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The fiscal response to the Italian COVID-19 crisis: A counterfactual analysis*

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Abstract. The COVID-19 pandemic is an unprecedented worldwide event with a massive impact on the economic system. The first Western country that had to face the COVID-19 crisis was Italy, which therefore represents a natural "case study." By using the microdata and granular policy information available at the Italian Ministry of Economy and Finance, this paper provides a macroeconomic quantitative assessment of the initial emergency fiscal measures introduced in 2020 and an analysis of the impact of the COVID-19 shock during the lockdown.

Keywords: COVID-19, coronavirus, macroeconomic impact, fiscal policies, lockdowns, fiscal-policy-study case.

JEL codes: E32, E62, E65

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1. Introduction

This paper presents an analysis of the effects of the COVID-19 emergency on the Italian main macroeconomic variables and provides a counterfactual assessment of the fiscal measures adopted to deal with COVID-19 consequences. The paper focuses on the consequences of COVID waves occurred between the first and second quarters of 2020, and in the fourth quarter of the same year. The considered fiscal measures include the combined impact of the main law decrees approved in 2020 by the Italian Government, which allocated €175 billion over the period 2020-2022 in terms of net borrowing (Ministry of Economy and Finance, 2021: 138).

The economic effects of the two pandemic waves are introduced considering four transmission channels. Following Pfeiffer *et al*. (2020), we assumed that the closure of some sectors and restrictions to household mobility generated negative effects on both the supply and the demand side of the economy. Two further channels were considered: an increase in the uncertainty perceived by firms, with effects on their ability to continue operating in the new conditions, and the (unobserved) shortage of credit granted to firms by the banking system.

All the assessments of the quantitative impacts were carried out using the QUEST dynamic general economic equilibrium model developed by the European Commission for Italy.[1] The model used has a multi-regional stylized structure that includes Italy, the rest of Euro Area and the rest of the world. In the simulation, a counterfactual scenario is constructed to describe what would have happened in the absence of the interventions introduced by the Government following the COVID-19 emergency. Simulations were calibrated by using the microdata and detailed policy information available at the Ministry of Economy and Finance.

We find that without the emergency fiscal measures the Italian GDP would have fallen by 13.4 per cent in 2020 against the 8.9 per cent observed. The impact of public interventions on the dynamics of investments is particularly significant. Without the liquidity support measures, investment would have fallen by 21.7 per cent in 2020, compared with 9.2 per cent in the observed scenario that includes the Government's measures.

[1] We use the QUEST-III R&D Italian version (cf. D'Auria *et al*., 2009), which is developed and updated by the European Commission for Italy. See also Ratto *et al*. (2009), Coenen *et al*. (2012), and Roeger *et al*. (2021).

After COVID-19 pandemic, interest in evaluating its impact on the economy and the policies implemented to contain its effects grew rapidly. A complete review of this literature is outside the scope of the present paper,[2] our aim here is to mention the studies directly related to our assessment. In this respect, the most important are Pfeiffer *et al*. (2020) and McKibbin and Fernando (2020) to which we share the approach. The idea is to map onto a general equilibrium model the effects of the pandemic as a combination of demand and supply-side shocks to evaluate the impact of the event or to assess the effects of the policies designed to mitigate it. An alternative approach incorporates the economic framework with an epidemiology model to account for the effects related to the dynamics of the pandemic.[3]

We borrowed most of the transmission mechanisms of the pandemic shock from Pfeiffer *et al*. (2020). They also analyze the economic impact of the COVID-19 pandemic and its associated containment measures, but they focus on an aggregate EU perspective. By contrast, we evaluate a specific observed country case (i.e., Italy) and a specific package of policy measures quantified through granular information.[4] Pfeiffer *et al*. (2020) implement the COVID-19 shock as a mix of demand and supply constraints[5] finding, on average, that the response of EU fiscal authorities would reduce the output loss by around four percentage points, one fourth of their assumed negative economic impact of the pandemic.

In their extensive study, McKibbin and Fernando (2020) quantify the potential economic costs of seven possible COVID-19 outbreak scenarios by using a global intertemporal general equilibrium model with heterogeneous agents (the G-Cubed Multi-Country Model).[6] McKibbin and Fernando (2020) show that even a contained outbreak could significantly impact the global economy. They also emphasize the tension between the short and long run. Covid-19 outbreak is a crisis with several

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[2] The interested readers can refer to the recent survey by Brodeur *et al*. (2021).

[3] Early examples include Lee and McKibbin (2003) and McKibbin and Sidorenko (2006), who respectively focus on the impact of SARS and Pandemic Influenza.

[4] Granular data on policies are obtained from RGS (Italian State General Accounting Department).

[5] A supply shock, arising from the Governments' closure of some sectors and implemented as a constraint on firms' demand for labor, and a demand shock, due to the Governments' imposition of limits on consumption of certain categories. Both shocks negatively affect the firms' gross operating surplus and the firms' ability to borrow, thereby amplifying the reduction in investment.

[6] Examples of applications to the COVID-19 case are Krüger *et al*. (2020), Glover *et al*. (2020), Gros *et al*. (2020), Bodenstein *et al*. (2020), and Eichenbaum *et al*. (2021).

facets that requires monetary, fiscal, and health policy responses in the short term, but long-term policies are equally important and require greater investment in public health system. We explicitly focus on the short-run issue.

A different stream of literature looks at the role of monetary policy measures in dealing with the pandemic emergency. In particular, Altavilla *et al*. (2020) investigates the combined role of monetary and prudential authorities in supporting bank-lending conditions. According to their results, monetary measures prevented the materialization of financial market volatility and the contraction of bank lending, with positive effects on firms' employment. In this respect, our paper complements their analysis, focusing on the role of fiscal measures in supporting bank-lending conditions, mostly through public guarantees.

Finally, Bartocci *et al*. (2020) focus on the monetary and fiscal policy interactions in a stylized a two-region monetary union after a pandemic shock, formalized as a mix of recessionary demand and supply simultaneous and symmetric shocks. In this setup, where an effective-lower bound for monetary policy is also considered, they show that expansive fiscal policies and monetary policies designed to limit the increase in long-term rates by purchasing sovereign bonds are required to effectively mitigate the union-wide recession. Moreover, effectiveness requires that a supranational fiscal authority issues a safe bond when investors perceive the bonds of one of the regions as riskier.

The rest of the paper is organized as follows. The next section provides an overview of the methodology on which our simulations are built. Section 3 describes the main features of the macroeconomic model used to simulate the pandemic crisis and the policy response during the lockdown. Section 4 describes the fiscal measures implemented in the model and the calibration of the transmission channels of the pandemic shock. Section 5 illustrates our findings. It reports the impact of the public intervention on the main macroeconomic variables and disentangles the relative relevance of the different fiscal measures and shock transmission channels. A final section provides some concluding remarks.

2. The methodology

We consider four channels to capture the transmission of the pandemic shock to the economy: 1) aggregate supply; 2) aggregate demand; 3) liquidity; 4) uncertainty. These channels are briefly described below, mainly referring to the impact of the pandemic emergency on Italy. The next section describes how they are formalized into the QUEST model.

The containment measures put in place during the two pandemic waves recorded during 2020 required the temporary closure of companies or a forced reduction in production, which negatively impact supply chains and labor demand, leading to prolonged periods of lay-offs and rising unemployment. This aspect is built into the model through a negative impact on the labor demand of firms (Brinca *et al*., 2020; Coibion *et al*., 2020b), which are forced to employ fewer workers than they would have done in the absence of the pandemic emergency (supply-side disruptions). We also assume that the reduction in labor input cannot be offset by an increase in production capacity.[7]

The restraint measures, the limited mobility, and the climate of uncertainty have led to a reduction in the propensity to consume. The most affected sectors were transport, tourism, catering, and entertainment (Binder, 2020). However, mainly due to the climate of uncertainty faced by households, almost all sectors recorded a loss in turnover. This aspect is introduced into the model through a reduction in the marginal utility of consumption (demand-side shock).[8] We formalize the "wait-and-see" expectation shock discussed by Baldwin (2020), who argues in favor of an attitude to postpone consumption choices when the economic climates is characterized by uncertainties and confidence falls.

