UNIVERSITÀ di VERONA | Department of ECONOMICS

Working Paper Series
Department of Economics
University of Verona

The dynamic approach of modelling regional recovery investment policies using environmentally-extended SAM Matrix

Darlington Agbonifi

WP Number: 4 April 2023

ISSN: 2036-2919 (paper), 2036-4679 (online)

The dynamic approach of modelling regional recovery investment policies using environmentally-extended SAM Matrix*

Darlington Agbonifi†

April 7, 2023

Abstract

This paper analyzes the socioeconomic and environmental dynamic impacts of an exogenous public-financed increases in infrastructure investments and modernization projects (CIS) of around EUR 1097 billion for the 2021-2026 period on industrial outputs, household employment and income distribution, in the Italian province of Taranto using an environmentally extended Social Accounting Matrix (ESAM) techniques for the year 2015. This method reconciles the analysis of the impact of an investment policy aiming at climate neutrality on a local economy. As well as an in-depth evaluation of the intersectoral production linkages through trade and multiplier analysis, with the cost-benefit (CB) analysis of a large-scale investment project. The evaluation of the dynamic impacts on the local economy produces a benefit/cost ratio of 5.63 that increases to 7.88 when the CB analysis of the project, and therefore the revenues generated during the operational period, are also included. The inclusion of environmental externalities associated with industrial greenhouse gas (GHGs) emissions reduces by about 16% the benefit/cost ratio in the construction period. In the operational period, when we assume that green production technologies are adopted, the reduction of the ratio is more consistent. The distributional impact of the investments on the annual income of households is also acceptably equitable.

Keywords: Policy Impact Evaluation, Cost Benefit Analysis, Local Economic Development, SAM
JEL - classifications: C67, D57, Q56, Q58, R11

---

* **Acknowledgements:** I gratefully thank my supervisor Alessandro Bucciol and my co-supervisor Emanuele Bracco for their support. I thank the Economic Living Lab for granting access to the dataset. The views expressed herein are those of the author and do not necessarily reflect the views of the University of Verona.

† Darlington Agbonifi is a PhD candidate in Economics at the Department of Economics, University of Verona, PO Box 24, 37129, VR, Italy. Email: darlington.agbonifi@univr.it

1 Introduction

Taranto is a provincial city with about 200.000 inhabitants, located in the Southern Apulia (Puglia) region of Italy. The city is home of the largest complete cycle steel production facility (Gruppo ILVA) in Europe with a capacity of about 10 million tons annually (Vagliasindi & Gerstetter, 2015; Neglia, Sangiorgi, Bordignon, & Marescotti, 2018). According to (Lai, Panfilo, & Stacchezzini, 2019) over the years, policy-making decisions by the Italian national authorities on ILVA steel company in the name of higher public interest neglected not only the environmental and health risk of corporate unsustainability practices but also the European union (EU) relevant legislation. Particularly, Taranto and the rest of the Apulia region economic structure are mostly dependent directly or indirectly on the steel supply value chain, lacking a strategic sustainable development plan for more than two decades. The ILVA steel production facility with a surface area of 15 million sq.m) still generates levels of pollution that are worrying not only to the Italian authorities, but also the EU institutions (Vagliasindi & Gerstetter, 2015; Neglia, Sangiorgi, Bordignon, & Marescotti, 2018). As a result, the crisis that began in the late 1980s led to abrupt halt on the city's growth, significant job losses, serious public health problems. Consequently, these negative trends have led to a gradual depopulation of residents and territorial abandonment in the region, as young people move north or abroad in pursuit of jobs.

The Taranto case study and the rest of the Apulia regional economic structural decline is reminiscent of the substantial heterogeneity and disparities in terms of production efficiency, living standards (Dalla Chiara, Menon, & Perali, 2019), and environmental quality across Italian regions (Istat, 2019). For example, the southern regions (Abruzzo, Basilicata, Calabria, Campania, and Apulia) are relatively poorer and lagging economically compared to the richer northern regions (Lombardy, Piemonte, and Veneto) where industrial production mainly take place. This "North-South dualism" has persisted since the reunification of Italy in 1861 and its associated structural imbalances have been compounded by the outbreak and subsequent fallout of the COVID-19 global health pandemic (Fabbris & Michielin, 2010; Pasquini & Rosati, 2020; OECD, 2020; Svimez, 2020).

The main objective of this paper is to examine the socio-economic and environmental dynamic impacts of calibrated fiscal policy interventions at the local level of the Taranto economy using an environmentally extended Social Accounting Matrix (ESAM) approach. The ESAM method is highly micro founded and contains information about the distribution of income, consumption, and savings, and three skill levels of the labor market related to each sector. The proposed method also uses a novel technique that unifies the cost-benefit analysis (CB) of a large-scale investment project with the traditional impact evaluation (Scandizzo, 2021).

Italy's persistent regional dualism raises numerous questions as to the effectiveness and potential benefits of sustainable development strategies targeting specific industries that do not include environmental policy instruments aimed at tackling territorial structural imbalances not only at a national-regional levels but also at a local provincial economic level. In this regard, empirical studies show that well calibrated local, regional, and interregional policy-making interventions as well as exogenous investment shocks in key sectors can be a crucial engine for inclusive economic growth over the medium to long-term horizon (Temursho, 2016), with both direct and indirect spillover effects on national economic agents. These agents include households, private enterprises, government as well as various industrial sectors and their interdependencies or linkages with global value chains (GVCs) across the world (Mainar-Causapé & Philippidis, 2018).

To address the dualism and the ensuing structural decline that have continually undermined the economic base of Italy's southern regions, various public policies have been designed to enhance economic performance and increase regional resources. Within these policies, and included in the post Covid Italian recovery plan, the 2021-2026 "Taranto Coming Future" strategic recovery investment plan of around EUR 1.097 billion by the Apulia region and the municipal administration of Taranto may be a critical step forward to take Taranto on a socio-economic and environmentally sustainable path.

The organization of the paper is as follows. Section 2 describes the methodological framework for constructing local SAMs and techniques to be used to augment the SAM to host the CB analysis of the so-called (Contratto Istituzionale di Sviluppo – CIS) Taranto large-scale strategic investment recovery project. Along with the socioeconomic impact evaluation on the local economy and to account for externalities due to the environmental impact from human activity. Section 3 presents the structure and main features of the Taranto local economy, followed by a brief introduction of the CIS investment plan for the economic and environmental restoration of the Taranto province. Section 4 focuses on the empirical simulation of the socioeconomic and environmental impacts of the CIS investment plan and the integrated CB analysis of the distributional transfers amongst different economic agents. Finally, section 5 provides concluding remarks and discusses key policy implications. The appendixes summarize the local economy and the market-based strategy and pricing measures of Greenhouse gases (GHGs) emission for the construction of Taranto ESAM for the reference year 2015.

2 Methodological Framework

The fundamental purpose of a SAM is to document all the economic-wide series of transactions and transfers of income between different economic sectors and institutions (i.e., households, private enterprises, government, and the rest of the world) within a socio-economic system (national, regional, or sub-regional, etc.) during a specific period, usually for a year. Furthermore, SAMs represent the core economic-wide flexible and comprehensive database required for the calibration of parameters for a family of Computable General Equilibrium (CGE) models, including multiplier analysis (see, for example, Scandizzo & Ferrarese, 2015; Perali & Scandizzo, 2018).

2.1 The Taranto Social Accounting Matrix

The potential benefits of the implementation of a large investment project with significant cost attracts high level of public attention due to the substantial direct and indirect impact on the local community and the environment (Donati, et al., 2020). Local SAMs are constructed using a top-down approach starting from the national SAM that is first consistently disaggregated at the regional level to get down to the provincial level. We now describe the design of the Taranto SAM, the data sources used and the technique to be used to augment the SAM to host the cost-benefit analysis of the CIS Taranto "large" project as well as externalities due to the environmental impact. The names of the industrial sectors included in the provincial local SAM of Taranto for the reference year 2015 are illustrated in Appendix **Table A1**. The SAM includes data for 75 sectors along with estimates of Taranto's international trade with the rest of the world. The labor employed in each sector is estimated according to its low, medium, and high skill components. Households' consumption, income and savings are disaggregated by deciles to account for the distributive impact of an exogenous shock (such as the CIS project).

2.1.1 The Basic Structure of the Local SAM for Taranto

From a double-entry accounting framework, SAM is a square matrix that extends the Leontief (I-O) model, with identical sequence of accounts in horizontal rows and vertical columns. The rows represent flows of goods/factors, while the columns represent the flows of payments. Following the current approach in economics (Robinson, Cattaneo, & El-Said, 2001; Lofgren, Harris, & Robinson, 2002), let ***T*** be a square matrix of SAM transactions in a given time period, where each of its nonzero elements or cell indicated by t_{ij} represents simultaneously an expenditure or outflow in monetary terms by the column account $j = 1,2, \dots . n$ and an income or inflow to the row account $i = 1,2, \dots . n.$. In accordance with accounting balance, the corresponding total revenues (row totals) and total expenditures (column totals) must be equal (represented as y_i) for a generic account i where $y_i = \sum_{i=1}^{n} t_{ij} = \sum_{j=1}^{n} t_{ji}$. A SAM coefficient matrix, **A**, can be constructed from **T** by dividing the cells in each column of **T** by the corresponding column sums denoted by a_{ij}, where $a_{i,j} = t_{ij}/y_j$.

A SAM constructed in this fashion can be taken as a snapshot that shows a complete circular flow of income distributions and consumption expenditures that characterizes a market economy in equilibrium (Leontief, 1991; Stahmer, 2004; Breisinger, Thomas, & Thurlow, 2009) and in our case it provide a summary of key structural features of the Taranto economy.

Figure 1 below shows the augmented macro-version of the local SAM for Taranto illustrated in Appendix **Table A1**, with aggregated accounts for activities, factors of production, ten household groups, three skills levels for the labor market of each sector, private enterprises, government, capital formation, investment projects, environmental externalities, and Taranto's international trade flows with the rest of the World. The Taranto SAM is augmented by a column and a row devoted to the cost (or the exogenous shock) and the return stream of the project, respectively. The matrix is also augmented for the environmental accounts specific to each pollutant. The matrix augmentation technique is explained in subsection (**2.1.3**). The SAM accounts are generally grouped into endogenous and exogenous variables (Civardi & Lenti, 2006). Endogenous accounts (i.e., factors, institutions, activities) are determined by the economic model. On the other hand, exogenous variables (policy instrument) are determined outside the model.

Figure 1. The Taranto SAM augmented with Project and Environmental accounts

		Activity	Value added			Institutions			Direct taxation	Capital formation	Export	Investment Project	Environmental externalities	Total
		55 sectors	Labor (low, med,high skill)	Capital	Indirect taxation	Household income decile	Enterprises	Government	Taxes	Capital formation	Rest of the world			
Activity	55 sectors	Intermediate Consumption				Consumption		Consumption		Investments	Export to the rest of the world			Demand
Value added	Labor (low, med, high skill)	Wages												Gross domestic product
	Capital	Mixed income												
	Indirect taxation	Taxes												
Institutions	Household income decile		Labor income	Other income		Transfer	Capital income	Income from pensions, subsidies, contributions		Negative savings	Income from abroad			Institution incomes
	Enterprises							Contributions, subsidies		Negative savings				
	Government				Tax transfer				Tax transfer	Negative savings	Transfer form abroad			
Direct taxation	Taxes					Taxes	Taxes							Direct taxation
Capital formation	Capital formation					Savings	Savings	Savings			Capital from abroad			Saving
Import	Rest of the world	Imports from the rest of the world				Consumption								Import
Investment Project														
Environmental externalities														
Total		Supply	Factor outlays			Institution expenditures			Direct taxation	Investments	Export			

2.1.2 Data sources for the Local Taranto SAM

While the basic standards used around the world for constructing SAMs tend to reflect the United Nations guidelines (SNA), in practice the classification of accounts and the degree of disaggregation can show considerable differences across countries, research, and policy applications, depending not only on the objectives and features under study, but also on the availability and quality of data (Keuning & de Ruuter, 1988; Mainar-Causapé, Ferrari, & McDonald, 2018). For example, macro-SAMs can be constructed, using data drawn from a country's national accounts, firms and household income surveys, government budgets and balance of payments, etc.

On the other hand, the disaggregated micro-SAMs can be obtained by using the data in the macro-SAMs accounts as control totals. The pressing challenges for constructing and updating consistent SAMs for recent years involves finding ways to incorporate fragmented or missing datasets ranging from different sources, and also how to fix statistical inconsistencies related to the timing and adjustment of the I-O tables (Lemelin, Fofana, & Cockburn, 2013; Robinson, Cattaneo, & El-Said, 2001). Balancing SAMs accounts to achieve broad consistency results under the equality constraints between incomes and expenditures include various mathematical and statistical techniques and may themselves yield heterogenous or different SAMs.

2.1.3 The Augmented Local SAM for Project Analysis

The idea proposed by Scandizzo (2021) of integrating of a project accounting framework in a SAM, amounts to adding a project column of cash outflows and a project row of cash inflows. This technique is based on the intuitive interpretation of the cost and revenues stream of a project as a column and row vector that can be used to augment a SAM defined in the absence of the project. By analogy, SAM production activities can be reinterpreted as sets of projects, that may consist in acquiring investment goods (in the case of the capital formation sector) or intermediate inputs, including capital user charges for the other sectors. Depending on its time profile, the project may generate net costs or net benefits in the various rounds of the calculation, but typically it is associated with net costs in the so-called construction period (T=0) and net benefits in the operational period (T=1). While the cost benefit approach is in general a partial equilibrium analysis, impact evaluation roots on a general equilibrium set of interdependent effects.

For a project with sufficiently positive returns, the operational period is characterized by project inflows that become larger than outflows, so that returns can be assigned to capital or institutions such as governments or households. The project contribution in both the construction and operation periods can be exhaustively described in terms of value-added formation and costs and benefits. Net returns are typically interpreted as capital costs and credited to the column thus ensuring accounting balance.

