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Using Macro-Financial Models to Simulate Macroeconomic Developments During the Covid-19 Pandemic: The Case of Albania

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Abstract:
The recent Covid-19 pandemic has increased the importance of properly forecasting macro-financial developments in turbulent times. Only a limited number of studies focus on how to employ macro-financial models to project key real and financial sector variables under large shocks and unusual assumptions. The aim of this paper is to examine whether a pre-constrained linear model can project the developments seen during the Covid-19 pandemic. We develop a macro-financial model for Albania and, using suitable assumptions, run two types of simulations and compare the results with the outturn. We also take into account the increased forecast risk by constructing uncertainty bands using a quantile regression approach. The results indicate that a linear model is flexible enough to analyse non-linear events and be used in abnormal times, but its precision is lower especially due to the government measures such as repayment moratoria that broke the link between the real and financial sector.

JEL: E66, C53, C32
Keywords: macro-financial model, scenario, quantile regression, uncertainty bands, pandemic

1. Introduction

Macro-financial models are important tools for analysing the economy. Their main use is in producing short to mid-term macroeconomic forecasts (Angelini, Bokan, Christoffel, Ciccarelli, & Zimic, 2019), but can also help to design counterfactual scenarios to analyse the quantitate impact of various factors, including policies. Central banks use macro-financial models as the main analytical instrument to underpin monetary policy decisions (ECB, 2021), (Brázdik, et al., 2020).

Nevertheless, the macro-financial models' ability to provide reliable macro-financial forecasts crucially relies on the model structure, the estimated or calibrated elasticities among the model variables, and reliable assumptions about the "exogeneously determined" variables and shocks that enter the model (Engelke, Heinisch, & Schult, 2019). Thus, given that there is always a certain degree of uncertainty in all these areas, the model projections are typically reported with confidence intervals or uncertainty bands. If, additionally, macro-economic conditions experience large shocks, the uncertainty about the model projections further increase as agents' behaviour might change and becomes more complex to model (McKibbin & Stoeckel, 2018), (Bobeica & Hartwig, 2021).

The Covid-19 pandemic, and the accompanying government measures such as lockdowns, business conduct restrictions, and temporary changes in regulation, represents an excellent example of such a large shock and provides an opportunity to test the ability of traditional macro-financial models to capture such developments and to provide reliable forecasts in times of challenging economic conditions.

A growing literature investigate the macroeconomic and financial implications of the Covid-19 pandemic. A first strand of literature compares the Covid-19 pandemic with past pandemics like the "Spanish Flu" (Barro, Ursua, & Weng, 2020)**,** (Velde, 2020), (Correia, Stephan, & Emil, 2020), or the "Black Death" (Jordà, Singh, & Taylor, 2020). Several studies explore the impact of the event on certain sectors i.e., trade and tourism (Afesorgbor, Van Bergeijk, & Demena, 2021), (Coutinho, Vukšić, & Zeugner, 2021), (Streimikiene, Svagzdiene, Jasinskas, & Simanavicius, 2021); labour market (Bieszk-Stolorz & Dmytrów, 2022), (Cerqua & Letta, 2022), (Duval, et al., 2022); financial market (Boissay, Patel, & Shin, 2020), (Aiyar, etj., 2021); or real economy (Croitorov, et al., 2021), (Grömling, 2021). A related strand of literature tries to amend existing macro-models or design new approaches to better quantify pandemic implications such as in (Chan, 2022) or (Eichenbaum, Rebelo, & Trabandt, 2021).

A number of recent studies have employed existing macro-models to conduct alternative scenarios using assumptions from the past epidemics to project macroeconomic developments during 2020-2021 (Mckibbin & Fernando, 2020), (Mihailov, 2020), (Bordo, Levin, & Levy, 2020). However, this approach has been challenged by other authors arguing that past epidemic scenarios are not suitable to estimate the macroeconomic impact of Covid-19 pandemic given its totally different intensity and unprecedented government interventions (Donadelli, Ferranna, Gufler, & Paradiso, 2021). Some studies try to make use of early 2020 information about the shocks to construct projections for the subsequent covid-19 pandemic horizon (Primiceri & Tambalotti, 2020), (Gomme, 2021), (Bartocci, Notarpietro, & Pisani, 2020), (Garcia, Jacquinot, Lenarcic, Lozej, & Mavromatis, 2021).

In this paper, we construct a macro-financial model for Albania, a small open emerging market economy in South-Eastern Europe, and test its ability to forecast macro-financial developments during the Covid-19 pandemic. Albania, similarly, to many other countries, has been hit hard by the pandemic, with large level of excessive deaths, strict lockdowns, and government measures targeting the sectors mostly hit by the pandemic such as tourism (MoF, 2020). Albania serves as a very good case study for our type of analysis as it implemented harsh measures such as lockdowns only during 2020. This gives us an opportunity to use the information from 2020 to quantify the effects of such measures and use them to construct a "pandemic" forecast for 2020-2021 that is using not only the observed levels of the exogeneous variables (such as euro area GDP, foreign interest rates etc.) but also takes into account the measures implemented in 2020, including their potentially persistent effect as captured by the lag structure of the individual model equations. This "quasi-real" forecast tests the model's forecasting power in times of large shocks. In spirit, we thus follow an approach by (Garcia, Jacquinot, Lenarcic, Lozej, & Mavromatis, 2021) but differ from them in several aspects. First, we incorporate financial market and financial regulatory measures. Second, we generate the pandemic shock using actual data, rather than propagandising pandemic development. Third, we employ a semi-structural macro-financial model with feedback loops while they use a dynamic general equilibrium model (DSGE) of the euro area. Finally, we estimate dynamic conditional distribution for key indicators via quantile regression method rather than relying on confidence intervals estimated by the errors of the model.