The uncertainties surrounding the pandemic development also created a climate of uncertainty for businesses. The pandemic crisis is an unprecedented shock, leading to massive spike in uncertainty (Baker *et al*., 2020). Before the start of the pandemic, more than 80 per cent of companies expected their sales to remain stable or increase. By April 2020, however, around 50 per cent of companies expected sales to fall sharply (more than a 15 per cent drop year-on-year) and only 18 per

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[7] We assume that capital utilization remains constant at its steady state level when this channel is used. This avoids a non-realistic increase of capital utilization that the model would normally generate given the forced reduction of the labor input.

[8] The Bank of Italy observes that the reduction in GDP observed in the first quarter of 2020 is largely attributable to the contraction in domestic demand in terms of household consumption and gross fixed capital formation (Bank of Italy, 2020: 21). The same study also highlights Italian households' difficulties in coping with past financial commitments and reports a substantial increase in the share of households that experienced a substantial reduction in income during the emergency.

cent expected a stable economic outlook.[9] Formally, this aspect is built into the model by assuming an increase in the risk premium on tangible capital (uncertainty shock on investments).[10]

Finally, companies with large reductions in turnover may experience liquidity problems, making them less creditworthy and thus subject to credit rationing.[11] This dynamic could trigger possible bankruptcies and a sharp drop in planned and future investments. The liquidity mechanism is built into the model by assuming that some firms are subject to credit rationing and are thus forced to finance investments only through their Gross Operating Surplus (GOS), defined as the difference between turnover and the labor costs. Schematically, the three channels previously described trigger a reduction in GOS. Firms that do not have access to credit lines face a liquidity crisis and are forced to finance investment only through internal financing (GOS). This, in turn, leads to a reduction in investment. The channel described is not part of the original version of the QUEST model and was introduced by adding an equation for the GOS and by modifying the private investment optimization mechanism following Pfeiffer *et al*. (2020).[12]

3. The QUEST model and the COVID-19

This section discusses in detail aspects of the model that are relevant for the understanding of how we formalize COVID-19 pandemic transmission to the economy. We accurately describe those parts of the QUEST model that have been used or modified to consider the impact of the pandemic crisis

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[9] The result on expectations is found in a study based on a sample of 7,800 Italian firms interviewed immediately before (January) and after (March) the start of the pandemic (Brancati and Brancati, 2020). Similarly, the Bank of Italy (Bank of Italy, 2020: 53) stressed that the impact of worsening confidence and increased uncertainty will be reflected in firms' investment decisions with a contraction of GDP by more than two p.p. in 2020, with effects that would only wear off in 2022. See also Balduzzi *et al*. (2020).

[10] See D'Auria *et al*. (2009) for a full description of this channel.

[11] We have not considered the credit-rationing problem from the household side as in this case the relevant channel would eventually be the demand for new loans to finance the consumption that we have assumed to be reduced due to the pandemic. However, it is worth noting that our assessment does not include the effects of the moratorium on real estate mortgages.

[12] When firms are subject to liquidity constraints, investments are not determined by intertemporal optimization choices, but depend on their GOS. The pandemic crisis restricts access to credit and by reducing turnover forces firms without access to credit to reduce investment.

to formalize the various transmission channels introduced in the previous section. We refer for the description of the standard features to D'Auria *et al*. (2009) and Roeger *et al*. (2021).[13]

The model and our exposition follow Pfeiffer *et al*. (2020), who use a QUEST-based DSGE model to analyze the transmission of the COVID19-pandemic and the effects of the economic policy response. We mainly adopt their methodology to formalize the economic fallout of the global COVID-19 pandemic. However, we use a less-parsimonious version of QUEST developed and regularly updated by the European Commission for the Italian economy. It includes three regions (Italy, rest of the euro area, rest of the world), semi-endogenous growth, and a heterogenous labor market.

The model structure, for each of the three regions, is as follows. The economy is composed of households, non-financial firms operating either in the domestic market or in the import-export sector, R&D institutes, a fiscal authority, and a monetary authority.

The euro area monetary setup is modelled assuming that the Italian economy and the rest of the euro area share the same central bank.

Agents face nominal and real rigidities (i.e., price and wage stickiness and adjustment costs associated with employment and investment). Households are of two types (two-agent New Keynesian, TANK, assumption). Some of them can access to asset markets (Ricardian households), whereas others cannot so they are liquidity constrained (non-Ricardian households). All provide low, medium, and high skilled labor services to firms. The supply side is populated by firms operating in the final good, intermediate good, and the R&D sector.

3.1 Aggregate demand lockdowns

3.1.1 Households

The economy is populated by two types of infinitely lived households distributed on a unit segment: Ricardian (indexed by i) and non-Ricardian or liquidity-constrained agents (indexed by k). The share of the former is $(1-\varepsilon)$, while that of the latter is ε. Members of both kinds of households offer low, medium, and high skilled labor services indexed by $s \in (L, M, H)$.

[13] All equations of the baseline model and their descriptions are reported in Appendix A of D'Auria *et al*. (2009). Further details are available upon request.

Each household h aims to maximize a discounted intertemporal utility function defined on consumption (C_t^h) and leisure ($1-L_t^{h,s}$):

$$(1)\qquad V_0^h = E_0 \sum_{t=0}^{\infty} \beta^t \left(\xi_t^{nlc,c} (1-\vartheta)\, log\left(C_t^h - \vartheta C_{t-1}\right) + \xi_t^{nlc,l} \sum_s \frac{\omega_s}{1-k} (1-L_t^{h,s})^{1-k} \right)$$

where β is the discount factor; instant utility from consumption accounts for habit persistence (ϑ), while a CES preference for leisure is assumed, which is based on a common labor supply elasticity $(1-k)$, but skill-specific weights (ω_s). Finally, $\xi_t^{nlc,c}$ and $\xi_t^{nlc,l}$ are exogenous preference shocks on consumption and leisure, respectively.

Ricardian households have access to financial markets, can smooth their consumption over time, and own the firms considered in the model. They can buy and sell domestic and foreign assets (government bonds) and accumulate physical capital that they rent out to the intermediate sector. Ricardian households can also buy patents of designs produced by the R&D sector and license them to the intermediate goods producing firms at a rental rate.

The budget constraint of the representative Ricardian household i is:

$$(2)\qquad (1+t_t^c) P_t^C C_t^i + \Lambda_{F,t,t-1}^i + \Lambda_{R,t,t-1}^i = \Omega_L^i + PR_t^i + TR_t^i,$$

where C_t^i refers to real consumption, t_t^C are consumption taxes, and P_t^C is the consumption utility deflator. In addition, $\Lambda_{F,t,t+1}^i$ and $\Lambda_{R,t,t+1}^i$ are the net financial and real investments between t and $(t-1)$; Ω_L^i is the after-tax labor income, which is obtained from all kinds of labor supplied, plus the unemployment benefits for households' members who are unemployed (net of the wage adjustment costs which will be later introduced); PR_t^i are all the profits from firm ownerships while TR_t^i are Government transfers.

Financial investments can be allocated to domestic (B_t^i) and foreign ($B_t^{F,i}$) assets, denoted in foreign currency. Formally, net financial and real investments are equal to:

$$(3)\qquad \Lambda_{F,t,t-1}^i = B_t^i - (1+r_{t-1}) B_{t-1}^i + e_t B_t^{F,i} - \left(1 + r_{t-1}^F - \Gamma_{B^F}\left(\frac{e_t B_{t-1}^F}{Y_{t-1}}\right)\right) e_t B_{t-1}^{F,i},$$

where e_t is the nominal exchange rate; r_{t-1} and r_{t-1}^F are the asset returns and $\Gamma_{B^F}(.)$is the financial intermediation premium which is function of nominal exchange rate, foreign assets, and output.

