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The Intra and Multi-Regional Impact of a Local PNRR

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Abstract: This study estimates the socio-economic impact of investments related to the Institutional Development Contract (CIS) for the city of Taranto on different categories of households, labor markets (skilled and unskilled), and enterprises in Italy by developing a multi-regional SAM (MR-SAM) model with inter-regional trade. The model is designed and implemented both at the level of Apulia region, to estimate the intraregional impact, and at the national level, to estimate the interregional spillover effects and the supply chain linkages. The study finds that the interregional effects are more than one half of the intraregional ones, with more than 26 percent of the interregional impact accruing to the Lombardy region and about 60 percent captured by the regions in the North of Italy. The model also shows that while the local Taranto economy is highly connected with the rest of the Apulia region, it has only weak linkages with the regions of Southern Italy. The ratio between the impact on added value at the national level and the total investment of the CIS is slightly more than 2. The study also suggests that impact analyses considering the area on which the public investment is developed as an island unconnected to the entire economic system may be misleading, because they provide no information about the propagation of the effects outside the administrative limits of the local economy, even though these effects may be crucial to fuel a desirable regional distribution of economic growth.

JEL Classifications: C67, D57, F14, Q56, Q58, R15

Keywords: interregional trade, multi-regional input-output (MR-SAM) analysis, PNRR, Taranto (Apulia, Italy)

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1 Introduction

The degree of a within-country interregional trade flows and participation in the global value chains depends on many factors such as trade-openness, productivity gaps, and competitiveness. Global value chains reflect the international division of production processes across different countries as national value chains reflect the distribution of production processes and their linkages across different regions.

Because Italy displays substantial disparities in terms of trade performance, living standards, and environmental quality within and across regions, national-regional planning and development policies are especially important. For example, the southern regions (i.e., Abruzzo, Molise, Campania, Apulia, Basilicata, and Calabria) are relatively poorer and lagging economically in trade performance compared to the richer northern regions such as Lombardy, Piemonte, Veneto and Emilia-Romagna where industrial production and agglomeration effects mainly take place. This “North-South Divide” has persisted since the reunification of Italy in 1861 (Bagnasco 1984, Menon, Perali, Ray and Tommasi 2021). These structural imbalances have been compounded by the outbreak and subsequent fallout of the ongoing Covid-19 global pandemic measures undertaken by the Italian government (Fabbris and Michielin 2010, Pasquini and Rosati 2020, Svimez 2020, OECD 2021) in the context of the “National Recovery and Resilience Plan” (PNRR).

This economic stimulus package will be especially effective depending on the degree of positive interrelations between decentralized regional development policies versus nationally centralized measures. In this regard, empirical studies show that well calibrated local, regional, and interregional policy-making interventions as well as exogenous investment shocks can be a crucial engine for economic growth accompanied by greater territorial equity. Thus, focusing on methods for developing integrated multi-regional economic models with interregional linkages and nationwide ramifications may allow to differentiate the impacts of policy variables across all sectors and regions represented in the model. These methods may also offer an appropriate information basis, as part of efforts to help in the implementation and management system of the public investments underlying the PNRR.

The construction of a *Multi Regional Social Accounting Matrix* (MR-SAM) model with intraregional and interregional trade for Italy, yet unavailable in the academic literature and for institutional use, is also a preparatory step for the construction of the spatial multi-regional structure of the spatial dynamic general equilibrium model MEG-SD for the Italian economy (Cufari, Magnani, Perali, Scandizzo 2023).

The aim of this study is to estimate the socio-economic impact at the national and multiregional level of the Taranto investment plan using a MR-SAM analytical framework to investigate how the impact of the local investment project of Taranto gets distributed across Apulia, and across Italian regions exploiting the multiregional set-up. The analysis allows us to estimate benefit-cost indicators of the Taranto investment for the Apulia region, all regions, and at the national level corresponding to the sum of the intraregional and interregional effects.