Under the assumptions of the Leontief IO model, the dynamic impact of a vector of investment expenditure shock can be consistently embedded in a specific row and column of a SAM beyond the construction period. As illustrated in **Figure 1** above, augmented SAM-based models can be applied both for the impact evaluation and the cost-benefit analysis of investment projects and their environmental footprint such as carbon emissions during the construction and operational periods (Stone, 1952; Stahmer, 2004; Scandizzo, 2021). Using the results presented by Scandizzo (2021), we can write the impact of a project on a vector of endogenous variables $\Delta\mathbf{X}_e = X_{ec} - X_{es}$ in the economy by considering for each period, three different variables: (i) the SAM submatrix for the endogenous accounts with $\boldsymbol{A_{ee,c}}$ and without $\boldsymbol{A_{ee,s}}$ the project, (ii) the variation $\Delta\boldsymbol{A_{ee}}$ of the $\boldsymbol{A_{ee}}$ matrix as a consequence of the project, (iii) the variation of exogenous SAM accounts induced by the project $\Delta\mathbf{X}_{\boldsymbol{x}} = X_{xc} - X_{xs}$:

$$\Delta\mathbf{X}_e = (\mathbf{I} - \boldsymbol{A_{ee,c}})^{-\mathbf{1}}[\boldsymbol{A_{ex,c.}}\Delta\mathbf{X}_{\boldsymbol{x}} + (\Delta\boldsymbol{A_{ee}})X_{es} + (\Delta\boldsymbol{A_{ex}})X_{xs}] \quad (1)$$

Equation (1) can be decomposed in three components (i) the autonomous variation of the exogenous variables (capital formation, exports or a specific vector of project expenditures); (ii) the variation of the SAM coefficient submatrix of the transactions within the endogenous accounts; and (iii) the variation of the SAM submatrix of the transactions between the endogenous and the exogenous accounts. Intuitively, the exogenous activities increase aggregate demand through the value chains quantified in the SAM, but may also introduce technological change via a change of the coefficient submatrix obtined after rebalancing the initial SAM after the shock.

Therefore, the corresponding present value at rate of discount *r* of project impact can be directly derived as

$$\sum_{t=0}^{T} \frac{\Delta\mathbf{X}_{et}}{(\mathbf{1}+\mathbf{r})^{t}} = (\mathbf{I} - \boldsymbol{A_{ee.}})^{-\mathbf{1}} \sum_{t=0}^{T} \frac{1}{(\mathbf{1}+\mathbf{r})^{t}} [\boldsymbol{A_{ex,t+1}}\Delta\mathbf{X}_{\boldsymbol{xt}} + (\Delta\boldsymbol{A_{ee}})X_{est} + (\Delta\boldsymbol{A_{ex,t}})X_{xt}] \quad (2)$$

Equation (2) (see, Scandizzo 2021) allows to estimate the present value of project impact using a single SAM and its variations as the direct and indirect effects of the present values of the project cash flows. In turn these are defined as the sum of two components: (i) the yearly project outlays for a given structure of the interdependencies between the project and the rest of the economy, and (ii) the yearly variations in the same outlays due to the variation of these interdependencies brought about by the changes of project outlays over time.

2.1.4 The Augmented Local SAM for Environmental Analysis

As a further extension of the Leontief IO model, we augment the Local SAM with the environmental accounts (see, **Figure 1**) to take into consideration sectorial emissions within the economic system of Taranto (Leontief, 1970). In other words, the total direct and indirect pollutant emissions (m_i) of sector i implied in satisfying a specific amount of final demand during a specified period (i.e., a year) can be represented as:

$$\mathbf{m} = \mathbf{e}(\mathbf{I} - \mathbf{A})^{-1}\,\mathbf{f}$$

or (3)

$$\mathbf{m} = \mathbf{eLf},$$

where, **e** is a $q \times m$ coefficient matrix representing the quantity of pollutants (i.e., in metric tonnes of CO2) emitted to produce one unit of sector i monetary output of each industry (Tukker, Huppes, van Oers, & Heijungs, 2006). **A** denotes the technological $n \times n$ square matrix, while $(\mathbf{I} - \mathbf{A})^{-1} = \mathbf{L} = [l_{ij}]$ is the Leontief inverse matrix, and **f** is the $n \times 1$ column vector of exogenous final demands. A detailed description of the method is illustrated in (Appendix A).

3 Data: Features of the Taranto Economy and the CIS Project

This section describes some of the most relevant characteristics and structure of the local economy in terms of consumption, income, savings, and taxes by income decile.

3.1 Consumption, Income, Savings, and Taxes by Income Decile

As illustrated in **Table *1*** below, SAM household accounts have been divided into income deciles to better understand the relations linking income, consumption, intra-family transfers, and direct taxation. The subdivision into deciles derives from elaborations on a regional basis performed using the dataset relating to the Survey on the Income and Living Conditions of Italian families (EUSILC) from ISTAT.

Consumption was imputed based on expenditure deciles, again with reference to the annual survey of EUSILC microdata of about 26,000 households whose data set was matched with the Household Budget Survey generating an Integrated Standard of Living Survey of Italian Households. This matched information allows us to construct a highly reliable information about savings and to conduct an accurate distributive analysis of the shocks of interest and the associated fiscal burdens on the income deciles. Taxation was estimated as a proportion of taxation and income for each decile of income of Apulian households. Income from work was divided according to the educational level of the recipient, low (up to middle school), medium (high school) and high (from graduation), attributing the level of education by sector and by earner based on regional data resulting from the roster of active companies (ASIA) of ISTAT.

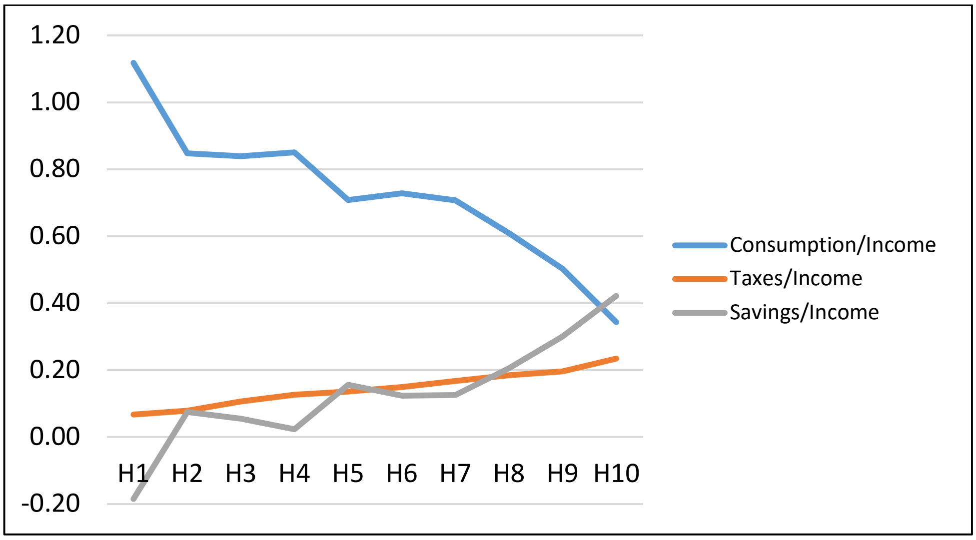
Table 1. Main budgetary aggregates of the Taranto families

Budgetary Aggregates	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	Total
Dep. Labor Income (low skill)	35	59	78	98	117	140	171	213	282	487	**1679**
Dep. Labor Income (med. skill)	39	66	87	110	131	157	192	239	316	547	**1884**
Dep. Labor Income (high skill)	18	31	41	52	62	74	90	113	149	258	**888**
Other incomes	156	282	359	380	411	433	426	562	658	1155	**4823**
Total Incomes	248	439	565	639	719	804	880	1128	1405	2447	**9273**
Transfer (in and out)	1	2	3	4	4	5	5	6	8	12	**50**
Consumption	278	371	474	543	509	585	622	687	707	841	**5617**
Direct Taxes	17	35	60	81	98	119	147	208	276	574	**1614**
Total Expenditures	**294**	**406**	**534**	**624**	**607**	**705**	**769**	**895**	**983**	**1414**	**7232**
Savings	-46	33	31	15	113	99	111	233	422	1032	**2042**

Note: values are in millions of euros unless otherwise specified

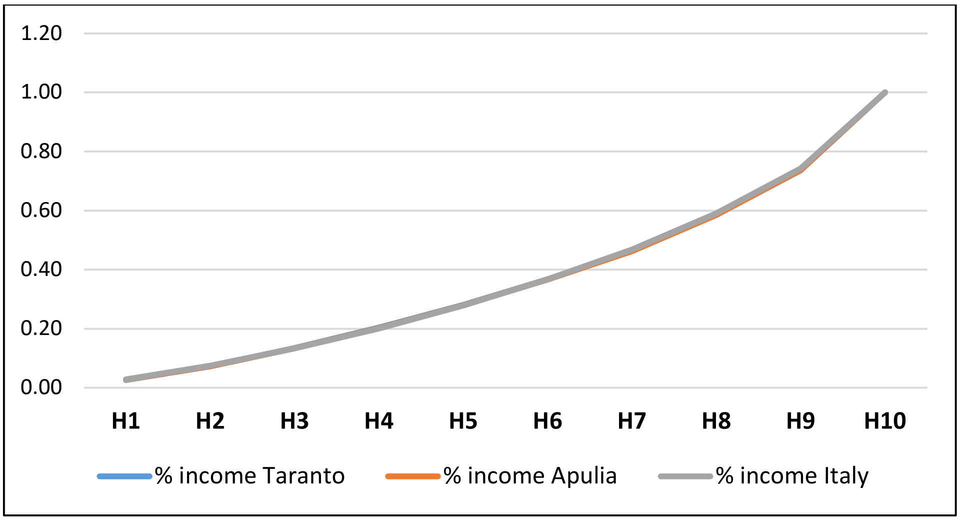
About half of the income derives from income from employees, while the other half from capital, income paid by companies, and social welfare sources (pensions, subsidies, etc.). Income from employment is 38% related to recipients with a low level of education, 42% with medium level and 20% with a qualification equal to or above a tertiary degree. Direct taxation represents about 7% of the income of the poorest families to reach 24% of the income of the 10th income decile; consumption represents 112% of the income of the families of the first decile and 34% of the income of the richest ones (see **Figure 2** and **Figure 3** below). The propensity to save is negative for the poorest families, while it reaches 42% of income for the richest families.

Figure 2. Household consumption, taxes, and savings by income decile



Comparison of the income distribution in the Taranto province, Apulia and Italy is represented by the Lorenz curves that shows the inequality in income distribution within an economy as illustrated below

Figure 3. Lorenz Curves



The ex-ante investment Gini index for Taranto (0.362) is lower than the Apulia index (0.363) and higher than the nation reporting (0.359). The level of inequality in the distribution of Taranto income is on average with the regional and national indexes.

3.2 Multiplier Analysis

The total sector multiplier reproduces the intensity with which a sectoral investment spreads over the entire domestic economy. For example, an investment of € 701.08 M in the construction period generates an overall impact on the Taranto economy of € 3946M, in terms of inter-sectorial purchases from intermediate suppliers (€ 2705M), of which € 954M deriving from the direct effect, € 1751M from the indirect effect, and € 1241M of value-added. The induced effect on potential household spending from earnings of direct and indirect expenditures is about € 1078M (see, **Table 6**).

An industry output multiplier is the total value that would be generated across the regional economy (under the assumptions of Leontief's model), when a unit of product in the subject industry is made available for consumption in final demand (Miller et al., 2009). The output multipliers are the column-wide sums of elements in the Leontief inverse matrix. From an intersectoral linkages perspective, we can derive the backward (BL) and forward (FL) linkages with the aim of identifying the importance of individual sectors that are economically important to the economy of the Taranto (Temursho, 2016; Khondker, 2018).

Table 2 below shows the multiplier effects for the local economy of Taranto. Energy, associative organizations, and social assistance are the three sectors with the highest total multiplier, over 4.5 points, followed by construction, 4.42, steel and metal, 2.84. It is important to specify that these production multipliers are very high because they record gross output effects and thus should be interpreted as indicators of the speed of diffusion of the economic impact of investment rather than the final effect, which is measured correctly only by the value-added multipliers.

Table 2. Taranto multipliers by selected sectors

Sectors	Production	Direct	Indirect	VA	Institutions
Energy	4.73	1.71	3.02	1.75	3.23
Associative organizations	4.57	1.02	3.55	2.10	3.70
Social Assistance	4.50	1.09	3.41	2.18	3.83
Water supply	4.46	1.38	3.07	1.93	3.42
Construction	4.42	1.51	2.91	2.15	3.88
Entertainment	4.40	1.25	3.15	1.99	3.61
Travel agency services	4.27	1.02	3.25	1.59	2.88
Sports and Entertainment	4.26	1.06	3.19	2.04	3.68
Security services	4.25	1.14	3.11	2.01	3.58
Accomm&Restaurants	4.25	1.12	3.13	2.02	3.66
Health Services	4.24	1.26	2.98	2.16	3.84
Postal Services	4.22	1.01	3.20	2.02	3.50
Other personal services	4.20	1.04	3.16	2.16	3.98
Wholesale Repair	4.17	1.06	3.11	1.93	3.50
Storage and transport support	4.13	1.23	2.90	1.80	3.24
Public Admin	4.13	1.22	2.91	2.32	4.06
Retail	4.06	1.15	2.91	2.14	3.93
Financial services	4.05	1.17	2.89	2.06	3.70
Education	4.05	1.10	2.96	2.36	4.06
Transports	4.03	1.20	2.84	1.77	3.20
Steel and metal (Metallurgy)	2.84	1.07	1.77	1.42	2.39
Mining	1.28	1.01	0.27	0.18	0.33

Note: The production multiplier is decomposed in direct and indirect multipliers.