After tax, real investments can be allocated to the acquisition of new tangible capital (J_t^i) or intangible ($J_t^{A,i}$) capital; therefore, $\Lambda_{R,t,t-1}^i$ is the sum of two components: i) $P_t^I \left(J_t^i + \Gamma_J\left(J_t^i\right)\right) -$

$\left(1-t_{t-1}^{k}\right)\left(i_{t-1}^{K}-rp_{t-1}^{K}-\xi_t^{rp}\right)P_t^J K_{t-1}^i - t_{t-1}^K \delta^K P_t^I K_{t-1}^i - \tau^K P_t^I J_t^i$ ii) $P_t^A J_t^{A,i} - \left(1-t_{t-1}^{k}\right)(i_{t-1}^{A} - rp_{t-1}^{K})P_t^A A_{t-1}^i - t_{t-1}^K \delta^A P_t^A A_{t-1}^i - \tau^A P_t^A J_t^{A.i}$,

where P_t^I and P_t^A are tangible and intangible capital prices; i_t^K and $i_t^A$are their rental rates; rp_{t-1}^K and rp_{t-1}^A are their risk premia; ξ_t^{rp} is an exogenous shock on the risk premium of tangible capital;[14] δ^K and δ^A are their depreciation rates; t_t^K is the capital tax, which is the same for both; τ^K and τ^A are tax credits received by households that invest in tangible and intangible capital; $\Gamma_J(J_t^i)$ is the adjustment cost of physical capital (see below).

Accumulation of tangible (K_t^i) and intangible $\left(A_t^i\right)$ capital exhibit the following dynamics:

(4) $$K_t^i = J_t^i + (1-\delta^K)K_{t-1}^i,$$

(5) $$A_t^i = J_t^{A,i} + (1-\delta^A)A_{t-1}^i.$$

As mentioned, the investment and wage setting decisions are subject to convex adjustment costs of the following form:

(6) $$\Gamma_J(J_t^i) = \frac{\gamma_K}{2}\frac{\left(J_t^i\right)^2}{K_{t-1}^i} + \frac{\gamma_I}{2}(\Delta J_t^i)^2 \quad \text{and} \qquad \Gamma_W(W_t^{i,s}) = \sum_s \frac{\gamma_W L_t^{i,s}}{2}\frac{\left(\Delta W_t^{i,s}\right)^2}{W_{t-1}^{i,s}},$$

where $\Gamma_J(J_t^i)$ refers to investment adjustment costs and $\Gamma_W(W_t^{i,s})$ to wage adjustment costs which are labor-service-kind specific (i.e., $s \in (L, M, H)$). Investment adjustment costs are calibrated through two parameters, which are related to the ratio of investment to capital stock (γ_K) and to the growth rate of tangible investment (γ_I). Similarly, the parameter γ_W rules the magnitude of the wage adjustment costs.

Finally, each Ricardian household maximizes the intertemporal utility function (1) with $h = i$ constrained by equation (2), (4), and (5). After receiving wage income, unemployment benefits, transfer income from the government, and interest income from financial and non-financial assets, Ricardian households make decisions about consumption, labor supplies, domestic and foreign financial assets, investment good (capital stock and new patents), renting of physical capital stock and licensing of existing patents.

[14] Investors into tangible and intangible capital require premia to cover the increased risk on the return related to these assets.

The liquidity-constrained households do not own any financial wealth. Therefore, they do not smooth their consumption over time and consume all their disposable wage and transfer income in each period. The real consumption of each liquidity-constrained household is the net wage income plus transfers from the government.

The real consumption of each liquidity-constrained household k is then:

$$(7) \qquad C_t^k = \frac{TR_t^k + \sum_s [(1-t_t^{w,s})W_t^{k,s}L_t^{k,s} + b_t^s W_t^{k,s}(1-\nu_t^{k,s} - L_t^{k,s}) - \frac{\gamma_W L_t^{k,s}(\Delta W_t^{k,s})^2}{2W_{t-1}^{k,s}}]}{(1+t_t^c)P_t^C} + \xi_t^{lc,c},$$

where $W_t^{k,s}$ and $L_t^{k,s}$ are the aggregate wage and employment variables for this class of households and TR_t^k are transfers from the government; $t_t^{w,s}$ are tax rates on labor types; b_t^s are the replacement rates indexed to consumer prices and net wages; 1-$\nu_t^{k,s}$ are the participation rate; $\xi_t^{lc,c}$ is an exogenous additive shock on the consumption of liquidity-constrained households.

Aggregate consumption and employment are obtained by integration. It follows that $C_t = (1-\varepsilon)C_t^i + \varepsilon C_t^k$ and $L_t = (1-\varepsilon)L_t^i + \varepsilon L_t^k$. As mentioned, households offer three kinds (low, medium, and high skilled) of labor services. Both types of households provide labor services to domestic firms, at the wage set by a labor union with monopoly power. Within each skill group, a variety of labor services are supplied which are imperfect substitutes to each other; the employment aggregates L_t^s combine varieties of differentiated labor types: $L_t^s = [\int (L_t^{s,h})^{(\sigma_s-1)/\sigma_s} dh]^{\sigma_s/(\sigma_s-1)}$, where $\sigma_s > 1$ determines the degree of substitutability among workers.

3.1.2 Consumption lockdown

Following the government lockdown, households are forced (or decide to) reduce their consumption. The reduction in consumption during the pandemic emergency occurs for two reasons. First, the government imposes, by law, to avoid certain consumption activities. Second, because of uncertainty, fear and other reasons related to the pandemic emergency, households decide to self-impose a reduction in consumption.[15]

The two exogenous shocks we introduced on the utility of Ricardian households ($\xi_t^{nlc,c}$) and on the consumption equation of the liquidity-constrained households ($\xi_t^{lc,c}$) mimic these two

[15] See, e.g., Baldwin (2020), Carvalho *et al*. (2020), Chronopoulos *et al*. (2020), Coibion *et al*. (2020a).

channels, reducing the marginal utility of consumption in the first case, and directly affecting consumption in the second one.

3.1.3 Uncertainty shock on investments

The pandemic crisis is an unprecedented shock. The unknowns about its development create a climate of uncertainty for businesses. The increase in uncertainty could translate into a consequent reduction in planned and future investment. Formally, this supply-side effect of uncertainty is grafted into the model by assuming an increase in the risk premium on tangible capital, through an exogenous shock on the variable ξ_t^{rp} in tangible investment equation.

However, it is worth noting that the fall in private investments is only partially linked to the increase in uncertainty about the future, a greater effect on their dynamics is certainly connected to the financing problems that firms have incurred (or could have incurred) due to lack of liquidity (Schivardi and Romano, 2020). The next section introduces another channel that influences investment choices thought liquidity shortages.

In summary, the increase in uncertainty a) reduces the prospects of expected future profits and therefore investments (this effect, as seen, is simulated through an increase in the risk premium); b) causes consumers to postpone their consumption (this effect is captured by the shocks to consumption preferences). The consequent dynamics are in line with the empirical effects found for increases in uncertainty (Altig *et al*., 2020; Benigno *et al*., 2020).[16]

3.2 Liquidity crisis and private investments

3.2.1 Intermediate and R&D sector

The intermediate firms enter the market by licensing a design from domestic households. Entry costs consist of the licensing fee for the design or patent ($i^A P_t^A$) and an initial payment (FC_A) to overcome administrative entry barriers. Firms rent (tangible) capital inputs from the households at the rental rate of i_t^K to transform each unit of capital (k_i) into a single unit of an intermediate input. Constrained by a linear technology, they maximize their profits ($PR_{i,t}^x$) expressed as

[16] An alternative approach requires to estimate the stochastic process affecting the economy in a non-linear model and then considering a change in the variances of innovations. See, e.g., Bloom (2009).

(8) $PR_{i,t}^{x} = px_{i,t}x_{i,t} - i_t^K P_t^C k_{i,t} - i^A P_t^A - FC_A,$

where $px_{i.t}$ and $x_{i,t}$ are the price and volume of intermediate inputs.

Entry occurs until the present discount factor of profits (where the discount factor contains the risk premium for intangible capital) is equal to the price of the patent (intangible) and a fixed entry cost. In the import sector, perfectly competitive firms (import retailers) buy economy-specific goods from the foreign country and assemble them to a final imported good. Final-good packagers combine the final imported good with intermediate domestic inputs to obtain final aggregate-demand components goods.

