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Pasquale Lucio Scandizzo and Daniele Cufari

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Pasquale Lucio Scandizzo[1]; Daniele Cufari[2]

Abstract

This paper presents a new methodology of project evaluation based on the use of a social accounting matrix (SAM). The method proposed considers both the project as an autonomous shock and as an endogenous activity, thus capturing both the demand and the supply side effects, that can be associated to investment. In assessing project impact, these two effects have to be considered complementary, even though they may be combined in different proportions and with different strength in different practical cases. The autonomous dimension is however a distinctive feature of a project as an economic concept. Its consideration has important implications to assess the structural impact of a project as an activity ranging complete isolation to total embeddedness in the economic system. The paper also shows that both in its construction and operational phases the project displays structural effects on the economic system and that these effects may be sizable and may be partly offsetting the direct impact of the project on demand and supply variables.

Keywords: Project, autonomy, embeddedness, structure, social accounting matrix, social rate of return

1. Introduction

Investment can be defined as the commitment of resources in the expectation of future returns, but both commitment and expectations typically require that a "project" is designed and implemented. The concept of a project is not uncontroversial, and its characteristics range from physical planning (the "analogic" project) to more complex projectization of implementation and governance ("meta-projects"). However, there is a growing consensus that projects may be important vehicles of technological change and institutional innovation and that their impact may extend beyond the benefits and costs envisaged by their stakeholders. Their main advantage in comparison with routine operations of firms and institutions is that they can be isolated from their parent organizations and offered a large degree of autonomy and creative initiative. They can thus be used to launch new ideas and act as catalyzers of technological and institutional change, through new institutional arrangements and innovative and even disruptive technologies. At the same time, their short-term horizon, limited scope and relative institutional insularity allows to carry on experiments of innovation, technology adoption and governance in an environment of limited risks and by maintaining a relative independence from the originating institution. As Vihma and Wolf (2022) point out in a recent EU survey, projects are increasingly developed (Munck Af Rosenschöld and Wolf 2017; Sjöblom, Löfgren, and Godenhjelm 2013; Sjöblom and Godenhjelm 2009) with the

[1] University of Rome "Tor Vergata" and OpenEconomics
[2] Independent Researcher

aim to to accelerate knowledge creation (innovation surplus) and expand social inclusion (democratic surplus) (Godenhjelm 2016).

The methodologies for the economic evaluation of investment projects have traditionally followed two polar approaches. On the one hand, the cost benefit literature, beginning with the classic work of Little and Mirrlees (1974), within a context of partial equilibrium analysis and microeconomic specifications, has looked at projects as mere instruments to achieve benefits for society or specific income groups by using costly resources. On the other hand, the input output and the general equilibrium studies have considered projects as exogenous shocks perturbing a preexisting equilibrium condition with main (though not necessarily exclusive) effects on aggregate demand, with ensuing multipliers of the Keynesian variety, under the assumption of less than full employment. Attempts to reconcile these two points of view (e.g., Bell and Devarjan, 1983), are based on the idea that projects can be evaluated by maintaining an essentially microeconomic focus but using shadow prices derived from economy-wide modelling. These methods have been challenged on theoretical grounds (e.g., Kuyvenhoven, 1980) and have received little diffusion among practitioners.

In this paper we wish to investigate the nature and potential of projects as a form of projectized governance within the structure of an economy as represented by a social accounting matric (SAM). The paper builds on results presented in Scandizzo (2021) to ask the more general question of the economic evaluation of a project as an economic activity that is articulated over time and comprehends both a construction and an operational phase. The results presented in his paper, however, are extended to the evaluation of the project as an exogenous activity during the construction phase, which becomes endogenous to the economy in the course of its operational implementation. In the construction phase, the project is an exogenous shock that is superimposed to a pre-existing economic structure and ripples through it by engaging the backward and forward linkages of its value chains. In the operational phase, on the other hand, depending on how successfully construction has been implemented, the project becomes an activity inserted among the others of the preexisting industrial structure, and its effects are endogenously determined by its interaction within the new linkages that its presence contributes to create.

Following Vihma and Wolf (2022), a central tension can be identified between innovative projects and both parent organizations and the economy at large (Godenhjelm and Johanson 2018; Munck Af Rosenschöld 2019; Munck Af Rosenschöld and Wolf 2017; Tukiainen and Granqvist 2016). Projects can be conceived as operations that need some distance from their institutional stakeholders, in order to deliver their benefits, especially if they experiment innovation and are expected to generate new knowledge. To the extent that they do not reflect average technology and exchange relationships, they are also based on designs of value chains that offer alternatives to the dominant structures prevailing in the economy at any one time. While projects' economy-wide impact may depend also on their size, access and institutional features, their autonomy may create opportunities to spread successful innovations and overcoming barriers to change, due dominant cultures, routines, and oversight (van Van Buuren and Loorbach 2009; Kapsali 2011). As envisaged by many development economists (e.g., Hirschman, 1967; Easterly, 2009), projects may exploit opportunities for changes, but may also be vehicles of rent seeking and power consolidation for the ruling elites. The distinction between marginal and non-marginal projects, or between program and projects, reflects both a certain granularity of the project strategy and a degree of autonomy from its institutional environment. At the same time, projects' autonomy must be considered together with their degree of embeddedness within an economy as a set of existing organizational structures, connections across economic actors and institutions, which represent the extent to which a project is a fruit or a victim of its own past. The first part of the paper analyzes the twofold condition of projects' autonomy and embeddedness by using the network of social accounts represented in a SAM. In the second part is further applied a practical case on the Italian SAM developed by the same methodology, applying as a project the Italian Recovery Plan of the Next Generation EU plan to cope with the post-pandemic situation.

(1) The project as an economic activity

According to a widely shared notion, an investment project can be defined as the immediate commitment of resources (the investment) to one endeavor (the project) in the expectation of future benefits (Knudsen and Scandizzo, 2005, Pennisi and scandizzo, 2006). While this definition appears to be operational and is the direct concern of planning and evaluation efforts, it does not circumscribe an unambiguous category. Rather, it subsumes a series of structures and actions that are themselves part of the complexity of the issue of capital accumulation. In general, at least three types of projects can be defined, all of them being part of the same investment endeavor. First, the project can be considered as a physical analog of the ultimate investment goal: as such, it can be defined as a design or a reproduction in scale of a physical counterpart resulting from implementing the project. Second, the project can be seen as a set of instructions (a "blueprint") to implement according to an "epigenetic" code similarly to the project contained in living beings through DNA information. Third, the project can be conceived as a programmed shock that impacts on its environment according to a plan that is only loosely conceived and discovers its consequences in an opportunistic and path dependent way. These three concepts are themselves interconnected as they describe different aspects of a project as an investment plan and relate to separable characteristics that are equally important to accomplish the investment goals. However, they cannot be pursued in a parallel way, since they are linked both by a structured hierarchy of instruments and objectives and by intrinsic dynamic properties that are only imperfectly predictable.

The concept of investment as "recombinant capital" has recently been revived in the context of a new attention of economics to complexity in human behavior and the autonomous nature of projects as manifestations of entrepreneurship and "animal spirits". As Harper and Endres (2016) indicate, this development takes as its starting point Schumpeter's ideas on the combinatorial nature of innovations, in terms of construction of new systems combining both old and new technologies, as well as other components that are already available as parts of the existing capital. Rather than to the notion of capital as a stock of productive capacity, therefore, the recombinant-capital approach is more convincingly applicable to investment projects, if these are conceived as autonomous enterprises that emerge from pre-existing structures to create new forms of capital and production processes. In line with E. Phelps' (2013) analysis, innovators are identified as exuberant and innovative agents of change, who transform discoveries into new forms of capital combinations in the pursuit of profit. This view implies that project design, for example, is not a mere technical exercise aimed to implement production plans through best practice applications. While not all projects can be innovative, they can all be interpreted as enterprises that enjoy, at the same time, given properties of autonomy and belonging, with the implicit mandate to close gaps in the capital structure, use new technologies and find new ways to use existing ones, by reshuffling and recreating production and marketing profiles. Projects' simultaneous isolation and embeddedness in a pre-existing institutional environment, also offer the opportunity to explore options to achieve given goals, by comparing alternatives and estimating their impact and costs and benefits, without putting at risk parent organizations, efficiency and markets. As such, shaping investment through projects empowers both public and private agents to undertake more daring initiatives, which may be limited in scale, but not necessarily in scope, with potential larger spill overs on both capital structures and production/consumption outcomes.

