June 2022

Fondazione Eni Enrico Mattei

Working Paper

08.2022

Besides promising economic growth, will the Italian NRRP also produce fewer emissions?

Ilenia Romani, Marzio Galeotti, Alessandro Lanza

Besides promising economic growth, will the Italian NRRP also produce fewer emissions?

By Ilenia Romani, Università degli Studi di Brescia and Fondazione Eni Enrico Mattei
Marzio Galeotti, Università degli Studi di Milano and Fondazione Eni Enrico Mattei
Alessandro Lanza, LUISS and Fondazione Eni Enrico Mattei

Summary

The funds allocated by the National Recovery and Resilience Plan (NRRP) aim to trigger a multiplier effect on GDP as they are designed to help the recovery after the Covid-19 pandemic. The GDP increase is in turn expected to drive energy consumption up which will increase CO2 emissions, given that fossil fuels still account for 79% of the Italian total primary energy consumption. At the same time, as the NRRPs are part of the EU Green Deal, an important share of the Plan's investments is aimed at facilitating the green transition, with expected favorable effects on emissions. Which one of these two effects will prevail remains to be ascertained.
In this study we have used the GEM (Global Economic Model) by Oxford Economics to build a number of scenarios and generate the relevant simulations aimed at assessing the impact of the Italian NRRP's interventions on energy consumption and CO2 emissions. To validate the use of GEM we extensively considered the macroeconomic impact on GDP and unemployment rate generated by the model and compare the results to those presented by other institutions and obtained using different models.
The results show that when the green investments of the NRRP display their effects, there are climatic benefits in terms of reduced emissions. Compared to the implementation of the NRRP in 2021, however, the reduction in emissions by 2030 is modest and equal to 5%. As those investments largely refer to the adoption of clean technologies, the climate benefits are likely to be more substantial only in subsequent years and over longer horizons.

Keywords: National Recovery and Resilience Plan, CO2 emissions, large-scale macroeconomic model, post-Covid recovery

JELClassification: E37, E61, E62, Q43, Q54, C30

Address for correspondence:
Ilenia Gaia Romani
FEEM and University of Brescia
Corso Magenta 63 – 20123
Milan, Italy
E-mail: ilenia.romani@feem.it

Besides promising economic growth, will the Italian NRRP also produce fewer emissions?

Ilenia Romani[1,4] Marzio Galeotti[2,4] Alessandro Lanza[3,4]

Abstract. The funds allocated by the National Recovery and Resilience Plan (NRRP) aim to trigger a multiplier effect on GDP as they are designed to help the recovery after the Covid-19 pandemic. The GDP increase is in turn expected to drive energy consumption up which will increase CO2 emissions, given that fossil fuels still account for 79% of the Italian total primary energy consumption. At the same time, as the NRRPs are part of the EU Green Deal, an important share of the Plan's investments is aimed at facilitating the green transition, with expected favorable effects on emissions. Which one of these two effects will prevail remains to be ascertained.

In this study we have used the GEM (Global Economic Model) by Oxford Economics to build a number of scenarios and generate the relevant simulations aimed at assessing the impact of the Italian NRRP's interventions on energy consumption and CO2 emissions. To validate the use of GEM we extensively considered the macroeconomic impact on GDP and unemployment rate generated by the model and compare the results to those presented by other institutions and obtained using different models.

The results show that when the green investments of the NRRP display their effects, there are climatic benefits in terms of reduced emissions. Compared to the implementation of the NRRP in 2021, however, the reduction in emissions by 2030 is modest and equal to 5%. As those investments largely refer to the adoption of clean technologies, the climate benefits are likely to be more substantial only in subsequent years and over longer horizons.

---

[1] Università degli Studi di Brescia
[2] Università degli Studi di Milano
[3] LUISS
[4] Fondazione Eni Enrico Mattei

1. The National Recovery and Resilience Plan: a short summary

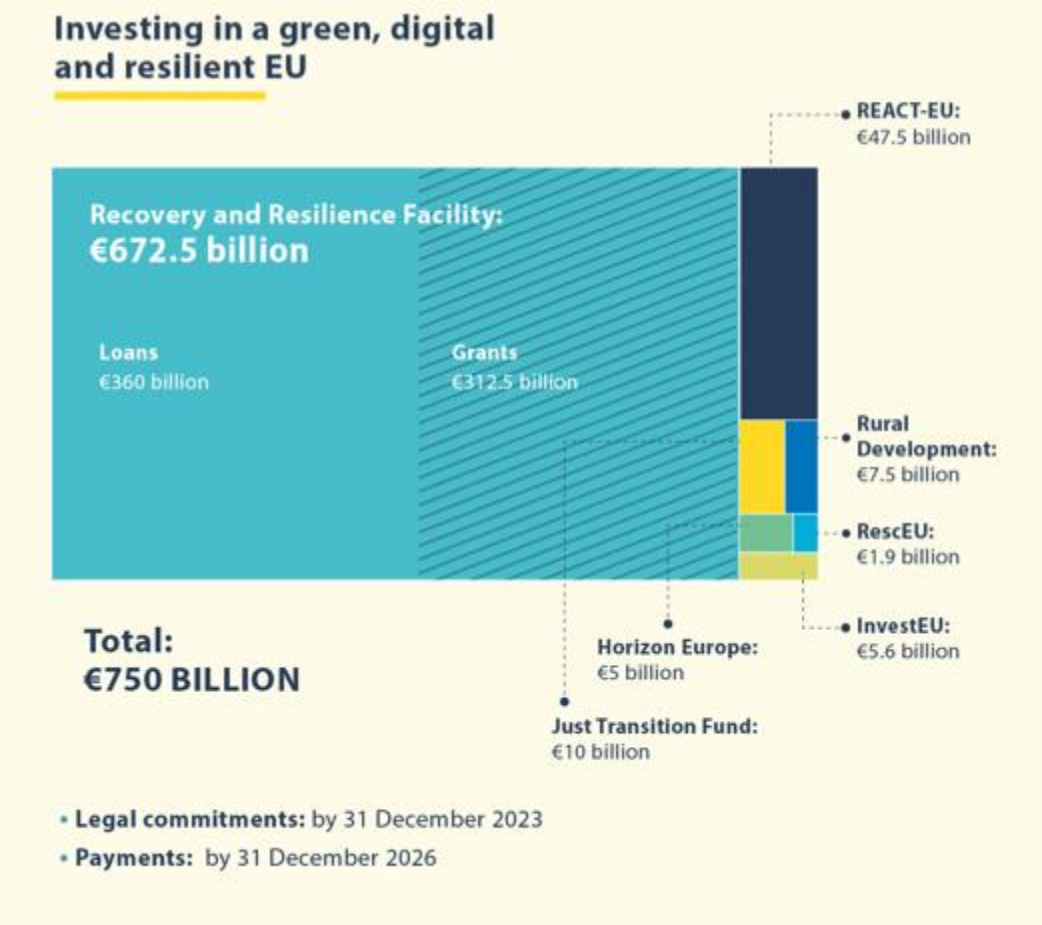
To address the economic consequences of the pandemic, the main instrument put in place by the European Union (EU) is the Next Generation EU (NGEU), the largest stimulus package ever introduced in Europe. To finance the economic recovery, NGEU provides for an allocation of 750 billion (bln) euros, of which around 208 bn for Italy only. NGEU covers the years 2021-2027 and will top up the 2021-2027MFF worth 1.1 trillion euro.

As a temporary tool to compensate for the immediate economic and social damages caused by the pandemic, NGEU aims to create a post COVID-19 Europe which is greener, more digital, resilient and fit for current and future challenges. As such, the package is fully aligned with the European Green Deal, the European Commission's overarching strategy aimed at making the EU "a modern, resource-efficient and competitive economy, ensuring that by 2050 no more net greenhouse gas emissions are generated, economic growth is decoupled from resource use, and no people and places are neglected." The EU has stated that 30% of the 2021-2027 budget (and thus of the NGEU) will be spent on combating climate change (European Commission, 2021).

NGEU is largely composed (89% of total funds) of the Recovery and Resilience Facility (RRF) which amounts to a total of 672.5 bln euros, of which 360.0 bln in loans and 312.5 bln in grants, i.e. non-repayable financing. To access these funds, European countries are required to present a National Recovery and Resilience Plan (NRRP) in which they describe the investments and the reforms they intend to activate thanks to the Facility.

In addition to the RRF, NGEU is also allocating 47.5 bln euros for the "Recovery Assistance for Cohesion and the Territories of Europe", a new initiative called REACT-EU, which advances and expands the crisis response measures within the Coronavirus Response Investment Initiative (CRII) and the Coronavirus Response Investment Initiative Plus (CRII+). NGEU will also allocate additional funding to other existing European programs or funds such as Horizon Europe, InvestEU, the Rural Development Fund, and the Just Transition Fund. The overall structure of NGEU is depicted in Figure 1.

Figure 1 – Structure of the Next Generation EU



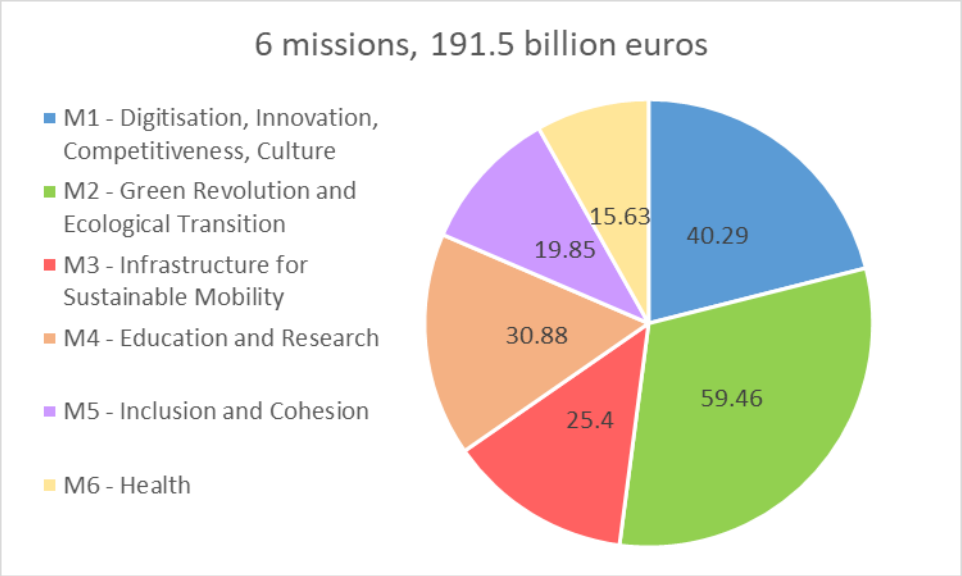
As regards Italy, the National Recovery and Resilience Plan (NRRPwas presented by the Government on the 25th of April 2021 and amounts to 191.5 bln euros, of which 122.6 bln are loans and 68.88 bln are grants. It should be noted that the Italian Plan, unlike other countries, provides for the use of the entire amount made available by the EU in terms of both grants and loans. On the 13th of July 2021, the European Council officially approved the Italian NRRP. The endorsement came with a document in which precise objectives and targets are defined for each investment and reform together with a timeframe whose achievement is the condition for the allocation of resources on a six-monthly basis (10160/21 ADD 1 REV 2).

In terms of timing, 70% of the grants (amounting to 47.925 bln), must be legally committed by the 31st of December 2022, while the remaining 30% (amounting to 20.955 bln) must be legally committed from the 1st of January 2023 until the 31st of December 2023 (Camera dei deputati).

In addition to the funds provided by the RRF, Italy will have access to 13 bln from the React-EU fund and to 30.62 bln from the Complementary Fund: these are national resources financed through the budget variance approved by the Council of Ministers of the 15th of April 2021 and authorized by the Parliament, with absolute majority, in the session of the 22nd of April.

The Plan includes 151 investments and 63 reforms. The investments projects are divided in 16 components, grouped in turn into 6 missions. These are shown in Figure 2. For each mission, the amount of funds allocated to it is also reported. It can be seen that Mission n.2, aimed at financing the ecological transition, is the richest, being endowed with almost 59.46 bln euros, equal to 37% of the total funds. Its interventions are aimed at pursuing the objectives of improving the quality of life and environmental safety, reducing polluting emissions, preventing and combating land disruption and minimizing the impact of productive activities on the environment. This is followed by Mission n.1, with 40.29 bln, around 25% of the total, aimed at promoting investments in digital technologies, digital infrastructures and processes, improving the Italian and European competitiveness and adaptability to market changes.

Figure 2 – Missions of the Italian National Recovery and Resilience Plan



An important aspect of Recovery and Resilience Plan is its environmental dimension. It has already been specified above how the Plan's funds are inserted in the context of EU Green Deal interventions in order to pursue the objective of a green transition. In particular, Mission n.2 "Green Revolution and Ecological Transition" presents investments and reforms relating to all the sectors affected by the European Green Deal, including renewable energy sources, transmission and distribution networks, and the hydrogen supply chain. This is displayed in Figure 3 and in detail in Table 1.