3.3 Construction of the Exogenous Shock of the CIS Investment Plan for Impact Evaluation

The provincial territory of Taranto will be affected in the short run by an exogenous investment shock for a total of 1.7 billion euros. Particularly, 1.1 billion euros from the CIS, about 200 million from industrial development contracts and another 400 approximately million euros for the program of the XX Mediterranean Games. The corresponding impact assessment, starting from a suitable economic modelling tool (such as a disaggregated SAM and / or a CGE applicable to it), can be carried out through the construction of specific expense vectors, which simulate both the construction phase and that of regime, also starting from the identification of the "producers" and "owners" sectors, based on the following assumptions.

For the CIS, which finances a total investment amount of about € 1.1 billion, the following documents were reviewed:

- the state of implementation by sector of intervention in 2018[1], which indicates the planned expenditure amounts and the part reported for each macro-category for a total value of 1,007 million euros (see, Annex 1.1),

- a preliminary form, still being completed, prepared by MIBACT, in which the actions and investment priorities for urban regeneration interventions are identified (which are added to the two interventions[2] that have in fact been concluded in the CIS); for these new interventions, an additional 90 million euros will be allocated, concentrated in the recovery of some historical-cultural sites and the neighbouring streets of the Old City (Città Vecchia) of Taranto.

Table 3 and **Table 4** summarize this analytical presentation of the Taranto Institutional Development Contracts (CIS) in a final vector representing both the vector of exogenous shocks applied to the local economy to evaluate the impact of the investment plan and the cost flow of the project as it is traditionally modelled in project analysis.

Table 3. Project List of the CIS investment Plan

Instrument	Related sector	Project	Project cost
CIS	Environment	Drainage Mar Piccolo	55.0
CIS	Environment	Platform riqualification	20.8
CIS	Environment	Ex Cemerad	10.0
CIS	Environment	Statte Aquifers	37.0
CIS	Environment	Environmental Centre	1.0
CIS	Environment	Waste water Ilva	14.0
CIS	Environment	Cimitery San Brunone	11.0
CIS	Environment	Restoration Statte Municipality	0.2
CIS	Environment	Water collection Crispiano	3.0
CIS	Environment	Environmental Riqualification Montemesola	3.0
CIS	Environment	Water collection Massafra	3.0
CIS	Environment	Environmental Riqualification Statte	3.0
CIS	Military Arsenal	Installations Military Arsenal	37.2
CIS	Military Arsenal	Enhancement Military Arsenal	5.7
CIS	Health	San Cataldo Hospital	207.5
CIS	Health	Medical equipments	70.0
CIS	Ports	Logistic plate Taranto	219.1
CIS	Ports	Riqualification Peer	75.0
CIS	Ports	Dredging	83.0
CIS	Ports	Taranto RFI Railroad	25.5
CIS	Ports	Foranea Dam	14.0

[1] The Governance of the CIS, supported by the related Mission Structure, had a setback in 2018, a critical issue that does not yet seem to have been resolved due to the resumption of construction sites and acceleration of spending; for these reasons it can probably be assumed that the actual progress is very similar to that recorded about two years ago.

[2] Restoration works of the former Convent of S. Antonio and restoration and enhancement of the Compendium of Santa Maria della Giustizia.

CIS	Education	Schools Riqualification	8.2
CIS	Education	School neighborhoods	1.2
CIS	Education	Risk Analysis of School Projects	0.1
CIS	Tourism and culture	Restoration Convento	5.1
CIS	Tourism and culture	Restoration Compendio	2.0
CIS	City Development	Soil remediation	2.0
CIS	City Development	Urban Forest	6.9
CIS	City Development	Carducci Palace	2.1
CIS	City Development	Residential construction	20.0
CIS	City Development	Restoration Via Garibaldi	2.1
CIS	City Development	Housing Sociale	15.2
CIS	City Development	Restoration Palazzo Troilo	3.6
CIS	City Development	Lungomare, Tamburi, sport facilities	40.0
CIS	MIBACT	Riqualification Città Vecchia	90.0
		TOTAL	**1096.3**

Table 4. Project costs by year and sectors (values in M€)

	Construction year						
	1	**2**	**3**	**4**	**5**	**6**	**Total**
Agriculture	2	2	0	0	0	0	**3**
Manufacture of non-metal products	9	9	8	8	6	4	**45**
Manufacture of metal products	9	5	4	4	4	2	**28**
Computer and electronic products	14	5	5	5	5	4	**38**
Electrical equipment	26	6	5	5	4	2	**48**
Machinery & equipment	16	12	11	11	7	4	**61**
Other transport equipment	9	9	9	9	9	9	**55**
All utilities & waste	5	5	5	5	0	0	**21**
Construction	129	125	113	107	59	40	**572**
IT services	1	1	1	1	1	0	**5**
Business services	0	0	0	0	0	0	**1**
Rest of the world	73	37	34	34	26	16	**220**
Total	**292**	**217**	**196**	**190**	**121**	**80**	**1096**

4 The Socio-Economic-Environmental Impact and Cost-Benefit Analysis of the Taranto CIS

This section focuses on the socio-economic and environmental impact evaluation, followed by the CB analysis of the Taranto CIS investment project. The results are obtained using the methodology explained in section (**2**) are presented first for the impact evaluation and secondly for the cost-benefit analysis that is inclusive of the impact evaluation.

4.1 The Socio-Economic Impact Evaluation

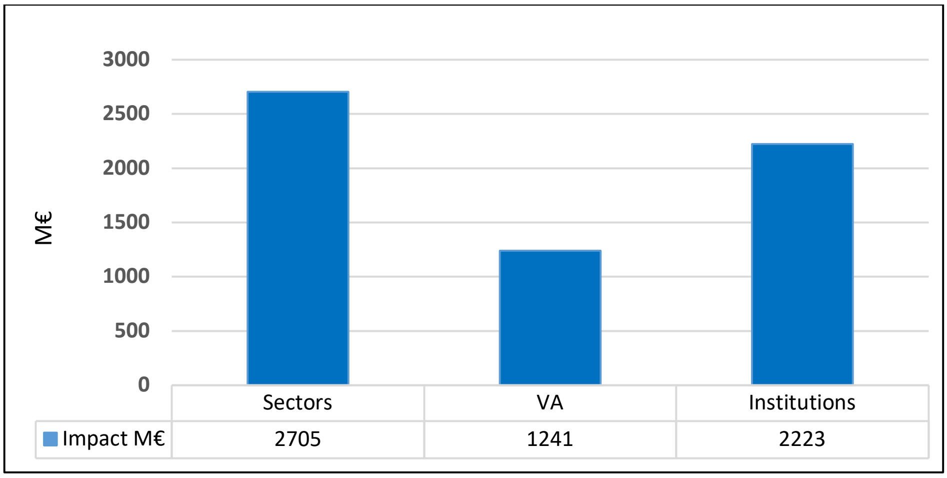
In order to obtain a feasible column vector of exogenous shock to the micro-based disaggregated local SAM, the CIS investment of 1096 M € as reported in section (**3.3**) was reduced by 220 M € for products / services from the rest of the world outside the Apulia region to obtain 876 M € of net investment. In general, supply is not able to respond perfectly elastically to changes in demand also because supply capacity is limited by the existing local resources. Some resources may be provided by adjacent provinces of the Apulia region. For example, increasing demand for steel exports from Taranto may not lead to increased mining production of limestone material if additional limestone deposits do not exist in Taranto or if the necessary extra investments in mining equipment have not been made. Moreover, increasing production in some sectors may lead to falling production in others if some resources are scarce. Therefore, to acknowledge such supply constraints and avoid overstating the impacts of linkage effects, we further apply a coefficient of 0.8 to the net investment of all sectors to isolate the impact on the province of Taranto alone thus generating an exogenous shock of 701 M € distributed across the productive sectors as shown in **Table 5**. The shock corresponds to the column vector of project costs for the construction period.

Table 5. Vector of CIS investment shock allocated to key sectors in Taranto

Ref. #	Sectors	CIS inv (mln euros)	Share (%)
-	Construction	457.52	65.26
-	Manufacture of computer, electronic and optical products	69.28	9.88
-	Manufacture of machinery and equipment	48.58	6.93
-	Manufacture of furniture; other manufacturing	43.83	6.25
-	Manufacture of basic metals	35.77	5.10
-	Manufacture of metal products, except machinery and equipment	22.28	3.18
-	Water collection, treatment, and supply	16.68	2.38
-	Software computer consulting and related activities	4.16	0.59
-	Agriculture, fisheries, forestry	2.47	0.35
-	Legal and accounting activities of head office; management consulting	0.44	0.06
-	Manufacture of rubber and plastic products	0.08	0.01
Total amount CIS project allocated to Taranto		**701.08**	**100**

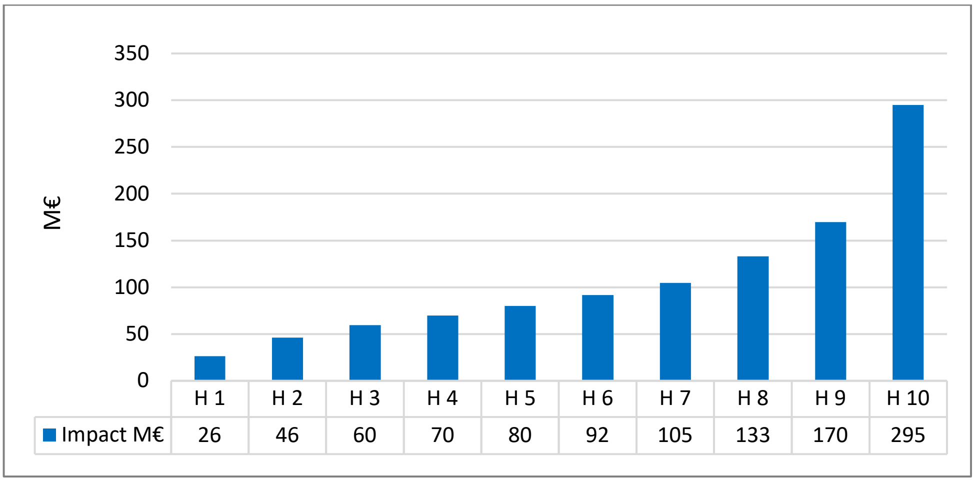
As shown in **Figure 4**, the total socio-economic impact generated is approximately 3946 M €, distributed for about 69% on the economic sectors (2705 M €), for 31% on the added value (1241 M €). The induced impact on institutional consumption (household, government, and enterprises) is about 2223 M € distributed for about 48% on household consumption induced effect (1078 M€), and for 34% government (754 M €), and for 18% (391 M€). The associated total impacts/cost ratio is 3946/701.08 = 5.63. This impact only accounts for the direct and indirect effects generated by the project on the local economy without accounting for the revenues generated by the project during the operational period as will be shown in section (**4.1.1**)

Figure 4. Impact on the Taranto Economy



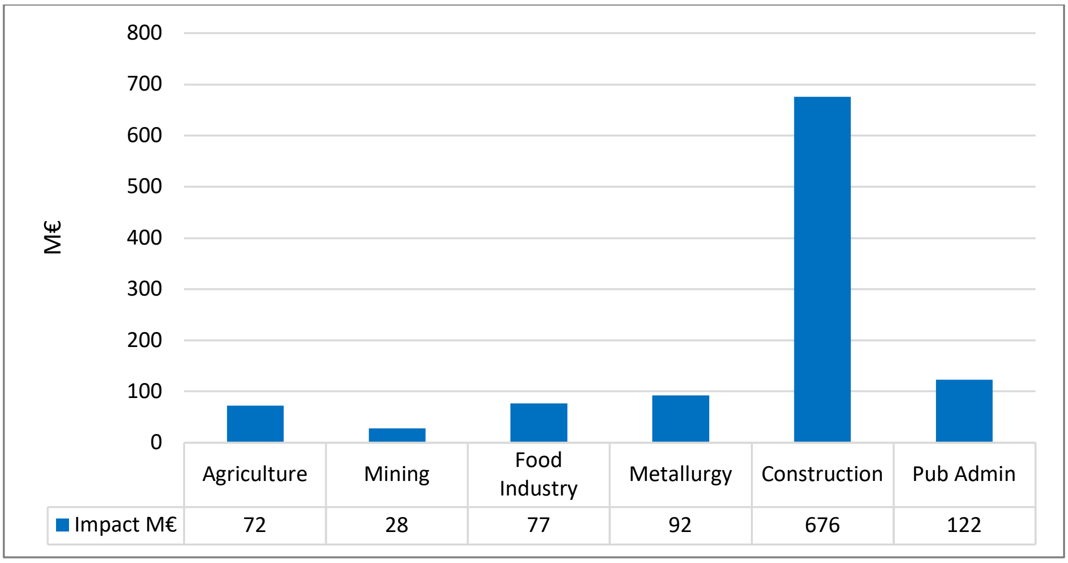
The monetary impact on households' income by decile, as shown in **Figure 5**, is not equally distributed. The richer households in the upper decile receive about more than ten times the benefits accruing to the poorest. The sum of the benefits received by the first 8 deciles is a little more than the monetary benefits received by the two upper deciles.