Albert O. Hirschman (1967), one of the key supporters of the role of projects in development economics, conceived investment projects as means to induce change by imparting an asymmetric shock to the economy. This shock would initiate or contribute to transformative development, through the leaps and bounds of unbalanced growth. Hirschman suggested further that this transformative power may be the most important aspect of the investment multiplier. The strength of backward and forward linkages should thus be used as a guiding principle to concentrate investment in industries with the highest potential to generate disruptive growth. While strong linkages imply high multipliers in terms of output and incomes, Hirschman was mainly concerned with the induced effects on private investment, and the importance of public investment to provide overhead capital, which could unleash the dynamic forces of growth of the type considered by Schumpeter and other advocates of "creative destruction".

Hirschman's suggestion could be easily overlooked as one more interpretation of Leontief's input output connections. Its hidden value, however, lies in the attempt to link investment design to the plurality of choices that it entails in terms of sectors, activities, institutions, location and, ultimately, design. That these elements are critical for the success of an investment, as a project driven by construction and design, is emphasized by the modern literature on cognitive architectures. "Knowing how to design something like X is a requirement for understanding how X works of course, doing explicit design is consistent with leaving some of the details of the design to be generated by learning or adaptive processes or evolutionary computations, just as evolution in some cases pre-programs almost all the behavioral capabilities (precocial species) and in others leaves significant amounts to be acquired during development (altricial species). In the altricial case, what is needed is higher-order design of bootstrapping mechanisms" (Sloman and Chrisley 2005, pp. 153-154)."

More generally, the concept of investment project has gradually converged to the concept of an enterprise whose structure has the twofold characteristic of a sustainable architecture and a self-constructing ability that interacts with the market. This is based on observed behaviors and on the hypothesis that these behaviors are the result of the application of human intelligence to economics. In this respect, in a way similar to the debate on artificial intelligence (see, for example, Penrose, 1983), two theories have historically confronted each other: on the one hand the one that sees markets and exchange emerge from the interaction of projects, as complementary or conflicting algorithms of economic agents, and on the other hand an interpretation that instead considers these economic agents the epiphenomena of systemic organizational elements. The more recent literature on the social rate of return or SROI can also be seen as an attempt to pull together these two separate lines of thought, by evoking participating stakeholders and social capital (Lingane and Olsen, 2004).

(2) The Project and the SAM

The Social Accounting Matrix or SAM for short (Stone, 1962, 1947) is a system of national/ regional / sub-regional accounts represented in a matrix format. It includes the inter-industry linkages through transactions typically found in the I-O accounts and the transactions and transfers of income between different types of economic agents, such as households, government, firms and external institutional sectors. As a generalization of Leontief input output system, the SAM represents an economy as a network of transactions across production sectors and institutional actors. The SAM depicts the economy as a series of agents interconnected through a double accounting system, with matrix columns representing expenditures as resource outflows and rows representing revenues as matching inflows. Total outflows match total inflows for each agent as accounting identities, but deficits and surpluses are balanced through a capital formation account, which collects savings from agents whose expenditure is lower than revenue (surplus units) and transfers them to agents that spend more than they earn (deficit units). The SAM provides an internally consistent representation of the resource flows across a given disaggregation of the economy and is the basis of the national accounts methodology officially endorsed by the UN and the multilateral organization and used by most countries' national governments.

As shown in Scandizzo (2021), within the SAM framework, an investment project can be analyzed both as a vector of expenditure shocks, and as a special form of an activity, with its own input output parameters that evolve over time. As an activity, the project is characterized by a series of transactions and corresponding cash flows that change over time. Thus, at any point in time it can be represented in a SAM as a column of cash outflows, including all capital and maintenance costs from intermediates and resulting value added, and as a row of cash inflows, including financing from the government and private savings during the construction phase, and revenues from increased production of goods and services during the operational phase. The SAM accounting principles require costs and revenues to balance, so that financing from the capital formation sector, or directly from the government or other project sponsors must be recorded as one or more row entries in the years where cash outflows are larger than cash inflows (typically in the project "construction" phase). Vice versa, once the project is operational and inflows become larger than outflows, returns can be credited to capital (as gross business margins) or institutions (government, enterprises, households). This methodology has been applied to computable general equilibrium modeling (Cervigni and Scandizzo, 2017) and, more recently, to build machine learning models for implementing COVID-19 prediction system (Kavitha 2022).

The structure of a typical SAM follows a classification scheme that is consistent with international statistical conventions and is based on eight categories of accounts: (i) activities, (ii) commodities, (iii) production factors, (iv) households, (v) enterprises, (vi) government, (vii) capital formation and, (viii) rest of the world. While the SAM provides a system of accounts of the transactions across these different agents for a period of time, it can also be used as a basis for a model, under specific hypotheses of technical and behavioral characteristics of the agents involved. The SAM thus consists of a set of interrelated subsystems that, on the one hand, give an analytical picture of the studied economy in a particular accounting period and, on the other hand, may be used within the framework of general equilibrium models for assessing the effects of changes on the particular resource flows. These may be represented by injections and leakages in the system, which might be the result of policy measures.

Indicating with T the SAM as a transaction matrix, the simplest form of SAM derived models is a generalization of the so-called open economy model originally associated with the Leontief input-output structure, and can be simply represented by the equation:

(1a) $$(TX_d^{-1})X = QX = 0$$

Where X is an n,1 vector of activity levels for productive sectors, commodities and incomes for factors and institutions and $Q = I - A = (TX_d^{-1})X$ the SAM coefficient matrix.

The SAM definition in (1) offers the opportunity to represent an investment project (or a program as a set of coordinated projects) as an autonomous activity, emerging from the existing economic context as a separate endeavor, with specific characteristics different from the other activities and, at the same time, endowed with a degree of embeddedness depending on its transactions with the rest of the economy. More precisely, we can think of a project as a two-stage process, first arising as an exogenous shock to the existing equilibrium, and then determining a new equilibrium by modifying the parameters regulating the flows of good and services and thus changing the structure of the economy. In other words, the project can be conceived as a combination of a disruption of an existing equilibrium and then, as an achievement of a new equilibrium that incorporates its structural characteristics in the economy. As shown in Scandizzo (2021), in the context of a SAM, this amounts to consider the investment project as an additional institution engaged in capital formation, in the construction period of the project, and as an additional production activity during the project operational period. This implies augmenting the size of the SAM by adding a column and a row of transactions corresponding, respectively, to the outlays and the receipts of the project cash flow. For the inflows and outflows to balance, this entails the accounting, among the receipts, of any financing flow and, among the expenditures, of any returns distributed to factors of production and other stakeholders.

This approach draws inspiration from the methodology of growth decomposition, as presented by Rose and Cassler (1998) and Duchin and Steenge (2007) as a quest to understand the drivers of economic growth by breaking it down into various factors such as labor, capital, and technological progress. However, the approach being described goes beyond traditional growth decomposition analysis by considering a project as a sequence of exogenous and endogenous changes. It recognizes that a project can have two distinct phases: the construction phase and the operation phase. During the construction phase, the project introduces exogenous changes to the economy, such as investment in infrastructure or facilities. In the operation phase, the project triggers endogenous changes, such as changes in production, consumption, and investment patterns.

What sets this approach apart from the usual analysis is its consideration of the project's impact on the input-output structure of the economy. In other words, the approach acknowledges that the project's activities can cause ripple effects throughout the economy, leading to changes in the relationships and interdependencies between different sectors and factors of production. This dynamic perspective allows for a more comprehensive understanding of the project's influence on the economy. By employing decomposition analysis within this framework, it becomes possible to delve deeper into the economic impact of investments. The analysis provides insights into how the project's stimuli, both exogenous and endogenous, may shape the economy. It reveals not only the direct effects of the project on specific sectors or factors of production but also the indirect effects and spillovers that result from changes in the input-output structure. The approach also expands upon the traditional growth decomposition methodology by considering projects as sequences of exogenous and endogenous changes, thereby allowing for a more nuanced understanding of the broader economic implications of investments. It highlights the importance of analyzing the evolving input-output relationships within the economy when evaluating the deeper impact of projects.

To represent the impact of the project on the economy, we can write this two-stage process by distinguishing two new equilibrium conditions for the situation" without" and "with the project" SAM as:

(2a) $$X_s = A_s X_s$$
(2b) $$X_c = A_c X_c$$

In A_s and A_c are n+1, n+1, SAM matrices augmented of one column and one row to represent, respectively the situation without and with a specific project. The matrix without the project A_s can either contain an additional column and row of zeros, for the case of full project additionality, or the data of the cash flow of an alternative project as a counterfactual.