Figure 3 – Mission n.2 "Green revolution and ecological transition" of the Italian Plan

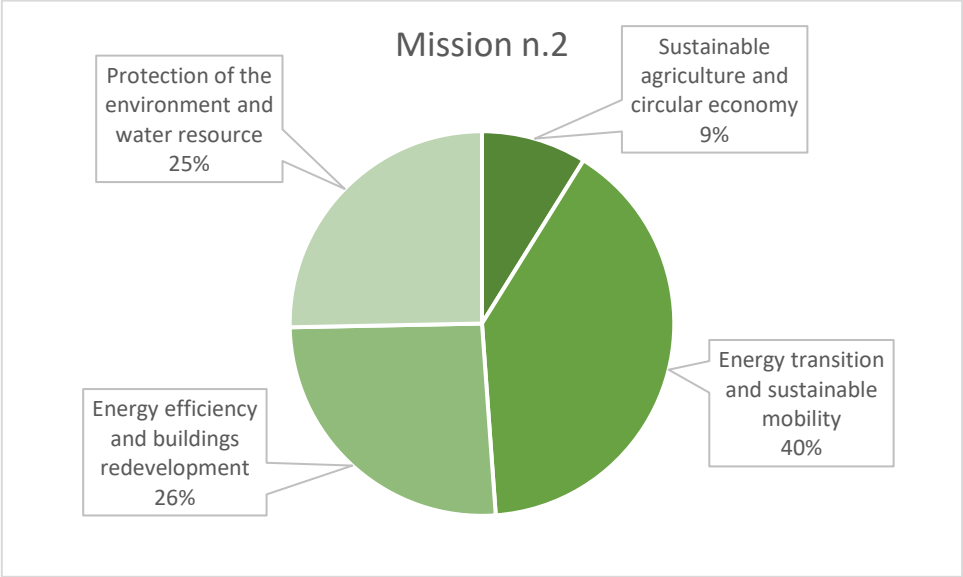


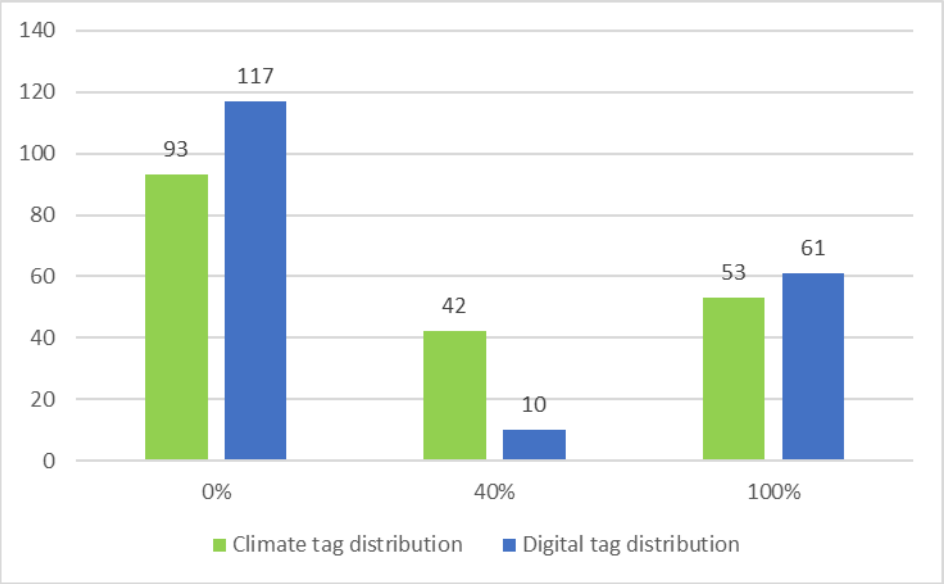
Table 1 – Mission n.2 "Green revolution and ecological transition" of the Italian Plan (bln euros)

Green Revolution and ecological transition	PNRR	ReactEU	Complementary Fund	Total
Sustainable Agriculture & Circular Economy	5.27	0.50	1.20	6.97
Ecological Transition & Sustainable Mobility	23.78	0.18	1.40	25.36
Energy Efficiency & Building Refurbishment	15.36	0.32	6.56	22.24
Environment and Water Resources Protection	15.06	0.31	-	15.37
Total Mission 2	**59.47**	**1.31**	**9.16**	**69.94**

In addition to this, the European Commission has assessed whether or not the National Recovery Plans: 1) do or do not cause significant harm to environmental objectives (DNSH, which stands for do no significant harm); 2) contain measures that effectively contribute to the green transition, biodiversity included, amounting to at least 37% of the total budget, and to the digital transition, with at least 20% of the total budget (Camera dei deputati).

Each country is required to specify the percentage of green and digital components that characterize its National Plan using the so-called climate tags and digital tags. In the case of the former, the EU required countries to assign a climate impact tag to each proposed investment/reform on the basis that it a) contributes primarily to (100%), b) contributes strongly to (40%), c) has no impact (0%) on the EU-defined objectives (Sweatman and Hessenius, 2020). The Annex to the "Commission Staff Working Document accompanying the document Proposal for a Council Implementing Decision" presents the detailed list of measures and sub-measures with the corresponding amounts of allocated funds as well as climate and digital tags. An analysis of the Italian Plan shows that 95 intervention fields have aclimate impact of 40% or 100% (42 and 53 respectively), for a total of about 70 bln euros (which is equivalent to 37% of the total), while 71 intervention fields have a digital impact of 40% or 100% (10 and 61 respectively), for a total of about 48 bln euros (which is equivalent to 25% of the total). Figure 4 represents the distribution of the interventions by tag.

Figure 4 – Distribution of climate and digital tags of the Italian NRRP



The National Recovery and Resilience Plans are, first and foremost, reform plans. The lines of investment must be accompanied by reforms aimed at improving the regulatory and legal framework conditions as well as at steadily increasing the equity, efficiency and competitiveness of the country. In this sense, the reforms must be considered, at the same time, an integral part of the national plans and catalysts for their implementation. Three types of reforms are envisioned: 1) horizontal, 2) enabling, and 3) sectoral. Horizontal reforms cut across all the Plan's Missions and the public administration reform and the judicial reform are singled out. Enabling reforms are functional interventions to ensure the implementation of the Plan and to improve competitiveness. The Plan identifies measures for the simplification and rationalization of legislation and for the promotion of competition. Finally, sectoral reforms accompany the investments of the individual Missions and consist of regulatory innovations to introduce more efficient regulatory and procedural regimes in the respective areas.

2. Impact assessment of the NRRP

The primary objective of the NGEU, and therefore of all NRRPs is to prompt the post-pandemic economic recovery and reconstruction. At the same time, this is an opportunity to make the EU economy more resilient, greener and more modern in terms of digitization. NRRPs have therefore a double purpose: on the one hand, the short-medium term objective is to activate, or rather reactivate, economic activities and stimulate growth through public investments according to the well-known Keynesian multiplier scheme. On the other hand, the reforms envisaged in the Plans aim to make those economies more productive and resilient in a structural and permanent way in the long run.

According to the "Guidance to member states recovery and resilience plans" of the European Commission, Member States are required to produce an assessment of the macroeconomic outlook and

to include it in their NRRP. Specifically, an estimate of the quantitative impact on GDP, employment and other key macroeconomic variables must be included, specifying the type of model / estimation technique used, the main assumptions made, the sources and the frequency of the macroeconomic data.

Following the approval of individual plans, the European Commission has published various working documents including the results of the simulations of the economic impact of the NGEU conducted by the Commission itself. In the case of Italy, in addition to the Commission, an impact assessment has been carried out by the Italian Government and by other public or private institutions and research bodies. However different in their forecasts (as will be shown), all evaluations are based on simulations produced by means of macroeconomic models, which are nothing more than a mathematical description of the simplified structure of an economic system. As is well known, there are various types of models, which are inspired by different philosophies, are based on different assumptions and use particular data and parameters. In other words, there is no such thing as *the* ideal model. For the study of the macroeconomic impact of policies there are generally three main approaches: first, there are macroeconometric models which are more suitable for the assessment of short-term consequences and for forecasts; second, there are dynamic stochastic general equilibrium models (DSGE) which are generally used for the analysis of medium-long term effects and of the consequences of specific shocks, as well as for "what-if" evaluations of individual measures or policy packages; and third, there are computational general equilibrium models (CGE) which are particularly useful to disaggregate the effects on specific sectors and for the assessment of structural changes.

Not only are models different, but the quantitative evaluation of the economic impacts is also affected by the various assumptions underlying the simulations with respect to the monetary entity of the measures, the time horizon for the implementation, the nature of the measures themselves, the manner in which financial resources are used, and so on.

Together with the official simulations published by the European Commission and the Italian government, the results of the analysis conducted by the Italian National Statistical Institute (Istat) and by Oxford Economics, a private company specialized in macroeconomic analysis and forecasts, are examined below. The impacts on GDP and unemployment rate of the different simulations will be compared with one another, with the aim of evaluating the differences in forecasts of the different models. In the absence of significant deviations in the results between different models and simulations, the outcomes and the previsions can be considered reasonably robust.

Before proceeding it is important to point out that none of the simulations presented below considers any environmental/climatic impact of the Plan. This aspect is the main motivation for the present paper and will be considered later.

2.1 Main features of the simulations of the macroeconomic impacts

In the "Commission staff working document analysis of the recovery and resilience plan of Italy", the European Commission presents the results of the impact of the NGEU for Italy (Box 4.3.1) using a dynamic stochastic general equilibrium model called QUEST. The simulations consider the entire NGEU (562 billion euros) and two different spending profiles: a fast, four-year scenario (2021-2024) and a longer, six-year one (2021-2026) for all Member States. Moreover, it is assumed that the total available grants are used but only half of the loans are and that all Member States will repay the debt starting from 2027 until 2058. The impact of the reforms is not quantified. The Commission also envisages a normal scenario and a low productivity scenario, which assumes a significant reduction in the elasticity of output to public capital.

The Italian government uses the same model QUEST, but "due to the differences in the assumptions and methodology, the results of this stylized assessment cannot be directly compared with the numbers reported in chapter 4 of the Italian RRP." In fact, the estimates made by the Commission consider the entire NGEU (therefore RFF but also ReactEU, Horizon, InvestEU, JTF, Rural Development and RescEU) for a total of 208 billion euros. In addition, the disbursement of funds is considered to be spread linearly over 6 years.

In the original document of the Plan transmitted by the Italian Government to Brussels, simulations of the Italian RRP are carried out using two models: 1) the aforementioned dynamic stochastic general equilibrium model QUEST and 2) the computational general equilibrium model MACGEM-IT (Multisector Applied Computable General Equilibrium Model for the Italian Economy), available both in its static version with a national and a regional detail and in the recursive dynamic version. In assessing the macroeconomic impact, the additional measures of the Plan are considered, bringing the total of the analysed resources to 182.7 billion euros, and it is assumed that these will be spent between 2021 and 2026. Furthermore, it is assumed that most of the funds are destined to finance public investments, while the remainder would go to incentives for business investments and for the reduction of fiscal contributions on labor and, to a limited extent, to current public spending and transfers to families. Here, too, the effects of the reforms are not considered.

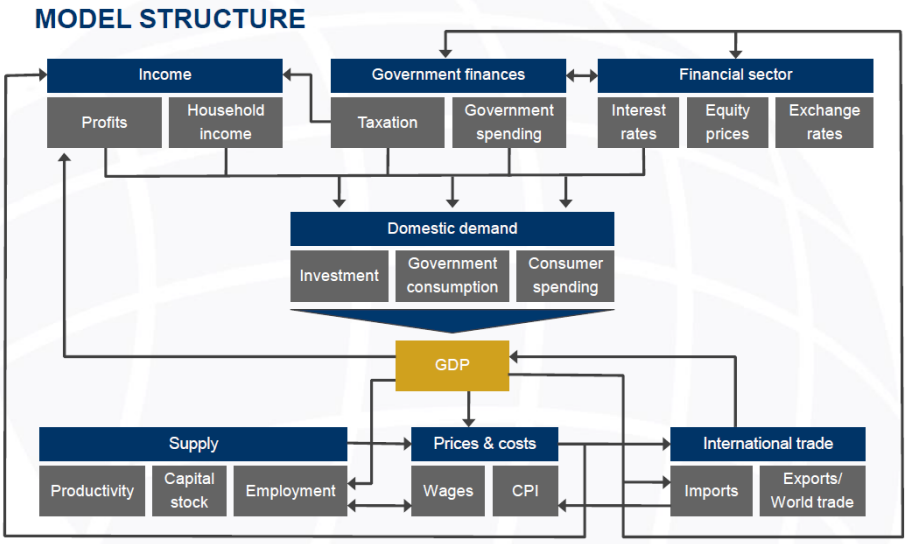
The simulations carried out with the QUEST model consider three alternative scenarios ("High", "Medium" and "Low"), which differ in their hypotheses of efficiency of public investments: an elasticity of GDP to the stock of public capital equal to 0.17, 0.12 and 0.07, respectively.

A third assessment of the effects of the NRRP is carried out by the National Statistical Institute (ISTAT) in its 2021 Annual Report which contains a quantification of the impact of the increase in investments on GDP is presented. Here two alternative scenarios with a different composition between investments in tangible (largely infrastructure) and intangible assets are considered. A macroeconometric model called MeMo-It (Bacchini et al., 2013) is used and the simulated amount is equal to (just) 110 billion

euros, i.e. only the value of planned interventions for which it is possible to identify a more precise and direct attribution between infrastructures and intangible assets.

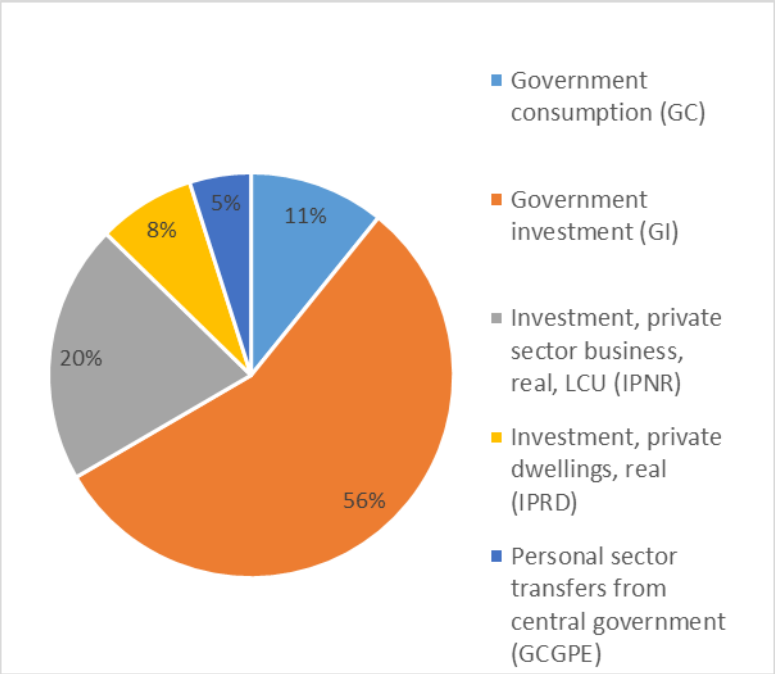
Finally, in the Research Brief "*Italy EU funds will help, but structural reforms are the key*" published in May 2021, Oxford Economics simulates the Plan's impact by using its own macroeconometric model called Global Economic Model (GEM). In the short term this model has Keynesian features (demand shocks generate economic cycles that can be influenced by fiscal and monetary policies), while in the long term it has a monetarist inspiration (the output is determined by factors on the supply side: investments, demographics, labor force participation, human capital and productivity). The behavioural equations that compose it have an Error Correction Mechanism (ECM) specification which allows to model at the same time the long-term equilibrium relations and the short-term dynamics. Figure 5 presents the structure of the model.

Figure 5 – Structure of Global Economic Model by Oxford Economics



The simulation by Oxford Economics considers only the funds that appear to be additional expenditure, for a total of 165 billion euros. Unlike the other simulations, Oxford Economics doubts that the Italian government will be able to spend all the funds by 2026, but that some expenses will be implemented even after the official deadline date, which is why their simulation extends to 2027. It is assumed that about 84% of the funds is given by investments (public and private), while the remaining 16% is current expenditures, of which 11% in public consumption and the rest is transfers to households and tax cuts. This partition is represented in Figure 6.

Figure 6 –Plan's simulation by Oxford Economics



2.2 Results of the simulations of macroeconomic impacts

In this section we present the results of the simulations on two key macroeconomic variables, GDP and unemployment rate. A second purpose is to assess the robustness of the results with respect to the various models and simulations. With this fact in mind, we look at the results also for some European countries. The comparative analysis across models and across countries are used to validate our use of the Oxford Economics GEM model for the analysis of the environmental effects of the Italian NRRP in section 3.

2.2.1 Comparative analysis *across models*

In Table 2 the percentage deviations of GDP with respect to the base scenario are shown. Each simulation consists of the comparison between two scenarios, one in which there are no additional investments due to the RRP and one in which they are activated. In the case of the European Commission only the "normal" scenario is shown (the Commission also considers a "low productivity" scenario), while in the case of the Italian government we have taken into account the "average" scenario in terms of public capital productivity (also an optimistic and a pessimistic scenarios are considered). For ISTAT both the scenario with greater infrastructural investments ("tangible") and the one with more intangible investments ("innovation") are reported.