Figure 5. Impact on households by income decile



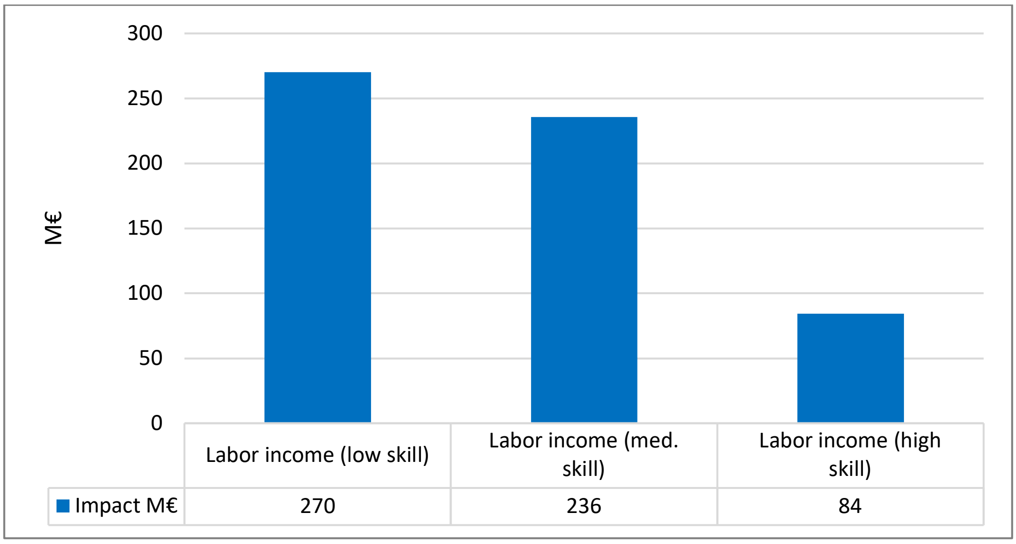
The construction sector is the most responsive sector (see **Figure 6**) accounting for 25% of the total impact accruing to the economic sectors. Among the other selected sectors shown in Figure 19, public administration generates an impact of 122M€, while metallurgy and food industry generate an impact of about 77M€ and 90M€ respectively, followed by agriculture, 72M€.

Figure 6. Impact on the Taranto main economic sectors



As shown in **Figure 7**, the overall impact on labor incomes reaches almost 300M€ distributed mainly to employees with a low level of education. This is due to the structure of the labor market of the construction sector, which employs about 60% low-skill labor where most of the investment is concentrated.

Figure 7. Impact on labor incomes by skill levels



4.1.1 The Socio-Economic Impact and Cost-Benefit Evaluation

Table 6 reports the values of the main SAM accounts affected by the project, while **Table 7** compares outcome variables with project costs. Multiplier estimates from value added and, considering depreciation charges, for Net National Product (NNP) are around 1.0 for the construction period and around 1.05 for the operational period, where not only costs but also net revenues from the project are considered. The total impacts-cost ratio at t=1 at the discounted values accrued to the project at the end of the operational period is 7.88. This ratio accounts for both the impact evaluation and the project's cost benefits, including activities, value added and households' income, compares consistently with similar ratio associated with only the impact on the local economy of 5.63 at the construction period.

Table 6. Total Project Impacts

Sector	Construction period (t=0)	Operational period (t=1)	Present values at (4%) discount rate
Intermediate consumption	**2704.54**	**4186.51**	**6730.03**
Direct effects	*953.75*	*278.46*	-
Indirect effects on other sectors	*1750.79*	*3908.05*	-
Value-added	**1241.16**	**3543.09**	**4647.98**
Income (Low)	*270.10*	*641.82*	-
Income (Mid)	*235.65*	*714.40*	-
Income (High)	*84.41*	*328.61*	-
Capital Income	*508.11*	*1446.05*	-
Indirect Taxes	*142.89*	*412.21*	-
Total Impact (Benefit)	**3945.69**	**7729.61**	**11378.01**
Impact on Institutions (*)	**2223.07**	**5701.20**	**7705.00**
Households	*1077.75*	*2784.42*	-
Government	*754.24*	*1931.02*	-
Enterprises	*391.09*	*985.76*	-

(*) Institution measures the impacts on the income of Households, Government and Enterprises which include:

- Household total income: Factor income distribution to households, Inter households' transfers, distribution of corporation income to households, Governments transfers to households' and transfers to households from the rest of the World (RoW),
- Enterprises total income: factor income distribution to enterprises, Governments transfers to enterprises, and transfers to enterprises from the RoW

Note: values are in millions of euros unless otherwise specified

Table 7. Project Performance Indicators

Indicators	Construction period (t=0)	Operational period (t=1)	Present values at (4%) discount rate
Project costs	**701.08**	**981.52**	**1644.85**
Project depreciation rate	1.00	1.05	-
Value-added increase	1241.16	3543.09	4647.98
Net National Product (NNP) increase	1179.10	3365.94	4415.58
VA/costs	**1.77**	**3.61**	**3.47**
NNP/costs	1.68	3.43	3.30
Total Impacts/costs (B/C)	**5.63**	**7.88**	**7.57**

In order to validate the results obtained in **Table 6**, we determine the intrinsic value-added capacity or profitability and the internal rate of return (IRR) of the CIS investment project using the discounted cash flow (DCF) analysis. As illustrated in **Table 8**, the project is assumed to produce no revenues in the construction period (t=0), while the total investment capital outflows of 701.08M€ invested over a period of six years is accounted as an augmented column activity in the Taranto local SAM. From a SAM perspective, these costs are entirely financed from the capital formation account and give rise, to the extent that they mobilize unemployed resources to value-added increases through indirect effect.

Table 8. CIS Investment Project Analysis – Economic flows

	CONSTRUCTION PERIOD (T=0)						OPERATIONAL PERIOD (T=1)													
Years	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Investment capital outflows	187	139	125	122	77	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual operating costs	0	0	0	0	0	0	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Operating revenues	0	0	0	0	0	0	203	203	203	203	203	203	203	203	203	203	203	203	203	203
Net cashflows (*)	**-187**	**-139**	**-125**	**-122**	**-77**	**-51**	**183**	**183**	**183**	**183**	**183**	**183**	**183**	**183**	**183**	**183**	**183**	**183**	**183**	**183**
Cumulative cashflows	**-187**	**-326**	**-451**	**-573**	**-650**	**-701**	**-519**	**-336**	**-153**	**30**	**212**	**395**	**578**	**760**	**943**	**1126**	**1309**	**1491**	**1674**	**1857**

Benchmark discount rate	**4%**
NPV (Mln of €)	**1229 €**
Internal rate of return (IRR)	**24.89%**

In the operational period (t=1) the project account includes projected total operating costs of 280.42M€ and total revenues 2838.79M€ assumed to incorporate the constancy of monetary value in Leontief fixed-coefficient systems distributed annually at 7% over a period of fourteen years for both costs and revenues respectively (El-Hodiri & Nourzad, 2006). These revenues are collected from various stakeholders who purchases the goods and services provided by the project, including households and government in part supported by the European union (EU) through the Next Generation Fund. The difference between project annual operating revenues and costs adds to the project net cashflow outlays. As illustrated in **Table 8**, the Net present value (NPV) of the CIS project at a 4% discounted benchmark interest rate is 1229M€ with an internal rate of return (IRR) needed to break-even of 24.89%, thereby validating the potential viability of the project

4.2 The Environmental Impact Evaluation

The environmental impact is evaluated at the level of the Taranto province. It measures the amount of carbon dioxide CO_2, methane CH_4, nitric oxide N_2O, Carbon oxide CO, Non-Methane Volatile Organic Compound (NMVOC), increased NH_3 Ammoniac, and Particulate Matter PM5 and PM10 emitted by each sector in Taranto. The method used is explained at greater analytical details in section **2.1.4** and, in the Appendix. As it is well known, one of the largest sources of carbon dioxide emissions (CO2) in Europe is the iron and steel plant in Taranto. A conservative estimate recently produced by the European Commission is 4,700,000 tons/year. The inclusion of the emissions of the two thermoelectric plants part of the integral iron and steel production cycle would raise this estimate to 10,688,650 tons/year (Vagliasindi & Gerstetter, 2015).

The consequent exposure to serious health risks of the Taranto local population is significantly higher as compared to an average Italian city. As a results of polycyclic aromatic hydrocarbons, benzo (a) pyrene, dioxins, metals of very high persistence and abatement costs, and other harmful powders such as PM5 and PM10 above the permissible critical threshold. **Table 9** below presents the national benchmark technological coefficients of transforming the Taranto industrial production levels in (M€) for each sector into their corresponding production of greenhouse gases (GHGs) expressed in metric tons.

Table 9. National pollution technology by selected sectors

Pollution Coefficients (*)	CO2 (tons/M€)	CH4 (tons/M€)	N2O (tons/M€)	CO (tons/M€)	NMVOC (tons/M€)	NH3 (tons/M€)	Pm5 (tons/M€)	Pm10 (tons/M€)
Energy	1003.36	1.95	0.01	0.27	0.29	0.05	0.01	0.01
Manufacture of Mineral Products	676.53	0.02	0.04	0.46	0.06	0.02	0.19	0.24
Manufacture of coke & petrol products	255.55	0.20	0.01	0.21	0.21	0.00	0.01	0.01
Transportation	244.61	0.01	0.01	0.33	0.08	0.00	0.18	0.19
Water Management	180.44	15.11	0.18	0.20	0.85	0.22	0.03	0.03
Paper Manufacture	172.03	0.02	0.00	0.00	0.05	0.00	0.01	0.02
Metallurgy	161.00	0.06	0.00	1.54	0.15	0.00	0.06	0.08
Agriculture	122.36	10.64	0.51	1.48	1.97	4.86	0.16	0.40
Mining	88.70	0.40	0.01	0.14	0.06	0.00	0.01	0.01
Press Activities	32.21	0.00	0.00	0.02	1.22	0.00	0.00	0.00
Social Assistance	31.77	0.00	0.00	0.04	0.01	0.00	0.00	0.00
Storage	31.09	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Food Industry	28.30	0.19	0.00	0.01	0.18	0.00	0.00	0.00
Construction	25.99	0.00	0.00	0.03	0.32	0.00	0.01	0.02
Computer Repair	24.07	0.00	0.00	0.04	0.51	0.00	0.00	0.01

(*) The pollution coefficients refer to carbon dioxide (CO_2), methane (CH_4), nitrous oxide N_2O), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), ammoniac (NH_3) and particulate matter PM5 and PM10 emissions in metric tons produced by each industrial sector per unit of output (M€) in Taranto using the national technical coefficients.

However, there is especially high GHGs emissions by specific industrial activities in Taranto relative to the national average due to the obsolete technology of iron and steel production based on blast furnaces that have not yet been upgraded to either electric arc type furnaces or hydrogen-based furnaces. According to (Vagliasindi & Gerstetter, 2015), in 2014, the ILVA steel production facility emitted 7.4 million tonnes of C02. This technological update would drastically reduce CO2 and particulate matters (Manning & Fruehan, 2001). Technological delays are also observed in the Taranto steel plant for the use of both renewable energy and natural gas as reductant.

For example, evidence gathered from the American Iron and Steel Institute, the World Steel Association and published independent research by (Hasanbeigi & Springer, 2019), show that the American steel industry has reduced its CO2 emissions per ton of steel shipped by 37 percent since 1990. The US electrical furnaces are adopted in about 70% of steel production plants as compared to about 30% in the rest of the world. The US Environmental Protection Agency (EPA) data indicate that the production of iron, steel and metallurgical coke in the U.S. amounted to less than one percent of national CO2 emissions, compared to the global scale of total CO2 emissions from steel, which is nearly seven percent.

To incorporate this state of technological backwardness of the Taranto iron and steel plant making the production of pollutants exceptionally high, we corrected the downward bias of the estimates reported in **Table 9** by increasing of a factor of 2.3 times the technical coefficients associated with the production of pollutants by the of the energy, manufacture of non-metal minerals, petrol and coke, transportation and metallurgy sectors; see **Table 10**.

Table 10. Pollutant technology by selected sectors specific to Taranto

Pollutant technology for industrial sectors in Taranto at (T=0)								
Pollution Coefficients (*)	**CO2 (tons)**	**CH4 (tons)**	**N2O (tons)**	**CO (tons)**	**NMVOC (tons)**	**NH3 (tons)**	**Pm5 (tons)**	**Pm10 (tons)**
Energy	2307.72	4.48	0.03	0.61	0.68	0.12	0.01	0.03
Manufacture of Non-Metal Minerals	1556.02	0.06	0.09	1.06	0.13	0.06	0.45	0.55
Manufacture of coke & petrol products	587.76	0.46	0.02	0.48	0.48	0.01	0.02	0.03
Transportation	562.61	0.02	0.02	0.77	0.18	0.00	0.41	0.43
Metallurgy	370.30	0.13	0.01	3.54	0.34	0.00	0.15	0.19
Pollutant technology for industrial sectors in Taranto at (T=1)								
Energy	802.69	1.56	0.01	0.21	0.24	0.04	0.00	0.01
Manufacture of Non-Metal Minerals	541.22	0.02	0.03	0.37	0.05	0.02	0.16	0.19
Manufacture of coke & petrol products	204.44	0.16	0.01	0.17	0.17	0.00	0.01	0.01
Transportation	195.69	0.01	0.01	0.27	0.06	0.00	0.14	0.15
Metallurgy	128.80	0.05	0.00	1.23	0.12	0.00	0.05	0.07

(*) The pollution coefficients refer to carbon dioxide (CO_2), methane (CH_4), nitrous oxide N_2O), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), ammoniac (NH_3) and particulate matter PM5 and PM10 emissions in metric tons produced by each industrial sector per unit of output (M€) in Taranto both at the construction and operational period.

At the end of the construction period (T=0), we assume that the private partner adopts in the operational period (T=1) environmentally friendly blast furnaces thanks to an appropriate incentive scheme designed as part of formal Private Public Partnerships (PPP) relations, established for the implementation of the National Recovery and Resilience Plan (PNRR) at the local level and is therefore capable to reduce to 0.8 the average level of per unit production of pollutants; see **Table 10**.

The results of the transformation are presented for the construction period (t=0) and the regime period (t=1) in **Table 11** for CO2 and **Table 12** for PM10. Tables 11 and 12 also shows the relative levels computed for each sector as compared with the smallest level of pollutant production. The tables also report the before and after the local PNRR predicted differences that are summarized in **Figure 8** for the selected CO2 and PM10 pollutants. The planned investments induce a technological change that, if incentives are correct, should be more friendly towards the environment thus reducing emissions of pollutants. The regime levels of pollutants have been computed by reassessing the *ex-post* matrix of technological coefficients conditional on the implementation of the CIS project. This is obtained by balancing the project augmented matrix of the Taranto economy.