The productivity depends on the R&D, which is formalized by using Jones' (1995, 2005) semi-endogenous model with foreign spillovers (Bottazzi and Peri, 2007). The R&D sector hires high-skilled labor (L_A) and invents new designs (innovation) building on the following knowledge production function:

(9) $\Delta A_t = f\left(A_{t-1}^{*\varpi}, A_{t-1}^{\varphi}, L_{A,t}^{\lambda}\right),$

where ϖ and ϕ measure the foreign and domestic spillover effects from the aggregate international (A^*) and domestic (A) stock of knowledge respectively, while λ measures the elasticity of the R&D production on the number of high-skilled workers (L_A).

The R&D sector is operated by research institutes. They employ high-skilled labor and face adjustment costs when hire new employees. The research institutes maximize their discounted profit-stream. Instantaneous profits are given by:

(10) $PR_{i,t}^{A} = P_t^A \Delta A_t - W_t^H L_{A,t} - \frac{\gamma_A}{2} W_t^H \Delta L_{A,t}^2,$

where γ_A is the wage-cost-adjustment parameter for to high-skilled workers employed in R&D sector.

The introduction of the R&D sector implies a skill-tradeoff, i.e., final production needs all types of skills, while R&D production can employ only high-skilled workers, thus, allocating more high-skilled workers to R&D decreases the share of high-skilled available for final goods production.

3.2.2 Investment liquidity constraints

Following Pfeiffer *et al*. (2020), we augment the standard QUEST model developed in D'Auria *et al*. (2009) by assuming that some of intermediate firms face a binding liquidity constraint, which force them to deviate from their optimal investment decisions, and to possibly make investments only through internal sources of finance.

In each period a subset of firms $s_t^{li} \in [0,1]$ may face a binding liquidity constraint and invests according to the following reduced-form rule:

$$(11) \quad \left(\frac{J_t^j}{K_{t-1}^j} - \delta^K\right) = \zeta_1\left(\frac{GOS_t^j}{K_{t-1}^j} - \delta^K\right) - \zeta_2,$$

where J_t^j are investment, K_{t-1}^j the available stock of capital in period $(t-1)$, δ^K the capital depreciation rate, and ζ_1, ζ_2 are the two parameters governing the strength of the liquidity constraint calibrated as in Pfeiffer *et al*. (2020).

Equation (11) states that investment of each liquidity-constrained firm, indexed by $j \epsilon [0, s_t^{li}]$, depends on its GOS, i.e., the firm's income net of labor costs. As the GOS is a function of the economic activity, shocks hitting the economy will affect this variable, making firms' investment a function of the business cycle of the economy. The direct link between GOS and investment represents the situation of a liquidity-constrained firm, which is not able to finance its investment through external financing.

The remaining share of (unconstrained) intermediate firms $(1 - s_t^{li})$ decide investment plans following a standard Tobin's Q equation of the form:

$$(12) \quad Q_t^i = 1 + \gamma_K\left(\frac{J_t^i}{K_t^i} - \delta^K\right) + \gamma_I\left[\Delta J_t^i - E_t\left(\frac{\Delta J_{t+1}^i}{i - \pi_{t+1}}\right)\right] - \tau^K$$

where Q_t^i represents the discounted value of physical capital. Equation (12) is derived by considering the effects of the investment-convex-adjustment costs (cf. equation (6)).

3.3 Supply-side disruptions

3.3.1 Final good sector

The final good producer *j* uses A_t varieties of intermediate goods and labor aggregate, combining low-, medium-, and high-skilled labor inputs. High-skilled can work in both the R&D and final goods sector; therefore, the high-skilled labor in the final goods sector is the total high-skill employment minus the high-skilled labor working for the R&D sector, i.e., $L_t^{j,HY} = L_t^{j,H} - L_{A,t}$.

The objective of the final goods firm is to maximize its profits ($PR_t^{f,j}$):

$$(13) \quad PR_t^{f,j} = P_t^j Y_t^j - \left(W_t^L L_t^{j,L} + W_t^M L_t^{j,M} + W_t^H L_t^{j,HY}\right) - \sum_{i=1}^{A_t}\left(px_{i,t} x_{i,t}^j\right),$$

where W_t^s is a wage index corresponding to the CES aggregate $L_t^{j,s}$.

Profits are maximized accounting for a fixed sunk cost FC and a Cobb-Douglas technology, which combines aggregate labor ($L_{Y,t}^j$), intermediate goods ($x_{i,t}^j$) and public capital (KG_t) for the final goods production (Y_t^j):

$$(14) \quad Y_t^j = \left(L_{Y,t}^j\right)^{\alpha} \left(\sum_{i=1}^{A_t} \left(x_{i,t}^j\right)^{\theta}\right)^{(1-\alpha)/\theta} KG_t^{\alpha_G} - FC,$$

where the elasticity of substitution of intermediate goods is $1/(1-\theta) > 1$, α_G is the elasticity of output to public capital while α is the parameter governing the share of production inputs in the production function.

Labor is aggregated by CES function:

$$(15) \quad L_{Y,t} = \left(s_L^{\frac{1}{\sigma_L}}\left(e_L L_t^L\right)^{\frac{\sigma_L-1}{\sigma_L}} + s_M^{\frac{1}{\sigma_L}}\left(e_M L_t^M\right)^{\frac{\sigma_L-1}{\sigma_L}} + \left(s_H - s_A\right)^{\frac{1}{\sigma_L}}\left(e_H\left(L_t^H - L_{A,t}\right)\right)^{\frac{\sigma_L-1}{\sigma_L}}\right)^{\frac{\sigma_L}{\sigma_L-1}}.$$

where σ_L is the elasticity of substitution between different labor types; s_L, s_M, s_H, s_A are the population shares of labor-force in the low-, medium-, high-skilled, and in the R&D sector (where only high-skilled are employed); e_L, e_M, e_H are the corresponding efficiency units.

As an example, in a symmetric equilibrium, the demand equation for labor type medium (*M*) is given by:

$$(16) \quad W_t^M = \alpha \frac{Y_t + FC}{L_{Y,t} - FC_L} \left(\frac{L_{Y,t}}{L_t^S}\right)^{\frac{1}{\sigma_L}} s_M^{\frac{1}{\sigma_L}} e_M^{\frac{\sigma_L-1}{\sigma_L}} \eta_t \xi_t^{L,M},$$

where FC_L is overhead labor, η_t the inverse wage mark-up and $\xi_t^{L,M}$ an exogenous shock on the demand for labour-type medium. Labor demand equations for labor types low (*L*) and high (*H*) are of the same type of equation (16).

3.3.2 Supply Lockdown

Because of the pandemic emergency, the Government imposed the closure and/or reduced the activities of certain businesses to prevent infection at the workplace and reduce people mobility. As shown in Pfeiffer *et al*. (2020), this supply-like shock can be modeled as a downward shift in the labor demand schedule, which we obtain through an exogenous positive shock on the variable $\xi_t^{L,s}$ in the demand for the different type of labor, i.e., $s \in (L, M, H)$. The rationale is that firms are forced by

Government to use a smaller number of employees than they would use in the absence of the pandemic emergency.

3.4 Closing the model

3.4.1 International trade and capital flows

The economies trade their final goods. Aggregate imports are given by

(17) $$IM_t = s^M \left(\frac{P_t^C}{P_t^{IM}}\right)^{\sigma} (C_t + I_t + G_t),$$

where σ is the elasticity of substitution between bundles of domestic and foreign good while s^M is a parameter governing the calibrated openness of the country towards foreign economies.

The net foreign assets (B_t^F) evolve according to the following equation:

(18) $$e_t B_t^F = (1 + r_t^F) e_t B_{t-1}^F + P_t^{EX} EX_t - P_t^{IM} IM_t,$$

where ${P_t}^{EX} = P_t$ and $P_t^{IM} = e_t P_t^*$ are producer pricing of imports (IM_t) and exports (EX_t). Note that foreign assets are denoted in foreign currency.