Table 2 –Impact on GDP (percentage variation from the baseline scenario)

Years	Gov ITA QUEST	Gov ITA, MACGEM-IT	Com EU QUEST	Istat MeMo-It Tangible scenario	Istat MeMo-It Innovation scenario	Oxford Economics GEM
2021	0.5	0.7	1.0	0.3	0.5	0.3
2022	1.1	2.0	1.8	1.0	1.3	1.3
2023	1.6	3.0	1.9	1.5	2.2	1.8
2024	2.0	3.1	2.0	2.1	2.6	1.9
2025	2.4	3.1	2.3	2.1	2.8	1.9
2026	2.7	3.1	2.5	2.3	2.8	1.6

In all cases it is observed that the growth of GDP gets stronger over time, leading to an increase of more than two percentage points compared to the level of GDP without the Plan. Overall, the push for economic recovery does not appear as significant as one might have hoped. Nevertheless, the results appear robust across models, with those of Oxford Economics systematically more pessimistic than all the other cases.

Table 3 shows the forecasts made by the various institutions regarding the GDP growth rate (no longer the difference between scenarios) and the unemployment rate. Note that the years 2019 (prior to Covid) and 2020 (first year of Covid) are added to the table, while the simulations by the European Commission and ISTAT are not carried out for the years after 2022.

Table 3 – Comparison of GDP and unemployment forecasts

Year	Author	GDP (% change)	Unemployment rate (%)
2019	Com EU / Gov ITA	0.30	10.00
	Oxford Economics	0.28	9.88
2020	Com EU / Gov ITA	-8.90	9.20
	Oxford Economics	-8.93	9.10
2021	Com EU	4.20	10.20
	Gov ITA	4.50	9.60

	Istat	4.70	9.80
	Oxford Economics	4.58	9.73
2022	Com EU	4.40	9.90
	Gov ITA	4.80	9.20
	Istat	4.40	9.60
	Oxford Economics	5.01	9.71
2023	Gov ITA	2.60	8.50
	Oxford Economics	2.07	9.10
2024	Gov ITA	1.80	8.00
	Oxford Economics	0.92	8.87

The fall in GDP growth is apparent during the first year of the pandemic. After that the effects of the NRRP are clearly felt, especially in the first two years of simulation (2021-2022). Subsequently, the impulse fades significantly. The forecasts are generally aligned with Oxford Economics which become more pessimistic in the last two years shown. As for the unemployment rate, it can first be noted that it does not significantly decrease following the introduction of the NRRP. This seems to reflect the fact that unemployment responds more to structural changes than to cyclical impulses, and the models used for these simulations do not seem to fully capture this aspect.

As previously noted, the results just presented originate from simulations that differ both in the methodologies and assumptions used and in the different values of the investments activated and their use. Despite these significant differences, it is fair to say that the different models and related simulations return a fairly unambiguous picture of the effects of NRRP. This observation provides the basis for our use of the Oxford Economics model in the analysis of the energy-environmental effects of the Plan.

2.2.2 Comparative analysis *across countries*

We now briefly look at the Plans of other EU Countries. In Table 4 we present the amounts requested as grants and loans. Nearly all countries that have submitted their plans so far requested the estimated full amount of grants or more. These estimates are based on the Commission's autumn 2020 forecasts, while the final amounts will be calculated in mid-2022 using actual data. So far seven countries have requested loans, with Greece, Italy and Romania requesting the full amount of loans available to them. It is important to remember that the total amount of NGEU funds were allocated to the various countries according to population, per capita GDP and unemployment levels.

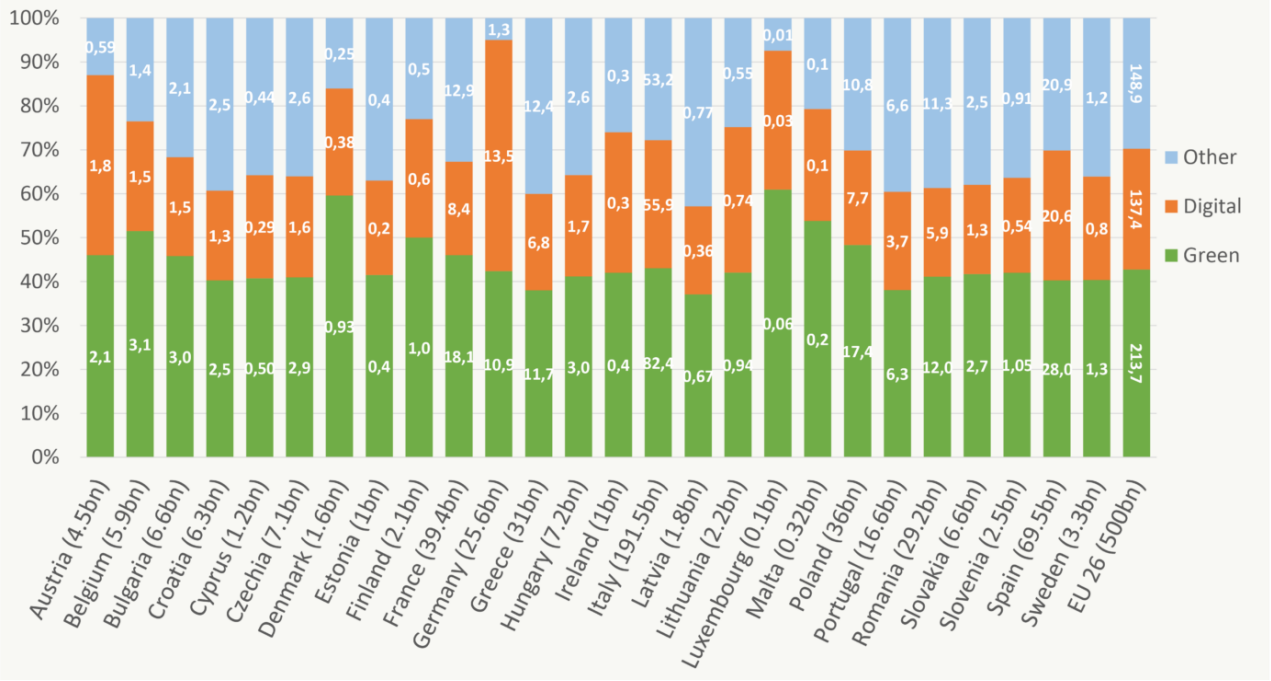
Table 4 – Available and requested grants and loans from the RRF (€ billions)

Country	Official submission date	Grants requested	Estimated grants	Loans requested	Maximum loans
Austria	1/5/2021	4.5	3.5	0	27.2
Belgium	1/5/2021	5.9	5.9	0	32.8
Bulgaria	15/10/2021	6.6	6.3	0	4.2
Croatia	15/05/2021	6.4	6.3	0	3.7
Cyprus	17/05/2021	1	1	0.2	1.5
Czechia	2/6/2021	7.1	7.1	0	14.3
Denmark	30/04/2021	1.6	1.6	0	21.9
Estonia	18/06/2021	1	1	0	1.9
Finland	27/05/2021	2.1	2.1	0	16.4
France	29/04/2021	40.9	39.4	0	168.4
Germany	28/04/2021	27.9	25.6	0	240.9
Greece	28/04/2021	17.8	17.8	12.7	12.4
Hungary	12/5/2021	7.2	7.2	0	9.7
Ireland	28/05/2021	1	1	0	18.7
Italy	1/5/2021	68.9	68.9	122.6	122.8
Latvia	30/04/2021	1.8	2	0	2
Lithuania	15/05/2021	2.2	2.2	0	3.2
Luxembourg	30/04/2021	0.1	0.1	0	2.7
Malta	13/07/2021	0.3	0.3	0	0.8
Netherlands	Not yet submitted		6		55.3
Poland	3/5/2021	23.9	23.9	12.1	34.8
Portugal	22/04/2021	13.9	13.9	2.7	14.2
Romania	31/05/2021	14.3	14.2	15	15
Slovakia	29/04/2021	6.6	6.3	0	6.3
Slovenia	1/5/2021	1.8	1.8	0.7	3.2
Spain	30/04/2021	69.5	69.5	0	84.8
Sweden	28/05/2021	3.3	3.3	0	33.2
EU26		331	325.9	166	892.7

Reproduced from Bruegel, "European Union countries' recovery and resilience plans", 10 February 2022: https://www.bruegel.org/publications/datasets/european-union-countries-recovery-and-resilience-plans/

Figure 7 shows the composition of the plans in terms of green and digital components. There is a high variance. There are countries that receive relatively smaller amounts from the RRF as a share of their GDP presented plans that concentrate on green and digital spending (Germany, Luxembourg and Denmark), while countries that receive larger amounts presented more diverse plans with higher 'other' (non-green and non-digital) shares of spending.

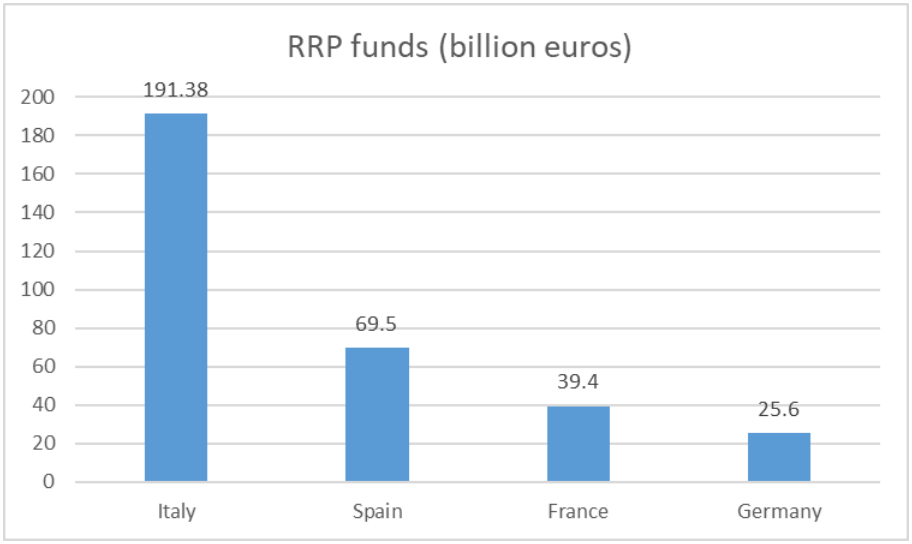
Figure 7 – Overall resource allocation in NRRPs (% ot total and billion euro)



Reproduced from Bruegel, "European Union countries' recovery and resilience plans", 10 February 2022: https://www.bruegel.org/publications/datasets/european-union-countries-recovery-and-resilience-plans/

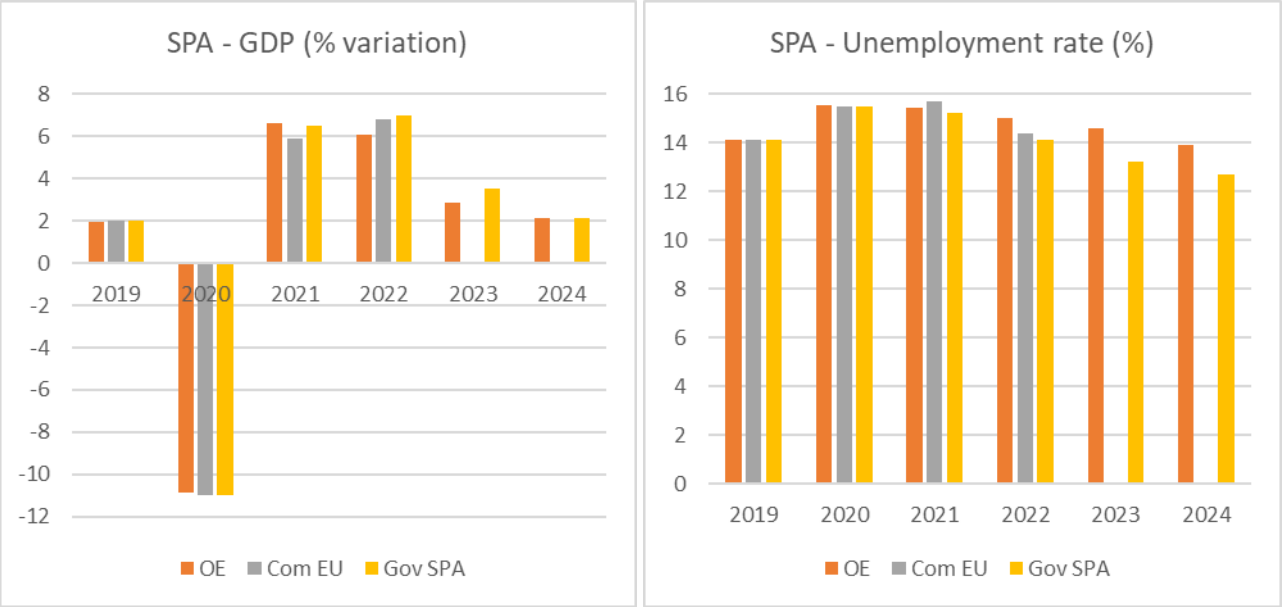
Turning to the economic impact of the plans, we have chosen to focus on Germany, France and Spain for which again the impacts on GDP and unemployment rate are considered. Figure 8 illustrates the NRRP allocations by country. It should also be noted that of the countries analysed only Italy has decided to resort to the subsidized loans made available by the EU (122.6 billion euros).

Figure 8 – National Resilience and Recovery Plan funds: selected countries



Spain presented a plan that provides for the use of almost 70 billion euros and is divided into four transversal lines: green transition, digital transformation, social and territorial cohesion, gender equality. The lines of action are then translated into ten policy levers, designed to promote the country's economic recovery in the short term and to support the transformation process to increase the country's economic productivity and growth potential. In Figure 9, the results of the simulations of the European Commission (Com EU, available only until 2022), the Spanish Government (Gov SPA) and Oxford Economics (OE) are illustrated.

