage. These relationships are subject to several constraints, the first of which envisages that the total production value generated in the *i-th* sector is equal to the sum of the intermediate uses and final uses (**balance equation**).

$$X_i = \sum_{k=1}^{n} \chi_{ik} + D_i \qquad (1)$$

Where *X* is the production, χ and *D* the intermediate and final uses, respectively, *i* and *k* are the index related to the final uses and the primary resources branches, respectively.

The second constraint envisages that the production value of an *i-th* sector is equal to the cost of the inputs and the overall income paid to carry out the production activities (**costs equation**).

$$X_i = \sum_{k=1}^{n} \chi_{ki} + V_i \qquad (2)$$

Where *V* is the income.

Finally, the **equilibrium equation** establishes the constraint that the total uses of the *i-th* sector be equal to the total resources of the same sector (equal values by row and by column).

$$\sum_{k=1}^{n} \chi_{ik} + D_i = \sum_{k=1}^{n} \chi_{ki} + V_i \qquad (3)$$

Using the input-output table, it is possible to construct the matrix of technical coefficients, which in turn calculates the impact in terms of production, added value, imports and jobs of a change in demand. The model's underlying assumptions used to analyze the impact are:

- linear production technology. In other words, it is assumed that in each production activity the input quantity required is directly proportional to the output volume achievable;
- fixed economies of scale in all the production sectors. The unit input need is assumed to be constant regardless of changes in production volumes;
- absence of external factors. The effect of an entity's economic activity outside the market transactions is not considered;
- fixed-coefficient production technology. There are no input substitutions for production, meaning that the quantities requested adapt only to the demand and not to price variations;
- imports as a share of the total product are assumed to constant regardless of changes in the final demand.

The technical coefficient matrix values are given by the ratio of the values in the intersectoral table to the row total or to the production of each sector (column total). These coefficients therefore show the contribution each sector makes to the value created in the other sectors.

$$\alpha_{ij} = \frac{\chi_{ij}}{X_J} \qquad (4)$$

The technical coefficient α_{ij} indicates how many units of the asset coming from branch *i* are necessary for producing one asset unit in branch j. The matrix of technical coefficients can be calculated not only for the internal production inputs but also for the imported inputs and the primary inputs (wages and salaries, added value, etc.).

Equation [4] can therefore be rewritten

$$X_i = \sum_{k=1}^{n} \alpha_{ij} X_k + D_i \qquad (5)$$

This system of equations expresses the internal production flow of the product as the value of the intermediate goods and services supplied to all productions plus the value of the goods and services that satisfy the final demand. The basic input-output model can thus be represented as follows in matrix form:

$$X = AX + D \rightarrow D = X - AX \rightarrow D = (I - A)X \rightarrow X = (I - A)^{-1} D \qquad (6)$$

Where X is the production vector, A is the production coefficient matrix, D is the final demand vector and I is the Identity matrix.

In this way, production broken down by production branch is expressed as a function of the final demand addressed to each single branch. The elements of the (I – A)-1 matrix, known as the Leontief matrix, indicate the overall need for goods and services generated internally by the product of the *i-th* row required for directly and indirectly satisfying a final unit demand for the product j, thereby enabling the impact of a change in external demand on production, intermediate import inputs and primary resources inputs to be estimated.

Starting for this matrix, it is possible to compute the demand multipliers used for estimate the overall (direct, indirect and induced) employment impact (considering both created and maintained jobs) of the investment supported.

Construction of the matrix activation vector. The ability of the model to assess properly the effects of the funds raised through the Sustainability Bond on national employment is clearly related to the proper split of the financing flows to the different product items in the classification of the input-output matrix. This reallocation inevitably contains a degree of subjectivity.

In this specific analysis, investments financed through the Bond emission are considered as investment able to activate production in the construction sector.

2. Methodology used to estimate the impact on water use efficiency

Water use efficiency definition adopted

The difference between water transfer and distribution is a measure of the as it represents water losses along the network. In this perspective, an absolute index of water use efficiency can be computed as:

$$EFF_{it} = I_{it} - E_{it} \qquad (6)$$

Where I is the water transfer volume, E the volume of water distributed, *i* is the *i-th* territorial units and *t* is the corresponding year.