3.4.2 Wage setting

For each skill group both types of households supply differentiated labor services to unions. These act as wage setters in monopolistically competitive labor markets. The unions pool wage income and distribute it in equal proportions among their members. Nominal rigidity in wage setting is introduced by assuming that the households face adjustment costs for changing wages, $\Gamma_W(W_t^{i,s})$. Trade unions charge a wage mark-up over the reservation wage, which is given as the weighted average of the marginal utility of leisure between Ricardian and liquidity constrained households divided by the corresponding weighted average of the marginal utility of consumption of the two types of households.

Formally, the resulting wage equation is:

(19) $$\frac{(1-\varepsilon)V'(1-L_t^{i,s})+\varepsilon V'(1-L_t^{k,s})}{(1-\varepsilon)U'(C_t^i)+\varepsilon U'(C_t^k)} \frac{1}{\eta_t^W} = \frac{W_t^s(1-t_t^{w,s}-b_t^s)}{(1+t_t^C)P_t^C},$$

where $(1/\eta_t^W)$ is the wage mark-up; $t_t^{w,s}$ are wage income taxes; $b_t^s W_t^{i,s}$ are unemployment benefits.[17]

3.4.3 Fiscal and monetary policy rules

The government and the central bank respectively manage fiscal and monetary policies. The systematic component of public policies is modelled according to simple rules: government consumption, government transfers, and government investment are proportional to GDP. Unemployment benefits are indexed to wages, while the accumulation of physical capital and R&D investments are subsidized through tax credits and depreciation allowances. On the revenue side, government collects taxes on consumption, labor, and capital income and set lump-sum taxes according to a tax-rule to respond to changes in the sovereign debt, expressed as debt to GDP ratio. The European Central Bank adopts a Taylor-kind rule; thus, the domestic monetary authority responds to changes in expected inflation and output gap at the EA level. We do not impose an effective-lower bound for the nominal interest rates.[18]

4. Assessment methodology and calibration

We adopt a two-stage strategy to assess the impact of government policies. The first stage consists in calibrating the model to replicate the main observed macroeconomic data for Italy by formalizing the four channels described above and including the policies introduced by the government. The second stage is to build a counterfactual scenario where policies are not implemented. The difference between the two scenarios indicates the size of the impact of the public intervention. In what follows, we describe the calibration of the pandemic shocks and the implemented fiscal policies.

4.1 The pandemic shock

[17] The relevant net real wage to which the mark-up-adjusted-reservation wage is equated is the gross wage adjusted for labor taxes, consumption taxes, and unemployment benefits (which act as a subsidy to leisure.)

[18] We allow the response of the central bank in the model to indirectly capture the unconventional monetary policies adopted by the ECB to tackle the pandemic. See Altavilla *et al*. (2020) and Bartocci *et al*. (2020) for a formal treatment of the ECB response to the COVID-19 crisis.

The four channels described in Section 2 are introduced in the model according to the following assumptions.

The supply-side lockdowns have been modelled as a reduction in labor demand proportional to the contraction of hours worked observed during the first lockdown. As explained in Section 3.3.2, the reduction in the demand for labor are in fact formally introduced by appropriate calibration of $\xi_t^{L,s}$ for $s \in (L, M, H)$.[19] We adapt the calibration of Pfeiffer *et al*. (2020) to the Italian case.[20] In Italy, we observed a period of partial forced closure equal to twelve weeks (starting from 9 March),[21] which roughly corresponds to a reduction in hours of 2.3 per cent in 2020Q1 and 6.9 per cent in 2020Q2. Regarding 2020Q3 and 2020Q4, we account for the less severe contraction observed in GDP.[22] It is worth remarking that this channel only captures the supply-side effect caused by the lockdowns.

The impact of COVID-19 through the liquidity channel is formalized by calibrating the share (s_t^{li}) of firms that may be liquidity constrained due to the pandemic when no policy measures are assumed (cf. Section 3.2.2). This value is calibrated by using estimates based on microdata from the Ministry of Economy and Finance.

Estimates are based on electronic invoicing data, cross checked with the drawdown of liquidity support measures mainly related to the SME Guarantee Fund. The result is shown in Table 1, which reports the weights of liquidity constrained firms in terms of output, value added, and number of firms.[23] According to these results, firms subject to liquidity constraints due to the

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[19] In the absence of data, we have assumed a reduction proportional to the pre-Covid distribution of skills among workers.

[20] Pfeiffer *et al*. (2020) consider for the first wave of the pandemic crisis an average lockdown duration for the EU equal to 1.2 weeks in 2020Q1 and 4.8 weeks in 2020Q2. This corresponds to a reduction in hours of 0.9 per cent in the first quarter of 2020 and 3.7 per cent in the second. These data match the figure obtained from the Treasury sectoral model (Ministry of Economy and Finance, 2020a).

[21] See also Bank of Italy (2020: 53).

[22] We use the same approach, but the reduction in hours was assumed to be proportional to the fall in GDP. Bank of Italy (2021) confirms, using mobility data and a stringency index, that restrictive measures were at their peak in the 2020Q2, with a rebound in the end of 2020.

[23] The trend change in the VAT-tax base has been estimated by available microdata on electronic invoicing. These changes have then been included as exogenous shocks in a microeconomic model based on the Orbis data of the Bureau van DijK (ORBIS-BvD), which reconstructs the liquidity flows according to firms' turnover. Turnover changes were applied to the operating revenues of the ORBIS-BvD and transformed into a loss of liquidity by applying the BT/turnover liability ratio. Finally, by integrating results with the data from the Italian National Institute of Statistics, the reported shares of liquidity-

pandemic crisis produce about 30 per cent of national gross value added, value that we use to fix the parameter s_t^{li} representing the share of liquidity-constrained firms. This value is set to 0.3 until 2021Q1. We than assume a decreasing path for the fraction of constrained firms equal to 0.05 for each subsequent quarter, up to zero in 2022Q3.

Table 1 - Distribution of macro-variables by size for liquidity constrained firms

Firm size (# employees)	**Output** (€ billion)	**VA** (€ billion)	**Firms** (thousands)
0-1	208.5	129.3	2646.0
2-9	66.5	29.3	184.3
10-19	83.2	58.8	35.7
20-49	100.7	74.8	15.5
50-249	158.1	118.1	5.8
250+	304.5	233.6	1.1
Tot.	**921.3**	**643.9**	**2888.4**
% liq. const. firms	**29.4%**	**29.7%**	**67.1%**

Note: the table reports an estimated distribution of Italian liquidity constrained firms following the pandemic shock. Results are in terms of output, value added, and number of firms by firm size. **Source:** Ministry of Economy and Finance (2020b).

Our estimates are in line with recent similar studies. Pfeiffer *et al*. (2020) assume that around 30 per cent of EU-firms would be subject to liquidity shortages because of the pandemic emergency. Based on a representative sample of Italian firms, the Bank of Italy found that in the absence of the Government's measures 20 per cent of firms would have faced liquidity crises. These firms employ 24 per cent of the workforce in the sample analyzed.[24]

In our simulations, the demand and uncertainty COVID-transmission channels complement those already described. Specifically, the size of the effects of uncertainty on consumption lockdown and on risk premium on capital are calibrated to align the model variables with the quarterly data observed in 2020 for GDP, consumption, and investment (cf. Section 3.1.2 and 3.1.3).

constrained firms were identified considering all 0-1 employee as liquidity constrained given the lack of representative data for this size class. For details, see Ministry of Economy and Finance (2020b).

[24] De Socio *et al*. (2020).

We focus on the Italian early fiscal measures in response to pandemics. Therefore, we do not explicitly formalize neither the impact of the pandemic nor the policy response in the other regions, where lockdowns were later imposed, and the later massive reaction of the European institutions (e.g., Next Generation EU or PELTRO). International factors are however incorporated in the shock calibration [25] and explicitly considered by adding shocks on imports and exports to match a current-account dynamics consistent with the observed GDP. Our assumption implies that the transmission mechanism of the spillovers is not formalized. Although the role played by spillovers might be important (e.g., Bartocci *et al*., 2020), this is outside the scope of the present paper, but we are confident that an exact disentanglement of domestic and foreign factors would not significantly affect our main results.[26] As we shall see in the next sections, the measurement of the fiscal response of the Italian Government primarily depends on the overall patterns of the macroeconomic variables and not on the nature of the disturbance triggers.[27]

Finally, it has been assumed that the impact on quantities caused by the lockdown is not initially transferred to prices and inflation.[28]

It worth noting that, by construction, the model is anchored to the observed data for 2020. By contrast, the simulated dynamics of GDP and other macroeconomic variables starting in 2021Q1 should be regarded as model-based outcomes.