We aim at answering the following questions. First, does on average a macro-model constrained and estimated on pre-pandemic data act as a good quantifier for Covid-19 pandemic dynamics? Second, did the significant deviation of Covid-19 path of key variables during 2020-2021 lies in the conditional distribution of the pre-Covid-19 pandemic forecast? Third, did the financial regulatory measures fit into the model flexibility or break the consistency of its output? Fourth, is a linear model accurate enough in its structure to analyse non-linear events and be used in abnormal times?

Our macro–financial model is built following the approach by (Skufi, Kika, & Cela, 2022). It is a semi-structural model consistent with neo-classical growth models for small open economies and provides a rich environment to assess the shocks and their impacts on the economy. In comparison to (Skufi, Kika, & Cela, 2022), our macro-financial model includes an endogenous monetary policy reaction function, an uncovered interest rate parity equation, a more recent sampling, and subsequently upgraded short-run dynamics.

We analyse the Covid-19 pandemic data in quarterly frequency over 2000-2021 and test the model's performance by comparing two forecasts (a pre-pandemic forecast and a pandemic forecast) with actual data. We also provide condition distribution of the forecasts to show whether the outturns have been within the confidence bands, using a percentile regression approach. Compared to other studies, our estimations allow us to examine the potential flexibility of a given semi-structure framework across a prolonged abnormal situation (4 pandemic waves over two years) and provide a unique insight into the relationship between indicators in terms of transmission channels and magnitude.

We contribute to the literature on modelling macroeconomic crisis by studying the flexibility and accuracy of a semi-structural model in a situation of significant shocks due to Covid-19 pandemic. The Covid-19 pandemic is an exogeneous shock originating in the real economy and spreading quickly in the nominal and financial sector. The pandemic hit the actual and expected outlook of the economic agents and caused sharp deviation of real indicators and prices, although following unprecedented monetary, fiscal and financial sector policies helped the financial sector remain to some extent insulated from this shock.

Our results reveal that a model estimated on pre-pandemic data is in general flexible enough to be used in abnormal times. However, even if we are able to control for the shocks in our simulations (pandemic forecast), there is still a large gap between such a forecast and the outturn in 2021-2022 which goes even beyond the conditional distribution of most macroeconomic variables. We interpret this as supporting the view that during pandemics, the behaviour of agents has changed, mostly reflecting the increase in uncertainty and adjustments in expectations, deviating from the pre-pandemic elasticities.

The remainder of this paper is organized as follows. Sections 2 and 3 describe the data and methodology. We present our main results in section 4 and provide their diagnostics to different extensions in section 5. Section 6 concludes.

2. Data and model setup

Our dataset is based on data from the Albanian National Institute of Statistics (INSTAT, 2022), the Bank of Albania (BoA, 2022), the Ministry of Finance (MoF, 2022), and the Eurostat (Eurostat, 2022). Additional indicators were generated out of the received data by formulas described in the next section on the model setup.

The dataset consists of quarterly frequency data between 2010 and 2021. Although most of the data are originally available in this frequency, some were received in monthly or annual frequency and thus selected frequency conversion methods were applied as follows: (i) average observations method is applied over monthly flow rate indicators (i.e., exchange rate, inflation rate); (ii) sum observations method is applied over monthly flow indicators (i.e., compensation for employ, fiscal expenditures); (iii) last observation method is applied over monthly stocks indicators (i.e., credit stock, nonperforming loans). We used Denton method (Chollette, 1984) to convert yearly observation in quarterly frequency (i.e., population).

Afterward, the data were seasonally adjusted with Tramo/Seats technique. Indicators that are constructed by ourselves (using a formula) are seasonally adjusted in in indirect way as they use seasonally adjusted variables as inputs. For example, the disposable income series is indirectly seasonally adjusted because all its components are seasonally adjusted before the series was generated (Table 1A in Appendix provides more detail about the source of the data and adjustments for individual variables used in the model).

The macro-financial model we employ is a semi-structural model consistent with neoclassical growth models for small open economies. The model covers all crucial aspects of a country's macroeconomic development and is similar in spirit to other semi-structural models, such as the Area Wide Model (AWM) for the Euro Area (Fagan, Henry, & Mestre, 2001) and the single country macro-model as by (Bulligan, et al., 2017) and (Budnik, et al., 2009). The model has four sectors (the real economy, the nominal side with prices, the labour market, and the credit market) and distinguishes between the long run and the short run. The long-run properties of the model follow neoclassical features (i.e., potential GDP estimated via Cobb-Douglas production function with constant returns to scale). Expectations are assumed to be adaptive (backward looking). Money is neutral in the long run. Prices are set by monopolistically competitive firms as a mark-up over the average minimum cost. Price rigidities are present in the short run, causing fluctuations of the output around the potential GDP following a Keynesian approach. All the markets are assumed to operate in monopolistic competition.