Table 11. Production of CO2 levels by selected sectors before and after the Local PNRR (CIS), comparison levels and before and after PNRR predicted differences

Main sectors	**$CO2_0$**	**Proportion wrt smallest (t_0)**	**$CO2_1$**	**Proportion wrt smallest (t_1)**	**% Diff CO2**
Energy	4608.59	107.51	3437.02	34.45	-25.42
Transportation	1119.11	26.11	809.47	8.11	-27.67
Metallurgy	1035.27	24.15	216.31	2.17	-79.11
Manufacture of Non-Metal Minerals	965.75	22.53	303.22	3.04	-68.60
Manufacture of coke and petrol products	908.66	21.20	705.99	7.08	-22.30
Construction	533.27	12.44	239.47	2.40	-55.09
Water Management	352.98	8.23	452.22	4.53	28.11

Agriculture	264.47	6.17	609.34	6.11	130.40
Mining	72.90	1.70	167.36	1.68	129.56
Food Industry	65.31	1.52	158.45	1.59	142.61
Wholesale	58.26	1.36	119.96	1.20	105.90
Retail	56.03	1.31	127.94	1.28	128.33
Health services	53.36	1.24	125.33	1.26	134.86
Accomm&Restaurants	45.68	1.07	99.76	1.00	118.38
Public administration	42.87	1.00	102.45	1.03	138.99

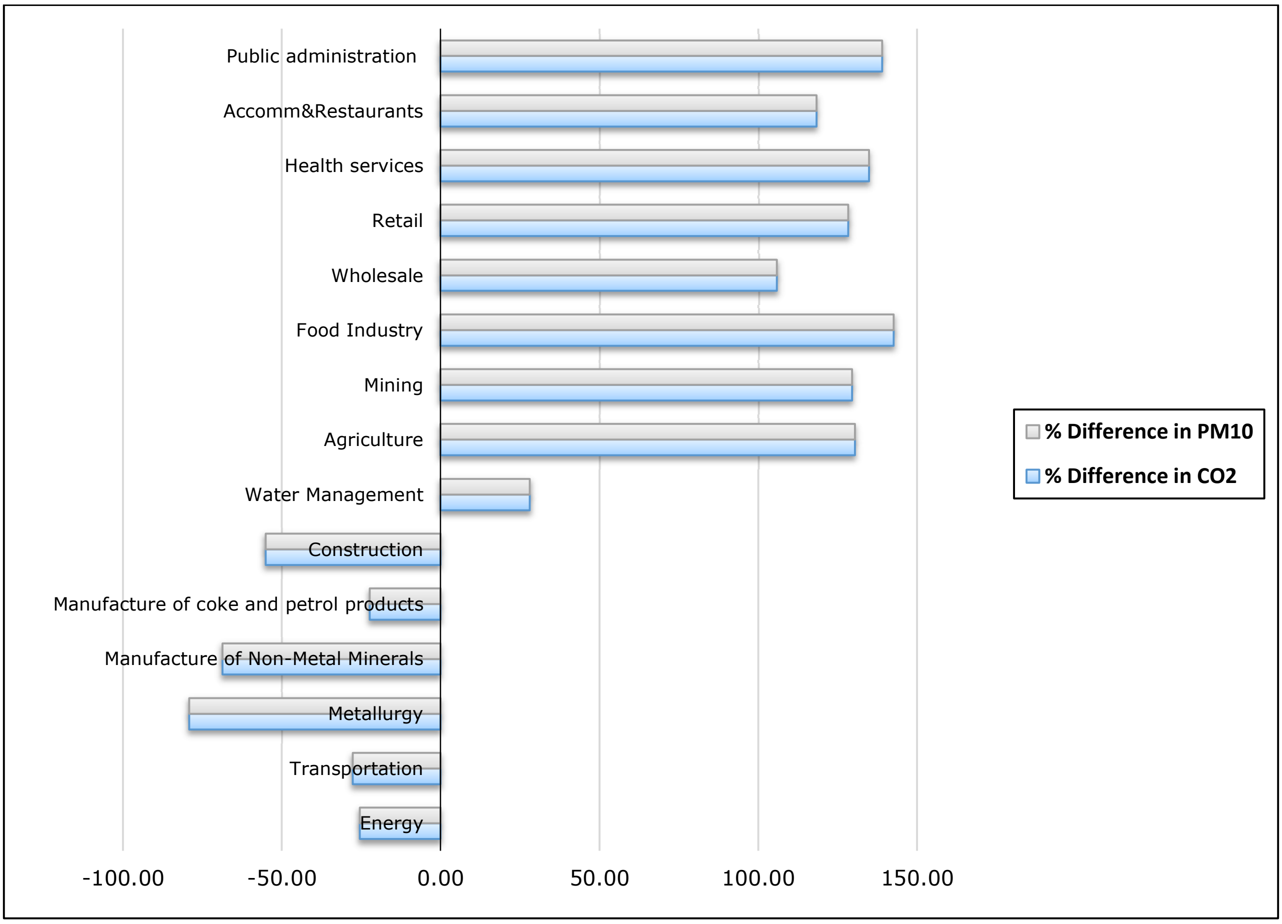
Table 12. Production of PM10 levels by selected sectors before ($PM10_0$) and after ($PM10_1$) the Local PNRR (CIS), comparison levels and before and after PNRR (CIS) predicted differences

Major Sectors	$PM10_0$	Proportion wrt smallest t_0	$PM10_1$	Proportion wrt smallest t_1	% Diff PM10
Energy	0.05	37.94	0.04	12.05	-25.42
Transportation	0.85	616.99	0.61	190.02	-27.67
Metallurgy	0.54	389.99	0.11	34.69	-79.11
Manufacture of Non-Metal Minerals	0.34	249.23	0.11	33.32	-68.60
Manufacture of coke and petrol products	0.05	35.82	0.04	11.85	-22.30
Construction	0.32	233.48	0.14	44.64	-55.09
Water Management	0.06	41.81	0.07	22.80	28.11
Agriculture	0.87	633.38	2.01	621.35	130.40
Mining	0.01	5.09	0.02	4.97	129.56
Food Industry	0.00	2.82	0.01	2.91	142.61
Wholesale	0.01	8.85	0.03	7.76	105.90
Retail	0.01	8.82	0.03	8.57	128.33
Health services	0.00	1.00	0.00	1.00	134.86
Accomm&Restaurants	0.00	1.45	0.00	1.35	118.38
Public administration	0.01	8.12	0.03	8.27	138.99

As an example, we may think at the decline in emissions of NMVOC since 1990. It has primarily been due to reductions achieved in the road transport sector due to the introduction of vehicle catalytic converters and carbon canisters, for evaporative emission control driven by tighter vehicle emission standards, combined with limits on the maximum volatility of petrol that can be sold in EU Member States as established in fuel quality directives.

As shown in **Table 11**, the energy, transportation, metallurgy, manufacture of non-metal products, metallurgy, manufacture of coke and petrol products and the construction sectors are high producers of CO2. On the aggregate, these sectors account for 97.8% of all CO2 production in Taranto. In relative terms, the energy sector produces 107.5 times the level of CO2 with respect to the public administration that produces the smallest quantity of CO2 per unit of product. This relative level reduces to about 34.4 after the implementation of the CIS plan responsible for an ex-post production of CO2 by the energy sector that amounts to less than 25.42% the *ex-ante* level. Interestingly, thanks to the adoption of a more environmentally sustainable technology, despite the increase in production levels of the main CO2 producing sectors, total levels of CO2 show a slight reduction; see **Figure 8**.

Figure 8. Change in industrial CO2 and PM10 pollution before and after the implementation of the local PNRR (CIS) project (t1-t0)



The same set of sectors accounts for 98.44% of the total production of PM10 shown in **Table 12**. Particularly, the transportation sector is among the highest producers of PM10 per unit of output in the ex-ante period corresponding to 616.99 times the lowest PM10 impact of the health service sector. In the *ex-post* scenario, the highest producers of PM10 are agriculture, construction, energy, manufacture of non-metal products, metallurgy and the energy sectors that show a large increase in emission of particulate matters; see **Figure 8**.

4.2.1 The Environmental Impact and Cost-Benefit Evaluation

The study conducted by (Matthey & Bünger, 2018) of the German Environmental Agency about the methodological convention for assessing environmental costs recommend using a cost rate of 180 Euro per ton of Carbon dioxide. These social cost rates for CO_2 and for the other pollutants shown in **Table 13** are determined mainly using the damage costs approach that estimates the level of damages incurred by society due to greenhouse gas emissions (see, for example, (Matthey & Bünger, 2018; TSD, 2016)).

Table 13. Social costs per metric tonnes of pollutant

	CO2 (tons)	CH4 (tons)	N2O (tons)	CO (tons)	NMVOC (tons)	NH3 (tons)	Pm5 (tons)	Pm10 (tons)
Price (€) per metric tonnes of pollutant	180	837	10881	180	58400	32000	58400	41200

(*) Environmental costs per metric tons of pollutant refer to carbon dioxide (CO_2), methane (CH_4), nitrous oxide N_2O), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), ammoniac (NH_3) and particulate matter PM5 and PM10 emissions in euros produced by each industrial sector in Taranto.

Source: Matthey et al. (2018); TSD (2016).

Due to the additional costs incurred by the local enterprises, the total project impact and the performance indicators including the environment are lower as the comparison of **Table 6** and **Table 7** without the environmental impact as **Table 14** and **Table 15** reveals.

Table 14. Total Project Impact including the environment

Sector	Construction period (t=0)	Operational period (t=1)	Present values at (4%) discount rate
Intermediate consumption	**2681.12**	**4150.19**	**6671.99**
Direct effects	*952.56*	*277.91*	-
Indirect effects on other sectors	*1728.57*	*3872.28*	-
Value-Added	**1227.99**	**3523.12**	**4615.61**
Income (Low)	*267.50*	*637.90*	-
Income (Mid)	*233.20*	*710.84*	-
Income (High)	*83.44*	*327.23*	-
Capital Income	*502.41*	*1437.05*	-
Indirect Taxes	*141.44*	*410.10*	-
Total impacts (Benefit)	**3909.11**	**7673.32**	**11287.30**
Impact on Institutions	**2199.29**	**5,668.63**	**7649.89**
Households	*1066.39*	*2768.97*	-
Government	*746.19*	*1920.04*	-
Enterprises	*386.70*	*979.62*	-

(*) Institution measures the impacts on the income of Households, Government and Enterprises which include:

- *Household total income:* Factor income distribution to households, Inter households' transfers, distribution of corporation income to households, Governments transfers to households' and transfers to households from the rest of the World (RoW);
- *Enterprises total income:* factor income distribution to enterprises, Governments transfers to enterprises, and transfers to enterprises from the RoW.

The total project impact in the construction period is less with respect to the case without consideration of the environmental impact. There is also a small welfare loss in terms of household income and the reduction in value-added as well as the contraction of activities. In the operational period, if the private owner of the iron and steel plant does invest in environmentally friendly technologies abating markedly the pollution coefficients from 2.3 time the national average to 0.8 of the national level, that is of about two thirds, a small welfare increase of about 1% materializes with an increase of both value added and activity levels.

Table 15. Project Performance Indicators including the environment

Indicators	Construction period (t=0)	Operational period (t=1)	Present values at (4%) discount rate
Project costs	**701.08**	**981.52**	**1644.84**
Environmental social costs (*)	81.55	116.26	193.34
Project depreciation rate	1.00	1.05	-
Value added increase	1227.99	3523.12	4615.61
Net National Product (NNP) increase	1166.59	3346.97	4384.83
Project Total Impacts	3909.11	7673.32	11287.30
VA/costs	1.75	3.59	3.45
VA/costs (include environmental costs)	**1.57**	**3.21**	**3.09**
NNP/costs	1.66	3.41	3.28
Benefit/costs (B/C) - (plus envr costs)	**4.99**	**6.99**	**6.72**

(*) The environmental costs of GHGs emissions by each industrial sector in Taranto include carbon dioxide (CO_2), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), ammoniac (NH_3), particulate matter PM5 and PM10 emissions at 30 €/metric tons. While the price for pollutants like methane (CH_4) and nitrous oxide N_2O) are 837 and 10881 per €/metric tons respectively.

However, the price of CO2 quoted by the European Trading System at the beginning of September 2021 is about 62 Eur/tonnes almost twice as much as compared to the level of the beginning of the year of about 30 Eur/tonnes. We therefore run a simulation assuming a price of 30, 80 and 180 Eur/ton. The results about the impact on the cost/benefit analysis of the sole CO_2 emissions are illustrated below in **Table 16**.

Table 16. Sensitivity analysis of total project impacts with respect to CO_2 prices - €/metric tons

Sector	Construction period (t=0)	Operational period (t=1)	Present values at (4%) discount rate
Project costs	**701.08**	**981.52**	**1644.85**
Environmental social costs 30€ (*)	107.26	88.49	192.35
PROJECT TOTAL IMPACT	3909.88	7,659.18	11274.47
Benefit/costs (B/C)	4.84	7.16	6.14
Environmental social costs 80€ (*)	270.67	231.75	493.51
PROJECT TOTAL IMPACT	3817.12	7,604.94	11129.57
Benefit/costs (B/C)	3.93	6.27	5.20
Environmental social costs 180€ (*)	548.02	503.29	1031.96
PROJECT TOTAL IMPACT	3646.83	7,500.05	10858.42
Benefit/costs (B/C)	2.92	5.05	4.06

The estimated discounted benefits to costs ratios are 6.14, 5.20 and 4.06 respectively for the cost rate per metric tons of CO_2 should be compared with the case that does not contemplate the environmental impact that achieves a discounted benefit cost ratio of 7.57 in **Table 7**.

5 Concluding Remarks and Policy Implications

The purpose of this study was to analyze the *ex-ante* socioeconomic and environmental impacts of the large public investment project (CIS) to be implemented in the Taranto province in the period 2021-2026 as part of the national plan for the restart and resilience of the Italian economy. The evaluation of the short-term impact on the local economy produces a benefit/cost ratio of 5.63 that increases to 7.88 when the cost/benefit analysis of the project, and therefore the revenues generated during the operational period, are also included. The impact of the project appears to be pervasive and boosts the local economy both through the steel value chain and the broader connections of the local economy industrial and service base. The distributive impact on households' income is moderately inequitable and is entirely dependent on the present structure of the local economy. The inclusion of environmental externalities in the economic evaluation reduces by about 16% the benefit/cost ratio in the construction period.