Subtracting equation (1) from equations (2a) and (2b), we obtain, after some manipulation:

(3a) $$X_c - X_s = A_c(X_c - X_s) + (A_c - A_s)X_s$$
(3b) $$X_c - X_s = A_s(X_c - X_s) + (A_c - A_s)X_c$$

Both the A_s and the A_c matrix are singular, but we can decompose them into a nonsingular square submatrix of coefficients of endogenous variables and three rectangular submatrices of coefficients of both endogenous and exogenous variables:

(3) $$A_iX_i = \begin{bmatrix} A_{ee,i} & A_{ex,i} \\ A_{xe,i} & A_{xx,i} \end{bmatrix} \begin{bmatrix} X_{ei} \\ X_{xi} \end{bmatrix} \text{ for } i = s, c$$

In (4) X_{ei} and X_{xi} are vectors respectively of endogenous and exogenous activity levels and $A_{ee,i}, A_{ex,i}, A_{xe,i}, A_{xx,i}$ corresponding submatrices from partitioning of A_i. Developing the expression, we can re-write (2) and (3) as follows:

(5a) $$X_{ei} = A_{ee,i}X_{ei} + A_{ex,i}X_{xi} \ ; \quad i = s, c$$

(5b) $$X_{xi} = A_{xe,i}X_{ei} + A_{xx,i}X_{xi} \ ; \quad i = s, c$$

By defining the variables X_{xi} as exogenous, we disregard equation (5b), and, as a consequence, we are led to disregard X_{xi}forward linkages, described by their SAM inflows from transactions with all sectors. More generally, exogenous sectors will be able to act as demand shocks on the endogenous sectors, while they will not be able to absorb and recycle induced demand increases, since their forward linkages from equation (5b) are assumed to be severed (i.e., exogeneity amounts to assume that both matrices in (5b) are null). The exogenous sectors thus have a twofold role. On the one hand they amount to exogenous demand shocks, while, on the other hand, as leakages in the circulation of income, since their forward linkages are muted by the exogeneity assumption, they put a limit to the demand multipliers generated by external resource injections. More specifically, the size of the demand shock and of the consequent increases of the endogenous variable depend on the level of the exogenous variables, while the sizes of the multipliers are negatively related to the number of exogenous sectors that are excluded from the endogenous circulation of income.

Expression (5a) identifies one part of the system ($A_{ex,i}X_{xi}$) as a vector of exogenous demand levels and one part ($(I - A_{ee,i})X_{ei}$) as a corresponding vector of endogenous supply levels necessary to satisfy the direct and indirect demand generated by the exogenous demand levels.

In the case of full project additionality (no alternative project in the counterfactual), the vectors in (5a) and (5b) have different dimensions, since the vector X_{ec} includes project output, while the vector X_{es} does not. In general, however, we can assume that both X_{es} and X_{ec} are *n+1, 1* vector. Indicating with x_{pc} the project activity level (e.g., project output), we can write:

(6) $$X_{ec,n+1} - X_{es,n+1} = \begin{pmatrix} X_{ec,n} \\ x_{pc} \end{pmatrix} - \begin{pmatrix} X_{es,n} \\ x_{ps} \end{pmatrix} = \begin{pmatrix} X_{ec,n} - X_{es,n} \\ x_{pc} - x_{ps} \end{pmatrix}$$

Where x_{pc} indicates the output of the project under consideration and x_{ps} is the output of a counterfactual project, which is zero in the case of pure project additionality.

In the construction phase, the project can be considered an exogenous activity, so that we can disregard the last line of equation (6). In the operational period, on the other hand, the project can be subsumed by the augmented n+1 SAM among the endogenous activities. Assuming that m exogenous variables (in addition to the project) can be specified, we obtain, by subtracting the endogenous vector without the project from the one with the project:

(7a) $X_{ec,n} - X_{es,n} = A_{ee,c}(X_{ec,n} - X_{es,n}) + A_{ex,s}(X_{ec,n} - X_{es,n}) + (A_{ee,c} - A_{ee,s})X_{es,n} + (A_{ex,c} - A_{ex,s})X_{xs,n} + A_{ep,c}(x_{pc} - x_{ps}) + (A_{ep,c} - A_{ep,s})x_{ps} + (A_{ee,c} - A_{ee,s})(X_{ec,n} - X_{es,n}) + (A_{ex,c} - A_{ex,s})(X_{xc,n} - X_{xs,n}) + (A_{ep,c} - A_{ep,s})(x_{pc} - x_{ps})$

(7b) $X_{ec,n} - X_{es,n} = A_{ee,s}(X_{ec,n} - X_{es,n}) + A_{ex,s}(X_{ec,n} - X_{es,n}) + (A_{ee,c} - A_{ee,s})X_{ec,n} + (A_{ex,c} - A_{ex,s})X_{xc,n} + A_{ep,s}(x_{pc} - x_{ps}) + (A_{ep,c} - A_{ep,s})x_{pc} + (A_{ee,c} - A_{ee,s})(X_{ec,n} - X_{es,n}) + (A_{ex,c} - A_{ex,s})(X_{xc,n} - X_{xs,n}) + (A_{ep,c} - A_{ep,s})(x_{pc} - x_{ps})$

The three coefficient submatrices with the project $A_{ee,c}\ (n,n)$, $A_{ex,c}(n,m)\ and\ A_{ep,c}\ (n,1)$ may differ from the corresponding submatrices without the project $A_{ee,s}, A_{ex,s} and\ A_{ep,s}$ from three separate reasons: (i) they may reflect financing from outside sources for the project (e.g., a grant) , (ii) they may reflect a resource shift due to the need to finance the project, (iii) they may reflect productivity changes due to spillovers from project technology, organization or other systemic changes. In order to analyze these possibilities, it is useful to focus on the case in which there is no project in the counterfactual state of the world, i.e., $x_{ps} = 0$.

Assuming full additionality ($A_{ep,s}x_{ps} = 0$), and omitting the n-th subscript, equations (7a) and (7b) can be solved for the endogenous activities ($i = e$) to give the following expressions:

(8a) $X_{e,c} - X_{e,s} = \Delta X_e = L_c A_{ep} x_p + L_c[A_{ex,c}\Delta X_x + \Delta A_{ex} X_{xs} + \Delta A_{ex}\Delta X_x] + + \Delta L[(A_{exs}X_{xs}) + A_{ex,s}(\Delta X_x) + \Delta A_{ex} X_{xs} + \Delta A_{ex}\Delta X_x],$

(8b) $X_{e,c} - X_{e,s} = \Delta X_e = L_s A_{ep} x_p + L_s[A_{ex,s}\Delta X_x + \Delta A_{ex} X_{xc} + \Delta A_{ex}\Delta X_x] + + \Delta L[(A_{ex,c}X_{xc}) + A_{ex,c}(\Delta X_x) + \Delta A_{ex} X_{xc} + \Delta A_{ex}\Delta X_x + A_{ep}x_p],$

where $L_i = (I - A_{ee,i})^{-1}, i = c, s$ and Δ is the difference operator: $\Delta X_x = X_{xc} - X_{xs}$, $\Delta A_{ex} = A_{xc} - X_{xs}$. $\Delta L = L_c - L_s$.

Expressions (8a) and (8b) yield different results because the interaction terms are different. In line with the literature on structural decomposition (e.g., Rose and Casler, 1996, Koppany, 2017), these expressions thus signal an index number problem since project changes can be calculated as differences from the variable levels and the SAM parameter values with the project or without it[3]. In the remainder of this paper, we will assume that this problem can be solved by averaging the results obtained from the two equations (Koppany 2017, p. 619) in each pair.

[3]Taking into account that we can define $X_c = X_s + \Delta X_c$ and $A_c = A_s + \Delta A_c$ $X_s = X_c + \Delta X_s$, $A_s = A_c + \Delta A_s$ we can write equations (3a) and (3b) as follows:

$X_c - X_s = \Delta X = A_c\Delta X + (\Delta A)X_s + \Delta A_c\Delta X_c$; $X_c - X_s = \Delta X = A_s\Delta X + (\Delta A)X_c - \Delta A_s\Delta X_s$.

The index number problem arises from the need to approximate the two interaction terms $\Delta A_c\Delta X_c$ and $-\Delta A_s\Delta X_s$ (Rose and Cassler, 1996, p.48).

Looking at the structure of equations (8a) and (8b), we note that that the first term in both cases is the project multiplier as it is usually calculated, although in (8a) the computation is performed with the inverse matrix with the project while in equation (8b) it is done with the matrix without it. In both equations the term in square brackets measures three different effects: (i) a variation of the exogenous variables in response to the project (for example to finance it), (ii) an effect due to the modification of technical coefficients or institutions' shares due to the project, (iii) the interaction between (i) and (ii). The last term in square brackets, on the other hand, contains a first order effect given by the product of the difference multiplier ΔL by the exogenous variables, respectively without (8a) and with (8b) the project and three higher orders differences. In sum, in addition to the indirect effects induced by the project through the traditional multiplier (with and without the project), the inclusion of a project in a market economy may be followed by four different effects to reestablish equilibrium: (i) a variation of the exogenous variables, (ii) resource reallocation /redistribution among the endogenous and the exogenous activities and institutions, (iii) an increase in the interconnectedness of the economy , (iv) a set of interactive changes.