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[25] The supply, demand, and uncertainty shocks previously described also capture international factors. To give some non-exhaustive examples, the supply shocks might well be the consequence of restrictions and forced closures on foreign parent/subsidiary companies or the consequence of disruption in global value chains. Demand shocks, primarily affecting private consumption, might arise due to mobility restrictions imposed by foreign governments, limitations in the actual availability of goods from abroad, and uncertainty stemming from the international dimension of the pandemic. Similarly, uncertainty shocks driving down investment are possibly the product of international factors, as the international dimension of the pandemic exacerbates the perception of risk and uncertainty.

[26] The role and relative size of international factors has been tackled, among others, in Bank of Italy (2021) which shows that the channels of transmission of the pandemic crisis to the Italian economy can be categorized and measured as a combination of reduction in tourist flows, containment measures, increase in uncertainty, and the international context.

[27] More precisely, the assessment of the impact of fiscal policies implemented by the Government depends on their consistency and not on the nature of the shocks, except for the assessment of liquidity policies that depend on the estimates of liquidity constrained firms and the resulting simulated macroeconomic scenario.

[28] Monetary policy is determined imposing a Taylor rule.

4.2 Policy measures

The Italian Government has adopted major economic interventions to contain the COVID-19 pandemic impact on the economic and social system. In our simulations, we consider the impact of the main law decrees approved in 2020 by the Italian Government,[29] which allocated approximately €175 billion over the period 2020-2022 in terms of additional net borrowing.

The Italian Government implemented a first response to pandemic in March 2020 with the *Cure Italy Emergency Package*. The decree allocated €20 billion for 2020 including funds for the healthcare system and measures to preserve jobs and to support income of laid-off workers and self-employed, businesses,[30] and credit supply. In April, the government adopted the *Liquidity Decree*, which allowed for additional state guarantees up to €400 billion.[31] In May, the government allocated €55 billion for 2020 to finance the *Relaunch Fiscal Package*, which provided further income support for households and firms, and additional funds to strengthen the healthcare system. After the Parliament's approval of a deficit deviation in August, the government adopted the so-called *August Decree*, which included labor and social measures and extensions of the moratorium on firms' debt repayment and the time to pay back tax obligations. Finally, from October to December 2020, the government approved four *Refreshments Packages* aimed at extending supports for those business and workers who were mostly affected by the lockdowns imposed because of the second wave of the pandemic. It also extended social contribution exemptions, the firing ban, and the furlough schemes. The total envelope of these four packages was close to €13.5 billion in 2020.

Table 2 reports the overall envelope of COVID-19 fiscal response adopted in 2020 considered for the simulation. The total amount of resources is equal to 6.4 per cent of GDP in 2020, 1.7 per cent in 2021, and 1.9 per cent in 2022.[32]

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[29] The so-called *Cura Italia* ("Cure Italy"), *Liquidità* ("Liquidity"), *Rilancio* ("Relaunch"), *Agosto* ("August"), and the four *Ristori* ("Refreshments") decrees.

[30] These included tax deferrals and postponement of payments.

[31] According to Government's estimates, the guaranteed envelope increased the potential resources to grant liquidity for businesses and households to more than €750 billion.

[32] The ratios are calculated with respect to 2019 GDP. Albeit outside our horizon, the simulation also considers additional resources equal to 2.1% of GDP in 2023 allocated by the 2020 decrees. The amount we consider for the simulation differs from official statistics mainly because we discard from the simulation a series of fiscal feedback effects which are endogenously generated by the model.

Table 2 – Fiscal policy measures in 2020-2022 (% GDP)

	2020	**2021**	**2022**
Income and labor support measures	2.4	0.7	1.6
Business support measures	2.8	0.6	0.0
of which liquidity measures	*0.4*	*0.0*	*0.0*
Other public expenditures	1.2	0.4	0.2
Total	**6.4**	**1.7**	**1.9**

Note: The table reports the 2020-2022 overall envelope of COVID-19 fiscal response adopted in 2020 considered for the simulation in p.p. of 2019 GDP. Figures might differ from official estimates due to model's requirements. **Source:** Elaborations on RGS (State General Accounting Department) technical reports data.

The economic policies implemented by the Government consisted of measures to support income and labor (transfers, tax cuts, temporary lay-off and furlough schemes), businesses (tax cuts, grants, investment grants, and public guarantees to support the firm's liquidity needs), and other public expenditure (public consumption and investments). Apart from public-guarantee schemes, these measures were mapped into the model by using its rich characterization in terms of fiscal instruments and the information about policy design provided by the Italian Department of the Treasury.[33] Details about the mapping are available upon request. It has been also assumed that the amount allocated by the various decrees were only progressively transformed into actual expenditure or lower tax burden.[34]

Regarding the liquidity-support measures, it has been assumed that public guarantees were able to fully eliminate the potential reduction in credit supply caused by the credit risks related to the

[33] As already mentioned, simulations are based on granular data from RGS (State General Accounting Department) and from studies of the Department of the Treasury Modelling Division developed as a preliminary step to the evaluation of the measures described (see, e.g., Ministry of Economy and Finance, 2020c). All expenditures are mapped in changes for eleven fiscal variables: public consumption, public investments, transfers to firms and (constrained and unconstrained) households, tax credits, postponed income taxation, VAT duties, and social contributions for high-, medium- and low-skill workers.

[34] This implies a smaller, but more persistent, immediate impact of the amount allocated. Formally, a moving average scheme has been assumed to describe the evolution of policies, i.e., we implemented a sort of time-to-spend assumption (Ramey, 2020).

pandemic emergency.[35] It should be noted that this simulation mainly captures the positive impact of the liquidity-support measures on planned investments, which were put at risk by the sharp drop in turnover and the potential reduction in the supply of credit. Hence, the assessment does not consider how these measures may have defused a potential generalized financial crisis that could have materialized because of widespread insolvency episodes. In this case, financial contagion would have involved all sectors, with a likely increase in spreads on government bonds and, over time, in impaired loans. Accordingly, the results of our exercise should be regarded as particularly conservative given the potential short-term and long-term impact that a generalized shortage of liquidity could have caused on the economy.

5. Results

The main results of our simulations are contained in Figure 1, which shows the quarterly observed and simulated dynamics for GDP, private consumption, total investment, and employment. We report the results of two scenarios: the policy scenario (solid blue lines) and the counterfactual scenario (red-dotted lines). The former takes account of the Italian government fiscal interventions, including the liquidity-support measures, while the latter shows the effects that the pandemic would have had on the economy in the absence of the extraordinary measures. As mentioned, in the policy scenario shocks are calibrated to match the observed data for the period 2020Q1-2020Q4 accounting for the fiscal measures. In the counterfactual scenario, we "switch off" the policy measures to obtain the latent counterfactual scenario. For the remaining period under analysis (2021Q1-2022Q4) the dynamics reported, under both scenarios, are only driven by the model.[36]