2.1 General structure of the model

On the **demand side,** the model describes the economy in a way that reflects the macro processes from national account point of view. Economic agents are aggregated in households, firms, foreign countries, fiscal authority, and monetary authority. Aggregate demand (GDP) splits into household consumption, public consumption, private investment, public investments, exports, and imports.

Households receive income as well as pay taxes. They spend a part of their disposable income to purchase domestically produced goods or imported goods. The level of household expenditures also reflects the intertemporal choice. *Firms* produce goods that are sold in the domestic market or to foreigners. When setting the level of investments, enterprises consider the level of economic activity and the real user cost of capital. *Foreign countries* provide goods purchased by domestic economic agents and at the same time they purchase domestically produced goods. *Fiscal authorities* obtain revenues from taxes, which they redistribute to households, purchase consumer goods, and finance investments. As the level of fiscal expenditure might be higher than the collected revenues, part of the financing is borrowed in the domestic economy. *Monetary authority* controls the base interest rate level in a way that inflation target is achieved. *Financial intermediaries* finance the real economy and play a crucial role in the transmission of central bank interest rate into loan rates.

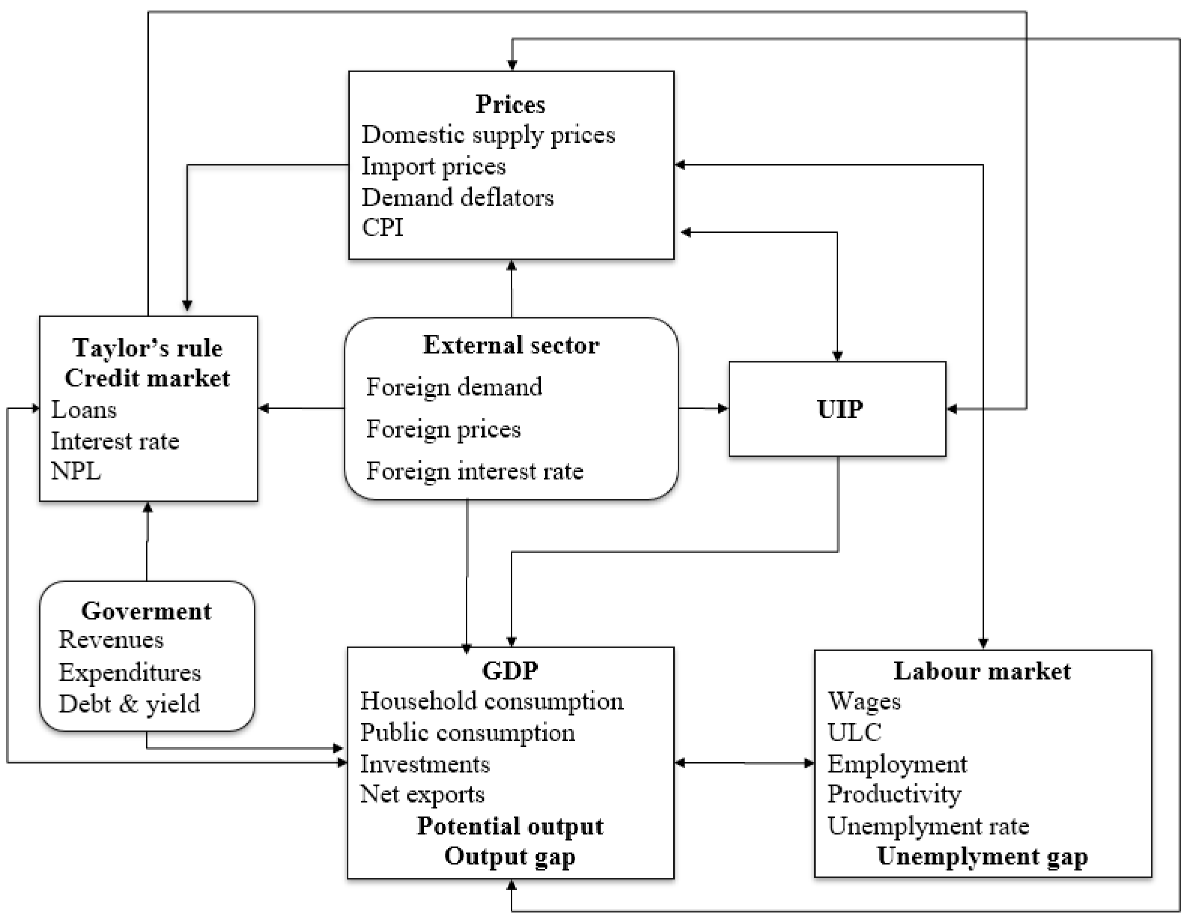
For the components of gross domestic product, the nominal developments are related to the development of the price deflators. *Demand deflators* are homogenous of first degree in supply prices reflecting the different import content of each aggregate respectively.

On the **supply side,** *potential output* is determined by a production function that combines total factor productivity (TFP), capital stock, and labour supply. *TFP* reflects the exogeneously predefined level of technical progress. *Capital stock* moves gradually according to the level of fixed capital formation (private and public investments) and depreciation rate. *Labour supply* moves in line with labour force development and structural unemployment rate.