In the operational period, the project becomes an endogenous activity, and the two expressions (8a) and (8b) can be modified as follows:

(9a) $$X_{e,c} - X_{e,s} = \Delta X_e = L_c[A_{ex,c}\Delta X_x + \Delta A_{ex}X_{xs} + \Delta A_{ex}\Delta X_x] + \Delta L[(A_{exs}X_{xs}) + + A_{ex,s}(\Delta X_x) + \Delta A_{ex}X_{xs} + \Delta A_{ex}\Delta X_x],$$

(9b) $$X_{e,c} - X_{e,s} = \Delta X_e = L_s[A_{ex,s}\Delta X_x + \Delta A_{ex}X_{xc} + \Delta A_{ex}\Delta X_x] + \Delta L[(A_{ex,c}X_{xc}) + + A_{ex,c}(\Delta X_x) + \Delta A_{ex}X_{xc} + \Delta A_{ex}\Delta X_x + A_{ep}x_p],$$

In (9a) and (9b) vectors and matrices include the project as an additional endogenous activity, so that the endogenous variables are n+1 in number and the corresponding Leontief inverse and submatrices are: $A_{ee,c}\ (n+1, n+1)$, $L_c(n+1, n+1)$, $A_{ex,c}(n+1, m)$.

Expressions (8) and (9) highlight the important difference in the role played by the project respectively during constructions and operations. In the construction period the project can be considered an exogenous shock coming upon an economy in equilibrium, but with underemployed resources. Its impact is thus likely to be dominated by the boost of aggregate demand through the Leontief inverse multiplier. In the operational period, on the other hand, the project becomes an endogenous variable, as one of the ongoing activities of the economy, and its main impact is due both to the increase in productive capacity and in increase in the multiplier effect of the exogenous variables. By increasing the interconnectedness of the economy, in other words, and the corresponding level of the Leontief multipliers, the project contributes to the increase in aggregate demand during its operational phase. In this phase the project thus plays a dual role: on the supply side, by opening another line of production that provides benefits to a number of possible stakeholders, and on the demand side, by increasing the circular flow of income throughout the economy. These two outcomes are due not only to the direct effects of the project cash flow, as recognized in traditional cost benefit analysis, but also to its boosting of the multiplier effects in the economy, which is able to take fuller advantage of exogenous demand.

Integrating the project within the SAM, however, is not a trivial operation. If a new activity is added to a Social Accounting Matrix (SAM), the resulting Leontief Inverse will reflect the changes in the inter-sectoral linkages and sectoral multipliers that result from the addition of the new activity. To calculate the increase in aggregate demand in response to the output of the new activity, we can use the Leontief Inverse multiplied by the vector of final demand. Specifically, the Leontief Inverse multiplied by the new activity vector would give the output of the new activity sector in response to the given level of final demand.

However, it is important to note that adding a new activity to the SAM will affect the overall balance and consistency of the matrix. Therefore, the new SAM must be re-balanced to ensure that the sum of all incomes equals the sum of all expenditures, and that the total value of production, income, and expenditure in the SAM matches the corresponding values in the national accounts. Once the new SAM is balanced and consistent, it should respect the condition that the Leontief Inverse multiplied by the new activity vector should equal the vector of aggregate demand for the new activity. This relationship reflects the fact that the Leontief Inverse captures the direct and indirect effects of changes in final demand on the output of each endogenous sector of the economy, including the new activity sector that has been added to the SAM.

The above implies that in addition to include one row and one column of transactions to the SAM without the project, it is necessary to rebalance the SAM in such a way that the new totals respect the requirement:

(10) $$X_{ec} = L_c(A_{ex,c}\, X_{x,c} + A_{ep}x_p)\ ,$$

Where $A_{ep}x_p$ is the project vector and L_c the Leontief inverse with the project. However, the value of the Leontief matrix L_c in turn depends on the new SAM with the project, which can only be calculated if the vector of totals in (9) is estimated. For small projects, the Leontief inverse with the project will be very close to the one without the project. For large projects, however, the following iterative procedure has proved to be effective:

Step 1: Use the Leontief inverse without the project to estimate a set of totals with the project:

(11a) $$X_{ec,0} = L_s(A_{ex,s}\, X_{x,s} + X_p)$$

In (11a), X_p is the vector of project expenditures, which at this stage is still not a proper part of the SAM.

Step 2: Compute a new SAM with the project consistent with the totals in (11a) and compute a new set of totals:

(11b) $$X_{ec,1} = L_1(A_{ex,1}\, X_{x,1} + A_{ep,1} x_p)$$

In (11b) L_1 is the Leontief inverse of the new SAM that incorporates the project as $X_p = A_{ep,1} x_p$, where $A_{ep,1}$ is the project coefficient column vector and x_p total project expenditure. Note that in estimating the new SAM, the matrix of coefficients as well as levels of the exogenous variables may also change.

Step 3: Compute:

(11c) $$\Delta X_{e,1} = X_{ec,1} - X_{e,s} = \Delta X_{e,1} = L_1 A_{ep,1} x_p + L_1[A_{ex,1}\Delta X_x + \Delta A_{ex,1} X_{xs} + \Delta A_{ex,1}\Delta X_x] + \Delta L_1[(A_{exs}X_{xs}) + A_{ex,s}(\Delta X_x) + \Delta A_{ex} X_{xs} + \Delta A_{ex}\Delta X_x]$$

Step 4: Compute the control as the difference between the totals with the updated matrix and the totals with the original matrix (without the project):

(11d) $$\Delta\xi_{e,1} = (A_{ee,1}\, X_{e1} + A_{ex,1}\, X_{x,1} + A_{ep,1} x_p) - (A_{ee,s}\, X_{e,s} + A_{ex,s}\, X_{x,s})$$

Step 5: Compute the difference between the new totals and the control: $\Delta X_{e,1} - \Delta\xi_{e,1}$. If this difference is$> |\varepsilon|$ go to step 6

Step 6: Obtain a new set of totals as:

(11e) $$X_{ec,2} = L_1(A_{ex,1}\, X_{x,1} + A_{ep,1} x_p) + (\Delta X_{e,1} - \Delta\xi_{e,1})$$

Obtain a new matrix consistent with this total and a new inverse L_2.

Step 7: Revise the SAM so that it is consistent with the new totals in (10e) and proceed iteratively until convergence ($\left|\Delta X_{e,i} - \Delta\xi_{e,i}\right| < [\varepsilon]$.

(11f) $$X_{ec,i} = L_i\big(A_{ex,i-1}\, X_{x,i-1} + A_{ep,i-1} x_p\big) + \Delta X_{e,i-1} - \Delta\xi_{e,i-1}\ ,\ i = 1{,}2 \ldots\ldots n$$

In (11f) i indicates the ith iteration ($i = 1{,}2 \ldots$) starting from the values without the project.

To sum up, expressions (6)- (8) show that once embedded into the SAM, the project can be considered either an exogenous or an endogenous variable. In the first case, which typically coincides with project implementation (the construction phase), the project can be considered an autonomous initiative, impacting the economy both as an exogenous shock and as a structural change. In the second case (the operational phase), the project expected cash flow defines a set of coefficients for a new activity producing goods and/or services, whose impact on the economy (including project performance) is determined by the variation of the structural parameters of all other sectors. In this case, project scale and impact are endogenous, but the project can still be considered autonomous to an extent because its expected cash flow reflects a set of parameters from exogenous technologies and expenditure patterns (the project business plan).

Expressions (8) and (9) also show that the impact of the project can be decomposed into the effects of the variation of the technology and behavioral parameters, evaluated at the average levels of the endogenous and exogenous variables between the situation with and without the project. In the construction period, the impact of a project will depend on its effects, as an exogenous demand shock, on the endogenous variables, as it is generally reported in the literature on the multipliers. However, both in its construction and operational phase, the project may have a significant impact as a supply side shock, that is, by modifying the demand for inputs of both productive sectors and institutions. This second effect will depend on the relative size of the project compared to economy, and will be larger, the larger, for given input change, the values of the exogenous variables. For a given economy, therefore, larger projects that introduce disruptive technologies may display both a broader and a deeper impact, by causing direct, indirect and induced changes in the parameters regulating exchanges for all sectors.