2 Methodological Framework for Constructing an MR-SAM Model with Regional Trade

International and interregional trade are complementary and potentially related. This is because interregional trade can affect international openness and viceversa (Cavalieri 1981, Brancati, Marrocu, Romagnoli, and Usai 2017). Competitiveness depends on firms performance in the other region. For example, Southern Italy's comparative disadvantage can be reflected by its poor development of an export base relative to the northern regions (Lüttge 2014). In Italy, at present, there are no inter-regional models based on estimates of inter-regional trades. Our model is an extension of the MRIO model described by Miller and Blair (2009) in chapters 3 and 6 and differs from previous applications of multi-regional models applied to SAMs (Jackson et al., 2006 and Robinson and Liu, 2006) in the way of calculating inter-regional import-export. Randall and Robinson (cit.) refer to the regional purchase coefficients that IMPLAN produces to estimate domestic imports (Lindhäl et al. 2005) while our study implements the Cross-Hauling Adjusted Regionalization Method (CHARM) proposed by Kronenberg (2009), where for each good i , z_i^{rs} is the flow in euros of goods i exported from region r to region s , regardless of the destination sector in the importing region. These flows include imports to the productive sectors of the region s and those relating to the final demand in s . For each good, we can define a matrix of exchange of the type shown in Table 1:

Table 1. Interregional exchange of Commodity i

Exporting Region	Importing Region					
	1	2	...	s	...	p
1	z_i^{11}	z_i^{12}	...	z_i^{1s}	...	z_i^{1p}
2	z_i^{21}	z_i^{22}	...	z_i^{2s}	...	z_i^{2p}
⋮	⋮	⋮	...	⋮	...	⋮
R	z_i^{r1}	z_i^{r2}	...	z_i^{rs}	...	z_i^{rp}
⋮	⋮	⋮	...	⋮	...	⋮
P	z_i^{p1}	z_i^{p2}	...	z_i^{ps}	...	z_i^{pp}
Total	T_i^1	T_i^2	...	T_i^s	...	T_i^p

Note that each column sum represents the total imports of good i into that region from all regions. For each column s and good i , the total is T_i^s .

The starting point for the construction of the MR-SAM model for the 20 Italian regions is the regional SAM with interregional trade estimated using Többen and Kronenberg (2015) CHARM method. We assume that cross-hauling q_i is function of product heterogeneity h_i , domestic production x_i , total intermediate use z_i^d , and final domestic use d_i :

$$q_i = q_i(h_i, x_i, z_i^d, d_i).$$

Interregional import-export is zero-sum at the national level, the sum of regional exports by branch corresponds to the sum of regional imports. For example, Figure 1 and Figure 2 below reproduce the values of the exports of agri-food products from the Apulia region to other Italian regions and the imports of agri-food products to the Apulia region from other Italian regions estimated with the CHARM model

Figure 1. Apulia: Export of agri-food products to other Italian regions

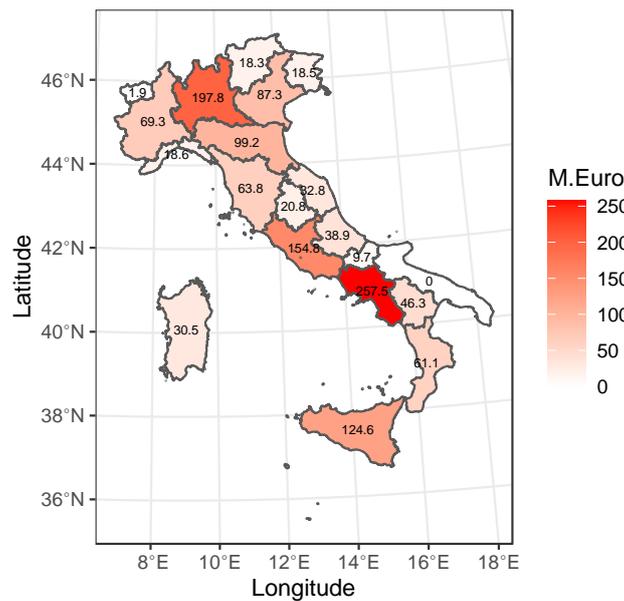
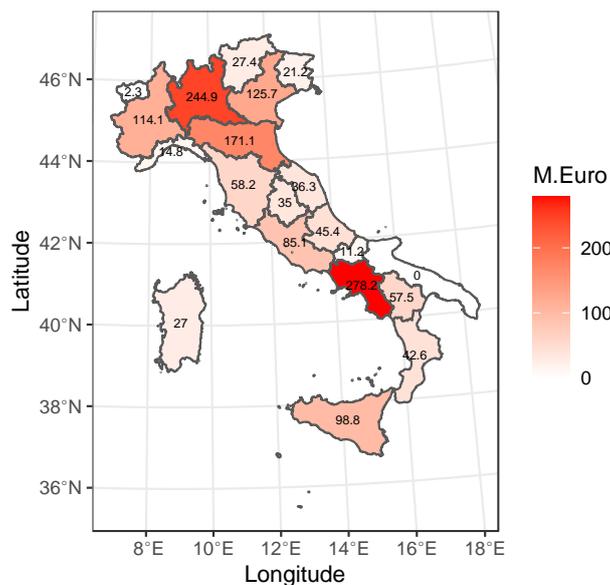