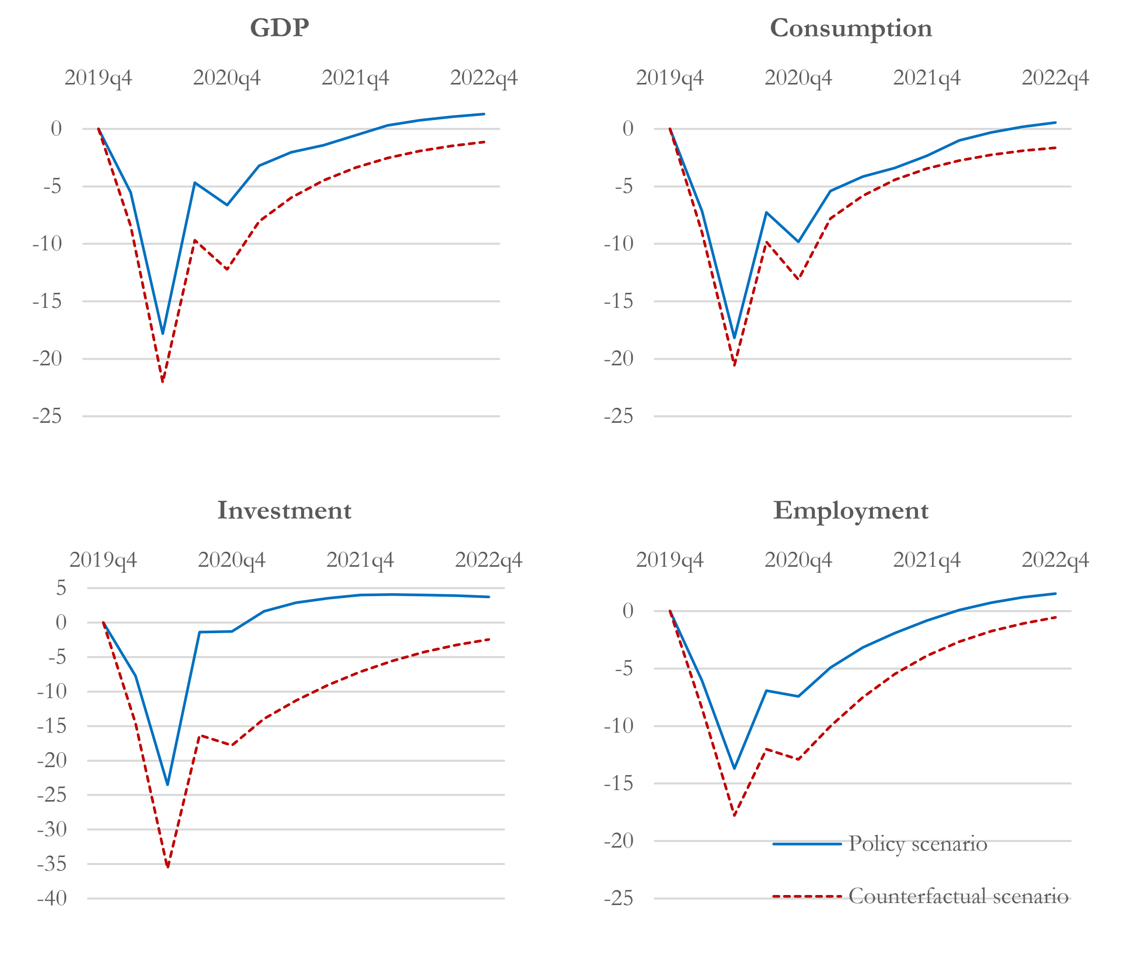
The GDP path reported in Figure 1 that clearly shows the crucial role of public intervention in avoiding an even wider reduction of the Italian GDP in 2020. On a yearly base, the observed GDP decreased by 8.9 per cent in 2020, against the 13.4 per cent in the counterfactual scenario. The role of fiscal intervention is found to be also relevant in the following two years (2021-2022). It contributes to a much faster recover of the economy to the levels registered before the pandemic crisis. The fiscal interventions sustained private consumption and has contributed decisively to avoid

[35] See CERVED (2020) and Schivardi and Romano (2020).

[36] We always assume that agents have rational expectations conditional to the scenario considered.

a collapse of investments. As we will see in more details, this latter result is mainly due to the liquidity measures.

Figure 1 – COVID-19 impact on selected macroeconomic variables



Note: Per cent deviations from the steady state (no pandemic). The figure shows the dynamic of GDP, consumption, investment, and employment in the policy (observed) and in the counterfactual (unobserved) scenarios.

Table 3 reports the annual averages for GDP, consumption, investment, and employment[37] in the policy scenario, the counterfactual scenario, and the difference between the two. The overall

[37] The employment dynamic is not forced to be aligned to the observed data given the detachment between employment and hours worked observed in 2020.

impact of public interventions on annual GDP in the policy horizon considered is equal to 10.7 p.p. (4.4 p.p. in 2020, 3.7 p.p. in 2021, 2.6 p.p. in 2022).[38]

Table 3 – COVID-19 impact on selected macroeconomic variables

Policy scenario				
	GDP	Consumption	Investments	Employment
2020	-8.9	-10.7	-9.2	-8.5
2021	-2.1	-3.9	2.2	-2.7
2022	0.5	-0.3	3.1	0.9
Counterfactual Scenario (without government measures)				
	GDP	Consumption	Investments	Employment
2020	-13.4	-13.2	-21.7	-12.8
2021	-5.8	-5.5	-11.0	-6.7
2022	-2.1	-2.3	-4.6	-1.5
Difference between the two scenarios (policy - counterfactual)				
	GDP	Consumption	Investments	Employment
2020	4.4	2.5	12.5	4.3
2021	3.7	1.6	13.3	4.0
2022	2.6	2.0	7.7	2.4

Note: The table reports the impact of the pandemic crisis on GDP, consumption, investment, and employment in the policy (observed) scenario, in the counterfactual scenario (unobserved), and the differentials between the two. Annual per cent deviations from the steady state (no pandemic). Differential are expressed in p.p.

The measures introduced by the government would ensure a faster recovery of the economy than in the counterfactual scenario. As a result, GDP would return to pre-pandemic levels in the first quarter of 2022. In the counterfactual (no-policy-measures) scenario, the fall in GDP would be instead steeper and GDP would not return to pre-crisis levels before 2023. The difference in the dynamics of investment in the two scenarios is particularly significant. In absence of the liquidity-support measures, investment would have fallen by 21.7 per cent in 2020, compared with 9.2 per cent observed in 2020 in the scenario that includes the considered fiscal measures. We do not report the price dynamics, which is however coherent with observed data. Despite the inflationary pressure from fiscal measures, with respect to the model's baseline in the policy scenario annualized inflation falls

[38] It is the difference between the two scenarios.

by 0.4 p.p. in 2020 (driven down by the pandemic shocks) to later rebound above the baseline by 0.1 p.p..

5.1 Fiscal policy contributions by policy measure

Table 4 reports the contribution of the different fiscal measures to the GDP differential between the policy and the counterfactual scenario, as implied by our simulation. Income and labor-support measures have an impact between 1.2 p.p. and 0.8 p.p. More relevant is the impact of business-support measures, which contribute for 2.2 and 2.4 p.p. in the first two years and 1.5 p.p. in 2022. It should be noted that liquidity-support measures alone have an impact of 1.5 p.p. in 2020, 1.5 p.p. in 2021, and 0.9 p.p. in 2022. Finally, other public expenditures have a decreasing impact, from 1.1 p.p. in 2020 to 0.3 p.p. in 2022.

Table 4 – Policy measures contributions to GDP

	2020	**2021**	**2022**
Income and labor support measures	1.2	0.6	0.8
Business support measures	2.2	2.4	1.5
of which liquidity measures	*1.5*	*1.5*	*0.9*
Other public expenditure	1.1	0.6	0.3
Total	**4.4**	**3.7**	**2.6**

Note: The table reports the contribution of the fiscal measures to the differential between the GDP in the policy and in the counterfactual scenarios (p.p.)

It is worth mentioning that, differently from other fiscal interventions, the evaluation of liquidity measures is related to the severity of the pandemic shock, and therefore, it is not independent from the counterfactual scenario. As outlined in Section 3.2.2, a fraction of firms becomes liquidity constrained after the pandemic and cut investment based on their GOS, whose dynamic is proportional to the severity of the imposed shock. Accordingly, a different pandemic scenario would entail a different pattern for private investment in the counterfactual and, consequently, on the contribution size of the Government liquidity measures.

Figure 2 helps us to visualize the quarterly contributions of the fiscal measures to the four macroeconomic variables considered.

The total (positive) contribution for each macroeconomic variable corresponds to the difference between the policy and the counterfactual scenario. As outlined, the contribution on GDP mainly stems from business-support measures, although the other policies are also relevant. As expected, the major (almost all) contribution to private consumption comes from labor- and income-support measures, while business-support measures (including liquidity measures) are the driver for total investment. Finally, the employment differential is mainly driven by the support measures for businesses, while the remaining gap is distributed between income and labor support measures and other expenditure.