N*ominal wage* evolves in line with labour productivity, inflation, and cyclical conditions in labour market. Wages follow a Phillips curve and prices are determined by domestic supply prices and import prices. *Domestic supply prices* are set by monopolistically competitive firms as a mark-up over the average minimum cost. Unit labour costs proxy the marginal costs, while mark-ups are influenced by cyclical conditions and commodity prices. The *import prices* follow a pricing to market approach, reflecting the developments of costs and exchange rate. The *exchange rate* is consistent with uncovered interest rate parity.

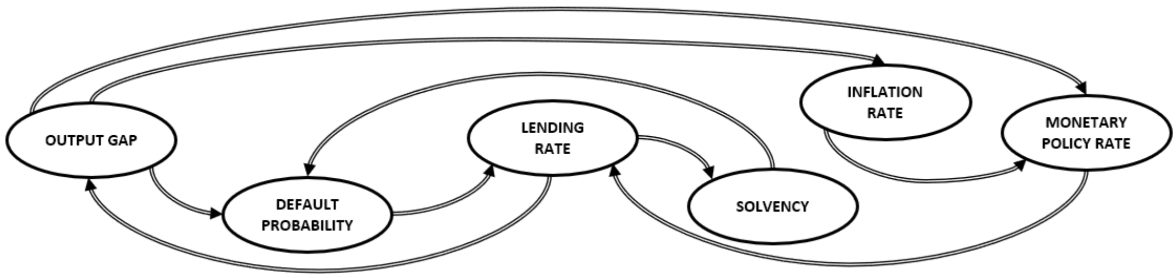
Chart 1 illustrates a simplified diagram of interdependencies in the model among sectors and economic agents.

Chart 1: Model interdependencies (round rectangle indicates exogeneous variables)



The model includes a **feedback loop** between the financial system and the real sector. Financial intermediaries finance the real economy by setting the loan interest rate, which is an aggregate of the costs faced by the financial intermediaries with a mark-up containing a risk premium capturing the risk that the borrower will default in repaying the loan. The borrower has a higher chance of non-repayment during negative cyclical conditions and whenever its solvency deteriorates. An increase in financial burden, a decrease of income, or both, increase the probability of default of borrower (non-performing loan rate). A higher default probability leads (via an increased risk premium) to higher interest rates, which result in higher capital costs, subsequently lower investments by private sector, and therefore a worsening of cyclical conditions. With default probability depending on real and financial indicators, a feedback mechanism between real economy and financial market thus builds in, as shown by Chart 2.

Chart 2. The feedback loop between the financial market and the real sector.



2.2 Behavioural equations

In this part, we list the main equations of the model.

The real economy

Potential output is modelled via the Cobb-Douglass production function with constant returns to scale. The total factor productivity consists of the so-called Solow residuals. Capital stock distinguish in private capital stock and public capital stock with different depreciations rates as calculated by (Gupta, Kangur, Papageorgiou, & Wane, 2011). Effective labour supply represents the labour force corrected by the NAIRU indicator, with the latter being exogeneously estimated as in (Cela & Skufi, 2018). The potential output is expressed in eq. (1).

$$\bar{Y} = A * C^{\alpha} * \bar{L}^{1-\alpha} \quad (1)$$

Where, $\bar{Y}$is Total factor productivity, *C* is capital stock, $\bar{L}$ is effective labour supply, and α is the share of capital in the production function.

Output represented by Gross Domestic Product (GDP) is calculated from the expenditure side as the sum of expenditures realized by private sector, foreign sector, and public sector. The relative difference between output and potential output defines the output gap.

Household consumption is in line with life-cycle hypothesis eq. (2). Household's expenditures depend on the disposable income and a real interest rate that captures intertemporal choices.

$$\Delta YC_t = -\alpha_0 * (YC_{t-1} - \alpha_1 * YDI_{t-1} - \alpha_2) + \alpha_3 \Delta i_t + \varepsilon \quad (2)$$

Where *YC* is real household consumption, *YDI* is real disposable income, *i* is the real interest rate, *α* are parameters, and *ε* is error term.

Private investments depend on the level of economic activity, the user cost of capital, and population developments eq. (3).

$$\Delta YIP_t = -\beta_0 * (YIP_{t-1} - \beta_1 * Y_{t-1} - \beta_2 * M2P_{t-1} - \beta_3 * ic_{t-1} - \beta_4) + \varepsilon \quad (3)$$

Where *YIP* is private gross fixed capital formation, *Y* is real gross domestic product, M2*P* represents inhabited square meters per capita (as a variable capturing the demographic factors), *ic* stands for capital costs, *β* are parameters, and *ε* is error term. M2 is residential square meters and has been estimated from Census data and construction permit for residential buildings in meter squares. The indicator is latter divided by the population to obtain M2P, for details see (Skufi, Kika, & Cela, 2022).