Figure 2. Apulia: Import of agri-food products from other Italian regions



To determine how the outflows from each region are divided among the remaining regions, we used a gravity model. The gravity model is used to predict the distribution of economic activity between different regions by considering the distance between regions and the relative economic strength of each region. Specifically, it calculates an indicator for each pair of regions by dividing the purchasing power of one region by the national purchasing power, and then multiplying that by the population of the other region. This indicator is then divided by the distance between the two regions. The resulting value is then used to estimate the potential flow of economic activity between the regions. These estimates of interregional flows were subsequently calibrated with a spatial interaction procedure (Wilson 1971, Fotheringham 1983a,b, Dennet 2012). By adjusting the estimates of interregional flows generated by the gravity model to match the known total of

outgoing and incoming flows for each region, this procedure ensures that the final estimates are consistent with the overall flow of economic activity among the regions.

The fixed supply form of the static MR-SAM model was formulated using the following four assumptions: 1) technology coefficients are constant and there is no substitution among inputs; 2) trade coefficients are constant and there is no substitution among supplying regions, thus, a region is assumed to continue supplying a given fraction of the consumption of another region over time (no empirical verification of this assumption has been possible because of lack of data); 3) industrial shares are constant so each industry in a given region continues purchasing a fixed share of the total amount of a given good supplied to the region; 4) all producers and transportation facilities are operating at less than full capacity.

3 Empirical Findings: Intra and Inter Regional Effects

The MR-SAM model has been used to estimate the impact across the Italian regions of the investment package under implementation in the provincial territory of Taranto in the South of Italy named Institutional Development Contract (*Contratto Istituzionale di Sviluppo* or CIS) as part of the Italian recovery plan (PNRR). We simulate a scenario where the Taranto local economy is affected in the short run by a total exogenous investment shock of 1.7 billion euros, of which, 1.1 billion euros are from the CIS, about 200 million from contracts with private companies and approximately 400 million euros from national funds for the program of the XX Mediterranean Games to be held in Taranto in 2026. The impact assessment of the investment is carried out by disaggregating investment costs by the same statistical categories (ATECO) considered in the SAM (Agbonifi *et al.* 2022).

To reconstruct the CIS investment plan of about 1.1 billion €, we reviewed the documents describing the state of implementation by sector of intervention in 2018¹, which indicates the planned expenditure amounts and the part reported for each macro-category for a total value of 1,097 M €. The plan also includes a preliminary program, still being completed, prepared by the central administration, in which the actions and investment priorities for urban regeneration interventions are identified. For these new interventions, an additional 90 million euros will be allocated, concentrated in the recovery of some historical-cultural sites and the neighboring streets of the Old City (Città Vecchia) of Taranto for a total of about 1.1 billion €.

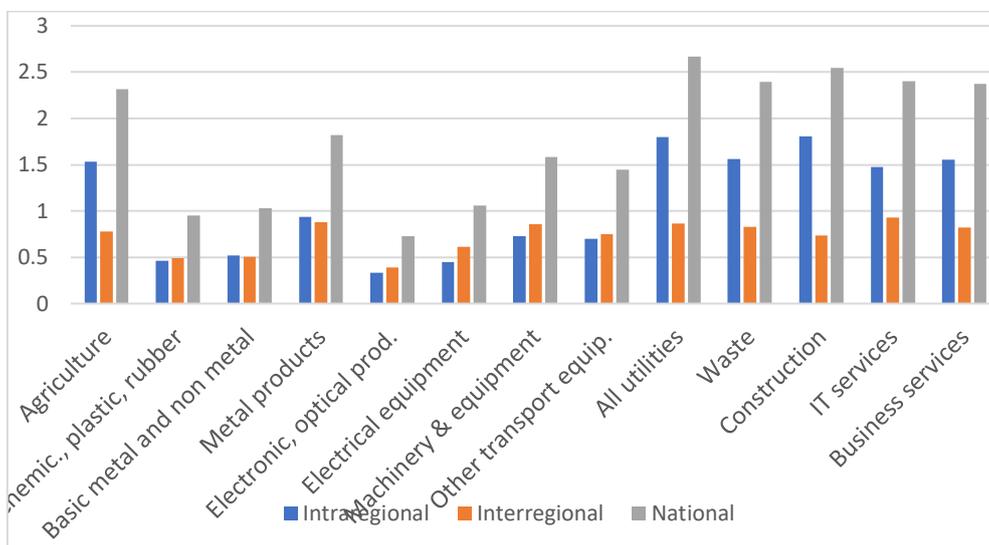
To obtain a column vector of exogenous shocks to the local SAM of the Taranto province, the CIS investment of 1097 M € described in section 3.1 was reduced of 220 M € for products / services from the rest of the world outside the Apulia region to obtain 876 M € of net investment. In general, supply is 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.