Note that expression (6) in this respect can also be interpreted as harboring two competing relationships, where the second row of the matrix can be neglected and the first row (corresponding to equation (8)) would prevail if the project were given full autonomy and the project would be instead subsumed by the augmented n+1 SAM among the endogenous activities if it remained dependent on the outcomes of the economy. The difference between these two conditions, and the relative weight of each during project implementation and operations, may be taken as an indication of the limited scope of the project, if it were given some autonomy, but at the same time it would have to obey the existing parameters of technology and market change. In practice, along the entire project life, there may be a tension between the project's attempt to follow an autonomous course and the tendency of its context to "normalize" it by reconducting its behavior to the basic routines of the parent organization, according to a "short leash-long leash" management dilemma (Vihma and Wolf, 2022).

In sum, the impact of a project on the economy may be more fully accounted within the SAM with its cash flow having different effects involving endogenous or exogenous variables. The project causes aggregate demand to increase both through its direct and indirect effects on the economy. At the same time, because of the balancing requirements, integrating the project into the SAM will cause the shares of preexisting activities (the SAM coefficients) to change. These changes will depend on the methodology used to rebalance the SAM with the project and can be evaluated in detail through the analysis developed in expressions (6)-(9) above.

(7) An application to the Italian Economy

In order to develop an interesting case study, we propose to analyze the impact of the large cluster of projects included in the PNRR (the Italian Plan for Reconstruction and Resilience). To this aim, we have estimated a compact, uptodate Italian Social Accounting Matrix (SAM). This matrix, presented in Table 6, in appendix is based on a larger study (Cufari et al., 2022) using data from national statistics and the available literature. These data have been supplemented by nationally representative industrial and households' surveys for production disaggregation, employment and Household's income and consumption (Statistical Registry of Active Enterprises (ASIA-Enterprises) of ISTAT, ISTAT (2014, 2015 a,b,c.). The SAM estimated is calibrated with the 2020 national account data. and is an aggregate version of a SAM estimated for twenty sectors, of which one sector for agriculture, eleven sectors for industry, and eight service sectors, including trade, transport services and public administration services.

The Italian PNRR is part of the NEXTEU (Next Generation EU Program), the European program for recovery from the economic and social damages caused by the COVID 19 pandemic [4]. The program is funded by an autonomous issuance of European bonds on the part of the European Commission and uses a mixture of loans and grants to finance investment for a total of about 723.5 million euros distributed among European countries. NEXTEU assignment and disbursement, which sees Italy as the largest beneficiary of the program, depends on the implementation of a national plan, approved by the Commission and is conditioned to a series of milestones and targets.

The three pillars of NEXTEU are:

1) Investment and reform support,
2) Reviving economy by encouraging private investments and
3) Learning from the crisis.

The Italian National Recovery and Resilience Plan (in Italian, Piano Nazionale di Ripresa e Resilienza, or PNRRR) aims to mitigate the economic and social impact of the pandemic and build a more equitable, green and inclusive country. The program is in line with EU pillars and the resources allocated in the PNRR are equal to 191.5 billion euros, divided into six missions:

- Digitization, innovation, competitiveness and culture - 40.32 billion
- Green revolution and ecological transition - 59.47 billion
- Infrastructure for sustainable mobility - 25.40 billion
- Education and research - 30.88 billion
- Inclusion and cohesion - 19.81 billion
- Health - 15.63 billion

For further interventions, the Italian government has approved a complementary fund with resources for 30.6 billion euros. Overall, the investments envisaged by the PNRR and the Complementary Fund amount to 222.1 billion euros.

The Plan is developed around three strategic axes shared at European level: digitization and innovation, ecological transition, social inclusion. This is an intervention that intends to repair the economic and social damage of the pandemic crisis, help resolve the structural weaknesses of the Italian economy, and accompany the country on a path of ecological and environmental transition.

[4] For further reading see. https://next-generation-eu.europa.eu/index_en

(8) Methodology and Results

Table 1 and Table 2 show the structure of the cash flow of the (financial) costs and benefits hypothesized to test the impact of the Italian National Recovery Plan, according to the nationwide development missions and strategies. In the tables, costs and benefits are given as totals (5 years for the construction period and 30 years for the operational and maintenance (O&M) period), and as present values at a discount rate of 5%.

Project evaluation with the model has been performed by using the methodology presented in section 3, that combines the SAM with the cash flow components envisaged by project plans to estimate both direct and indirect effects on activities, commodities, and institutions. The figures in the tables are hypothetical levels of costs and benefits based on estimates of similar projects.

Table 1 The Program Target Cash Flow (Direct Costs in Million €)

	TOTAL (2023-2027)	Present Value
INVESTMENT COSTS		
Agriculture	330.00	285.75 €
Computers	1,750.00	1,515.32 €
Electric Machineries	11,505.00	9,962.13 €
Machineries	36,920.00	31,968.86 €
Construction	88,895.00	76,973.77 €
Other Services	36,060.00	31,224.19 €
R&D	16,060.00	13,906.28 €
TOTAL INVESTMENT COSTS	**191,520**	**165,836**
TOTAL O&M COSTS	**114,912**	**58,883**

Source: Authors' calculation on PNRR Data

Table 2 The Program Revenue Target Cash Flow (Anticipated Direct Revenues in Million €)

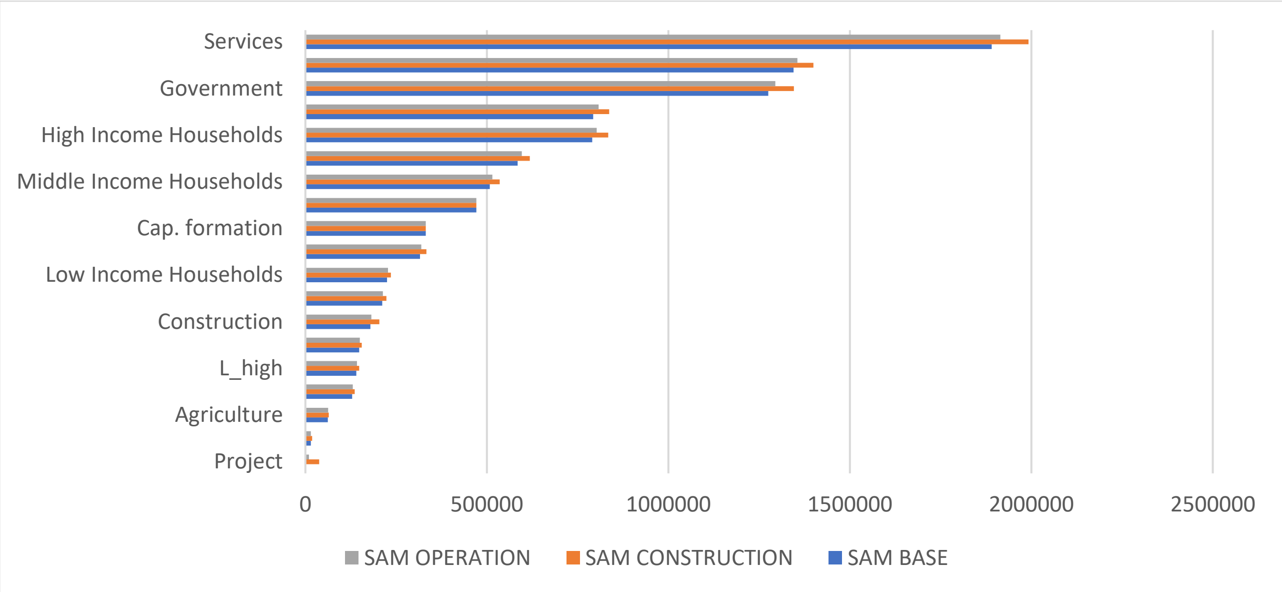
REVENUES	TOTAL (2027-2047)	Present Value
Agriculture	7,905.00	4,050.64 €
Energy	81,285.00	41,651.66 €
Transport Services	38,100.00	19,523.01 €
Other Services	45,855.00	23,496.79 €

R&D	17,160.00	8,793.04 €
Public Admin	27,540.00	14,111.91 €
Education	29,160.00	14,942.02 €
Health	23,445.00	12,013.57 €
Social Services	16,830.00	8,623.95 €
TOTAL BENEFITS	**287,280**	**147,207**

Source: Authors' estimation

In practice, we have first disaggregated the investment costs starting from the budget allocated to each mission of the Italian NRP (see above), into SAM's activities and then extended the SAM with a further activity containing the project's cash flow. Figure 1 below shows the differences between SAM totals.

FIGURE 1. DIFFERENCES BETWEEN SAMS (MILLION €)



Source: Authors' estimation

The three SAMs are presented in the appendix respectively in table 6 (SAM without the project), table 7 (SAM in the construction period) and table 8 (SAM in the operational period).