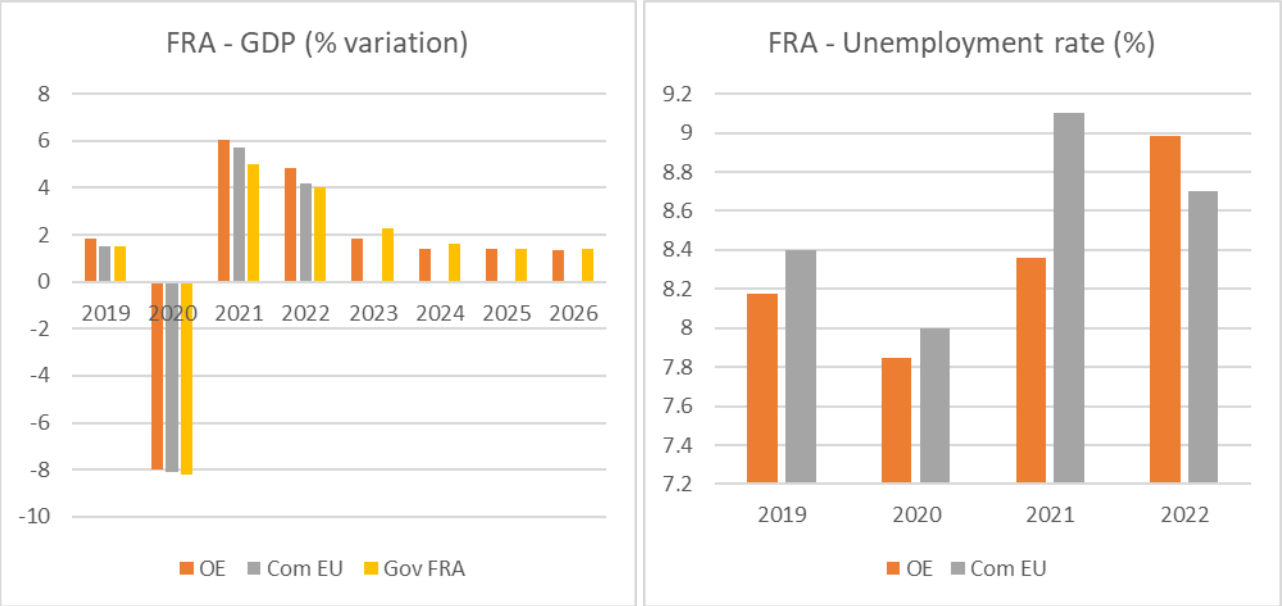
Figure 9 – Comparison of the GDP and unemployment forecasts for different simulations, Spain



It can be seen that the estimates for GDP are somewhat homogeneous with each other, with Oxford Economics initially a little more optimistic (in 2021) and becoming more conservative in the following years. Also for unemployment there are no big discrepancies, a part from the Spanish government's estimates which are somewhat more optimistic than those of the Commission and Oxford Economics.

The French Plan presents investments and reforms for a value of almost 40 billion euros focused on three pillars: environment, competitiveness, and social and territorial cohesion and divided into nine main components. Figure 10 shows the results of the simulations of the European Commission (Com EU, available only until 2022), the French government (Gov FRA) and Oxford Economics (OE).

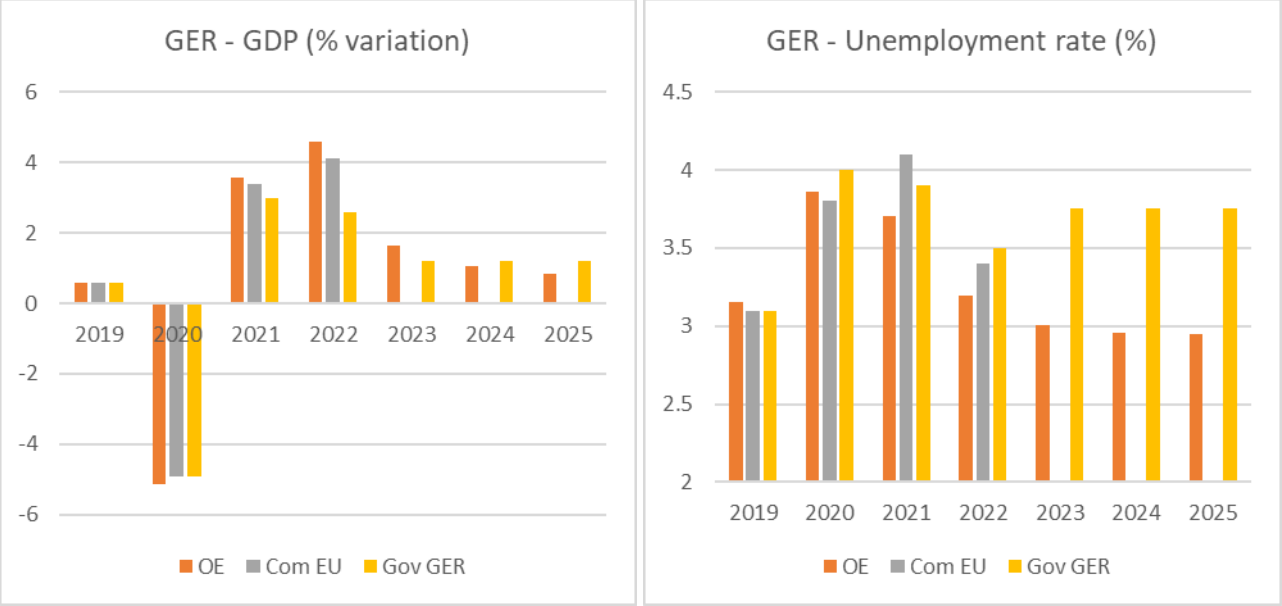
Figure 10 - Comparison of the GDP and unemployment forecasts for different simulations, France



For GDP a certain homogeneity is observed between the various simulations even if, as for Spain, the estimates of Oxford Economics are initially more optimistic and then become slightly more conservative. Instead, with respect to unemployment, the Commission expects a peak in 2021, while the simulation of Oxford Economics postpones it to 2022.

Germany foresees the use of 25.6 billion euros of the Recovery and resilience Facility in its Plan, which consists of 40 measures divided into 6 priority areas. Figure 11 shows the results of the simulations of the European Commission (Com EU), the German Government (Gov GER) and Oxford Economics (OE).

Figure 11 - Comparison of the GDP and unemployment forecasts, Germany



The estimates for the growth of German GDP produced by the various simulations are also in this case quite consistent with each other, even if those of the German government turn out to be more prudent

in 2021 and 2022 and then display greater optimism in 2025. The estimates for unemployment, the estimates calculated by Oxford Economics tend to be more optimistic – especially from 2023 onwards – compared to the other simulations.

This brief comparative analysis underlines the homogeneity of the results between the different simulations, especially in the GDP projections.

2.3 Impacts of the Italian NRRP reform package

An extremely important aspect that needs to be emphasized is that the NRRP analysis conducted so far has disregarded a fundamental component of the Italian NRRP, and that is the role and impact of reforms. Especially in the case of Italy, structural reforms are crucial for the Plan to have permanent effects on the economic system.

From a methodological point of view, simulating the impacts of structural reforms with the help of a model is a complex task characterized by a higher degree of arbitrariness than in the case of investments. In fact, what is required amounts not simply to modify the (monetary) value of a variable, such as public investments, but modify the parameters of some equations of the model that are believed to be connected to the effects of the reforms.

In the case of the simulations produced by the Italian government, the QUEST model is used to simulate the effects of the two horizontal reforms of the public administration and of the judicial system together with the reform of market competition are considered. Specifically, these three reforms are translated into the following model changes:

- Reform of the public administration: direct impact on general productivity (+ 1.5%); reduction of bureaucracy costs for businesses (-10%); improvement of human capital, i.e. aggregate labor productivity (-1% share of low-skilled workers);
- Reform of the judicial system: improvement in total factor productivity (TFP) (+ 0.5%) triggered by the reduction in the duration of the judicial processes;
- Reform of market competition: changes in the components of the PMR (the OECD's product market regulation index) and consequent reduction in profit margins.

Table 5 shows the impact of these reforms NRRP, limiting the attention to the impact on GDP. The impact is calculated after 5 and 10 years from implementation and in a long-term perspective.

Table 5 – Macroeconomic effects of the Plan's structural reforms on GDP (percentage change from the baseline scenario)

Reform	Variable	T+5	T+10	Long-term
Efficency of public administration	GDP	1	1.8	2.3

Improvement of the investment climate connected to reforms in the justice sector	GDP	0.2	0.4	0.5
Reforms aimed at improving competition	GDP	0.2	0.3	0.5
Overall effect of the three reforms	GDP	1.4	2.5	3.3

It can be noted that the cumulative effect of the three reforms on GDP is conspicuous especially in the long-run, and that the public administration is the pivotal one to achieve structural improvements.

The European Commission also addresses the issue of reforms, albeit in a qualitative way. In stating that structural reforms have the potential to support the estimated investment-induced effects on production, the Commission also supports public administration and judicial reforms as well as fairer and clearer regulations to improve competition in product markets.

In addition to that of the Italian government, the quantitative assessment of the effects of the reforms is conducted by Italy's public investment fund *Cassa Depositi e Prestiti* (CDP) and by Oxford Economics.

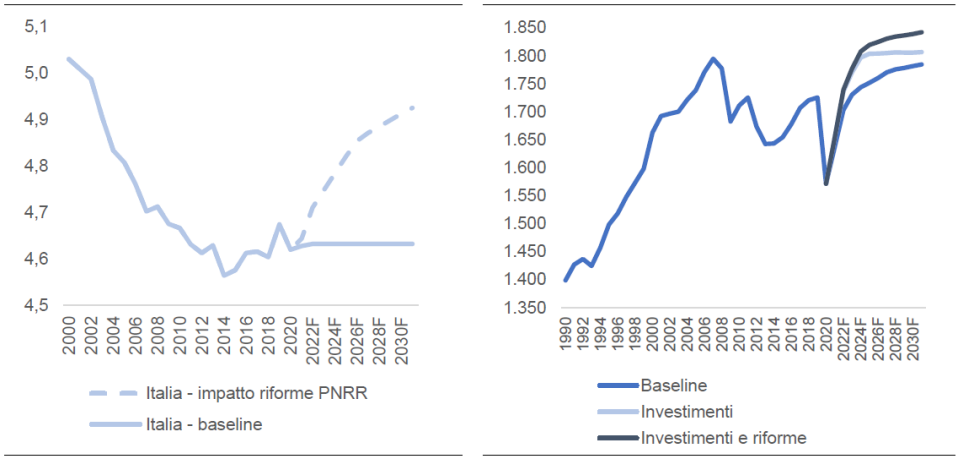
In a Brief dedicated specifically to the reforms of the Plan entitled "The long-term challenge of the NRRP passes through reforms" and published in July 2021, CDP argues that an improvement in institutional quality, implying a reduction in bureaucratic burdens and production costs incurred by companies, would free up new resources for investments. In turn, more ambitious investment plans would stimulate an increase in aggregate demand and therefore an increase in effective GDP. Finally, the reduction in production costs would lead to a reduction in the price level and therefore to a containment of the inflation rate.

For their quantitative assessment CDP aggregates six variables taken from the World Bank database to assess the quality of Italy's governance in a single "proxy" indicator. This indicator is then included within the GEM model of Oxford Economics in order to simulate the overall impact on the economy of an improvement in the institutional context. Figure 12 shows the result.

Figure 12 – Impact of the Plan on institutional quality and on GDP

Left hand side: "proxy" indicator of the Italian institutional quality (index, min=0, max=7)

Right hand side: real GDP trend (billion euros, 2015)



Reproduced from CDP, with data from Oxford Economics

The simulations show that the dynamics of GDP could improve significantly, allowing the recovery of 2007 levels already by 2025, a result that in the absence of reforms would only be achieved in 2031.

In its aforementioned Research Brief, Oxford Economics also analyses the impact of reforms, stating that those on the agenda have a low probability of success given that ambitious reforms need strong political support. However, it is argued that if the Draghi government were able to put Italy on a path of structural reforms, following the detailed lines of the NRRP, the growth trajectories could change radically. Table 6 illustrates how Oxford Economics GEM model accommodates the reforms in the Italian scenario.

Table 6 – Structural reforms in Oxford Economics GEM model

	Assumption	Transmission	Calibration
Near to Medium Term	**Investor sentiment improves**	Lower government rates help with the interest payments and reduces private rates.	**Italian 10-year government bond yield spread increases only marginally from current level and stabilizes at around 100bps after 2021**, in line with the 10-year government bond yield of Spain.
Long Term	**Gender gap is reduced**	Potential output is stronger over the longer term, in line with increased capital accumulation, strengthening labour supply and faster productivity growth.	**Implied gender gap participation rate diminishes by 10ppt**, with the overall participation rate gradually increasing over the next 10 years.
	Quality of institutions is improved		**Quality of institutions in Italy improves over the next 10 years**, in line with the historical improvements seen in the the best eurozone countries.
	Better educational quality		**Average years of education increases at a quicker rate** than in baseline and reaches 15 at the end of the scenario simulation (2050).
	Additional fiscal easing as debt burden issues soften	Stronger government investment and government consumption help with both demand and potential output.	**Additional fiscal easing in government consumption and government investment**, from mid-2020 with targeting a primary surplus of around 2.5-3% of GDP.

The simulation shows an almost doubled GDP between 2021 and 2040, going from 0.7% to 1.3%. In 2040, GDP would be 13% higher than the in the baseline year and public debt would drop to 120% of GDP. This result shows that the central issue for Italy remains that of solving its structural problems, regardless of the injection of NGEU funds. In particular, the gap between the Italian GDP per capita and that of the Eurozone would remain stable, as opposed to the further decline that emerges in the baseline scenario.

Overall, the above simulations illustrate the importance that reforms can and must play for the stable recovery of our economic system and confirm that the opportunity presented with the NRRP should not be lost.

3. Impact assessment by Fondazione Eni Enrico Mattei

The funds allocated by the Italian NRRP are designed to generate a multiplier effect on GDP following the classical Keynesian recipe, being the post-pandemic recovery the main objective of the Plan. The expected increase in GDP should induce greater energy consumption which, in turn, would lead to an increase in CO2 emissions. This is beacues the Italian energy mix is still heavily tilted toward fossil fuels, which accounted for 79% of total primary energy consumption in 2019. On the other hand, a significant portion of the investments of the Plan is aimed at encouraging the green transition, with favorable effects on emissions.

To assess the impact of the Plan's interventions on energy consumption and carbon dioxide emissions we used the GEM model by Oxford Economics to construct a number of scenarios and produce the relevant simulations. This model has demonstrated its validity in the macroeconomic impact simulations seen above in terms of the robustness of the results compared to alternative models.

First, we generated two different baselines, the first one projecting macroeconomic variables forward from December 2019 and the second one starting from May 2021. The first scenario, labelled "no Covid scenario" (Scenario A), simulates the situation as if Covid-19 had not occurred, whereas the second scenario takes it fully into account. This second scenario in turn is divided into a "Covid scenario" without the introduction of NRRP (Scenario B) and a "Covid scenario" with NRRP (Scenario C). The NRRP whose effects are simulated in these scenarios relates to planned investments; however, we also consider a "Covid scenario" that includes both the investments and the reforms of the Plan. The CDP Brief was used as a reference for the reforms in the Plan.

It is not possible to simulate with the GEM model the macroeconomic and environmental effects of the increase in green investments, i.e., those planned by the Mission n.2 of NRRP (see Figure 2 above), separately from non-green investments, such as the digital investments of Mission n.1. This limitation, also shared by the other models considered above, is due to the absence of statistical data that disaggregate total public investment according to this distinction.