From a policy perspective it is fundamental to determine where to allocate scarce resources able to maximize the socioeconomic and environmental benefits to the local economy of Taranto. In this regard, the transition to a more environmentally sustainable technology, despite the increase in production levels of the main CO2 producing sectors, total levels of CO2 show a slight reduction. However, the real impact depends crucially on the price of GHGs emissions, public investment, and private incentives to adopt lower emission and abatement technologies.

Some of the limitations of input-output analysis, include the constant returns to scale in production and the assumption that relative prices play no role in the allocation of resources between activities. In addition, the lack of supply-side constraints assumption implies that supply is not able to respond perfectly elastically to changes in demand also because supply capacity is limited by the existing labor, capital, and other productive inputs. Furthermore, the impact of an investment project at a regional or provincial level are location-specific, cannot be fully understood unless interregional relationships are studied. Further research is needed to measure interregional relationships and to what extent the reduction in the incidence of pollution related pathologies during the operation period effectively improves the environmental quality and health status of the Taranto inhabitants.

References

Ahmed, Y., El Serafy, S., & Lutz, E. (1989). Environmental accounting for Sustainable Development. A UNEP-World Bank Symposium. The World Bank, Washington DC, 1-97. [Crossref]

Banerjee, O., Cicowiez, M., Vargas, R., & Horridge, M. (2019). Construction of an Extended Environmental and Economic Social Accounting Matrix from a Practitioner's Perspective. Documentos de Trabajo del CEDLAS, CEDLAS-Universidad Nacional de La Plata (253), 1-23.

Breisinger, C., Thomas, M., & Thurlow, J. (2009). Social Accounting Matrices and Multiplier Analysis: An Introduction with Exercises. International Food Policy Research Institute (IFPRI), 1-42. [Crossref]

Civardi, M., & Lenti, R. (2006). Multiplier decomposition, inequality, and poverty in a SAM framework. Società Italiana di Economia Pubblica (SIEP), 1-26. [Crossref]

Dalla Chiara, E., Menon, M., & Perali, F. (2019). An Integrated Database to Measure Living Standards. Journal of Official Statistics., 35(3), 531-576. 10.2478/jos-2019-0023.

Donati, F., Aguilar-Hernandez, G., Sigüenza-Sánchez, C., de Koning, A., Rodrigues, J., & Tukker, A. (2020). Modeling the circular economy in enviromentally extended input-output tables: Methods, software, and case study. Resources, Conservation and Recycling, 152, 1-12. [Crossref]

Duchin, F., & Steenge, A. E. (2007). Mathematical Models in Input-Output Economics (Rensselaer working papers in economics: No.0703). Rensselaer Polytechnic Institute, 1-32. [Crossref]

El-Hodiri, M., & Nourzad, F. (2006). A Note on Leontief Technology and Input Substitution. Journal of Regional Science, 119-120.

Fabbris, T., & Michielin, F. (2010). The economy of the Italian regions: recent developments and responses to the economic crisis. European Union Regional Policy, 1-15. [Crossref]

Hasanbeigi, & Springer. (2019). How Clean is the U.S. Steel Industry? An International Benchmarking of Energy and CO2 Intensities. San Francisco CA: Global Efficiency Intelligence, 1-22.

IMF/OECD. (2021). Tax Policy and Climate Change: IMF/OECD Report for the G20 Finance Ministers and Central Bank Governors, April 2021, Italy. IMF/OECD Report, 4-34. [Crossref]

Istat. (2019). Le Differenze Territoriali di Benessere: una lettura a livello provinciale. Roma: Territori, Lettura di Statistiche, 5-175. [Crossref]

Kaufman, N., Barron, A., Krawczyk, W., Marsters, P., & McJeon, H. (2020). A near-term to net zero alternative to the social cost of carbon for setting carbon prices. Nature Climate Change, 10, pp. 1010 -1014. [Crossref]

Keuning, S. J., & de Ruuter, W. A. (1988). Guidelines of the construction of a social accounting matrix. Review of income and wealth, 34(1), 71-100. [Crossref]

Khondker, B. H. (2018). Backward and Forward Linkages in the Bangladesh Economy: Application of the Social Accounting Matrix Framework. In: Raihan S. (eds) Structural Change and Dynamics of Labor Markets in Bangladesh. South Asia Economic and Policy Studies. Springer, Singapore, 171-187. [Crossref]

Lai, A., Panfilo, S., & Stacchezzini, R. (2019). The governmentality of corporate (un)sustainability: the case of the ILVA steel plant in Taranto (Italy). Journal of Management and Governance, ISSN 1385-3457, 23(1), 67-109. DOI 10.1007/s10997-019-09457-1.

Lemelin, A., Fofana, I., & Cockburn, J. (2013). Balancing a Social Accounting Matrix: Theory and application (revised e dition. SSRN, 1-24. [Crossref]

Leontief, W. (1970). Enviromental Repercussions and the Economic Structure: An Input-Output Approach. Review of Economic Statistics, 52(3), 262-271. [Crossref]

Leontief, W. (1991). The Economy as a Circular Flow. Structural Change and Economic Dynaimics, 2(1), 181-212. [Crossref]

Lofgren, H., Harris, R., & Robinson, S. (2002). A Standard Computable General Equilibrium (CGE) model in GAMS. International Food Policy Research Institute (IFPRI), 1-68 [Crossref]

Mainar-Causapé, A., & Philippidis, G. (2018). BioSAMs for the EU Member States. Constructing Social Accounting Matrices with a detailed disaggregation of the bio-economy, Joint Research Centre (JRC), the European Commission, PUBSY No. JRC111812, 1-29. [Crossref]

Mainar-Causapé, A., Ferrari, E., & McDonald, S. (2018). Social Accounting Matrices: basic aspects and main steps for estimation. Joint Research Centre (JRC) Technical Reports, European Commission, 1-35. [Crossref]

Manning, & Fruehan. (2001). Emerging Technologies for Iron and Steelmaking. JOM, 53(10), 20-24.

Matthey, A., & Bünger, B. (2018). Methodological Convention 3.0 for the Assessment of Environmental Costs - Cost Rates. German Environment Agency (UBA), 1-44.

Miller, R., & Blair, P. (2009). Input-Output Analysis: Foundations and Extensions (second edition). New York: Cambridge University Press, 1-733.

Morilla, C., Díaz-Salazar, G., & Cardenete, M. (2007). Economic and environmental efficiency using a social accounting matrix. Ecological Economics, 774-786.

Neglia, M., Sangiorgi, A., Bordignon, M., & Marescotti, A. (2018). The Environmental Disaster and Human Rights Violations of the ILVA steel plant in Italy. FIDH-Peacelink-UFDU-HRIC, p.4-37 [Crossref].

OECD. (2020). Italian regional SME policy responses. OECD Trento Centre for local Development of the OECD Centre for Entrepreneurships, SMEs, Regional and Cities (CFE)., p. 1-55. [Crossref].

OECD. (2021). The Inequality-Environment Nexus: Towards a people-centred green transition. OECD Green Growth Papers, 2021-01, OECD Publishing, Paris, 3-55. [Crossref].

Pasquini, A., & Rosati, F. (2020). A Human Capital Index for the Italian Provinces. IZA – Institute of Labor Economics - Discussion Paper Series (13301), 1-32. [Crossref]

Perali, F., & Scandizzo, P. (2018). The New Generation of Computable General Equilibrium Models. Springer International Publishing, Part.1-3.

Robinson, S., Cattaneo, A., & El-Said, M. (2001). Updating and Estimating a Social Accounting Matrix using Cross Entropy Methods. Economic System Research, 13(1), 47-64. [Crossref]

Scandizzo, P., & Ferrarese, C. (2015). Social accounting matrix: A new estimation methodology. Journal of Policy Modelling, 37, 14-34. [Crossref]

Scandizzo. (2021). Impact and cost–benefit analysis: a unifying approach. Journal of Economic Structures, 1-13. [Crossref]

Stahmer, C. (2004). Social Accounting Matrices and Extended Input-Output Tables", in OECD, Measuring Sustainable Development: Integrated Economic, Environmental and Social Frameworks. OECD Publishing, 313- 344. [Crossref]

Stone, R. (1952). Simple Transaction Models, Information and Computing. Paper presented at a conference on Automatic Control, Cranfield, 1951, in The Review of Economic Studies, 19(2), (1951-52): pp. 67-84. [Crossref]

Svimez. (2020). L'Italia diseguale di fronte all'emergenza pandemica: il contributo del Sud alla ricostruzione. Associazione per lo sviluppo dell'industria del Mezzogiorno (SVIMEZ), Roma, pp.1-66. [Crossref]

Temursho, U. (2016). Backward And Forward Linkages and Key Sectors in the Kazakhstan Economy. Joint Government of Kazakhstan and the Asian Development Bank Knowledge and Experience Exchange Program, 2-71. [Crossref]

TSD. (2016). Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis ¬ Under Executive Order 12866. Interagency Working Group on Social Cost of Greenhouse Gases, United States Government, 1-35. [Crossref]

Tukker, A., Huppes, G., van Oers, L., & Heijungs, R. (2006). Environmentally extended input-output tables and models for Europe. European Commission Joint Research Centre (DG JRC) Institute for Prospective Technological Studies, 7-111.

Vagliasindi, G., & Gerstetter, C. (2015). The ILVA Industrial Site in Taranto: In-depth analysis. Policy Department A: Economic and Scientific Policy, European Parliament, IP/A/ENVI/2015-13, 4-18.

Appendix A

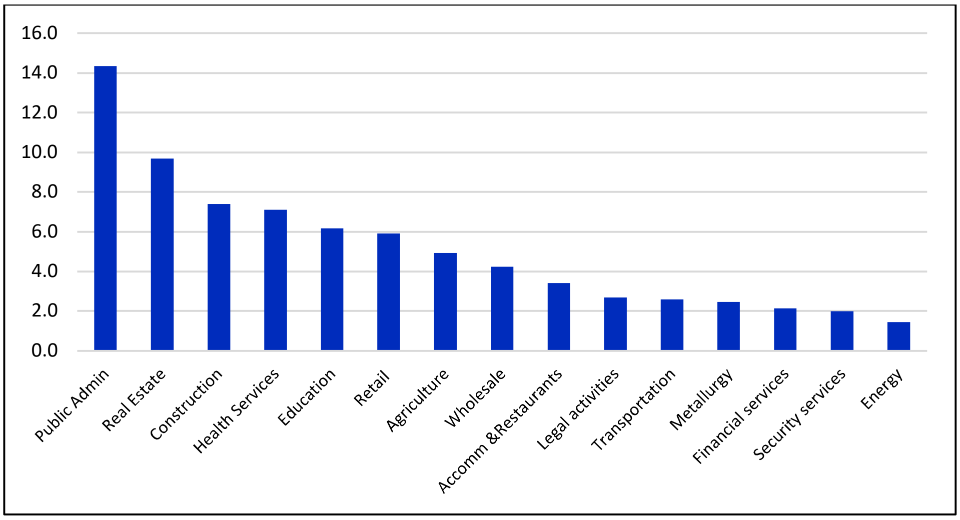
Table A1. The industrial-sectoral classification of the Taranto Economy

No.	Sectors for the Taranto Local SAM	No.	Sectors for the Taranto Local SAM
1.	Agriculture, fisheries, forestry	39.	Scientific research and development
2.	Mining and quarrying	40.	Advertising and market research
3.	Food, drink and tobacco industries	41.	Other professional, scientific and technical activities; veterinary services
4.	Textile industry, manufacture of wearing apparel and leather goods.	42.	Rental and leasing activities
5.	Manufacture of wood and of products of wood and cork, except furniture	43.	Personnel recruitment, selection and supply activities
6.	Manufacture of paper and paper products	44.	Travel agency service activities
7.	Printing and reproduction of recorded media	45.	Investigation and security services
8.	Manufacture of coke and refined petroleum products	46.	Public administration and defence; compulsory social security
9.	Manufacture of chemicals and chemical products	47.	Education
10.	Manufacture of rubber and plastic products	48.	Human health activities
11.	Manufacture of other non-metallic mineral products	49.	Social work activities
12.	Manufacture of basic metals	50.	Creative, arts and entertainment activities
13.	Manufacture of fabricated metal products, except machinery and equipment	51.	Sporting, entertainment and recreational activities
14.	Manufacture of computer, electronic and optical products	52.	Activities of membership organisations
15.	Manufacture of machinery and equipment n.e.c.	53.	Repair of computers and goods for personal ahd home use
16.	Manufacture of motor vehicles, trailers and semi-trailers	54.	Other personal service activities
17.	Manufacture of furniture; other manufacturing	55.	Activities of households as employers of domestic staff
18.	Repair and installation of machinery and equipment	56.	Income from employee work (low)
19.	Electricity, gas, steam and air conditioning supply	57.	Income from employee work (mid)
20.	Water collection, treatment and supply	58.	Income from employee work (high)
21.	Construction	59.	Capital
22.	Wholesale and retail trade and repair of motor vehicles and motorbikes	60.	Indirect taxes
23.	Wholesale trade, except of motor vehicles and motorbikes	61.	Households_1st_decil
24.	Retail trade, except of motor vehicles and motorbikes	62.	Household_2nd_decil
25.	Land transport and transport via pipelines	63.	Household_3rd_decil
26.	Warehousing and support activities for transportation	64.	Household_4th_decil
27.	Postal and courier activities	65.	Household_5th_decil
28.	Accommodation; food service activities	66.	Household_6th_decil
29.	Publishing activities	67.	Households_7th_decil
30.	Motion picture, video and television programme production, sound recording and music publishing activities	68.	Households_8th_decil
31.	Telecommunications	69.	Household_9th_decil
32.	Computer programming, consultancy and related activities; information service activities	70.	Households_10th_decil
33.	Financial service activities (except insurance and pension funding)	71.	PA
34.	Insurance, reinsurance and pension funding, except compulsory social security	72.	Direct taxes
35.	Activities auxiliary to financial services and insurance activities	73.	Enterprises
36.	Real estate activities	74.	Capital formation
37.	Legal and accounting activities; activities of head offices; management consulting	75.	Imports rest of the world
38.	Architectural and engineering activities		

A1.1 Value Added Increase at Factor Costs

As illustrated in **Figure A1.1** the value added of the Taranto economy is mostly made up of service sectors compared to good-producing sectors. Public administration and defense account for about 14% of the provincial value added, real estate for 9.7%, health services 7.1%; the educational services and retail trade accounts for both for 6.2% and 5.9% respectively.