The foreign sector is modelled in terms of an activation variable and prices ratio. Concretely, export of goods and services is a function of foreign demand and competitiveness eq. (4) and import of goods and services reflect the need for imports and the level of relative prices eq. (5).

$$\Delta YE_t = -\delta_0 * (YE_{t-1} - \delta_1 * YF_{t-1} - \delta_2) + \delta_3 \Delta CT_{t-1} + \varepsilon \quad (4)$$

Where *YE* is exports of goods and services, *YF* is foreign demand, *CT* is competitiveness term, δ are parameters, and *ε* is error term.

$$\Delta YM_t = -\zeta_0 * (YM_{t-1} - \zeta_1 * DM_{t-1} - \zeta_2) + \zeta_3 RP_{t-1} + \varepsilon \quad (5)$$

Where *YM* is real imports of goods and services, *DM* is absorption variable, *RP* are relative prices, *ζ* are parameters, and *ε* is error term.

The public sector, which includes public consumption and public investment is exogeneous.

The nominal side

The prices are distinguished in supply and demand prices. Supply prices differentiate in domestic supply price, which are modelled as a mark-up over marginal costs eq. (6) and foreign supply price, latter being specified according to the pricing to market (PTM) law eq. (7). All demand prices are homogeneous of degrees one in supply prices and imported prices eq. (8). It is important to highlight that inflation which is represented by consumer price index is related to household deflator with a time-varying coefficient.

$$\Delta EX_t = \varpi_0 * + \varpi_1 * \Delta EX_{t-1} + \varpi_2 * \Delta(\pi_{t-1} - \pi f_{t-1}) + \varpi_3 * (i_{t-1} - if_{t-1}) + \varepsilon \qquad (6)$$

Where, *PD* is the domestic supply prices, *ULC* is unit labour costs, $\tilde{Y}$ is output gap, *PO* is the oil price, ψ are parameters, and ε is error term.

$$\Delta PM_t = -\varsigma_0 * (PM_{t-1} - \varsigma_1 * PF_{t-1} - \varsigma_2 * EX_{t-1} - \varsigma_3) + \varepsilon \qquad (7)$$

Where, *PM* is the import deflator, PF is the foreign price, EX is the exchange rate in unit of foreign currency (Euro), ς are parameters, and ε is error term.

$$\Delta PDD_t^i = \Omega^i\left(\lambda^i * PD_{t-1} + \left(1 - \lambda^i\right) * PM_{t-1} - \phi^i\right) + \varepsilon \qquad (8)$$

PDD is the domestic deflator index with '*i*' represents the component of aggregate demand, *PD* is the domestic supply prices, *PM* is the import deflator*,* λ the weight of the domestic content for each component, the rest are parameters, and ε is error term.

Labour Market

Labour market includes the demand and supply for labour and its price approximated with nominal average wage. Labour supply is taken as exogeneous. Labour demand is a function of real activity developments, the real cost of employment approximated with the real wage, and capital productivity eq. (9). The average wage follows the Philips curve specification, in here we assume that inflation dynamics are fully transmitted to the wages within a year (in line with the adopted model) and let the rest of parameters to be stochastically estimated eq. (10).

$$\Delta LD_t = -\eta_0 * (LD_{t-1} - \eta_1 * N_{t-1} - \eta_2 * Y_{t-1} - \eta_3 * (Y/C)_{t-1} - \eta_4) + \varepsilon \qquad (9)$$

Where, *LD* is labour demand, *N* is real wage, *Y* is real gross domestic product, *Y/C* is capital productivity, η are parameters, and ε is error term.

$$\Delta PN_t = -\vartheta_0 * \Delta PN_{t-1} + (1 - \vartheta_0) * \pi_{t-1} + \vartheta_1 * \Delta LP_{t-1} + \vartheta_2 * \Delta \widetilde{LD}_{t-1} + \varepsilon \qquad (10)$$

Where, *PN* is the nominal average wage, π is inflation, *LP* is labour productivity, $\widetilde{LD}$ is the unemployment rate gap, ϑ are parameters, and ε is error term.

UIP and Monetary policy reaction

Monetary policy reacts to changes in inflation and cyclical conditions eq. (11). While exchange rate deviations depend on price level and interest rate disparity between the domestic and the foreign economy, as well as the risk premium eq. (12).

$$\Delta ir_t = \theta_0 + \theta_1 * \Delta ir_{t-1} + \theta_2 * \widetilde{\pi_{t-1}} + \theta_3 * \Delta \widetilde{Y_{t-1}} + \varepsilon \qquad (11)$$

Where, *ir* is monetary policy rate, $\tilde{\pi}$ is the deviation of inflation rate from target, $\tilde{Y}$ is the output gap, *Θ* are parameters, and ε is error term.

$$\Delta EX_t = \varpi_0 + \varpi_1 * \Delta EX_{t-1} + \varpi_2 * \Delta(\pi_{t-1} - \pi f_{t-1}) + \varpi_3 * (i_{t-1} - if_{t-1}) + \varepsilon \qquad (12)$$

Where, *EX* is the exchange rate in unit of foreign currency (Euro), π is inflation rate, πf is foreign inflation rate, *i* is domestic interest rate, *if* is foreign interest rate, ϖ are parameters, and ε is error term, representing at the same time the risk premium.