The construction and operational period SAMS are estimated incorporating the project cash flows of tables 1 and 2, respectively in the construction period (t=0), and in the operational period (t=1), with the project cash flow being accounted for as an extra activity and/or institution in the matrix. The cash flow data in the construction period include only capital expenditures (capital goods produced by activities) in the account column and financing from Government and rest of the World in the account row. In the operational period, the project account column includes all estimates of project costs (including capital depreciation and operational costs), while the row account contains all estimates of project revenues. As already discussed in Section 3, the cash flow figures for the operational period, are used to estimate correspondent SAM coefficients which determine the project economic profile as a proportion of inputs and outputs. Basically, both the Construction and Operational SAMs have been estimated following the Steps of section 3. Starting with the Leontief inverse without the project, new SAM totals have been estimated multiplying the inverse matrix for the column vector of the project (see Table 1 and Table 2), treated at this stage as an exogenous variable and for the vector column of the other exogenous variables which are capital formation and rest of the world. Once found the new totals, the construction and operational SAMs have been balanced using the RAS procedure (Lemelin et al, 2013)[5].

As Table 7 in the appendix shows, in the construction period, the expenditure for project implementation, detailed in the project column, is financed from Government for 60% and from the Rest of the World for 40% (in the project row) with further balancing of the SAM involving capital formation and other institutions. Since the project at this stage can be considered an exogenous activity, the row describing its financing can be disregarded, while the column can be considered an exogenous shock, which generates, to the extent that its expenditures mobilize unemployed resources, increases in revenues, consumption, trade and value added through indirect effects. In other words, in the construction period, the project operates as a demand stimulus and produces spillover effects. Because its introduction in the SAM changes also the SAM parameters, the project has also some structural effects, with a prevailing role of its expenditure pattern.

In its operational phase, on the other hand, the project becomes an activity endowed with the productive capacity created in the construction phase. To be sustainable, it has to collect revenues that are equal or exceed the capital costs undergone in the construction phase plus the operating costs of the operational phase, including any financing. Project revenues are listed in the project row in Table 2. They are collected from various stakeholders who purchase the goods or services provided by the project. We assume that benefits correspond to a 5% rate of return to capital in the sectors whose productive capacity is increased by project investments. Project direct net (financial) benefits are thus simply the portion of value added credited to capital, net of any charges due to user costs for maintenance.

The value-added account in the operation phase is the sum of the project direct payments to production factors and indirect taxes to meet operational costs and of the returns to capital obtained from project revenues after paying for intermediate goods and capital formation. The capital formation expenditures include loan repayments, interests, capital depreciation (assumed to be 5% per year) and any expenditure for replacement of capital goods. As an endogenous activity, the project cash flow in the operation period is consistent with the revenues and the expenditures of the other accounts in the SAM and is determined by the value of the exogenous variables (see table 8 in the appendix)

[5] For both the construction and operational period the colum vector of the project was annualized assuming a constant value per year. Hence for the construction period an annual value of 38.3 billion (191.5 billion divided by 5 years) was considere to estimate the relative SAM, while for the operational period a value of 9.58 billion was considered to estimate the relative SAM (287.3 billion divided by 30 years).

Impact estimates for the construction phase are reported in Table 3 and figure 2, using average values computed according to expressions (7a) and (7b), and assuming that project expenditures are equally distributed over a six-year period. The structural impact of the project through the coefficients of the endogenous variables is positive for all sectors mainly due to project's impacts, but with some crowding out effect (column 2 of table 3), since the project acts as a substitute of existing activities and thus absorbs resources that would otherwise be used by the other sectors. Crowding out is counterbalanced, although only partially so, by the increase in connectedness in the economy due to the project and the consequent increase in the impact of the Leontief inverse. The total impact of the project on value-added is thus positive for around 390 billion euros in present value with a value-added overall project multiplier of 2.14. From the production point of view, in the construction period, compared to the base case without the project, large positive impacts emerge for Research and Development (99%), Construction and Public Administration (respectively about 60% and 24%) (figure 2). All households' categories participate equally to the benefits in the construction period (about 24% increase in income) with a smaller impact for low-income households (about 21%) (figure 2).

TABLE 3. CONSTRUCTION PHASE IMPACT (PRESENT VALUES IN MILLION €)[6]

	Project's Impact	Exogenous Variables' Impact	Multiplier changes' Impact	Total Impact	Percentage increase respect to Base year
Agriculture	12,068.73	-5,249.83	4,858.93	**11,677.83**	19%
Industry	242,192.87	-113,115.34	103,470.36	**232,547.88**	17%
Energy	31,444.12	-11,065.44	10,239.68	**30,618.36**	21%
Construction	106,958.71	-3,901.80	4,065.82	**107,122.73**	60%
R&D	14,672.61	-405.28	377.89	**14,645.22**	99%
Other Services	447,218.36	-60,323.41	127,374.29	**437,502.21**	23%
Public Admin	30,907.67	-8,953.19	8,304.84	**30,259.32**	24%

[6] Project's Impact in the construction period is given by an average of the formula 7a and 7b according to the term: $(L + \Delta L) * A_{ep} x_p$.
In the same manner, *Exogenous variables' impact* is given by the term:
$L * ((\Delta A_{ex}) X_x + L * (A_{ex}) \Delta X_x \;\; + \;\; L * (\Delta A_{ex}) \Delta X_x \;)$
and *Multiplier changes' impact* is given by the term:
$\Delta L * ((\Delta A_{ex}) X_x + (A_{ex}) \Delta X_x + (\Delta A_{ex}) \Delta X_x + (A_{ex} X_x))$
where $L = 1/2(I - A_{ee,c})^{-1} + 1/2(I - A_{ee,s})^{-1}$ and $\Delta L = (I - A_{ee,c})^{-1} - (I - A_{ee,s})^{-1}$.

Low skilled labour	**51,883.68**	**-15,180.12**	**14,068.94**	**50,772.50**	24%
Mid skilled labour	**77,755.18**	**-22,613.76**	**20,951.19**	**76,092.62**	24%
High skilled labour	**35,086.09**	**-9,888.72**	**9,165.98**	**34,363.35**	25%
Capital	**196,872.95**	**-56,514.59**	**52,499.84**	**192,858.20**	24%
Total Value Added	**361,597.90**	**-104,197.19**	**96,685.96**	**354,086.67**	**24%**
Low Income Households	48,475.34	-11,733.76	10,900.88	**47,642.46**	21%
Middle Income Households	123,016.49	-34,829.89	32,300.82	**120,487.41**	24%
High Income Households	195,033.18	-56,303.34	52,211.12	**190,940.95**	24%
Government	309,086.53	-89,727.08	83,200.12	**302,559.57**	24%
Enterprises	145,184.73	-41,690.52	38,724.62	**142,218.83**	24%

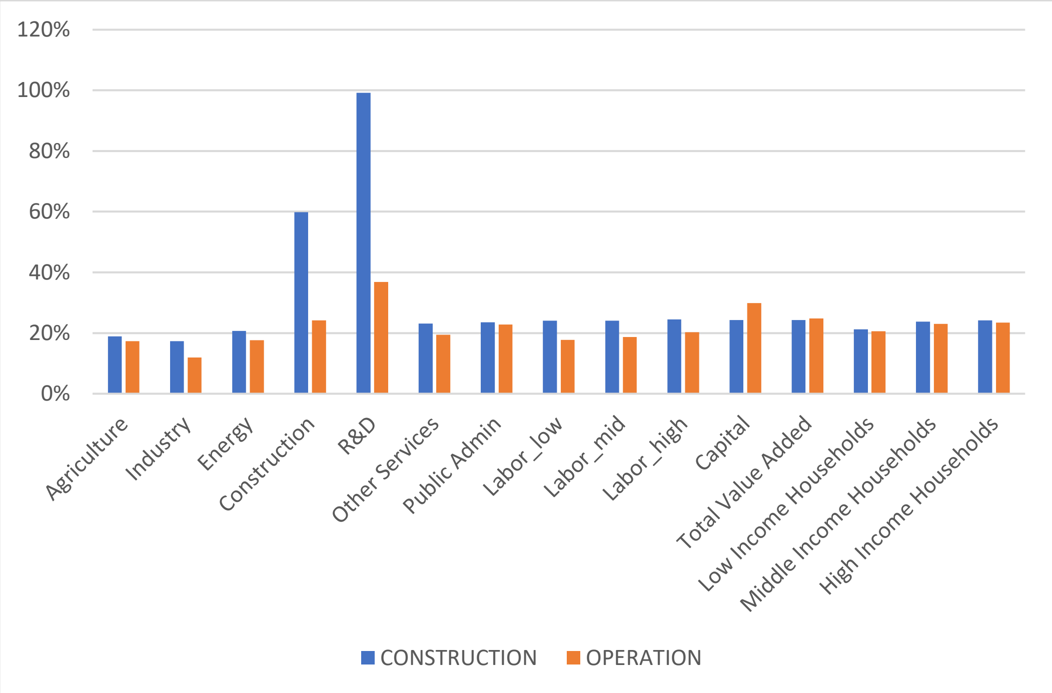
Source. Model Simulations

Table 4 reports the results for the operational period, where we have also assumed that project cash flows and related effects would be equally distributed over 30 years of project life. In this case, the effects of the project, in addition to its net cash flow (which at 5% is just enough to compensate for the discount rate), consist of the increase in value of the impact of the exogenous variables, as compared to the situation without the project. This increase, in turn, is decomposed in an increase in the shares and values of the exogenous variables with the average multiplier (first column of Table 4), and an increase in the multipliers with respect to the no project situation, due to the higher connectedness induced by the project (second column of Table 4). Both structural changes lead to positive effects for all sectors but are dominated by the increased linkage effects. In terms of value-added, in fact, project performance adds about a net amount of 23.5 billion Euros per year to the economy, roughly equivalent to a PV (at 5% discount) of more than 361.4 billion Euros. Compared to PV project operation costs of about 58.8 billion Euros, and the present value of the investment costs about 165.8 billion euros, the total ratio between benefits and costs of the value added for the operation period is around 1.61.