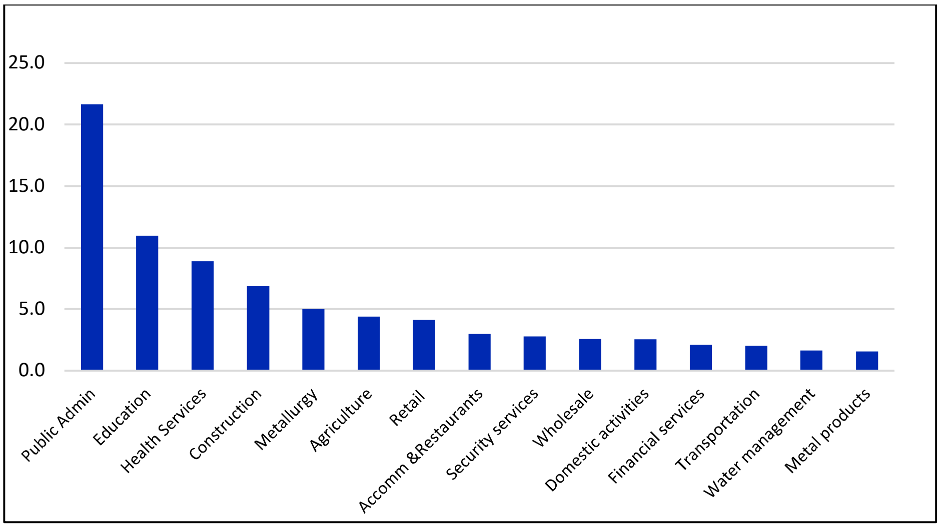
Figure A1.1. Sectoral shares of VA (%)



A1.2 The Labor Market Value-Added

Labor contributes about 48.4% to the formation of the provincial added value, of which 22% is represented by the salaries of personnel employed in the public sectors of administration and defense, education for (11%) and health care services (9%). Among the private productive sectors, construction, metallurgy has an incidence of labor on value added of about 7% and 5% respectively, followed by agriculture at 4.4%; see **Figure A1.2**.

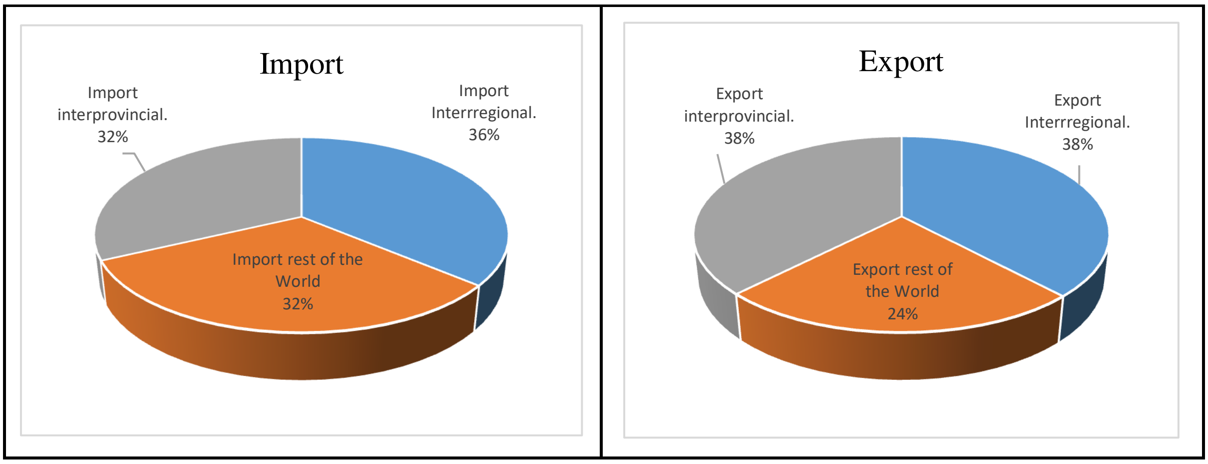
Figure A1.2. Labor value added shares



A1.3 Imports and Exports

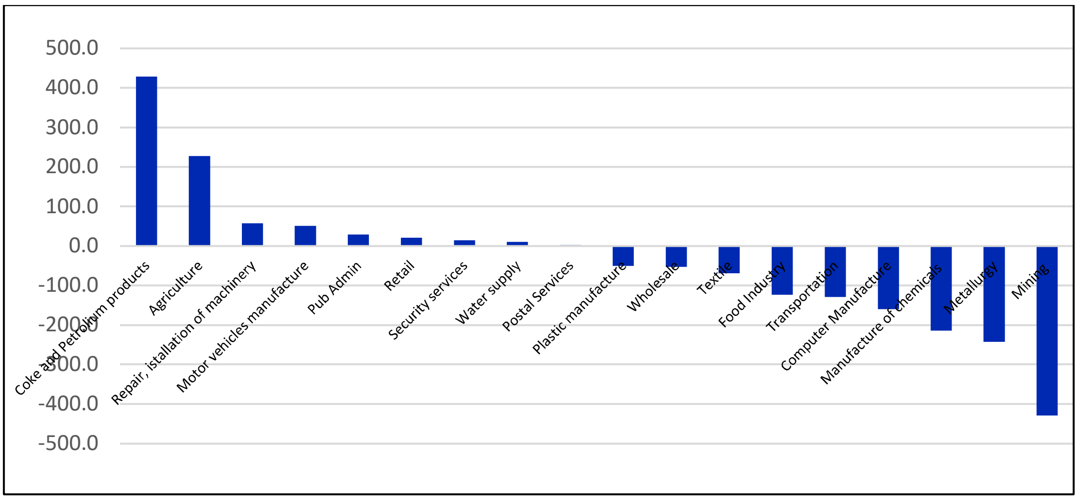
Imports and exports refer to goods and services exchanged with other Apulian provinces, with other Italian regions and with the rest of the world. As shown in **Figure A1.3** the province of Taranto imports about € 7.7 billion of products and services from outside, 36% from the rest of Italy, 32% from the other Apulian provinces and 32% from abroad. The metallurgy and production of coke and petroleum derivatives sectors account for about 16% of total local imports. Exports amount to approximately € 6.4 billions.

Figure A1.3. Imports and exports by interprovincial, interregional, and international origin



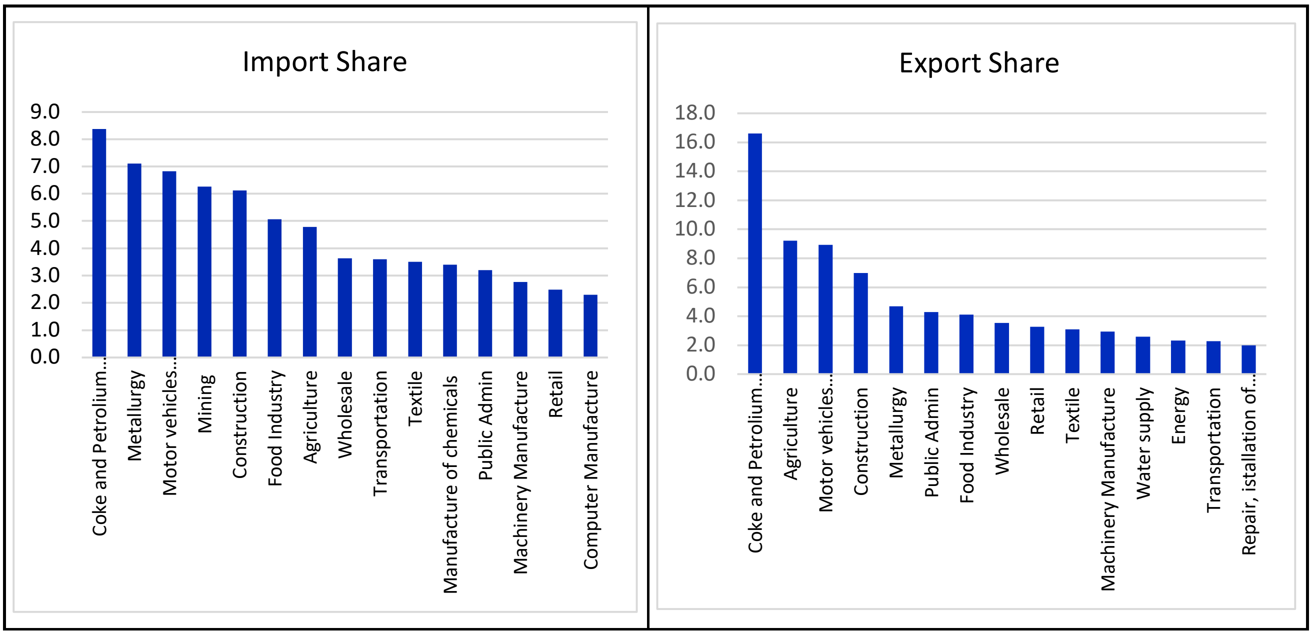
Trade balance is the difference in value between exports and imports for a specific period. The province of Taranto records an active trade balance for the manufacturing of coke and petroleum derivatives (+ 428M €) and agriculture (+ 227M €), a passive balance for mining (-429M €), metallurgy (-243M €) and chemicals (-214M €) sectors; see **Figure A1.4**.

Figure A1.4. Trade balance by sectors



The length of the value chains of the metallurgy and coke and petrol products sectors are especially high, although Taranto steel production value chain is one of the shortest among the global steel production sites. This may be a crucial feature in the post-pandemic scenario of economic restart and interestingly, mining, which is mainly concentrated on limestone production used in the steel making process, shows a high import share but no export share because its production is mostly used in the Taranto province; see **Figure A1.5**. Mining, at the end of the extraction cycle, is often reused as a landfill owned by the metallurgic company, thus becoming a potential source of pollution, especially of micropollutants.

Figure A1.5. Total Import and Export shares by sector



The metallurgic, coke and petrol products and mining integrated sectors are responsible for 28% of all the imports from the rest of the world; see **Figure A1.6**. As shown in **Figure A1.7**, while the metallurgic and coke and petrol products still account for about 25% of total imports from other Italian regions, mining is only marginally related to other Italian regions because it is not one of the first 15 sectors and is therefore not present in the graph. The manufacture of coke and petrol products, machinery, vehicles, and agriculture account for 41% of the exports to the rest of the world. While coke and petrol products are also the two most export-oriented towards both the rest of the world and other Italian regions, agriculture is the second sector in terms of importance with respect to Italian regions.