Credit market

Credit market covers the variables credit stock, loan interest rate, and nonperforming loans. On the credit market, monetary impulse is transmitted completely to the yield of domestic government papers eq. (13). Government papers represent the risk-free asset, which altogether with a risk premium (approximated by the non-performing loan ratio) determine the bank lending rate eq. (14). In our specification, the risk-free asset is a weighted average between the Albanian treasury bills and Euribor, representing the funding costs for loans denominated in foreign currency. Risk premium is a function of cyclical condition, lending rate, and the solvency eq. (15). The stock of loans specification is based under the assumption that the share of economic activity financed by bank intermediation remains largely unchanged. Also, investors take in consideration the lending rate developments during the borrowing decision eq. (16).

$$\Delta i_t = -\tau_1 * (i_{t-1} - 1 * ir_{t-1}) + \tau_2 \Delta i_{t-1} + \tau_3 \Delta ir_{t-1} + \tau_0 + \varepsilon \quad (13)$$

Where, *i* is interest rate of government papers, *ir* is monetary policy rate, τ are parameters, and *ε* is error term.

$$il_t = \kappa_0 + \kappa_1 il_{t-1} + \kappa_2 rp_{t-1} + \kappa_3 * [k_t * i_t + (1 - k_t) * if_t] + \varepsilon \quad (14)$$

Where, *il* is lending rate, *RP* is risk premium, *i* is domestic interest rate, *if* is foreign interest rate, *k* is the share of loan denominated in domestic currency, κ are parameters, and *ε* is error term.

$$rp_t = \chi_0 + \chi_1 rp_{t-1} + \chi_2 \tilde{Y}_{t-1} + \chi_3 * S_{t-1} + \varepsilon \quad (15)$$

Where, *rp* is risk premium, $\tilde{Y}$ is the output gap, S is solvency, χ are parameters, and *ε* is error term.

$$L_t = (\rho_0 + \rho_1 \frac{L_{t-1}}{Y_{t-1}} + \rho_2 * il_{t-1}) * Y_t + \varepsilon \quad (16)$$

Where, *L* is the stock of loans, *Y* is real gross domestic product, *il* is lending rate, *ρ* are parameters, and *ε* is error term.

We use the data for 2010-2019 (pre-pandemic period) to estimate the matrix of parameters of our newly constructed macro-financial model and historical shocks. The estimation of unobservable indicators (i.e., potential GDP, output gap, NAIRU) and construction of additional variables (i.e., capital stock, disposable income, competitiveness term, and real terms) follows the same methodology as described in (Skufi, Kika, & Cela, 2022). In case of methodological breaks in variables' time series, dummy variables are used. The series of capital stock and output gap do not reflect the losses of November 2019 earthquake in Albania (European Commission, 2021). This event was intentionally left out. Given the backward nature and the transmission mechanism of the model the event would not fit our simulation.

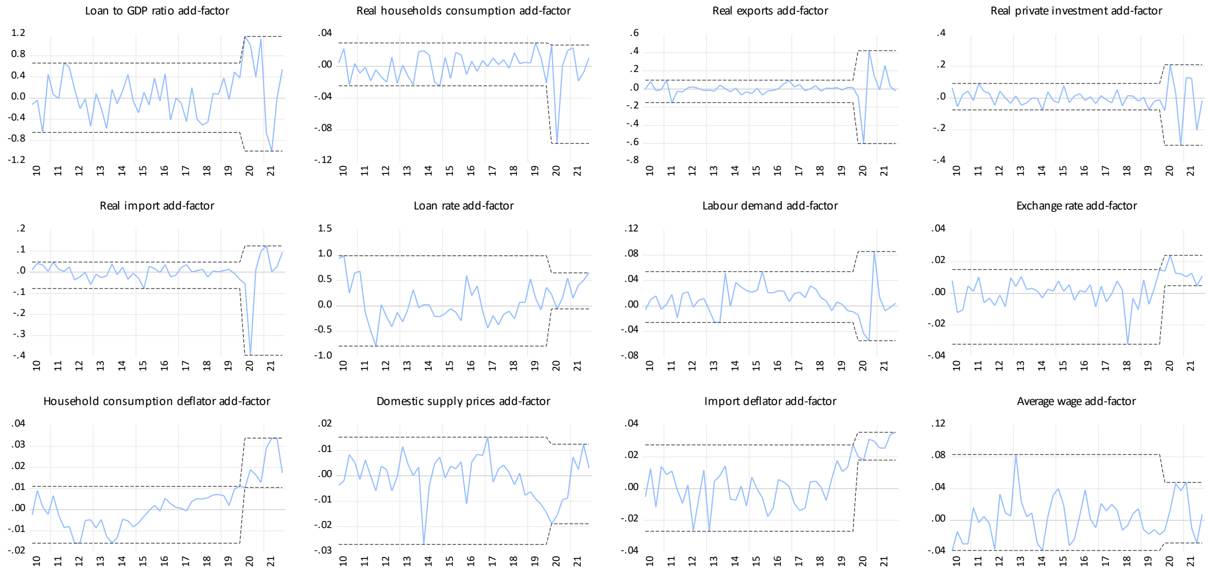
Behavioural equations were estimated as Error-Correction Models (ECM) or Ordinary Least Square (OLS) depending on whether a co-integration relationship among variables was found or not. Long run parameters of all equations are calibrated according to (Skufi, Kika, & Cela, 2022) while the short run dynamics is estimated on the basis of historical data for the period 2010-2019. Table 3A in Appendix provides the parameter values and whether are derived from an estimation or a calibration process.