¹. The Governance of the CIS project had a setback in 2018 that has not fully recovered yet. Therefore, we can reasonably assume that the actual progress is similar to that recorded about three years ago.

The size of the shock is estimated to be 80% of the total investment in the province of Taranto alone, resulting in an estimate of an exogenous shock of 701 M €. This shock is distributed across different productive sectors, following the allocation rule adopted by CIS planners. Specifically, about 65% of the resources are allocated to the construction sector, about 30% to various types of manufacturing, and the remaining 5% mainly to water management activities and agriculture. The shock corresponds to the column vector of project costs for the construction period.

In all manufacturing sectors, the intra-regional component of the value-added multiplier, Figure 3, is lower than the interregional component, except for Metal products. The total multiplier of value-added, again for the manufacturing sectors, is always lower than that of the other sectors. The highest values of the national multiplier of the value-added are obtained for All utilities and Construction with 2.665 and 2.544, respectively, while the lowest ones are related to Chemicals and Electronic products with 0.952 and 0.729, respectively.

Figure 3. Intra-regional, interregional, and national multipliers of Value Added



The income multipliers for Households and Enterprises for the sectors involved in the investments related to the CIS reflect the trend of value added (Figures 4 and 5). The manufacturing sectors all have an intra-regional component that is lower than the interregional one, except for Basic metal products and Metal products.

Figure 4. Intra-regional, interregional, and national multipliers of Households

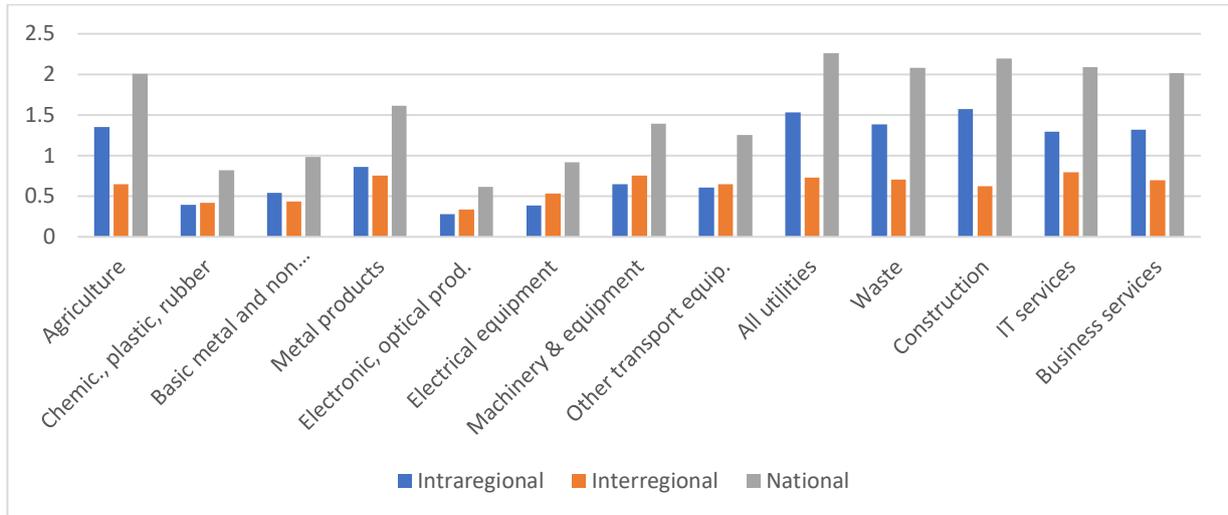
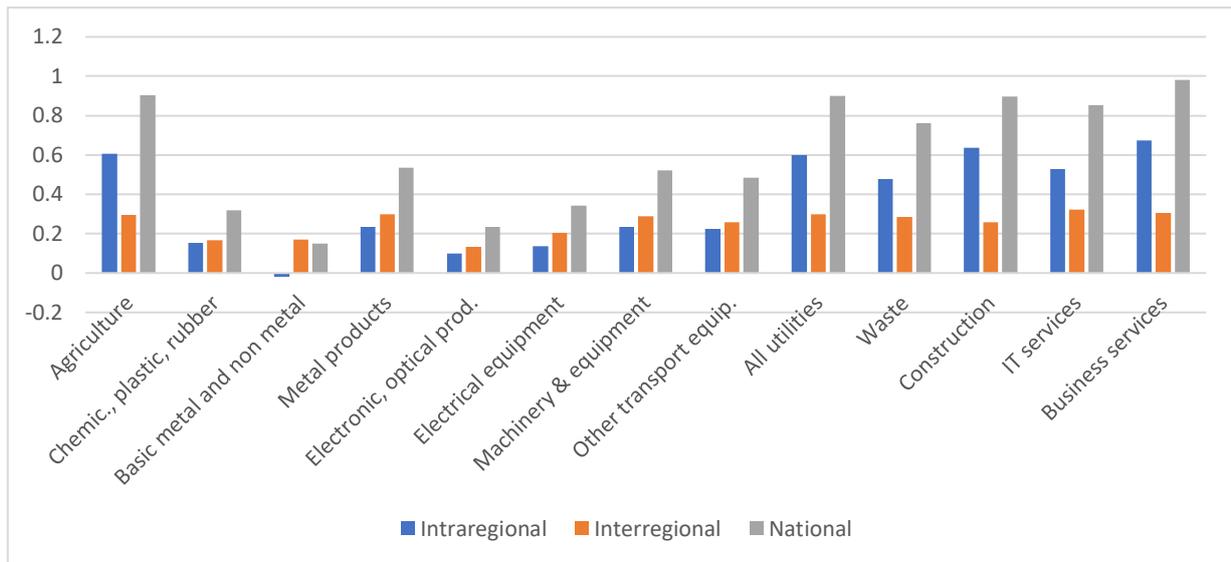