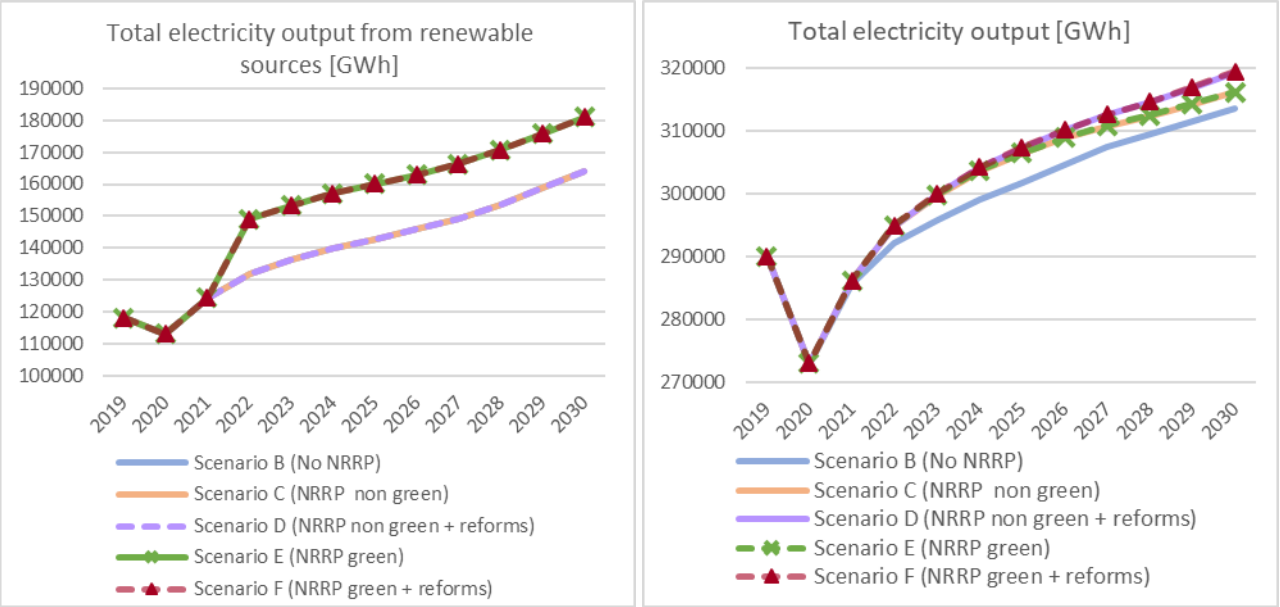
However, we generate a green scenario of the NRRP with the GEM model by increasing, starting from 2022, the generation of electricity for the part obtained by renewable sources. This increment is determined by considering the Component 2 of the second Mission (M2C2) "Renewable Energy, Hydrogen, Grid and Sustainable Mobility", which is aimed at "increasing the share of energy produced from renewable energy sources" and includes four areas of investment. Of these, the first three specify the expected generation in terms of GWh per year: 1) agro-voltaic development: 0.8 million tons/year avoided CO2 emissions (expected generation: 1,300 GWh/year), 2) energy communities: 1.5 million tons/year avoided CO2 emissions (expected generation: 2,500 GWh/year), 3) innovative plants: 286,000 tons/year avoided CO2 emissions (expected generation: 490 GWh/year). Adding up the expected generation from these three investment areas results in an increase of 4290 GWh/year. The scenarios thus obtained are a "Covid scenario" with the Plan's green investments (Scenario E) and a "Covid scenario" with the plan's green investments and reforms (Scenario F). All these scenarios are shown in Table 7.

Table 7 – Scenarios by FEEM

Scenario A: No Covid (December 2019)
Scenario B: Covid, without NRRP (May 2021)
Scenario C: Covid, with NRRP investments (non *green*)
Scenario D: Covid, with NRRP investments (non *green*) and reforms
Scenario E: Covid, with NRRP *green* investments
Scenario F: Covid, with NRRP *green* investments and reforms

In the left panel of Figure 13 we show the increase in electricity generation from renewables that characterizes the green scenarios E and F. This implies a reduction in generation from fossil sources since, as shown in the right panel, the total output of the green scenarios (scenarios E and F) and non-green scenarios (scenarios C and D) is the same. There is therefore a substitution of brown with green sources especially in the first subperiod.

Figure 13 – Electricity output, total and from renewable sources



3.1 Macroeconomic impacts of the Italian Resilience and Recovery Plan

In Figures 14 and 15 we show the expected behavior of real GDP and of the unemployment rate generated by the scenarios considered above.

Figure 14 – GDP (billion euros, constant prices)

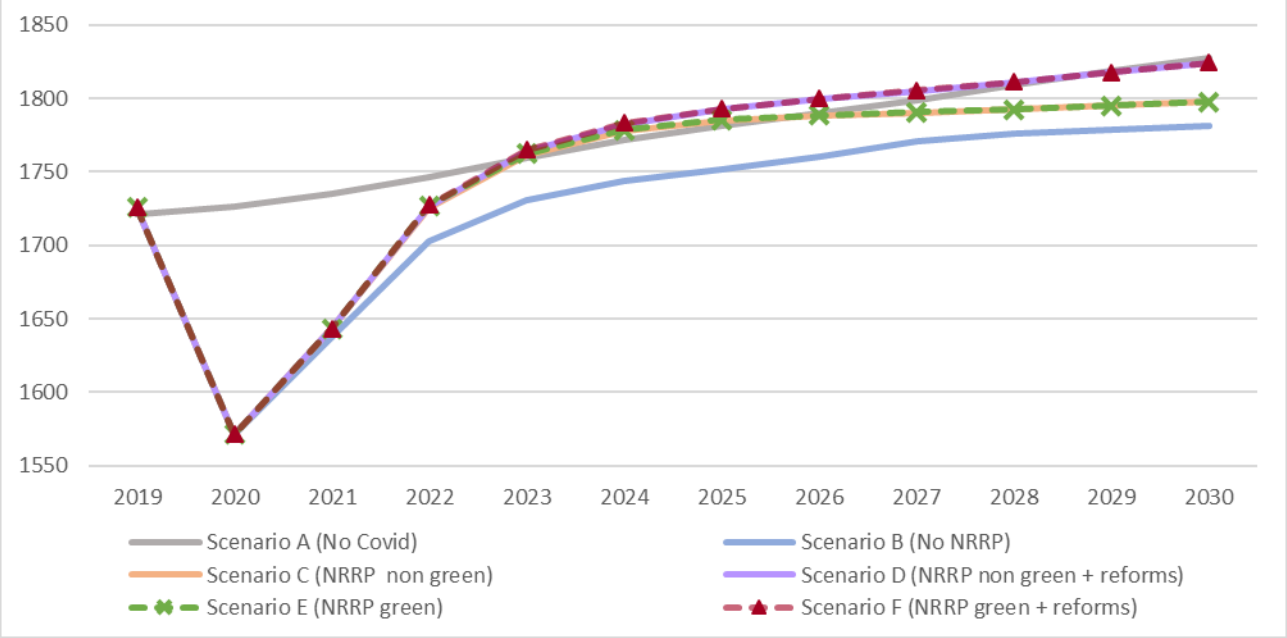
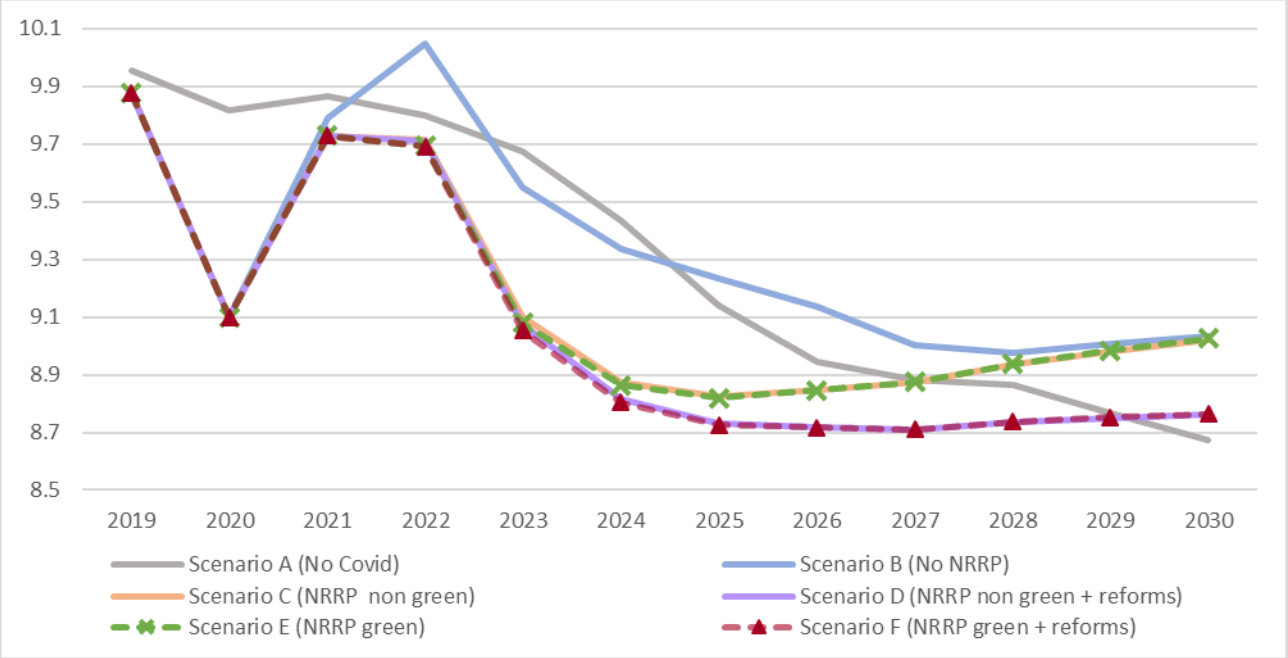


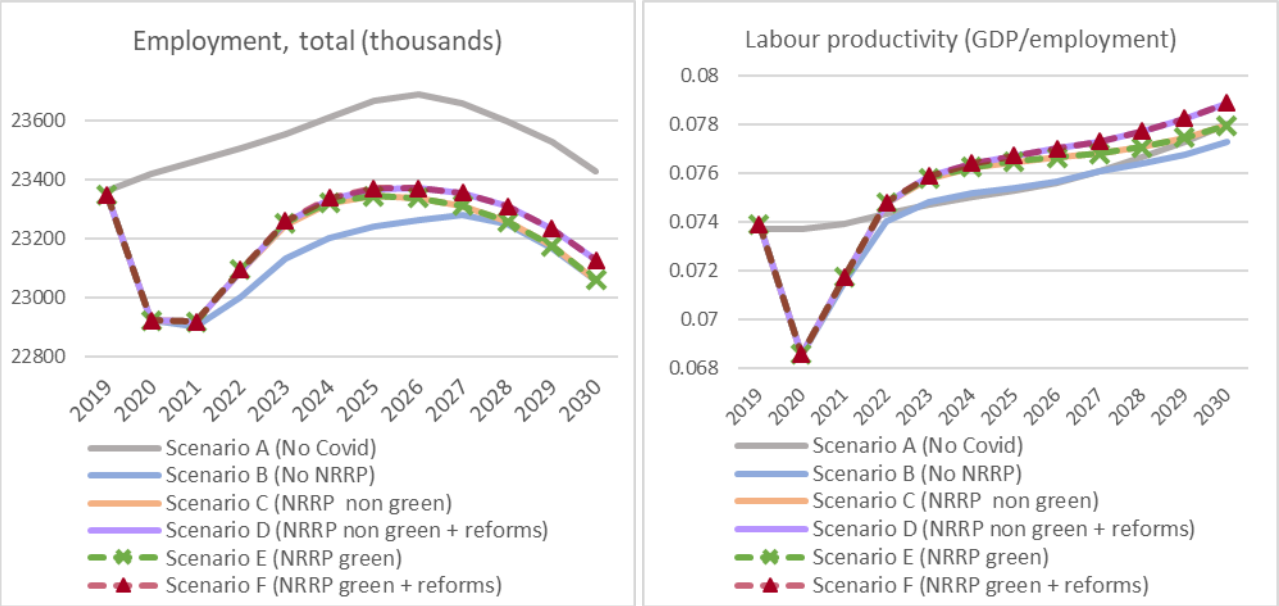
Figure 15 – Unemployment rate (percentage values)



Looking at 2019 and 2020, all the scenarios except for Scenario A "No Covid" show the effects of the pandemic in the form of a drop in GDP and a one percentage point reduction in the unemployment rate. This apparently counterintuitive effect, which has already emerged in Table 2 above, is presumably attributable to a reduction in the labor force, so that the unemployed weighed less on the total. The positive effects of the NRRP on GDP (scenarios C and E) and even more those including also the effects of structural reforms (scenarios D and F) can be seen in comparison with the scenario without NRRP (scenario B).

We can also consider in Figure 16 the employment levels which confirm that the investments and reforms of the Plan are not sufficient to bring total employment back to pre-Covid values. The higher increase occurs in 2024, the year in which the scenarios with reforms (scenarios D and F) present 133,000 more employed than the scenario without NRRP (scenario B). The increase in employment led by the NRRP will fade in the case of the two scenarios with reforms (D and F) and even disappear in the case of the two scenarios without reforms (C and E) by 2030. Looking at labor productivity, defined as the ratio of GDP to employment, it increases in all the scenarios with the Plan compared to the scenario without Plan. Of particular note is the positive impact of the reforms (scenarios D and F) which allows labor productivity to remain above pre-Covid levels. The situation is different for the scenarios without reforms (C and E), which return to pre-pandemic levels in 2030.

Figure 16 – Total employment (thousands) and labour productivity



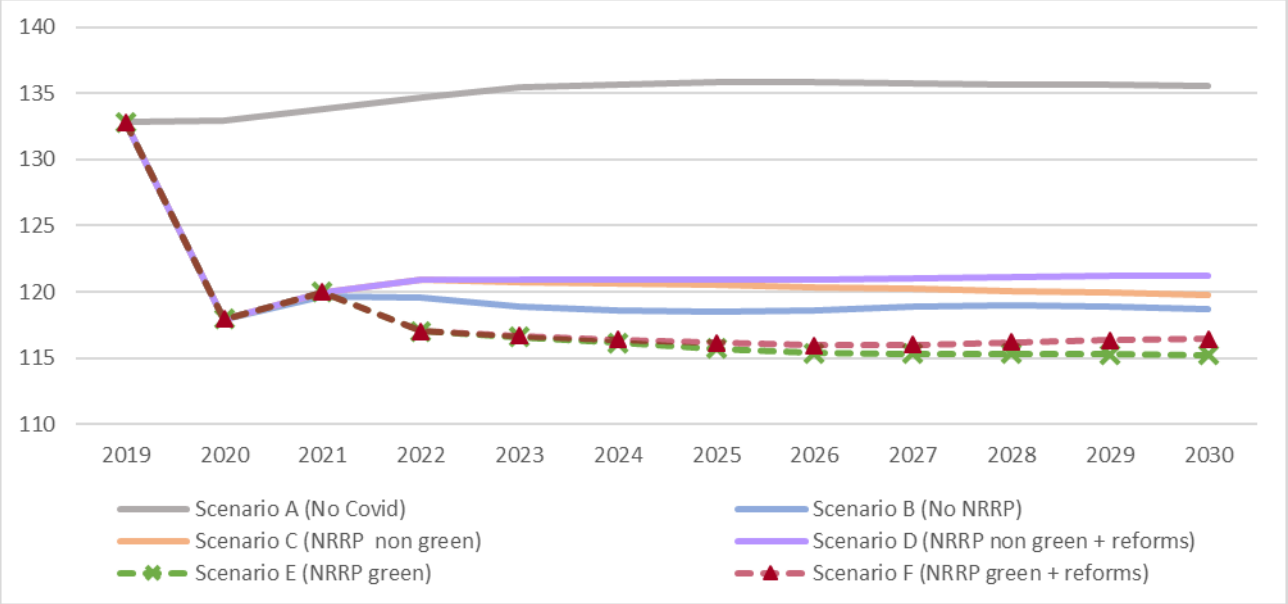
From what has been seen thus far, it can be noted that the NRRP, with investments and reforms, makes it possible to recover by 2030 the level of GDP we would have had without Covid (scenario A). While this is certainly positive, the NRRP is not the panacea for all the ills afflicting the Italian economy. On the unemployment front, the crucial role that reforms can play becomes evident. In addition, the distinction between green and non-green investments appears irrelevant in its effects on GDP and unemployment rate. However, it is important to emphasize that these results must be taken with caution because they are model-dependent, i.e., they depend on the model used and the characteristics according to which we have simulated the green part of the NRRP.

