Methodology for estimating the impact of the Social Bond 2021

The impact generated by CDP's Social Bond is evaluated along the following economic dimensions: i) production, ii) value added, iii) employment and iv) income and private consumption. In particular, for each variable of interest, the ***total impact*** generated by the Social Bond includes:

- the *direct impacts,* exclusively related to the sector affected by the issuance;
- the *indirect impacts*, related to the increased demand of intermediate goods and services provided by other sectors not directly affected by the issuance (Leontief multiplier);
- the *induced impacts,* generated from the increase in income stimulated by the social bond (Keynesian multiplier).

The estimates have been carried out using a Multi-Regional Input-Output (MRIO) model. The analysis of the interdependencies between the regional economic systems assesses how the total impacts are distributed across the local area which has been invested in. The model[1] presents a disaggregation into four macro-regions (Northeast, Northwest, Centre and South) and 54 production sectors. The interdependencies between the different areas represent the peculiarity of the MRIO models, as they make it possible to determine the ability of the local area to internalise (retain) the multiplier effect of both domestic final demand and that coming from the other macro areas.

Input-Output tables and multiregional matrices

The IO tables or tables of sectoral interdependencies are a schematic-accounting representation of the different value flows in a given economic system and over a given time frame (normally one year, known as the base year). The reference unit consists of economic sectors grouped together in branches (production units characterised by similar cost structure, production processes and products). Each branch carries out two types of transactions: i) purchases from other sectors of goods and services used for their own production activities (use branches); ii) sales of goods and services it produces to other sectors and end consumers (supply branches).
The accounting structure of the tables underlying the MRIO model consists of two sets of accounts: the single region supply and use table[2] (SUT) and a multi-regional trade matrix linking the four macro-regions.
Starting from the standard IO models formulation and the basic assumptions of perfect competition and economic equilibrium between supply and demand, total production (domestic

[1] Developed by the Regional Institute for Economic Planning of Tuscany (IRPET).
[2] For a detailed description of the IRPET's SUTs construction and balancing methodology, see Paniccià R. & Rosignoli S., "*A Methodology for Building Multiregional Supply and Use Tables for Italy*", IRPET, 2018

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and imported) in sector *m* is equivalent to what is consumed locally (intermediate or final goods) and to what is exported. Formally[3], the following relationship holds:

$$X^m = \sum_n K^{mn} + Y^m \qquad (1)$$

Where X^m corresponds to total production of sector *m*; $\sum_n K^{mn}$ represents the intermediate demand of the production in sector *m* necessary to satisfy the production in sector *n,* and Y^m corresponds to the final demand of the sector.
The assumptions underlying the IO model can be summarised as: i) linear production technology, that is, the input quantity used by each production sector is proportional to the volume of output X^m; ii) assumption of constant economies of scale in all economic activities, i.e. the unit input needed is assumed to be constant regardless of changes in production volumes; iii) absence of externalities, i.e. the effects deriving from economic activity outside the market transactions are not considered; iv) Leontief's production function, which assumes no substitutability between production factors (capital and labour).

The key element of the IO models is the matrix of technical coefficients, whose single elements a^{mn} define the relationship between production levels and intermediate demand:

$$a^{mn} = \frac{K^{mn}}{X^n} \quad \Longrightarrow \quad K^{mn} = a^{mn} \cdot X^n \qquad (2)$$

Where a^{mn} are the technical coefficients and represent the monetary value of the product in sector *m* (input) necessary to produce a unit of value in sector *n* (output), K^{mn} is the production' intermediate demand in sector *m* necessary to satisfy the production in sector *n* and X^n represents the production value in sector *n*. It should be noted that the value assumed by the technical coefficients depends on the production technology of the area considered. The matrix of technical coefficients can be calculated not only for production but also for imported and primary inputs (wages and salaries, value added, etc.).
Once equation (2) has been defined, (1) can be rewritten as:

$$X^m = \sum_n a^{mn} \cdot X^n + Y^m \qquad (3)$$

And the basic IO model can be represented, in matrix notation, as follows:

$$X = (I - A)^{-1} \cdot Y \qquad (4)$$

Where $(I - A)^{-1}$ is the well-known Leontief inverse matrix or multipliers matrix. The sum of the matrix columns values represents the increase in production due toa unitary variation in the final demand of the sector considered and enables to estimate the impact of an exogenous change

[3] Adapted from Cherubini L., Ghezzi L., Paniccià R. and Rosignoli S, *"Economic integration between the Mezzogiorno and the Centre North"*, Bank of Italy, 2011.

in the final demand on production, intermediate imported inputs and primary inputs. Finally, from the Leontief's inverse matrix it is possible to compute the multipliers used to estimate the impact of investments in terms of employment supported and value added.

Starting from the basic IO model, the use of interregional matrices has allowed to extend the accounting structure of the model (MRIO) to estimate the impacts of the social bond in terms of trade flows between the macro regions. The interregional matrix introduce a second causal relationship (in addition to the Leontief-type technical relationship) of multiregional trade patterns, distributing the total final demand among the various macro areas considered and determining the production levels of each macro region (Cherubini et al., 2011). Therefore, compared to the basic model, the MRIO model is able to take into account the (more realistic) assumption that the region *j* of consumption of intermediate production K_j^{mn} and final consumption Y_j^m may differ from the region *i* of production X_i^m and import J_i^m. In other words, it is possible to model the monetary flows between different sectors of the economy and regions under analysis.

Formally, after the introduction of the *trade coefficient (T) matrix*, whose elements t_{ij}^{mn} (interregional trade coefficients[4]) represent the share of product in sector *m* coming from region *i* and used by sector *n* in region *j*, equation (4) can be rewritten as follows:

$$X = (I - \mathbf{T} \cdot A)^{-1} \cdot Y \qquad (5)$$

Finally, the vector of the investments attributable to the social bond issuance was imputed in the model using a bridge matrix to match the sectoral classification used in the multiregional IO matrices. More specifically, the use of a bridge matrix makes it possible to assign the changes in final demand due to the social bond in a more precise and accurate manner, as specific[5] categories of expenditure[6], then converted into the classification used in the IO matrices (NACE rev.2), are used.. In this case, investments have been converted from sector of origin to sector of destination (user).

[4] More in detail, for the construction of the interregional trade coefficients, IRPET has followed the Chenery-Moses model (1970), where the underlying assumption is that the elements t_{ij}^{mn} are unconnected to the sector in which they are used. Please refer to p.2 therein for further information.

[5] For example, if one considers the government consumption by function in infrastructure, the bridge matrix allows to correctly allocate these expenditures to the various economic sectors involved such as the construction sector, transport sector, machinery sectors, etc.

[6] In particular, the following international standards defined by the United Nations Statistics Division were used; i) COICOP (Classification of Individual Consumption by Purpose), for household consumption, ii) COFOG (Classification of the Functions of Government), for government expenditure; and iii) Gross fixed capital formation by asset for gross fixed investments.