Figure 5. Intra-regional, interregional, and national multipliers of Enterprises



3.1 Intra-regional impact of the Taranto CIS on the Apulia region

The intra-regional impact calculated with the MR-SAM model shown in Table 2 have been grouped into Total impact: Intermediate consumption, and Value added (Low income, Mid income, High income, Capital income and Indirect taxes), and Impact on Institutions (Households and Enterprises). As the table shows, the total intra-regional impact of the Taranto public investment project on the Apulia region estimated with the MR-SAM model is 3,847.30 million Euros in response to a shock of 876.35 million Euros.

The impact on intermediate consumption of 2,600.29 million euros is 67.59% of the total, divided into 989.98 million euros of direct impact and 1,610.31 of indirect impact. The impact on value added is 1,247.01 million euros, 32.41% of the total impact. The impact on labor income, 511.68 million euros, is 41.26% of the impact on value added, while impact on capital income accounts for

41.03%. In addition to absolute impact values, Table 3 shows the impact in percentage terms to be compared with the impact at the regional level obtained as the ratio between the sectoral impact values and the regional total. These values refer only to intra-regional effects, while the remaining impact spreads to the other 19 regions as described in the next section.

The value of the impact on value added is limited because of the low values of the multipliers of the sectors affected by the CIS investment, as highlighted in Figure 6. The intraregional component has the greatest influence on the total multiplier, especially in the manufacturing sectors.

Table 2. Intraregional impacts Apulia region of CIS (millions of Euros)