3.2 Environmental impact of the Italian Resilience and Recovery Plan

The availability of the GEM model allows us not only to create alternative scenarios, as done above, but also to look at the evolution of other variables of interest with respect to which the official documents and the relative impact analyses of the NRRP are silent. Since, in addition to the post-pandemic reconstruction of the economy, the NRRP intends - for an important part of its interventions - to promote the green transition, it is interesting to analyze the trends in energy consumption, in particular of fossil fuels, in order to examine CO2 emissions, the main greenhouse gas.

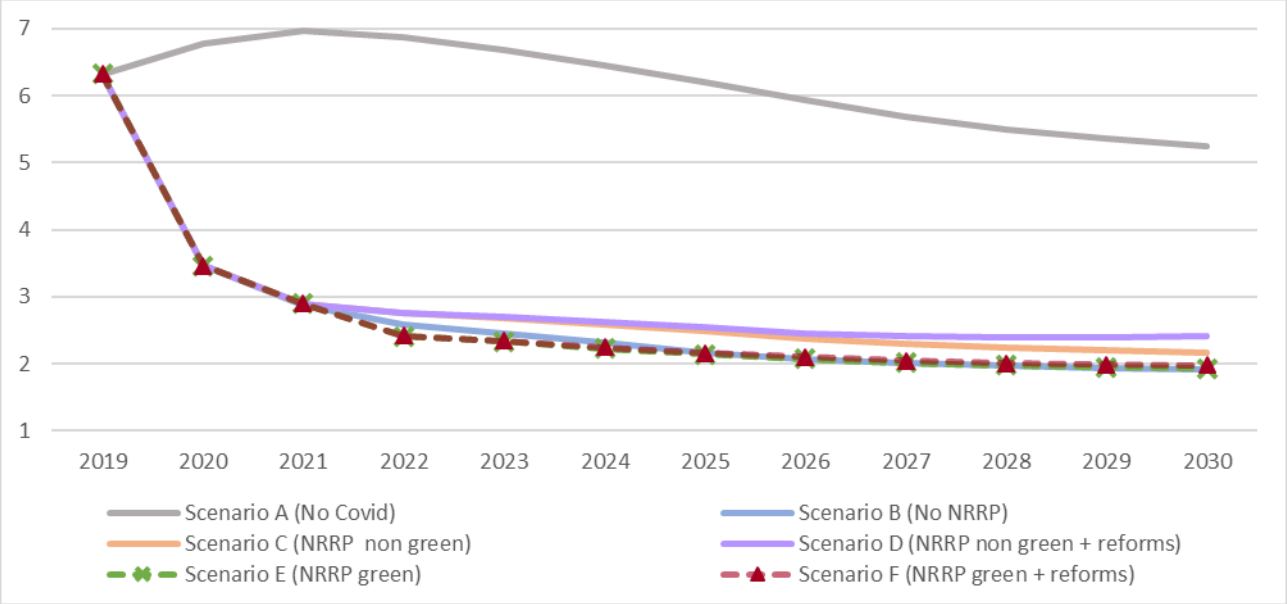
As noted fossil sources represent 79% of total consumption. Figure 17 shows the evolution of demand, expressed in millions of tons of oil equivalent (Mtoe), under the various scenarios considered.

Figure 17 – Energy consumption from fossil sources (Mtoe)



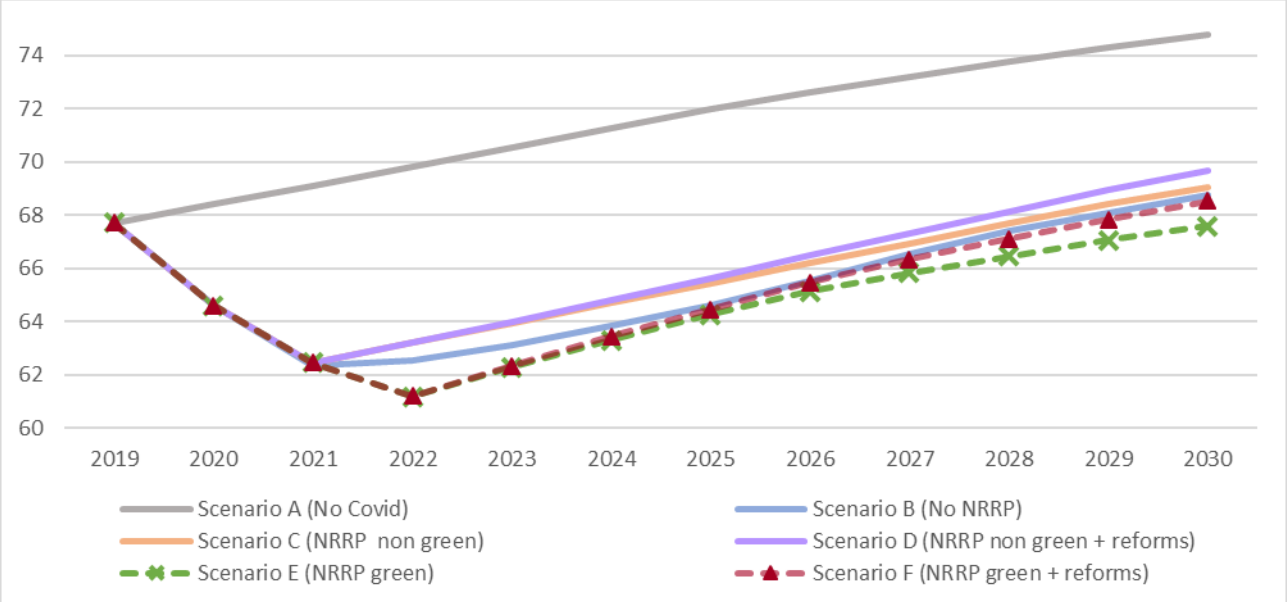
First of all, the impact of Covid is evident, which has severely limited economic activity and therefore caused energy consumption to fall. There follows a mild recovery in the years following 2021, remaining stable thereafter and, in any case, very far from those of a hypothetical No Covid scenario (scenario A). The role of the green investments of the NRRP (scenarios E and F) implies a clear decrease in fossil fuel consumption, while non-green investments (scenarios C and D) show an increase. It should be noted that the reforms (scenarios D and F) lead, in any case, to an increase in energy demand compared to the scenario without reforms, due to the positive effect on GDP that these determine and the fact that these are structural reforms without specific reference to any possible green dimension. Looking then at the breakdown of energy consumption by source, Figure 18 shows a slow decline, more pronounced in the early post-pandemic years, in the use of coal, barely accentuated by green investments. It is worth noting that in 2019 coal accounted for 4% of total primary consumption, a very small share.

Figure 18 – Coal consumption (Mtoe)



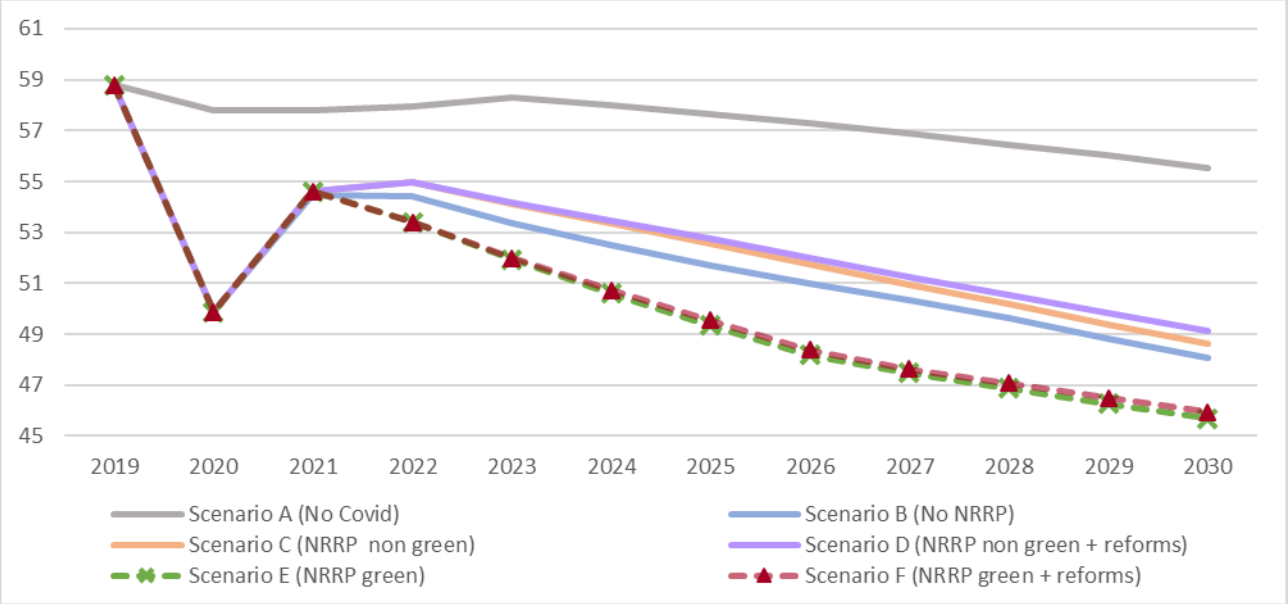
This evolution indicates a progressive substitution of this source, used in Italy mainly for electricity generation, in favor of renewable sources and especially natural gas. As a reference, the share of natural gas in total primary consumption was in 2019 equal to 41%. This explanation seems to be confirmed by the dynamics shown in Figure 19.

Figure 19 –Natural gas consumption (Mtoe)



A sharp reduction is observed in terms of oil consumption, especially in the green scenarios. Crude oil and oil products represented 41% of primary consumption in 2019. Figure 20 highlights a continuous decrease throughout the simulation period attributable almost entirely to the transport sector where, according to the characteristics of the GEM model, there is a gradual replacement of vehicles and engines powered by petroleum-derived fuels in favor of other options such as natural gas and electric vehicles.

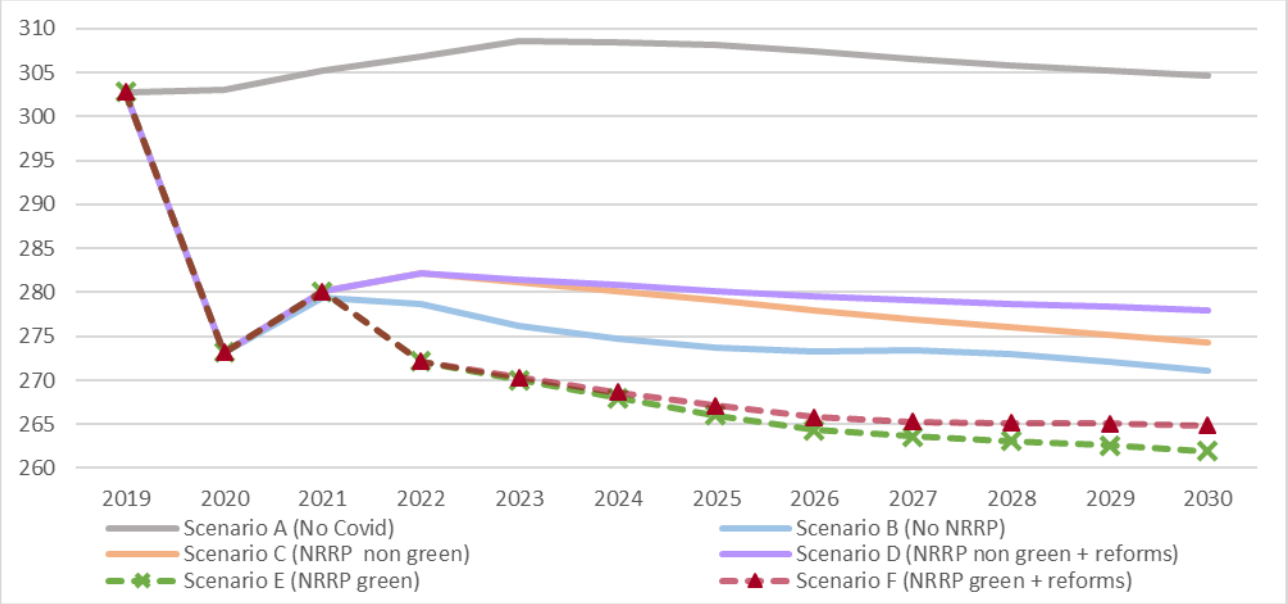
Figure 20 – Oil consumption (Mtoe)



Given the dynamics of energy consumption in the various scenarios, especially of fossil sources, we finally turn to carbon dioxide emissions. Our country is a signatory to the Paris Agreement of 2015 and, as a member of the EU, fully engaged in the European strategy to fight climate change within the framework of the European Green Deal. As a crucial part of it, the European climate law aims to achieve emission neutrality by 2050 and along this path to reduce emissions by 55% by 2030 compared to 1990 levels. Although it is not yet possible to say exactly what is the effort required for our country within this framework, a report by Italy for Climate (Barbabella and Montanini, 2021) shows that, if in the last 30 years we have reduced emissions by 100 million tons (Mt) of CO2eq (not only carbon dioxide but also other greenhouse gases), in the next ten we should reduce them by about 200Mt to be in line with the new European target and the Paris Agreement. One assumption is to cut an average of 17Mt each year from 2019 to 2030, 13Mt in 2030-2040 and 11Mt in 2040-2050.

Getting back to our simulations, Figure 21 presents the trends in CO2 emissions under the various scenarios.

Figure 21 – CO2 emissions (Million tons)



Emissions plummet in parallel with the drop in economic activity (and energy consumption) following the pandemic and then partially rebound when the economy reopens in the following year. Subsequently, it is to be noted that the NRRP brings climate benefits only in the green version. In the absence of these green investments, the Plan remains a tool to boost production activity, as seen above. In the non-green NRRP scenarios (C and D), there is even an increase in emissions compared to the "no NRRP" case: in this case, the impulse to GDP growth drives energy consumption, including fossil fuels, and consequently emissions. Here, therefore, a scale effect prevails in the absence of a substitution effect with green sources, as happens instead in the green scenarios (E and F). However, if we consider the reduction in emissions from the implementation of the plan (2021) up to 2030, that looks modest, being it equal to 5%. Again a word of caution is in order here. These numbers should not be overemphasized as much depends on the characteristics of the model and its simulations, and may not be reflected in reality. On the whole, the picture that emerges is a positive impact of the Plan on CO2 emissions above all owing to its energy transition component. However, it is possible to conclude that these beneficial effects can only be glimpsed in the time horizon considered (2030). Since these are investments in clean technologies, the climate benefits are likely to be more substantial in subsequent years and therefore over a longer horizon.