A relative index of water use efficiency can therefore be compute in percentage terms as:

$$eff_{it} = \frac{EFF_{it}}{I_{it}} \qquad (7)$$

Any improvement (reduction) of indexes (6)-(7) can be considered as a reduction (improvement) of water use efficiency, as long as there are higher (lower) volumes of water losses.

These indexes are compliant with those indicated in the Handbook – Harmonized Framework for Impact Reporting (2019) published by ICMA[1].

Data

The data reported in the Istat Census of water for civil use[2] define a relatively in-depth picture of the condition of the national water system, with details over the municipal and regional contexts.

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[1] See indicators for Sustainable Water Management, Core indicator A, #1, pp. 13.

[2] Cfr. https://www.istat.it/it/archivio/207497

In particular, Istat collects information of the total amount of water transferred and distributed at municipal level, with updates that follow the different releases of the census. Up to now, the last editions of the census refer to 2012 and 2015.

Analysis strategy and sample construction

From a theoretical point of view, the correct identification of the causal effect between a potential intervention and the generated outcomes, necessarily implies a comparison between the condition observed after the intervention and a hypothetical situation, named counterfactual, that would have been observed for the same subjects and in the same period in the absence of intervention

Given the impossibility of making such a comparison in the real situations, the main problem of the impact analysis is therefore to identify an adequate approximation of the counterfactual situation.

In this specific case is necessary to identify two sample: the first one includes the municipalities financed by CDP for investments in the water network during the analysis period and the second one includes municipalities that have not received funding during the same period (the so-called "control sample")[3].

This classification permits the identification of a group of counterfactual municipalities (“control sample”) which is used to estimate the net effects of investments in the Bond portfolio, assuming that municipalities not financed by CDP have not been financed by other financial institutions for the same scopes or that they have not used their own resources to realize the same type of investments[4].

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[3] Although the Bond portfolio also includes funding after 2015, for the purposes of the first step of the analysis, the sample of municipalities benefiting from CDP's intervention included only those that received funding before 2015, in order to verify the effects of the investment made by comparing it with official ISTAT data, which, as mentioned, are updated to that year. In the second step of the analysis, the results obtained are used with extrapolation methodology to produce an estimate of the overall effects generated in subsequent years.

[4] This assumption, although strong, is corroborated by the evidence that CDP is the main and almost exclusive provider of funding to local authorities, especially those of medium and small size. CDP's market share of new financing flows in recent years has been over 90%.

Estimating the impact

Once the two samples were identified, the variation in the absolute efficiency index of the water supply system was calculated as follow:

$$\Delta EFF_{it} = EFF_{it} - EFF_{it-1} \qquad (8)$$

Where t and t-1 refer to the years 2015 and 2012, in line with the information currently available from Istat.

In order to consider the aggregate effects of the investments financed by the Bond, the results of equation (8) were then aggregated for the sample of treated municipalities (CT) and for that of untreated municipalities (CNT):

$$\Delta EFF_{CTt} = \sum_{j=1}^{CT} EFF_{jt} - EFF_{jt-1} \qquad (9)$$

$$\Delta EFF_{CNTt} = \sum_{k=1}^{CNT} EFF_{kt} - EFF_{kt-1} \qquad (10)$$

Where *j* is the *j-th* municipality in the sample of subjects who were financed by CDP for the water supply before 2015, and *k* is the *k-th* municipality in the sample of subjects who were not financed by CDP in the same period. Equations (9) and (10) have also been aggregated by checking for the size of municipalities expressed in classes of resident population in order to create more robust comparative scenarios.

Equations [9] and [10] can be expressed in growth rates (%):

$$\gamma_{CTt} = \frac{\sum_{j=1}^{CT} EFF_{jt} - EFF_{jt-1}}{\sum_{j=1}^{CT} EFF_{jt-1}} \qquad (11)$$

$$\gamma_{CNTt} = \frac{\sum_{k=1}^{CNT} EFF_{jt} - EFF_{kt-1}}{\sum_{k=1}^{CNT} EFF_{kt-1}} \qquad (12)$$

Where γ_{CTt} and γ_{CNTt} are respectively the growth rate between 2012 and 2015 of the water dispersion volumes in the sample of municipalities financed by CDP and in the “counterfactual sample”.