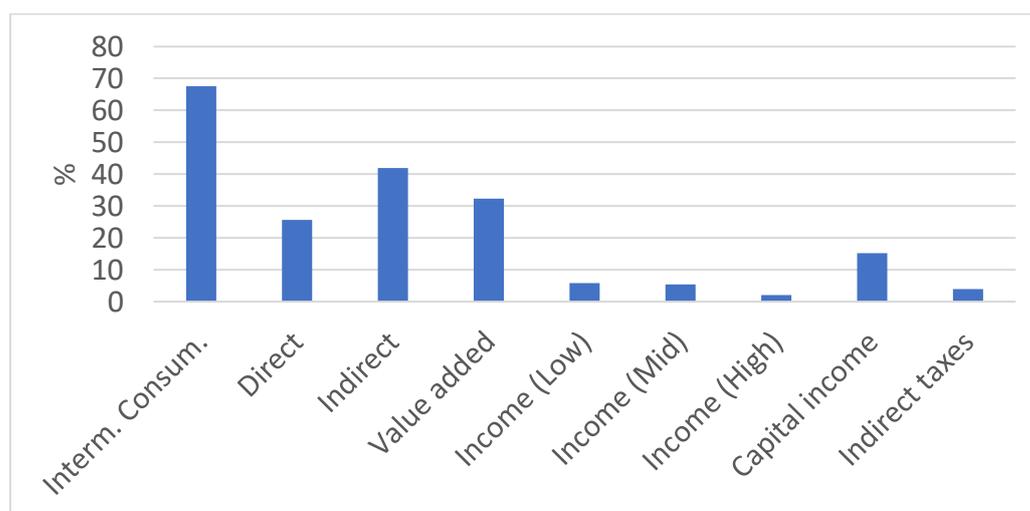
Sectors	Sam values (M. euro)	Impact (M. euro)	Impact/Sam values (%)	Impact/Total (%)
Interm. Consumption	54,629.30	2,600.29	4.76	67.59
<i>Direct impact</i>	-	989.98		25.73
<i>Indirect impact</i>	-	1,610.31		41.86
Value-added	72,116.34	1,247.01	1.73	32.41
<i>Income (Low)</i>	10,742.00	223.86	2.08	5.82
<i>Income (Mid)</i>	12,573.38	207.72	1.65	5.40
<i>Income (High)</i>	5,862.63	80.10	1.37	2.08
<i>Capital income</i>	34,343.55	585.59	1.71	15.22
<i>Indirect taxes</i>	8,594.78	149.74	1.74	3.89
Total impact	-	3,847.30	-	100.00
Impact on Institutions (*) or Induced effects (**)	92,625.26	1,513.31	1.63	100.00
<i>Households</i>	67,767.26	1,090.33	1.61	72.05
<i>Enterprises</i>	24,858.00	422.98	1.70	27.95

(*) Institutions measures the impacts on the income of Households and Enterprises which include:

- *Household total income*: Factor income distribution to households, Inter Households transfers, Distribution of corporations income to households, Government transfers to households, Transfers to Households from RoW;
- *Enterprise total income*: Factor income distribution to enterprises, Government transfers to enterprises, Transfers to Enterprises from RoW.

(**) An example of the source of induced effects is the link from regional wages to labor and household spending. This link is an expression of endogenous consumption – money earned in the region that is also spent in the region. A sector’s export demand typically creates the combined effects of induced along with the direct and indirect effects. Interestingly, a source of pure induced effects happens when outside-the-region payments, e.g., social security payments from the federal government, are made to households. Regional household spending from outside sources of income can have a strong induced effect, but it does not have any direct or indirect effect. This is because, by convention, institutions like households do not produce an output as measured by social accounts (Watson, Cooke, Kay, & Alward, 2015)

Figure 6. Intraregional impacts of CIS on Apulia (% of total impact)



3.2 Interregional impact of CIS on the other Italian regions

The estimated impacts on the other Italian regions, (Table 3), are reported graphically on the regional maps of Figure 7 illustrating the total impact, Figure 8 describing the impact on intermediate consumption, Figure 9 reporting the regional value-added and Figure 10 with the impacts of the institutional sector (households and enterprises). More than 26 percent of the total impact accrues to the Lombardy region and about 60 percent is captured by all regions in North Italy. Intermediate consumption, value added, and institutional components of the total impact follow a similar pattern. Interestingly, value added, and the institutional impact of households and enterprises are similar in size across regions. This evidence clearly shows a very weak degree of connection of the Taranto local economy with the rest of the Apulia region and the rest of the South of Italy.

The total interregional impact on the rest of Italy regions estimated with the MR-SAM model is 2,021.05 million Euros, which is 52.53% of the intraregional impact of 3847.30 million euros. The impact on intermediate consumption, which includes the cost of goods and services used in the production process, is 1,389.47 million euros, or 68.75% of the total impact. This is further divided into 137.06 million euros of direct impact and 1,252.41 million euros of indirect impact.

The impact on value added, which is the value of output minus the value of intermediate goods and services, is 631.58 million euros, or 31.25% of the total impact. Of this amount, the impact on labor income, which is the income generated by the additional employment of labor, is 249.5 million euros, or 39.5% of the impact on value added. The impact on capital income, which is the income generated by the ownership of capital, is 47.6%.