We conclude with a look at the degree of "carbonization" of the Italian economy. Carbon intensity, given by the ratio between emissions and GDP, tells us how many emissions are generated per euro of GDP produced and provides interesting indications for climate policies. Measures aimed at changing the energy mix in favor of less emissive fossil fuels such as gas or renewable or zero-emission sources, favor a reduction in carbon intensity.

Figure 22 – Carbon intensity

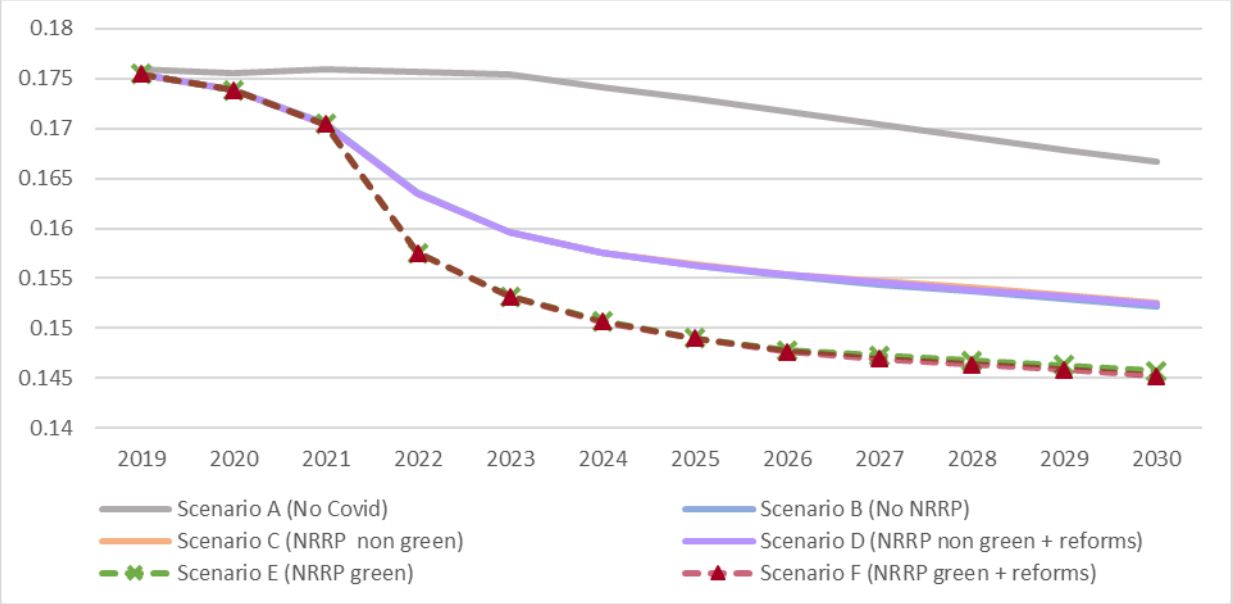


Figure 22 shows the substantial drop in the index due to the combined effect of the significant increase in GDP and the observed reduction in emissions. This reduction is driven by the Plan and is most pronounced in the case of green investments (E and F), which have the lowest carbon intensity.

4. Conclusions

In this study we have analyzed the impact of the Italian Recovery and Resilience Plan following the established practice of evaluating the effects of economic policies with the help of mathematical models representative of the structure of the economic system, through the construction of scenarios and corresponding simulations.

We have devoted substantial space to the evaluation of the impact of the Plan on two key macroeconomic variables, Gross Domestic Product and unemployment rate, in order to verify the scope of the Plan in the post-pandemic revival and recovery, looking at short and medium term effects. With the aim of verifying the robustness and congruence of the results, we have considered the assessments conducted by official institutions such as the European Commission and the Italian Government, as well as other organizations and research institutes. We found an unequivocal message about the recovery of the economy and confirmed the need for structural reforms in order for this revival to become consolidated over time.

A second objective of the impact assessment was to "validate" in particular a macro-econometric model, that of Oxford Economics, which we subsequently employed to go "beyond" the impact assessments currently existing and publicly available. In fact, we have analyzed what are the consequences of the NRRP with respect to the dimension of the "green revolution and ecological transition", to put it in the language of the NRRP itself. We have asked what are the presumed implications of the Plan for energy consumption, of fossil fuels in particular, and especially for emissions of carbon dioxide, the main

greenhouse gas. The fight against climate change, the commitments made by our country under the Paris Agreement and the obligations arising from the European Union are already leading and even more will lead our authorities to strenuous efforts to reduce emissions.

This document - the only one of its kind to date - has provided some initial answers regarding the contribution that the Plan, in addition to relaunching the economy, would be able to make to reducing emissions. It must be remarked that the evidence presented here can only produce qualitative messages, of guidance, in terms of scenarios, due to the typical "caveats" that must always be made when using models that represent complex systems in a simplified way.

References

Bacchini, Brandimarte, Crivelli, De Santis, Fioramanti, Girardi, Golinelli, Jona-Lasinio, Mancini, Pappalardo, Rossi, Ventura, Vicarelli (2013). "Building the core of the Istat system of models for forecasting the Italian economy: MeMo-It". Rivista di statistica ufficiale, N. 1/2013: 17-45.

Camera dei deputati, Servizio Studi - Dipartimento Bilancio. "Piano nazionale di ripresa e resilienza (PNRR) - La proposta del Governo del 12 gennaio 2021." 25 gennaio 2021.

Camera dei deputati. "Il Documento di Economia e Finanza (DEF) 2021 e l'ulteriore scostamento di bilancio." 20 aprile 2021.

Camera dei deputati. "La valutazione del Piano nazionale per la ripresa e la resilienza dell'Italia da parte della Commissione europea." Dossier n° 51. 24 giugno 2021.

CDP Think Tank. "La sfida di lungo periodo del PNRR passa per le riforme". Luglio 2021.

Commissione Europea. "Allegato della proposta di decisione di esecuzione del Consiglio relativa all'approvazione della valutazione del piano per la ripresa e la resilienza dell'Italia {SWD(2021) 165 final}". 22 Giugno 2021.

Commissione Europea. "Documento di Lavoro dei Servizi della Commissione. Analisi del piano per la ripresa e la resilienza dell'Italia che accompagna il documento Proposta di Decisione di Esecuzione del Consiglio relativa all'approvazione della valutazione del Piano per la Ripresa e la Resilienza dell'Italia {COM(2021) 344 final}". 22 Giugno 2021.

European Commission. "Commission Staff Working Document. Analysis of the recovery and resilience plan of Spain, Accompanying the document Proposal for a Council Implementing Decision on the approval of the assessment of the recovery and resilience plan for Spain {COM(2021) 322 final}". 16 June 2021.

European Commission. "Commission Staff Working Document. Analysis of the recovery and resilience plan of Germany Accompanying the document Proposal for a Council Implementing Decision on the approval of the assessment of the recovery and resilience plan for Germany {COM(2021) 341 final}". 22 July 2021.

European Commission. "Commission Staff Working Document. Analysis of the recovery and resilience plan of Belgium Accompanying the document Proposal for a Council Implementing Decision on the approval of the assessment of the recovery and resilience plan for Belgium {COM(2021) 349 final}". 23 June 2021.

European Commission. "Commission Staff Working Document. Analysis of the recovery and resilience plan of France Accompanying the document Proposal for a Council Implementing Decision on the approval of the assessment of the recovery and resilience plan for France {COM(2021) 351 final}". 23 June 2021.

German Recovery and Resilience Plan – Germania https://www.bundesfinanzministerium.de/Content/EN/Standardartikel/Press_Room/Publications/Brochures/2021-01-13-german-recovery-and-resilience-plan.pdf?__blob=publicationFile&v=8

Istat. “Rapporto annuale 2021, La situazione del Paese”. 9 Luglio 2021.

Italia Domani – Piano Nazionale di Ripresa e Resilienza https://italiadomani.gov.it/it/home.html

National Recovery and Resilience Plan – Francia https://www.economie.gouv.fr/files/files/PDF/2021/PNRR-SummaryEN.pdf

NextGenerationEU https://europa.eu/next-generation-eu/index_it

Oxford Economics. “Italy EU funds will help, but structural reforms are the key”. 21 Maggio 2021.

Piano Nazionale di Ripresa e Resilienza - Italia https://www.governo.it/sites/governo.it/files/PNRR.pdf

Recovery, Transformation and Resilience Plan – Spagna https://www.lamoncloa.gob.es/temas/fondos-recuperacion/Documents/05052021-Executive_Summary_Recovery_Plan.pdf

Sweatman and Hessenius (2020). “Applying the EU Taxonomy: Lessons from the Front Line”. Climate Strategy and Climate & Company.

Vargas and in't Veld (2014), "The potential growth impact of structural reforms in the EU: a benchmarking exercise", European Economy Economic Papers no. 541.

Appendix 1: Russia – Ukraine war, an update

One year after the start of the implementation of Recovery Plan from Covid-19 another impactful event occurred: the Russian invasion of Ukraine begun on the 24th of February 2022. To account for this event and assess potential changes to the simulation results reported in the main text we supplement here the quantitative analysis with the same methodology used throughout the paper. Specifically, we considered the following four scenarios:

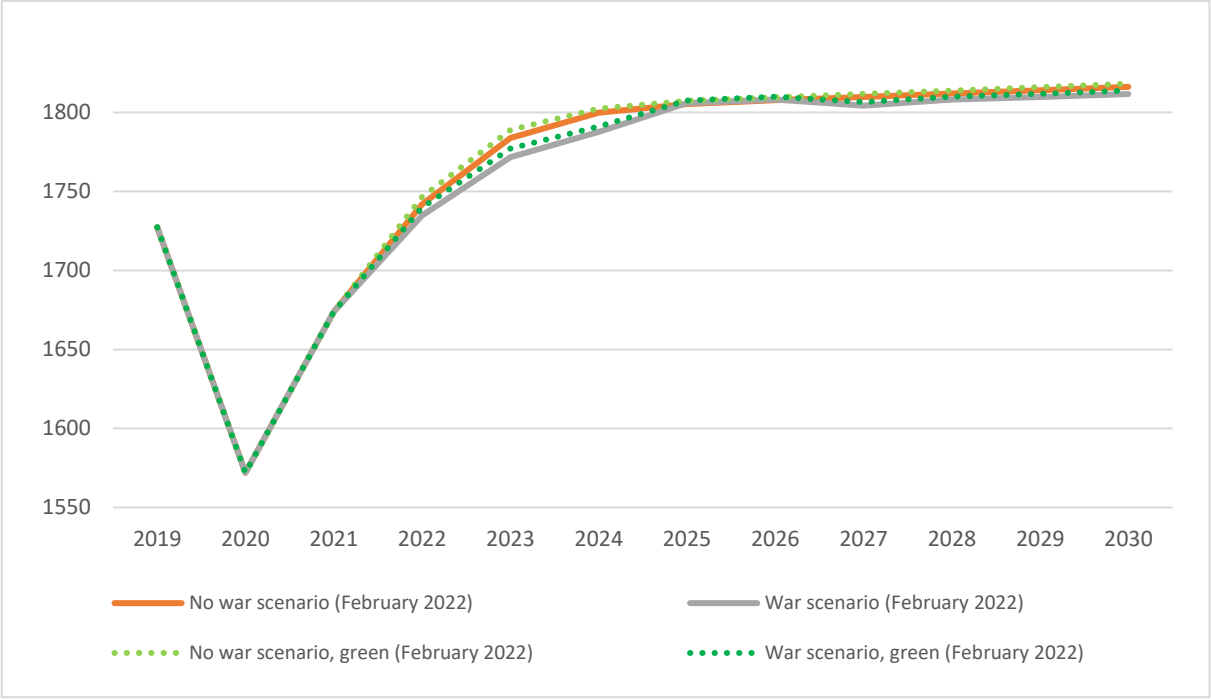
- *No war scenario*: this simulation covers the period after February 2022, before the Russian invasion of Ukraine, but already incorporating the impact of the European Recovery Plan's funds;
- *War scenario*: this simulation covers the period beginning at the end of February 2022 right after the conflict had started, clearly also incorporating the impact of the European Recovery Plan's funds;
- *No war scenario, green*: this is the "No war" scenario with the green connotation of the Recovery Plan as described in the main text: starting from 2022 we increase the generation of electricity for the part obtained by renewable sources, considering the objectives set out by the Component 2 of the second Mission (M2C2) of the Italian NRRP.
- *War scenario, green*, this is the "war" scenario with the green connotation of the Recovery Plan as described above.

Oxford Economics models the war scenario by making modifying the GEM model as detailed in the table below.

Variable	Change imposed (in percentage terms)
Bank's deposit rate [%] - Eurozone (EURO_11)	+19% in 2025 and 2026, +7% in 2027 and 2028
Corporate borrowing rate, period average [%] - Russia	+50% in 2022, + 13% in 2023, + 5% in 2024
Costs, relative unit labor [2008=100] - Russia	-1% in 2025, +3% in 2026, + 2.5% in 2027
Equity shock (domestic) [%] - Germany	-4.6% in 2022, -2.7% in 2023, -0.75% in 2024
Equity shock (domestic) [%] - Russia	-4.6% in 2022, -2.7% in 2023, -0.75% in 2024
Exchange rate, period average [Ruble per US$] - Russia	+22% in 2022, +9% in 2023, +0.7% in 2024, +3.4% in 2025
Interest rate, central bank policy [%] - Russia	+10% in 2022, -1.5% in 2023, -16% in 2024, -31% in 2025
Interest rate, central bank policy, end of period [%] - Russia	+13% in 2022, +10% in 2023, -11% in 2024, -31% in 2025
Interest rate, Government Bond Yield: 10 Year (Avg) [%] - Russia	+55% in 2022, +4% in 2023, +0.7% in 2024
Investment, private sector business, real, LCU [Ruble; Billions: chained 2016 prices] - Russia	-4.5% in 2022, -8.7% in 2023, -10.6% in 2024, - 11% in 2025
Natural gas, production, annualized [mtoe] - Russia	-6.8% in 2025, -4.6% in 2026, +2% in 2027, -0.9% in 2028
World gas price (WPGAS)	+13.5% in 2022, +23% in 2023, +13% in 2024,
World food price [2005=100] – World (WPFOOD)	+3% in 2022, 2023 and 2024
World oil price, Brent crude spot, $pb [US$ per barrel] - World	+13% in 2022, +12.6% in 2023, +9.9% in 2024

We report below the main results in terms of impact of the war on GDP, consumption of gas, coal and oil, and CO_2 emissions.