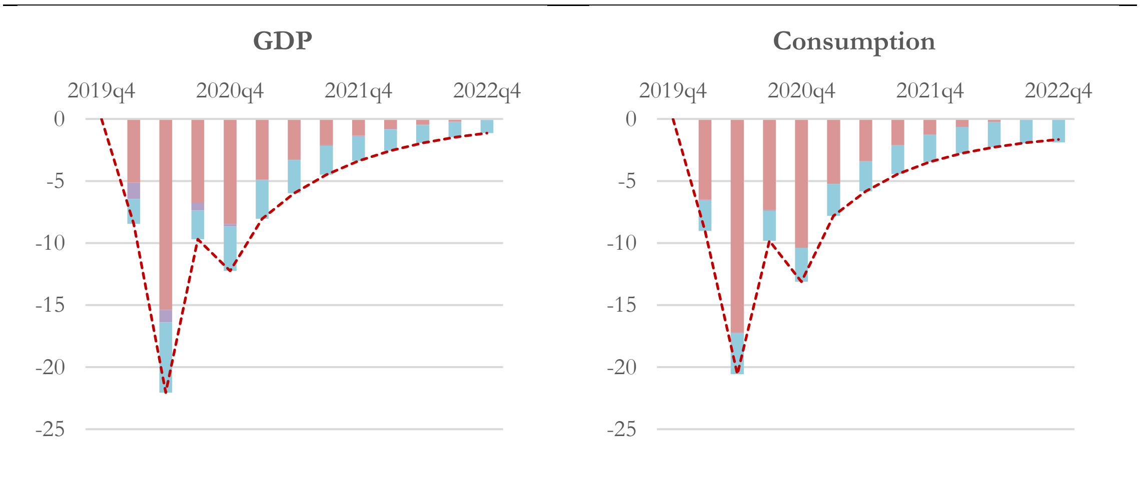
Figure 2 – Policy measures contributions to selected macroeconomic variables

Note: The figure reports the quarterly contributions of the fiscal measures to the variables considered (per cent deviations from the steady state.)

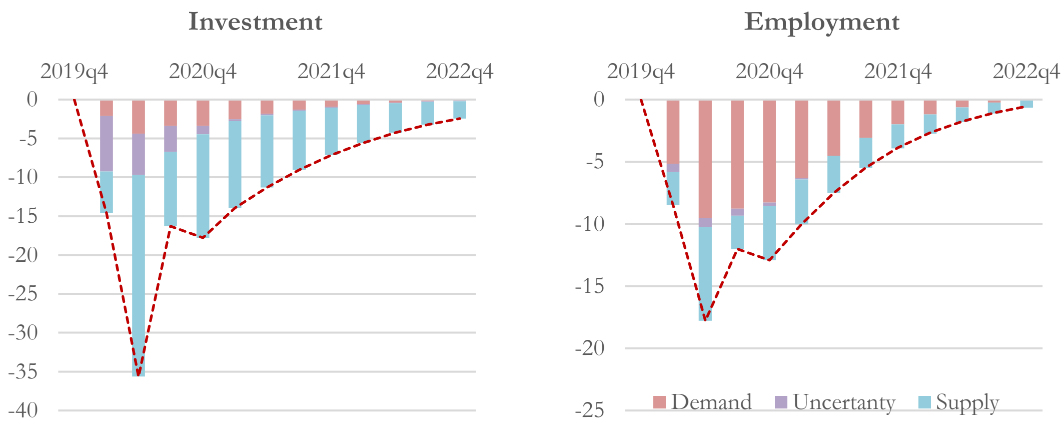
5.2 COVID-19 shocks decomposition

The quantification of the economic effects of the COVID-19 pandemic is clearly a complex exercise because of its exceptional nature and particular attention should be placed on the assumptions introduced. Among these, it is crucial to underline the quantitative assumptions on the transmission mechanisms of the pandemic. Therefore, to understand the nature of the pandemic shocks behind our analysis, Figure 3 reports the dynamics of the macroeconomic variables in the counterfactual scenario (no policy measures) together with a decomposition of the calibrated shocks driving them. As previously stated, the counterfactual scenario assumes that some intermediate firms face a binding liquidity constraint. The three shocks triggered by the pandemic crisis and reported in Figure 3 are thus conditional on the liquidity constraint, which operates as a shock amplifier.[39]

Figure 3 – COVID-19 conditional shock decomposition.



[39] An alternative would be to report the liquidity constraint as an additional shock. However, we arguably preferer to describe this channel as an amplifier of the other disturbances.



Note: The figure reports the dynamics of the macroeconomic variables in the counterfactual scenario (no policy measures) together with a decomposition of the calibrated shocks driving them, conditional on liquidity constraints on firms. The figure reports per cent deviations from the steady state (no pandemic.)

The dynamic of GDP in the counterfactual scenario is mainly driven by demand shocks, which are the key disturbance behind consumption deviations from the steady state[40]. As expected, supply-side and uncertainty shocks play a prominent role for the dynamic of investments and have, together, a significant effect on GDP. Our exercise is in line with the view that the nature of the economic crisis triggered by the pandemic has a demand nature, although supply-side and uncertainty shocks drive firms' investment decisions. Focusing on 2020, on annual basis the contraction of GDP in the counterfactual scenario would have been mainly triggered by demand shocks (68%), supply shocks (26%), and uncertainty shocks (6%). As a reference, the previously mentioned study of Bank of Italy (2021) attaches a higher weight to uncertainty/confidence shocks (18%) while the rest of the contraction of GDP would be triggered by a combination of demand- and supply-side shocks.[41]

[40] Using survey data Bottone *et al*. (2021) and Balleer *et al*. (2020) find that firm's decisions were mainly driven by demand factors.

[41] According to the Bank of Italy (2021), absent fiscal and monetary policy measures and net of the pre-pandemic forecasted growth, GDP would have fallen in 2020 by 11.5 percentage points. This result would have been a combination of reduction in tourist flows (-1.5 p.p.), containment measures (-6.5 p.p.), increased uncertainty and reduced confidence (-2.1 p.p.), and the international context (-1.4 p.p.).

5. Conclusions

Our analysis underlines that the fiscal policies, implemented since March 2020 to contrast the negative impact of the pandemic, have obtained significant results. Italian firms and households are experiencing the dramatic consequences of the most severe economic crisis of the last two centuries. However, without the prompt intervention of the Government, a much more devastating scenario would have been observed. The huge increase in public spending and postponement of tax collection supported income and consumption during lockdowns, while the liquidity support provided significantly decreased the number of firms and households hit by the quantity credit rationing.

The overall impact of public intervention can be quantified in 10.7 p.p. of GDP during the three-year-policy horizon considered. In a counterfactual without fiscal measures, the Italian GDP would have fallen by 13.4 per cent in 2020 against the 8.9 per cent observed. In the following two years, albeit to a lesser extent due to the recovery, significant differences are estimated between the two scenarios, with a differential between the policy and the counterfactual scenarios of 3.7 and 2.6 p.p. in 2022 and 2023 respectively.[42] The impact of fiscal measures on the dynamics of investment is particularly significant. In the counterfactual without fiscal measures and liquidity support, they would have fallen by 21.7 per cent in 2020 against the 9.2 per cent observed.

Future studies could fruitfully explore the issue further by combining our assessment to that of the post-pandemic massive fiscal reaction designed by the European Union, i.e., the National Recovery and Resilience Plan for Italy. Moreover, as the focus of the paper is on fiscal adjustment, it could be useful to track the output gap, which we plan to consider in future extensions of this study.[43]

A cautionary notice should be finally marked. The quantification of the economic effects of the COVID-19 pandemic and the policies implemented to mitigate its effects is a complex exercise due to the exceptional nature of the situation, therefore, the results must be viewed with due caution, paying particular attention to the assumptions underlying the simulations.

[42] It is worth emphasizing that "expected values" are not forecasted values, but the figures that, everything equal, would be observed because of the fiscal policy measures adopted in 2020.

[43] A model-based measure of the output gap is in fact a natural complement to the quantification of the contribution of fiscal measures with respect to a counterfactual scenario (see, e.g., Burlon and D'Imperio, 2020).

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