The set of estimated behavioural equations and identities is solved for the unique solution through the linear approximation by Gauss-Siedel algorithm. At this stage we obtain the in-sample solution for the endogenous indicators, whose paths differ from the historical trajectories by means of misspecification, estimation, calibration, breaks, and shocks (new information). The difference between the estimated and historical value represents the residuals. Each equation is then assigned an explicit error term (add factor) to make sure that the endogenous variable solution overlap with historical paths and solved again. As the set of equations is solved simultaneously, the model ensures that the in-sample add-factors in individual equations can be associated with a specific economic interpretation.

Figure 1 illustrates the path of add-factors for selected indicators during 2010-2021. Most add factors, during 2010-2019, feature zero mean, but the variance statistics shows a notable volatility in the series.[1] Thus, it is worthy to extrapolate the paths of add-factors out of sample when preparing forecasts. Add factors statistics are notably different during the period 2020-2021. They feature higher volatility, peaking and toughing much higher and lower than their extreme values before the pandemic hit.

Figure 1: In-sample (2010-2019) and (2020-2021) add factors (blue line add factors, black dotted line minimal and maximal values)

[1] Figure A1 in Appendix shows the descriptive statistics of selected add factors over 2010-2019.



3. Constructing pre-pandemic and pandemic forecasts

We construct two distinct forecasts for 2020-2021.

The *pre-pandemic forecast* is generated using the model with the following assumptions about the exogeneous variables for 2020-2021:

(i) foreign sector variables are assumed to grow according to the Consensus Forecast projections from January 2020 (Consensus Economics, 2020);

(ii) fiscal variables growth rates are based on the Ministry of Finance Budget Plan 2020-2021 (MoF, 2021), including reconstruction plan of November 2019 earthquake [2];

(iii) demographic developments are assumed unchanged;

(iv) square meters are assumed to grow by its average over 2010-2019, after accounting for capital losses and depreciation[3];

(v) NAIRU is estimated using a methodology described in (Cela & Skufi, 2018);

(vi) total factor productivity (TFP) is assumed to grow by its average over 2010-2019.

Pre-pandemic forecast does not include any information about the Covid-19 pandemic and serves as the starting point to assess the observed developments during 2020-2021. The projection can be interpreted as the most probable macro-financial development that would have been observed over 2020-2021 if the pandemic had not come.

[2] Although, we let untouched the supply side indicators from the impact of earthquake in last quarter of 2019, here we have included the reconstruction plan due to the spillovers on the demand side, the implications in the simulation, and the impacts of the lockdown in the reconstruction plan.

[3] For more details on this variable and its use in the model see section 3.1.

In this forecast, endogenous variables are not only driven by the evolution of explanatory variables and the elasticities in the individual behavioural equations but are also assigned the add-factors for each of the 8 quarters of 2020-2021. These are based on the add-factors (error terms) in individual equations estimated during the simulation process when estimating the model (OECD, 2014). Apart of fine-tuning the historical paths of the indicators, add-factors play a key role in the forecasting process capturing expert judgment by (Giannoni, 2016), (Roberts, 2019), (Mestre & McAdam, 2008). We impose our judgment in the pre-pandemic forecast only for a set of indicators.

With respect to real economy sector, the corresponding add-factors of household consumption, exports and imports are assigned to one standard deviation, reflecting the spill over of reconstructing plan in the real economy. For the same reason, private investment add factor is subtracted by one standard deviation, as partly private capacities would be oriented toward government reconstruction plan. Private investment add factor path reflects the scheduled fiscal expenditures for reconstruction. On the nominal side, prices are assigned with one standard deviation in order to capture for a possible increase in energy prices. Monetary policy rate is fine tuned in a way to reflect monetary policy forward guidance. In order to remove the pressures of monetary policy rate and inflation on exchange rate, we added two standard deviations to exchange rate add factor. Finally, we set one standard deviation to nonperforming loan rate, as the improved cyclical conditions born as a fiscal stimulus rather than private sector acceleration.

The *pandemic forecast* represents a forecast that combines knowledge about the Covid-19 pandemic impact (both on the exogeneous variables and on the endogenous variables via add factors) and the power of the macro-financial model with the elasticities estimated up to 2019. This forecast serves to illustrate whether – if we perfectly knew the path of exogeneous variables and were able to quantify the impact of the covid-19 related measures such as lockdowns via add factors – the model would be able to predict the evolution of key macro-financial variables during 2020-2021.

The pandemic forecast's assumptions about exogeneous variables reflect the observed developments in 2020-2021 as follows:

(i) a worsening of the foreign economy (euro area GDP growth) and higher implicit deflator;
(ii) lower oil prices;
(iii) lower remittances;
(iv) a negative fiscal impulse reflected in the interruption of after-earthquake reconstruction plan; lower fiscal consumption, due to lower government income; although the government increased the transfers to households and provided guaranty schemes to businesses.

Contemporaneously, constructions free capacity re-orientated toward the private sector resulting in 2020Q2 a positive shock for private investment;

(v) a decrease in population and labour supply.

For variables that enter the model as directly seasonally adjusted, we apply the following procedure. First, we calculate year on year growth rates from historical data for the period of interest 2020Q1-2021Q4 and used them to prolong the direct seasonally adjusted series over 2020Q1-2021Q4; indirect seasonally series are generated according to their specification.