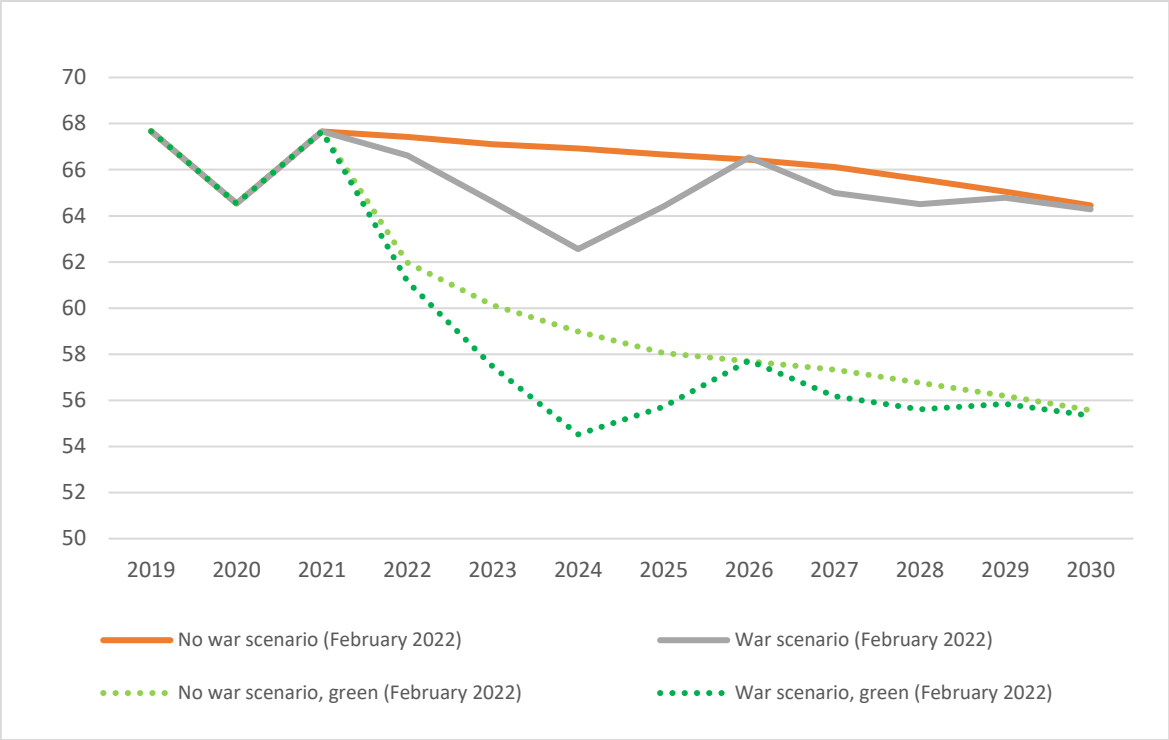
Figure A1: Real GDP (Billion Euros, chained 2015 prices)



The Russia-Ukraine war has an impact – even tough limited – on the Italian GDP, which is expected to decrease during the NRRP period by 0.40% in 2022, 0.68% in 2023 and 0.67% in 2024 in the non-green scenarios, relative to the no war case. The same holds for the green scenarios, which however display higher GDP levels compared to their corresponding non-green scenarios.

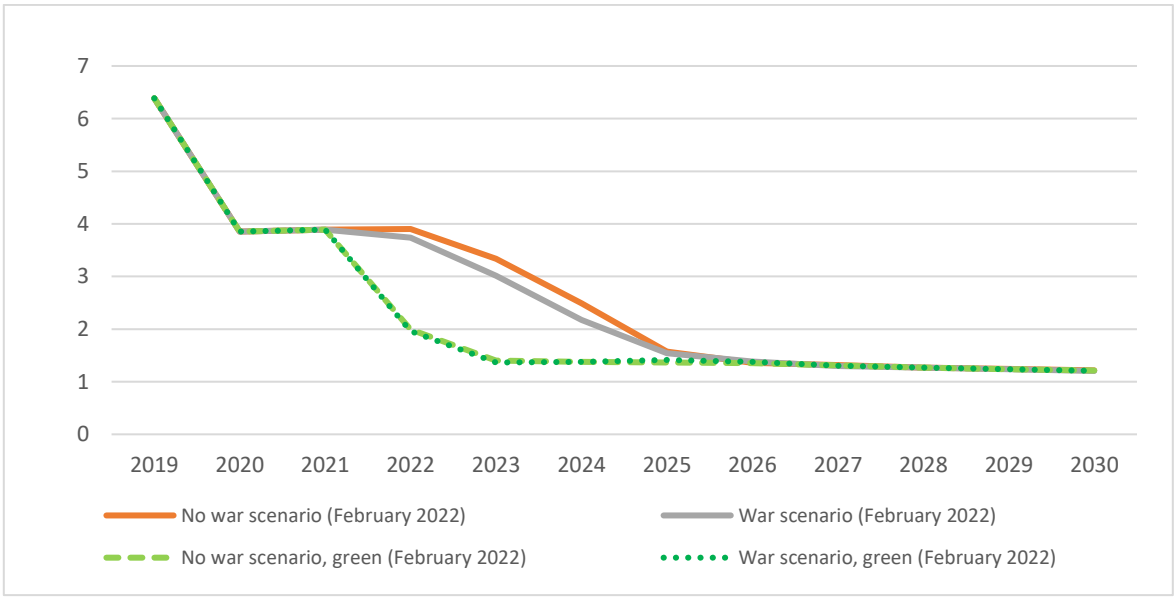
Considering the total impact of the war, hence summing up the differences between the scenario with and without war, for the whole period considered (2022-2030), GDP "loses" an amounts equal to around 50 billion euros (for both the neutral and green recovery cases).

Figure A2: Gas consumption, annualized (mtoe)



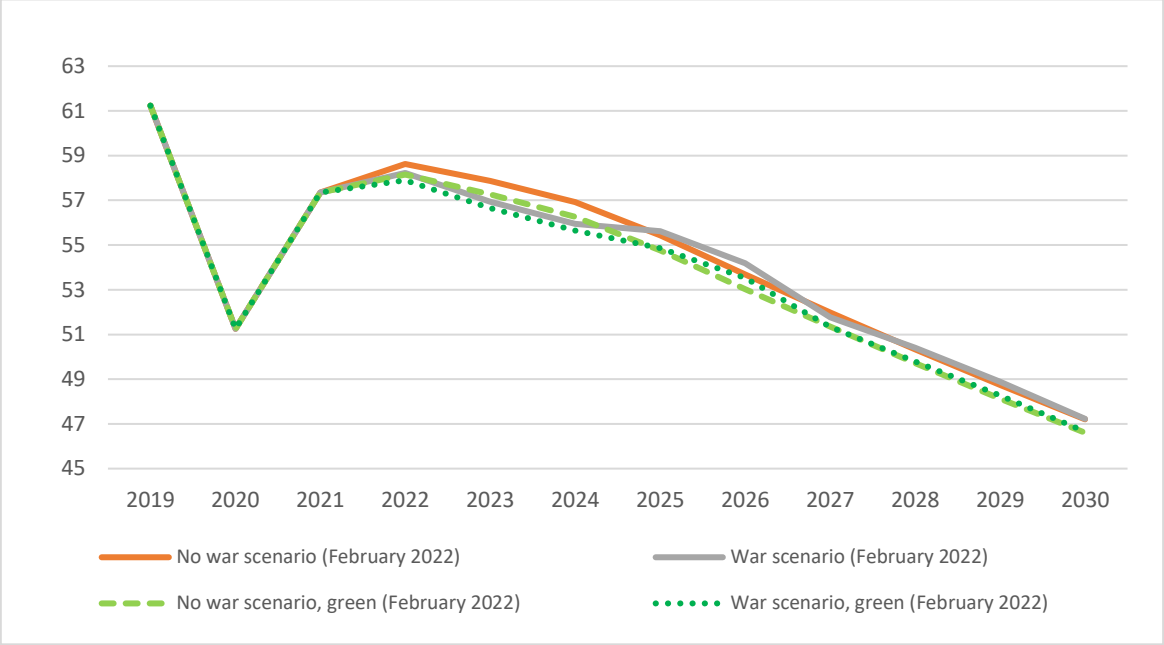
A strong reduction in the demand for gas occurs in the war scenarios, for both the neutral and green recoveries, which actually display the same dynamics (obviously with decreased gas demands in the case of the green recovery due to the expansion of renewables).

Figure A3: Coal consumption, annualized (mtoe)



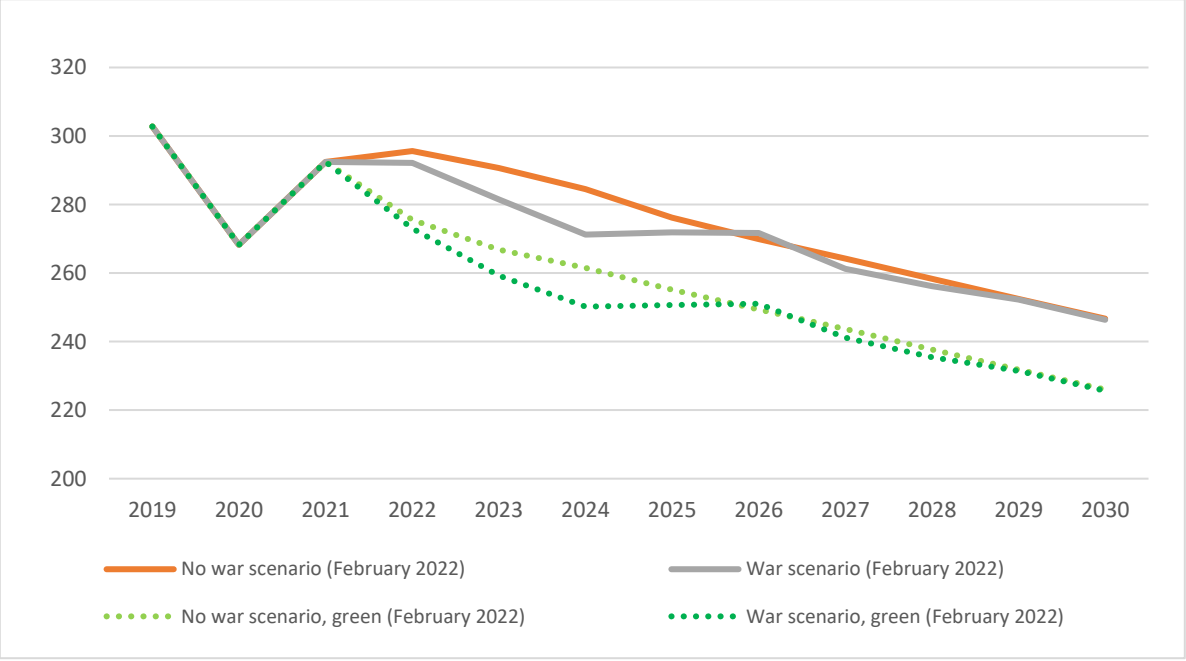
Coal demand is obviously less impacted by the war relative to gas demand. Again, the green scenarios display lower levels of coal demand, due to the higher presence of renewable-generated energy).

Figure A4: Oil consumption, annualized (mtoe)



As for oil, the war scenarios show a slight bounce in its demand: in fact, it initially decreases below the non-war levels, to rebound later on, finally reaching again slightly lower levels. Still, these changes are far less significant than those showed for gas demand).

Figure A5: Carbon dioxide emissions (Million tonnes)



Aggregating the carbon emissions levels associated with the three fossil sources we obtain an estimate of total CO_2 emissions. The war scenarios display lower emission levels due do the decrease in energy demand. However, the fall in emissions caused by the green recovery is larger and, most of all, persists up until 2030. Instead the decrease in emissions due to the war is clearly short-term and bound to run out by 2026.

Appendix 2: The Global Economic Model (GEM) by Oxford Economics

The simulations in Sections 2 and 3 of the main text have been conducted the Global Economic Model (GEM) by Oxford Economics, a private company specialized in macroeconomic analysis and forecasts. GEM is a macro-econometric model designed to provide a good description of the historic relationship between economic variables and to capture the key linkages between those variables. GEM is probably the most widely used commercial international macro model.

The behavioral equations have an Error Correction Mechanism (ECM) specification which allows to model at the same time the long-term equilibrium relations and the short-term dynamics. In the short run the model has Keynesian features – demand shocks generate economic cycles that can be influenced by fiscal and monetary policies) – while in the long term it has a monetarist inspiration – the output is determined by factors on the supply side: investments, demographics, labor force participation, human capital and productivity.

Within this theoretical framework consumption if a function of real income, wealth and interest rates; Investment is a function of the return on capital and of changes in capacity utilization; exports depend on world demand and relative unit labor costs; imports depend on total final expenditure and competitiveness; real wages depend on productivity and unemployment relative to NAIRU and finally prices are a based on a New Keynesian Phillips Curve.

In terms of coverage, the model covers eighty-five economies in detail and six regional blocks interlinked through trade, prices, exchange rates, and interest rates. Each of the individual countries in the GEM reflects the structure of those economies but should not necessarily be seen as separate models in their own right as this ignores the independencies between countries. It is important to highlight that parameters across countries differ, hence different countries display different behavior in response to shocks. For example, real wage rigidity is higher in some countries than others, and specific coefficients in wage and price equations reflect this. Unemployment will tend to rise further and faster in these countries in response to an adverse demand shock, even though the functional form of wage and price equations is identical across countries.

In terms of expectations, the GEM assumes adaptive rather than forward-looking expectations. Where appropriate, the model does introduce expectations implicitly and explicitly, therefore accounting for how and the extent to which agents respond to information about changes in fundamentals. For example, the model's derivation of exchange rate forecasts implicitly captures expectations: in the short-run, the exchange rate is driven by movements in domestic interest rates relative to the US, therefore accounting for uncovered interest rate parity.

An important feature that has been used extensively for running the simulations of this paper is that the GEM contains several scenario levers. For example, the model has a system of exogenous confidence shocks, connected to observations of developments in U.S. financial market volatility, which can be used as a scenario lever. More information can be found at: https://www.oxfordeconomics.com/service/subscription-services/macro/global-economic-model/.

FONDAZIONE ENI ENRICO MATTEI WORKING PAPER SERIES
"NOTE DI LAVORO"

Our Working Papers are available on the Internet at the following address:
http://www.feem.it/getpage.aspx?id=73&sez=Publications&padre=20&tab=1

"NOTE DI LAVORO" PUBLISHED IN 2022

1. 2022, Daniele Crotti, Elena Maggi, Evangelia Pantelaki, Urban cycling tourism. How can bikes and public transport ride together for sustainability?
2. 2022, Antonio Acconcia, Sergio Beraldo, Carlo Capuano, Marco Stimolo, Public subsidies and cooperation in research and development. Evidence from the lab
3. 2022, Jia Meng, ZhongXiang Zhang, Corporate Environmental Information Disclosure and Investor Response: Empirical Evidence from China's Capital Market
4. 2022, Mariagrazia D'Angeli, Giovanni Marin, Elena Paglialunga, Climate Change, Armed Conflicts and Resilience
5. 2022, Davide Antonioli, Claudia Ghisetti, Massimiliano Mazzanti, Francesco Nicolli, The economic returns of circular economy practices
6. 2022, Massimiliano Mazzanti, Francesco Nicolli, Stefano Pareglio, Marco Quatrosi, Adoption of Eco and Circular Economy-Innovation in Italy: exploring different firm profiles
7. 2022, Davide Antonioli, Claudia Ghisetti, Stefano Pareglio, Marco Quatrosi, Innovation, Circular economy practices and organisational settings: empirical evidence from Italy.
8. 2022, Ilenia Romani, Marzio Galeotti, Alessandro Lanza, Besides promising economic growth, will the Italian NRRP also produce fewer emissions?

Fondazione Eni Enrico Mattei
Corso Magenta 63, Milano – Italia

Tel. +39 02.520.36934
Fax. +39.02.520.36946

E-mail: letter@feem.it
www.feem.it

Fondazione Eni Enrico Mattei