With respect to the situation without the project, the value added in the operation period has the highest positive impact for capital (around 30%), the impact on labor income is almost the same for all the categories (around 19% in average) (figure 1). This result reflects in the impact on households' income which is similar for all the categories (around 22% in average), as figure 4 shows. From the production point of view, large positive impacts are estimated again for Research and

Development (around 37%), followed by Construction (24%) and Public Administration (23%) (figure 2). Table 5 summarizes the cost benefit analysis of the project, showing a positive NPV for 425.3 billion euros including the positive impact on value added in the construction period and 71 billion euros including just the positive impact on value added of the Operational period, with an 8% internal rate of return (IRR).

FIGURE 2 TOTAL IMPACT. CONSTRUCTION AND OPERATION PERIODS



Source: Model results

TABLE 4. OPERATIONAL PHASE IMPACT (PRESENT VALUES IN MILLION €)[7]

	Exogenous Variables' Impact	**Multiplier changes' Impact**	**Total Impact**	**Percentage increase respect to Base year**
Agriculture	-4.59	10,687.20	10,682.60	17%
Industry	3,356.90	157,599.07	160,955.97	12%
Energy	1,125.11	24,987.08	26,112.19	18%
Construction	2,795.35	40,390.20	43,185.54	24%
R&D	139.43	5,303.53	5,442.95	37%
Other Services	6,294.62	371,732.25	367,140.97	19%
Public Admin	318.78	28,987.14	29,305.92	23%

[7] In the operational period, as the project is endogenopus, total impact is given by *Exogenous variables' impact* and *Multiplier changes' impact* by the term, calculated in the same manner than the construction period (see previous footnote).

Low skilled labour	**813.19**	**36,733.49**	**37,546.68**	18%
Mid skilled labour	**1,094.56**	**57,862.03**	**58,956.59**	19%
High skilled labour	**435.44**	**27,958.00**	**28,393.44**	20%
Capital	**2,970.78**	**233,546.51**	**236,517.29**	30%
Total Value Added	**5,313.97**	**356,100.03**	**361,414.00**	**24%**
Low Income Households	-1,015.32	47,241.07	46,225.75	21%
Middle Income Households	1,095.91	115,902.89	116,998.80	23%
High Income Households	2,744.23	182,628.57	185,372.80	23%
Government	3,407.85	290,974.58	294,382.43	23%
Enterprises	2,173.28	171,171.83	173,345.11	30%
Project	22.75	147,229.34	147,252.09	-

Source. Model Simulations

TABLE 5. PROJECT'S CASH FLOW

PV. Operation Benefits (Value added increase)	361,414.00 €
PV. Construction Benefits (Value added increase)	354,086.67 €
PV. Operation Costs	-58,882.64 €
PV. Investment Costs	-165,836.27 €
CASH FLOW Withouth Constrcuction Benefits	136,695.09 €
CASH FLOW With Constrcuction Benefits	490,781.76 €
NPV Withouth Constrcuction Benefits	71,204.96 €
NPV With Constrcuction Benefits	425,291.63 €
IRR Withouth Constrcuction Benefits	8%
IRR With Constrcuction Benefits	-

Source. Model Simulations

Conclusions

This paper has presented a new technique of economic analysis for investment projects, based on a social accounting matrix (SAM), that can be applied to different modelling frames using the SAM, including Computable General Equilibrium Models. The technique expounds the approach developed in Scandizzo (2021), to consider the twofold case in which the project is considered an exogenous, autonomous endeavor, or is embedded in the economic system which ultimately determines its performance as an endogenous economic activity. These two polar cases are identified, respectively with the construction and the operational phase of the project, but in practice can be combined, to fit the structural and management characteristics of the projects examined. The use of the SAM gives both the possibility of distinguishing among project phases, the evolution of project over time and the project impact on technology, demand structure and social variables. It thus extends the project evaluation to the assessment of its impact on different institutions and social groups, participating and absentee stakeholders, and allows to analyze the different components of the social return to investment. The theory developed suggests that a successful project tends to be disruptive of the previous social order and that its success depends on striking the right balance between positive shifts in demand and supply on one hand, and reduction of pre-existing incomes and rents on the other hand. Even in the case of seemingly neutral projects, with apparently inoffensive spending profiles, their mere introduction in the economic system tends to reduce some of the gains of the ongoing transactions, giving rise to major shifts of benefits and costs. Net project impact, therefore, even when it is highly positive, as in the numerical case study presented, appears to be characterized by structural changes that may cause losses or gains by shifting resources across stakeholders. Depending on the project scale and structural features, these resource shifts may be significant and create diverse and possibly diverging patterns of benefits and costs across project stakeholders.

The above framework was applied to the evaluation of the PNRR impact on the Italian economy by using a compact SAM estimated with the latest data available. The simulations indicated that sizable sector diseconomies should be expected from crowding out effects due to structural changes, but that these would be overcompensated by both demand and productivity effects from project increased resources and by its positive allocation impact. Overall, the SAM experiments suggest that the PNRR effects would be of the order of 3 % of GDP per year in the construction phase compared to the business-as-usual scenario, and of about 1% per year in the operational phase.

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APPENDIX

Table 6 Base SAM 2020 (withouth project, billion euros)

	Agriculture	Industry	Energy	Construction	R&D	Services	Public Admin	L_low	L_mid	L_high	Capital	Low Income Households	Middle Income Households	High Income Households	Government	Enterprises	Cap. formation	RoW	**Total**
Agriculture	4.41	25.88	0.57	0.07	0.03	6.28	0.09	-	-	-	-	3.79	7.32	6.83	0.70	-	0.42	5.23	**61.64**
Industry	8.56	455.10	14.32	33.85	1.08	135.13	2.10	-	-	-	-	45.37	92.48	90.82	5.57	-	86.24	374.78	**1,345.39**
Energy	1.23	28.76	48.69	1.69	0.11	21.32	3.54	-	-	-	-	7.83	15.21	14.67	0.67	-	2.29	2.22	**148.23**
Construction	0.45	6.45	1.92	35.85	0.14	14.26	2.30	-	-	-	-	2.16	4.19	4.05	1.35	-	104.65	1.16	**178.94**
R&D	0.01	2.06	0.05	0.03	0.18	0.67	0.01	-	-	-	-	0.02	0.06	0.06	0.12	-	9.84	1.65	**14.76**
Services	3.82	196.10	34.07	35.89	2.69	503.67	17.93	-	-	-	-	140.03	303.22	313.23	188.25	-	70.65	81.07	**1,890.61**
Public Admin	0.00	0.92	0.16	0.07	0.00	2.67	0.19	-	-	-	-	0.29	0.68	0.75	122.19	-	0.37	0.13	**128.41**

Low skilled labour	4.67	60.05	5.59	14.34	0.64	110.06	15.94	-	-	-	-	-	-	-	-	-	-	-	**211.29**
Mid skilled labour	2.26	66.95	6.58	11.55	3.43	196.30	28.72	-	-	-	-	-	-	-	-	-	-	-	**315.79**
High skilled labour	0.62	16.96	2.05	1.84	2.30	94.82	21.42	-	-	-	-	-	-	-	-	-	-	-	**140.01**
Capital	23.68	104.50	22.50	34.58	2.17	576.49	28.67	-	-	-	-	-	-	-	-	-	-	-	**792.59**
Low Income Households	-	-	-	-	-	-	-	22.21	33.12	14.63	23.64	-	-	-	73.56	30.68	26.70	-	**224.54**
Middle Income Households	-	-	-	-	-	-	-	68.38	102.11	45.15	72.91	-	-	-	116.85	94.13	8.12	-	**507.66**
High Income Households	-	-	-	-	-	-	-	120.70	180.56	80.23	128.91	-	-	-	113.89	165.97	-	-	**790.26**
Government	-	42.60	3.59	8.48	1.24	157.22	7.41	-	-	-	-	21.17	67.86	149.11	634.34	175.78	2.08	4.39	**1,275.28**
Enterprises	-	-	-	-	-	-	-	-	-	-	567.13	-	-	-	17.79	-	-	-	**584.93**