The impact on intermediate consumption of 1,389.47 million euros is 68.75% of the total, divided into 137.06 million euros of direct impact and 1,252.41 of indirect impact. The impact on the value added is 631.58 million euros, 31.25% of the total impact, lower than the average ratio of about 45% of value added to total production. The impact on labor income, 249.5 million euros, is 39.5% of the impact on value added, with the lion share going to capital income for 47.6% of the total value added generated by the project.

Table 3. Interregional impact of CIS (in millions of Euros)

Sectors	Impact	Impact/Total (%)
Interm. Consumption.	1,389.47	68.75
<i>Direct impact</i>	137.06	6.78
<i>Indirect impact</i>	1,252.41	61.97
Value-added	631.58	31.25
<i>Income (Low)</i>	78.40	3.88
<i>Income (Mid)</i>	117.78	5.83
<i>Income (High)</i>	53.27	2.64
<i>Capital Income</i>	300.67	14.88
<i>Indirect Taxes</i>	81.46	4.03
Total impact	2,021.05	100.00
Impact on institutions (*) or Induced effects (**)	758.05	100.00
<i>Households</i>	538.39	71.02
<i>Enterprises</i>	219.66	28.98

(*) (**) See Table 10.

Figure 7. Interregional effects: total impact in the other Italian regions

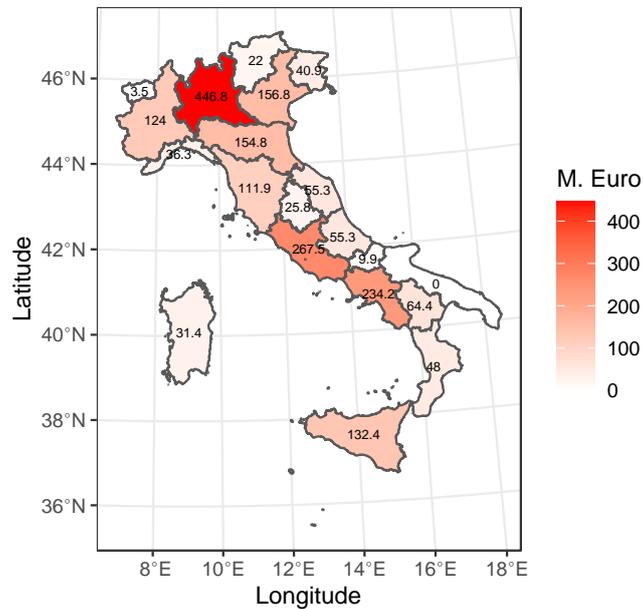
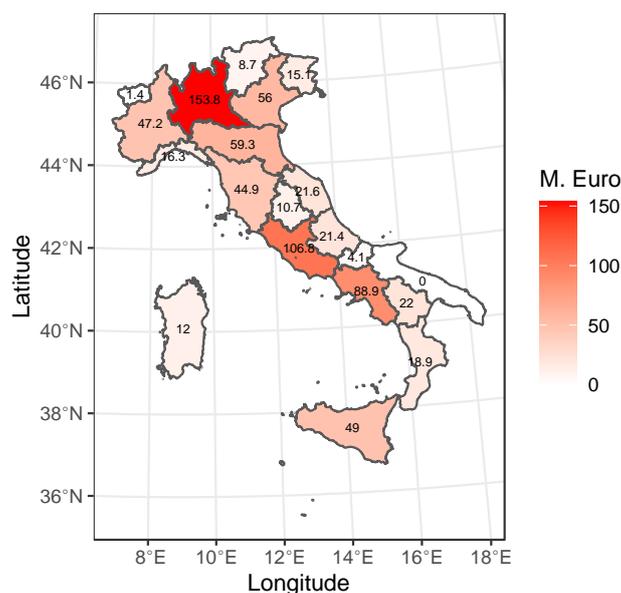


Figure 10. Interregional effects: households and enterprises total income impact on the other Italian regions



3.3 National impact of the CIS public investment plan

The national impact of CIS investment plan estimated with the MR-SAM model (Table 4), is given by the sum of the MR-SAM intraregional and interregional impact 3,847.30+ 2,021.05= 5,868.35 million Euros.