Finally, the impact estimation is obtained by confronting the evolution of the dispersion in water network in the sample of municipalities financed by CDP (equation 9) with that which would have occurred in the same municipalities if the trend had been that of the municipalities in the “counterfactual sample”:

$$\mathrm{Impact}_{\mathrm{t}} = \left[\Delta EFF_{CTt} - (EFF_{CTt-1} * (1 + \gamma_{CNTt}))\right] \qquad (13)$$

Equation (13) expresses an absolute dimension of the impact on the dispersion of the water network (to be interpreted as a positive or a negative change), expressed in volumes of water (m^3), generated by the investments financed by CDP.

In order to generalize the estimates obtained through equation (13) to the whole Bond portfolio, which also include financing and investments realized after 2015, an out-of-sample extrapolation of results were carried out. In particular, starting from the results obtained for 2015, the unitary impact, in monetary terms, of a reduction (increase) of the dispersion was calculated by dividing the estimated volumes through equation (13) by the amount of the financing disbursed. This measure expresses the impact of 1 euro of financing in terms of decreased or increased volumes of water dispersion.

The final step of the evaluation was to multiply the unit monetary impact by the total amount of the financing included in the Bond portfolio. The assumption underlying this last estimate is that the effectiveness of the interventions is invariant over time and is not conditioned by exogenous dynamics that could occur.

3. Methodology used to estimate potential beneficiaries for intervention the prevention of hydrogeological instability and territorial protection

The social impact and effectiveness of funding for the prevention of hydrogeological instability and territorial protection have been measured in terms of the number of beneficiaries reached[5]. Considering, in fact, the nature of the investments financed, aimed at the maintenance of the infrastructures of reference in the water management of the territories and also at the safety of the same, the benefits that derive from this kind of interventions extend to the entire population present in the municipalities financed.

4. Methodology used to estimate the impact on wastewater treatment management

Data

The impact evaluation has been conducted starting from the data that refer to the percentage share of pollutant loads flowing into secondary or advanced plants, in population equivalents[6], compared to total urban loads (Aetu) generated[7]. The official statistical data related to this indicator can be inferred from the Istat Census of water for civil use[8] and is also present in the SDG Database of Asvis. The indicator is aggregated at regional level and also in this case the last available data dates back to 2015.

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[5] These indexes are compliant with those indicated in the Handbook – Harmonized Framework for Impact Reporting (2019) published by ICMA. See indicators for Other Sustainable Indicators, #3, pp. 14

[6] The equivalent inhabitant is a measure conventionally defined as the amount of pollutant load produced and discharged into the wastewater by a resident. According to the definition given by the current legislation on the protection and purification of water from pollution (Directive 91/271/ EEC), equivalence applies: 1 equivalent inhabitant = 60 grams per day of BOD5 (biochemical oxygen demand at 5 days).

[7] These indexes are compliant with those indicated in the Handbook – Harmonized Framework for Impact Reporting (2019) published by ICMA. See Wastewater Treatment Projects indicators, Core Indicator B, #3, pp.13.

[8] Cfr. https://www.istat.it/it/archivio/207497

Estimating the impact

The first step was to calculate the difference, between 2012 and 2015, of the percentage share of pollutant loads flowing into secondary or advanced plants, in population equivalents, compared to total urban loads (Aetu) generated, to verify how this indicator has evolved over time.

At the same time, those investments in category C financed in the period 2014-2015 were selected.

It was then estimated a linear regression of the following type:

$$\mathrm{Y}_{\mathrm{i}} = DX_i + \beta T_i \qquad (14)$$

Where Y is the difference between 2012 and 2015, of the percentage share of pollutant loads flowing into secondary or advanced plants, in population equivalents, compared to total urban loads (Aetu) generated; X is a carrier of control variables that include geographical distribution and dimensional characteristics; T is the share of funding provided, and *i* is the *i-th* region.

In the estimation of equation (14), the parameter β express the impact of the financement over the percentage share of pollutant loads flowing into secondary or advanced plants, in population equivalents, compared to total urban loads (Aetu) generated. A positive (negative) value of β indicates a positive (negative) impact over the percentage share of pollutant loads. The estimation of equation (14) for the sample used shows a positive and statistically significant impact at 10%[9].

Equation (12) was then used to extrapolate the value of the dependent variable following financing in subsequent years until 2019. In practice, the effects generated by the investment up to 2019 have been considering using the estimated parameters and assuming constancy over time of the functional relationship.

Further information about the methodology and data used is available on request, by contacting sostenibilita@cdp.it

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[9] The R^2 of the regression is equal to 0.5.