Cap. formation	-	-	-	-	-	-	-	-	-	-	-	-	10.87	202.44	-	118.36	-	-	**331.66**
RoW	11.93	339.06	8.14	0.69	0.75	71.72	0.09	-	-	-	-	3.87	5.77	8.31	-	-	20.30	-	**470.63**
Total	**61.64**	**1,345.39**	**148.23**	**178.94**	**14.76**	**1,890.61**	**128.41**	**211.29**	**315.79**	**140.01**	**792.59**	**224.54**	**507.66**	**790.26**	**1,275.28**	**584.93**	**331.66**	**470.63**	

Source: Authors' estimation

TABLE 7 CONSTRUCTION PERIOD SAM (BILLION EUROS)

	Agriculture	Industry	Energy	Construction	R&D	Services	Public Admin	L_low	L_mid	L_high	Capital	Low Income Households	Middle Income Households	High Income Households	Government	Enterprises	Project	Cap. formation	RoW	**Total**
Agriculture	4.65	27.12	0.60	0.08	0.04	6.61	0.09	-	-	-	-	3.97	7.70	7.28	0.71	-	0.07	0.41	5.03	**64.35**
Industry	9.07	480.90	15.11	38.73	1.33	143.29	2.23	-	-	-	-	47.73	97.83	97.37	5.68	-	10.12	86.81	363.47	**1,399.67**
Energy	1.29	30.02	51.05	1.92	0.13	22.41	3.73	-	-	-	-	8.17	15.96	15.60	0.67	-	-	2.27	2.12	**155.35**
Construction	0.48	6.78	2.03	40.84	0.17	15.08	2.44	-	-	-	-	2.26	4.42	4.33	1.37	-	17.73	104.59	1.12	**203.65**

R&D	0.02	2.17	0.05	0.04	0.23	0.71	0.01	-	-	-	-	0.03	0.06	0.07	0.12	-	3.21	9.86	1.59	**18.15**
Services	4.03	205.95	35.83	40.77	3.32	531.17	18.95	-	-	-	-	146.70	319.55	334.64	195.62	-	7.17	70.45	78.02	**1,992.16**
Public Admin	0.00	1.01	0.17	0.08	0.00	2.91	0.20	-	-	-	-	0.31	0.74	0.83	128.66	-	-	0.38	0.13	**135.44**
Low skilled labour	4.91	62.92	5.86	16.24	0.78	115.60	16.76	-	-	-	-	-	-	-	-	-	-	-	-	**223.08**
Mid skilled labour	2.38	70.21	6.90	13.09	4.22	206.44	30.23	-	-	-	-	-	-	-	-	-	-	-	-	**333.46**
High skilled labour	0.65	17.81	2.16	2.09	2.83	99.89	22.57	-	-	-	-	-	-	-	-	-	-	-	-	**147.99**
Capital	24.92	109.59	23.61	39.21	2.67	607.18	30.17	-	-	-	-	-	-	-	-	-	-	-	-	**837.35**
Low Income Households	-	-	-	-	-	-	-	23.49	35.03	15.49	24.99	-	-	-	76.34	33.03	-	27.23	-	**235.60**
Middle Income Households	-	-	-	-	-	-	-	72.26	107.91	47.77	77.00	-	-	-	121.17	101.23	-	8.29	-	**535.62**
High Income	-	-	-	-	-	-	-	127.33	190.51	84.73	135.90	-	-	-	117.91	178.20	-	-	-	**834.59**

Households																				
Government	-	45.58	3.85	9.82	1.56	168.98	7.97	-	-	-	-	22.58	72.78	162.31	655.33	188.35	-	2.11	4.31	**1,345.51**
Enterprises	-	-	-	-	-	-	-	-	-	-	599.47	-	-	-	18.47	-	-	-	-	**617.93**
Project	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23.46	-	-	-	14.84	**38.30**
Cap. formation	-	-	-	-	-	-	-	-	-	-	-	-	10.80	203.73	-	117.13	-	-	-	**331.66**
RoW	11.97	339.61	8.14	0.75	0.87	71.89	0.09	-	-	-	-	3.85	5.78	8.44	-	-	-	19.24	-	**470.63**
Total	**64.35**	**1,399.67**	**155.35**	**203.65**	**18.15**	**1,992.16**	**135.44**	**223.08**	**333.46**	**147.99**	**837.35**	**235.60**	**535.62**	**834.59**	**1,345.51**	**617.93**	**38.30**	**331.66**	**470.63**	

TABLE 8. OPERATION PERIOD SAM (BILLION EUROS)

	Agriculture	Industry	Energy	Construction	R & D	Services	Public Admin	Low skilled labour	Mid skilled labour	High skilled labour	Capital	Low Income Hous	Middle Income	High Income Hous	Government	Enterprises	Project	Cap. formation	RoW	**Total**

												eholds	Households	eholds						
Agriculture	4.44	26.18	0.57	0.07	0.03	6.34	0.09	-	-	-	-	3.84	7.44	6.98	0.71	-	0.01	0.42	5.23	**62.33**
Industry	8.61	459.02	14.18	34.33	1.06	136.17	2.11	-	-	-	-	45.97	93.91	92.76	5.68	-	1.00	86.32	374.75	**1,355.86**
Energy	1.24	29.21	48.56	1.73	0.11	21.63	3.58	-	-	-	-	8.00	15.56	15.09	0.68	-	-	2.31	2.23	**149.93**
Construction	0.45	6.51	1.91	36.37	0.14	14.38	2.31	-	-	-	-	2.19	4.26	4.14	1.38	-	1.77	104.79	1.16	**181.75**
R&D	0.01	2.08	0.05	0.03	0.18	0.67	0.01	-	-	-	-	0.02	0.06	0.06	0.12	-	0.32	9.85	1.65	**15.12**
Services	3.84	197.93	33.76	36.41	2.65	507.89	18.00	-	-	-	-	141.95	308.05	320.07	191.40	-	0.72	70.72	81.10	**1,914.48**
Public Admin	0.00	0.93	0.15	0.07	0.00	2.68	0.19	-	-	-	-	0.29	0.69	0.76	124.06	-	-	0.37	0.13	**130.32**
Low skilled labour	4.72	60.83	5.56	14.61	0.63	111.32	16.06	-	-	-	-	-	-	-	-	-	-	-	-	**213.73**
Mid skilled labour	2.29	67.91	6.55	11.77	3.39	198.72	28.99	-	-	-	-	-	-	-	-	-	-	-	-	**319.62**

High skilled labour	0.63	17.25	2.05	1.88	2.28	96.09	21.68	-	-	-	-	-	-	-	-	-	-	-	-	**141.86**
Capital	23.93	105.85	22.38	35.21	2.14	583.83	28.88	-	-	-	-	-	-	-	-	-	5.75	-	-	**807.97**
Low Income Households	-	-	-	-	-	-	-	22.49	33.56	14.84	24.12	-	-	-	74.57	31.39	-	26.59	-	**227.55**
Middle Income Households	-	-	-	-	-	-	-	69.18	103.36	45.76	74.32	-	-	-	118.34	96.23	-	8.08	-	**515.27**
High Income Households	-	-	-	-	-	-	-	122.07	182.71	81.27	131.36	-	-	-	115.31	169.61	-	-	-	**802.32**
Government	-	42.86	3.54	8.57	1.21	157.97	7.41	-	-	-	-	21.39	68.71	151.95	644.16	180.18	-	2.07	4.38	**1,294.42**
Enterprises	-	-	-	-	-	-	-	-	-	-	578.18	-	-	-	18.02	-	-	-	-	**596.20**
Project	0.27	-	2.69	-	0.56	5.14	0.92	-	-	-	-	-	-	-	-	-	-	-	-	**9.58**
Cap. formation	-	-	-	-	-	-	-	-	-	-	-	-	10.79	202.08	-	118.79	-	-	-	**331.66**

RoW	11.90	339.29	7.99	0.70	0.73	71.67	0.09	-	-	-	-	3.89	5.81	8.42	-	-	-	20.14	-	**470.63**
Total	**62.33**	**1,355.86**	**149.93**	**181.75**	**15.12**	**1,914.48**	**130.32**	**213.73**	**319.62**	**141.86**	**807.97**	**227.55**	**515.27**	**802.32**	**1,294.42**	**596.20**	**9.58**	**331.66**	**470.63**	

Source: Authors’ estimation