Table 4. National impact of CIS (in millions of Euros)

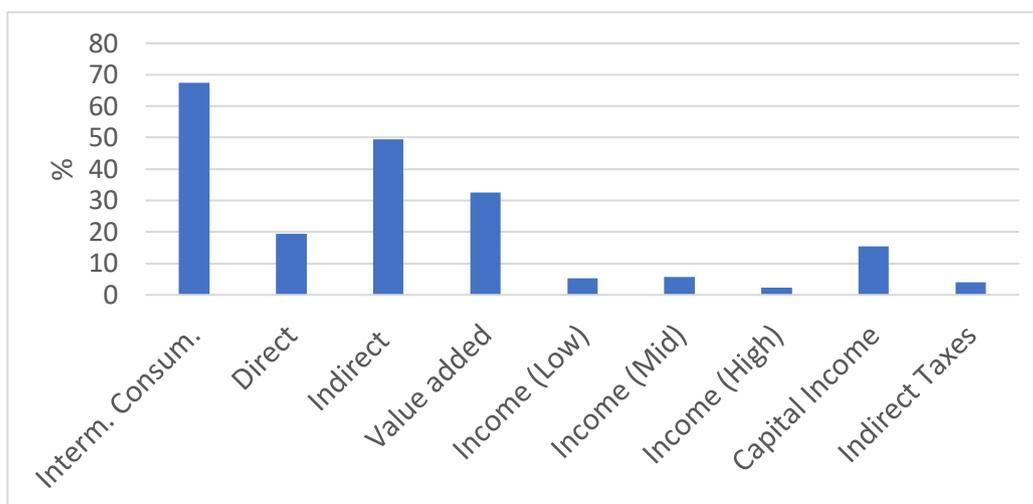
	Impact (M. euro)	Impact/Total (%)
Interm. Consumption.	3,989.76	67.99
<i>Direct impact</i>	1,127.04	19.21
<i>Indirect impact</i>	2,862.72	48.78
Value-added	1,878.59	32.01
<i>Income (Low)</i>	302.26	5.15
<i>Income (Mid)</i>	325.50	5.55
<i>Income (High)</i>	133.36	2.27
<i>Capital Income</i>	886.27	15.10
<i>Indirect Taxes</i>	231.20	3.94
Total impact	5,868.35	100.00
Impact on Institutions (*) or Induced effects (**)	2,271.36	100.00
<i>Households</i>	1,628.72	71.71
<i>Enterprises</i>	642.64	28.29

(*) (**) See Table 10.

The estimates of the national impact are less favorable than the local estimates, with the impact on intermediate consumption of 3,989.76 million euros dominating the scene with 67.99% of total impact, divided into 1,127.04 million euros of direct impact and 2,862.72 of indirect impact. The

impact on value added is 1,878.59 million euros, 32.01% of the total impact. The impact on labor income, 761.12 million euros, is 40.51% of the impact on value added, while capital income accounts for 47.18%. The intraregional impact is about 67 percent of the total impact of the Taranto CIS plan at the national level. As shown in Table 4 and Figure 11, the total impact is decomposed among its components. The impact on intermediate consumption constitutes the change in Base output, while the sum of the total impact with the induced effects, 8049,71 million of euros, constitutes the change in gross output (Watson, Cooke, Kay, and Alward, 2015).

Figure 11. National impact of CIS - Percentage of total impact



4. Conclusions

The application of the MR-SAM model to the evaluation of the impact of investments related to the Institutional Development Contract (CIS) for the city of Taranto makes it possible to develop an initial estimate of the repercussions on the local-regional and national economic system, since it allows to estimate the impact both intra-regional and inter-regional level. The sectors affected by the CIS investment plan are characterized by low multipliers, compared to other sectors, relating to value added. This generates a multiplier of 2.1 between the increase in aggregate value added, at intra-regional and inter-regional level, and the investment.

The subdivision of the impact on intermediate consumption into direct and indirect output and employment increases shows a clear prevalence of the indirect effects both at the intraregional and interregional level. While in the first case the ratio between direct and indirect effects is 61%, at the interregional level the ratio is much lower, about 40%. This shows how investments at the local level mainly affect the sectors directly involved, while exchanges between sectors are much more present in economic relations outside the region. These results show how an ex-ante evaluation of investments may provide useful indications for orienting the investments themselves so that they can be as advantageous as possible for local economies and the economic systems in close proximity, especially in the time span of the PNRR implementation. The considerable share of the impact, over 35%, which is transferred outside the region, should not be surprising as it re-proposes the duality between areas with different degrees of development, where the more developed ones benefit from the repercussions of investments made in the most marginal areas, as widely discussed in the case of EU Cohesion policy.

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