Figure A1.6. Import and Export share by sector from and to the Rest of the World

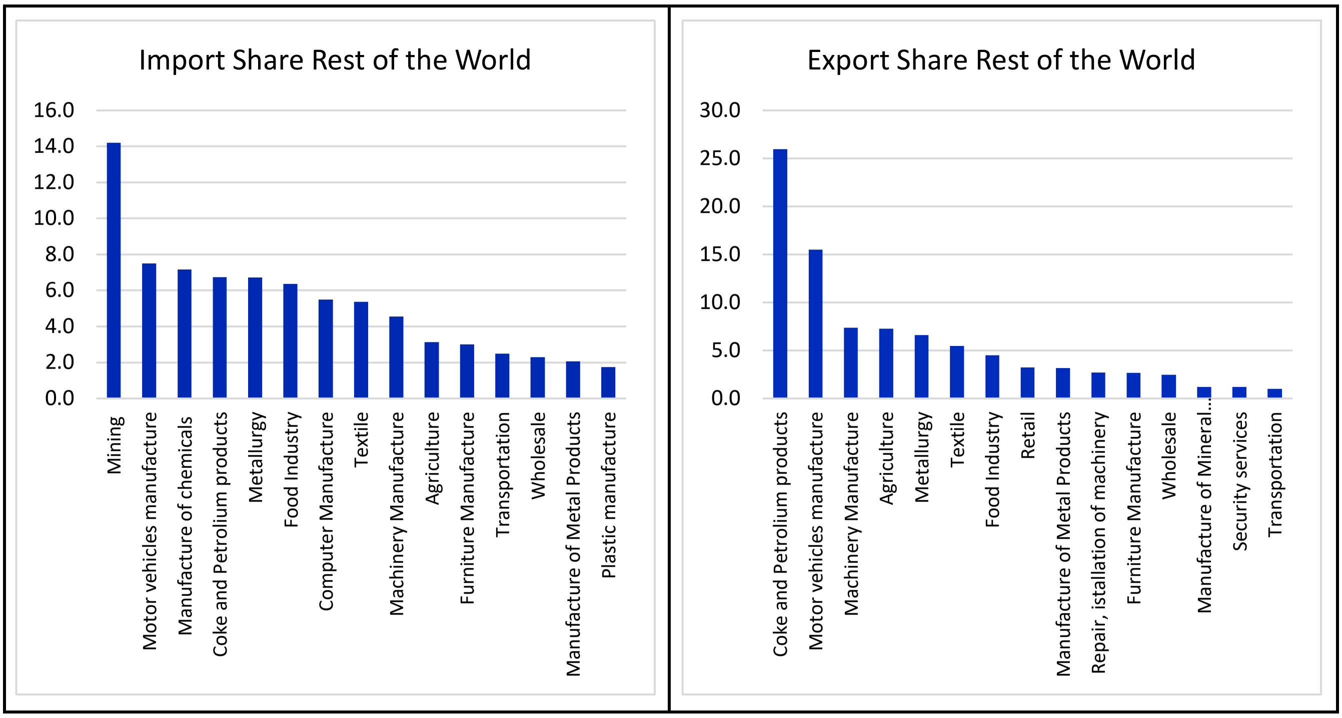
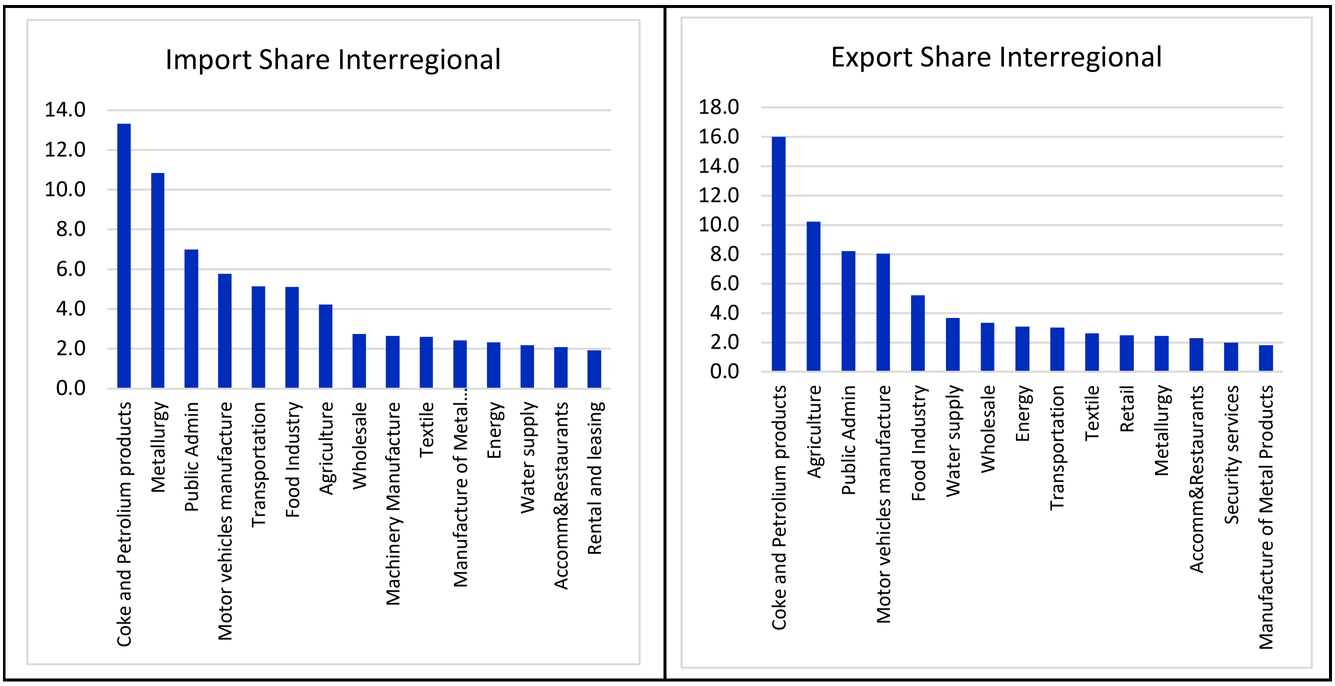


Figure A1.7. Import and Export shares by sector towards other Italian regions



A2. The construction of Taranto environmentally extended SAM 2015

The structural linkages between economic activities and the environment are very complex but can have a significant and long-term impacts on trade, human health, ecosystem, and climate. Including socio-welfare implications for achieving sustainable development goals (SDGs), not only at a local and national levels, but also on a global scale (Banerjee, Cicowiez, Vargas, & Horridge, 2019; OECD, 2021). The quantity of carbon emissions of greenhouse gases (GHGs) by the industrial sectors can be linked directly or indirectly to the level of production and consumption patterns, as well as their specific technological characteristics (Leontief, 1970, p. 1; Donati, et al., 2020). As noted by (Duchin & Steenge, 2007, p. 2), this is because the production process in an economic system requires resource inputs from the environment, but also discharge waste in form externalities into the environment. The environmental extension adds accounts for the environment as a source of natural capital and ecosystem service flows, and quantitatively describes the environment's role as a sink for by-products and waste generated through productive processes following the conventions established in the SEEA.

The enviromental data is composed of values in metric tonnes for the emissions sources of each individual sector at a provincial level. The pullant sources covered are carbon dioxide (CO_2), methane (CH_4), nitrous oxide N_2O), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), ammoniac (NH_3) and Particulate Matter PM5 and PM10 produced by each sector in Taranto. However, the critical question is how to introduce environmental metrics, i.e., social cost of carbon (SCC) and benefits from emission reductions into SAM with identical sequence of accounts in horizontal rows and vertical columns. From a double-entry accounting framework, policies that potentially increase emissions, the tonnage of increased emissions is multiplied by the SCC; the result becomes part of the policy's cost. For policies that cut emissions, the decrease in tonnage is multiplied by the SCC and added to the benefits side of the equation (Morilla, Díaz-Salazar, & Cardenete, 2007).

A2.1. Greenhouse gas emissions (GHGs) included in the model

The major greenhouse gases (GHGs), generally expressed in unit of emission sources resulting from human activities are carbon dioxide (CO_2) from burning of fossil fuels (oil, natural gas, and coal). Methane (CH_4) i.e., from agricultural practices. Nitrous oxide (N_2O) from combustion of solid waste. Non-methane volatile organic compounds (NMVOC) are mainly emitted from transportation, industrial processes, and the use of organic solvents. Carbon monoxide (CO) odorless, colorless formed by the incomplete combustion of carbon, fuels, fumes of vehicles and furnaces. Sulphur dioxide (SO_2). Ammonia (NH_3) produced in nature by the action of bacteria on organic matter such intensive livestock production and animal waste decomposition. As well and air pollution due to ammonia release, produced artificially from industries used in manufacturing of plastic, fertilizers, pesticides. However, these major GHGs can also be summed up and measured in unit of tonnes of carbon-dioxide equivalents (CO_2eq) units where equivalent implies having the same warming effect as CO_2 over a period of 100 years.

A2.2. Carbon emission pricing and social cost-benefit estimates

The fundamental goal behind the prioritization, implementation of carbon emissions pricing measures with varying scope and the social cost of carbon (SC-CO_2) estimates is to reduce emissions of GHGs and drive investment into cleaner options. In order words, it is built on a market-based strategy of polluter pays principle by adding the relevant price or social costs, known as negative externalities to economic agents such as households and various industrial sectors that generate pollution. Accordingly, it serves as a benchmark for cost-benefits analyses of climate-change intended regulatory actions for governments and taxpayers (Ahmed, El Serafy, & Lutz, 1989; IMF/OECD, 2021).

According to (IMF/OECD, 2021), limiting global warming to 1.5°-2°C degrees Celsius which is the central goal of the 2015 Paris Agreement would require policy action equivalent to a global carbon price rising to around USD 25-75 per tonne of CO_2 or more by 2030. However, it is important to specify that little consensus exist among economist about the appropriate price level for damage per metric ton of carbon emissions (Kaufman, Barron, Krawczyk, Marsters, & McJeon, 2020). The table below provided by the US Environmental Protection Agency (USEPA), illustrates the social cost of emitting CO_2 in US dollars (USD). given different future strategies. We then convert the values to in euros at current market (Euro/Dollar) exchange rate.

Table A2.2.1. (SC-CO_2) 2015-2050 (in 2007 US dollars per metric ton of -CO_2)

Discount rate in US dollars						(EUR/USD) at 23/06/2021			0.837
YEAR	5% Average	3% Average	2.5% Average	High impact (95th pct at 3%)		5% Average	3% Average	2.5% Average	High impact (95th pct at 3%)
2015	11	**36**	56	105		9	**30**	47	88
2020	12	42	62	123		10	35	52	103
2025	14	46	68	138		12	39	57	116
2030	16	50	73	152		13	42	61	127
2035	18	55	78	168		15	46	65	141
2040	21	60	84	183		18	50	70	153
2045	23	64	89	197		19	54	74	165
2050	26	69	95	212		22	58	80	177
Source: Adapted from the USEPA, website									

According to (TSD, 2016), SC-CO_2 is a useful measure, in dollars of the long-term damage done by emitting a metric ton of carbon dioxide into the atmosphere each year using integrated assessment models based on given different future strategies. That is, the average (of three climate models times five climate change scenarios) cost given a 5%, 3%, and 2.5% discount rate. The above table also includes a high impact case that is calculated from the 95th percentile (of three climate models times five climate change scenarios), rather than the average, cost given a 3% discount rate. The discount-rate is used to estimate the present value of all projected future avoided damages for emission reduction (i.e., the benefit of a CO_2 reduction). This implies that the monetary amount can also represent how much it is worth for current generation today to avoid the damage that is projected for the future. From a society point of view, the higher the discount rate, implies placing more burden on future generations and vice-visa.

Table A2.2.2. (SC-CH_4), 2015-2050 (in 2007 dollars per metric ton of CH_4)

Discount rate in US dollars						(EUR/USD) at 23/06/2021			0.837
YEAR	5% Average	3% Average	2.5% Average	High impact (95th pct at 3%)		5% Average	3% Average	2.5% Average	High impact (95th pct at 3%)
2015	450	**1000**	1400	2800		377	**837**	1172	2344
2020	540	1200	1600	3200		452	1004	1339	2678
2025	650	1400	1800	3700		544	1172	1507	3097
2030	760	1600	2000	4200		636	1339	1674	3515
2035	900	1800	2300	4900		753	1507	1925	4101
2040	1000	2000	2600	5500		837	1674	2176	4604
2045	1200	2300	2800	6100		1004	1925	2344	5106
2050	1300	2500	3100	6700		1088	2093	2595	5608
Source: Adapted from the USEPA, website									

Table A2.2.3. (SC-N_2O), 2015-2050 (in 2007 dollars per metric ton of N_2O)

Discount rate in US dollars						(EUR/USD) at 23/06/2021			0.837
YEAR	5% Average	3% Average	2.5% Average	High impact (95th pct at 3%)		5% Average	3% Average	2.5% Average	High impact (95th pct at 3%)
2015	4000	**13000**	20000	35000		3348	**10881**	16740	29295
2020	4700	15000	22000	39000		3934	12555	18414	32643
2025	5500	17000	24000	44000		4604	14229	20088	36828
2030	6300	19000	27000	49000		5273	15903	22599	41013
2035	7400	21000	29000	55000		6194	17577	24273	46035
2040	8400	23000	32000	60000		7031	19251	26784	50220
2045	9500	25000	34000	66000		7952	20925	28458	55242
2050	11000	27000	37000	72000		9207	22599	30969	60264
Source: Adapted from the USEPA, website									

It is important to specify that we decided to use the same (SC-CO_2) of 30 euros per metric ton given a 3%, discount rate for non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), ammoniac (NH_3) and Particulate Matter PM5 and PM10 produced by each sector in Taranto.

Table A2.2.4. Implementation status CIS Taranto

STATUS OF IMPLEMENTATION BY SECTOR OF INTERVENTION OF THE CIS OF TARANTO					
SECTOR	AMOUNT FINANCED AT 30.06.2018 (mlns €)	SECTOR IMPACT ON THE TOTAL CIS (%)	EXPENDITURE MADE AT 30.06.2018 (mlns €)	IMPACT OF SECTOR EXPENDITURE ON THE TOTAL CIS FUNDED (%)	IMPACT OF SECTOR EXPENDITURE ON THE FUNDED SECTOR (%)
Reclamation and environmental dev't	161.00	15.99	16.23	1.61	10
Port infrastructure and transport	416.64	41.37	252.74	25.09	61
Health	277.50	27.55	4.30	0.43	2
Urban regeneration	91.84	9.12	1.51	0.15	2
Redevelopment and adaptation of school buildings	8.28	0.82	7.01	0.70	85
Infrastructural recovery and tourist enhancement Arsenale Militare	42.89	4.26	1.16	0.11	3
Cultural assets and activities for tourism promotion	7.02	0.70	6.76	0.67	96
System actions to support the acceleration of interventions	2.00	0.20	0.00*	0.00*	0*
Total CIS	**€ 1007.18**	**100**	**€ 289.71**	**28.76**	**--**

Table A2.2.5. Economic- Financial Framework

Economic - Financial Framework
(Costs for works and Infrastructure for the Mediterranean Games – Taranto 2025)

Financing costs and funds *Amount in millions of euros*	*Public with State contribution*	*Region, Municipality, and other Local Authorities*	*Private*	***TOTAL***
WORKS AND INFRASTRUCTURE	***100***	***130***	***20***	***250***
Restructuring, adjustment				*75%*
Construction of new sports facilities				*15%*
Athletes' villages and media centre				*2%*
Competition set-up and equipment				*3%*

Economic - Financial Framework
(Costs for organizing the Mediterranean Games - Taranto 2025)

financial costs and funds ***Amount in millions of euros***	*Public with State contribution*	*Region, Municipality, and other Local Authorities*	*Private*	***TOTAL***
ORGANIZATION	*20*	*12*	*8*	*40*
SPORTS, GAMES SERVICES AND OPERATIONS				*30%*
Hotel accommodation services, Food and Beverage, Medical Services (incl. Anti-Doping), Logistics Costs, Safety Costs, Sports Competition Costs, Transportation Costs, Spectator Services, Venue Operation Management, Test Events, etc.				
TECHNOLOGIES				*20%*
IT & Telecommunications				
COST OF LABOR				*20%*
Staff, volunteers, law enforcement, security				
CEREMONIES AND CULTURAL PROGRAMS				*10%*
Opening and closing ceremony, cultural and educational programs				
COMMUNICATION, PROMOTION AND MARKETING				*5%*
ADMINISTRATION AND LEGACY				*10%*
OTHER COSTS (RIGHRS, Trademarks, etc.)				*5%*

Source: http://asset.regione.Puglia.it/?Ambiente-dossier