Additionally, we include add factors into the behavioural equations that go beyond their levels in the pre-pandemic forecast, capturing the loosening of monetary policy by 50 basis points, a decrease of household consumption due the high uncertainty and lockdowns, a decrease of exports and imports in 2020 due to the lockdown policy and the travel restriction as well as a decrease of nonperforming loans rate and an increase of credit stock due to the financial sector measures (moratoria etc.). However, in order to let the model "speak for itself", we only impose these "additional" add factors (compared to the pre-pandemic forecast) in the four quarters of 2020 (even if the exogeneous variables trajectory is defined over 8-quarter ahead) and only for selected behavioural equation. (Garcia, Jacquinot, Lenarcic, Lozej, & Mavromatis, 2021) follow a similar technique to generate the Covid-19 pandemic shock. We limited the add factors for 2020 to reflect that the lockdowns were imposed only in 2020 (and not in 2021) and also to reflect the fact that the endogenous variables are able to propagate the shocks imposed in 2020 further down into the future due to the estimated persistence. Anyway, if we imposed the add factors to bring all variables to the observed levels across the whole 8-quarter horizon, we would not be able to assess the forecasting performance of our model at all!

We are aware of the fact that during pandemic, some of the elasticities reflecting agents' behaviour might have changed, too. Several studies adapt the macroeconomic transmission channels under non-standard measures (Coenen, Montes-Galdón, & and Smets, 2020), (Pariès & M. and Papadopoulou, 2020). We approach this issue in the following way: we keep our original macro-financial model as designed but provide uncertainty bands around both pre-pandemic and pandemic forecasts using a quantile regression. This approach allows for changing elasticities across different quantiles of distribution of the dependent variable. We use the period 2010-2019 to generate these uncertainty bands to test whether this approach is sufficient to accommodate the large shock observed during 2020-2021 within the bands.

Quantile regression recently took popularity in investigating the Covid-19 pandemic (Barajas, etj., 2021), (De Santis & Van der Veken, 2020), (Kipriyanov, 2022), and (Mishra & Mishra, 2021). We follow the quantile regression approach introduced by (Roger & Bassett, 1978) and updated by (Koenker, 2005). Quantile regression methodology overview is briefly presented below.

Let *Y* be an indicator with *F(y)* probability distribution function (*PDF*) *(eq. (18))*. For, $\tau \epsilon\ ]\ 0;\ 1[$, the τ^{th} quantile of *Y* is defined as the inverse PDF of *Y* satisfying $F(y) \geq \tau$ *(eq. (19))*. Given *n* observations of *Y*, the sample quantile 'Q_τ' is obtained by sorting the series in ascending order, or by optimizing for the smallest deviation *(eq. (20))*, where $\rho_\tau(u)=u(\tau-1(u<0))$, is the so-called check function which weights positive and negative values asymmetrically.

$$F(y) = P(Y \leq y) \tag{18}$$

$$Q(\tau) = inf\{y: F(y) \geq \tau\} \tag{19}$$

$$Q_n(\tau) = argmin_\xi \left\{ \sum_i \rho_\tau(Y_i - \xi) \right\} \tag{20}$$

The quantile regression allows for explanatory indicators *X*, where the conditional quantile of *Y* is linearly related to X. Therefore, the quantile minimization is the conditional quantile regression estimator *(eq. (21))*

$$\hat{\beta}_n(\tau) = argmin_{\beta(\tau)} \left\{ \sum_i \rho_\tau(Y_i - X_i'\beta(\tau)) \right\} \tag{21}$$

Uncertainty bands are generated by the upper and lower conditional quantile regression estimator. We estimate τ=10 for the lower band and τ=90 for the upper band. The results are smoothed by 2-term centred moving average technique. Following the described methodology, 12 equations are re-estimated. Concretely, equations *(2)-(6), (9)-(10)*, and *(14)-(16)* are specified as below:

$$Q_\tau(YC_t) = \alpha_{0(\tau)} + \alpha_{1(\tau)} * YC_{t-1} + \alpha_{2(\tau)} * YI_t + \alpha_{3(\tau)} i_t + \varepsilon_\tau \tag{22}$$

$$Q_\tau(\Delta YIP_t) = \beta_{0(\tau)} + \beta_{1(\tau)} * \Delta YIP_t + \beta_{2(\tau)} * \Delta Y_t + \beta_{3(\tau)} * \Delta M2P_{t+1} + \beta_{4(\tau)} * \Delta ic_t + \varepsilon_\tau \tag{23}$$

$$Q_\tau(YM_t) = \zeta_{0(\tau)} + \zeta_{1(\tau)} * YM_{t-1} + \zeta_{2(\tau)} * DM_{t-1} + \zeta_3 RP_{t-2} + \varepsilon_\tau \quad (24)$$

$$Q_\tau(PD) = \psi_{0(\tau)} + \psi_{1(\tau)} * PD_{t-1} + \psi_{2(\tau)} * ULC_t + \psi_{3(\tau)} PO_t + \psi_{4(\tau)} * \tilde{Y}_{t-2} + \varepsilon_\tau \quad (25)$$

$$Q_\tau(\Delta PM_t) = \varsigma_{0(\tau)} + \varsigma_{1(\tau)} * \Delta PM_{t-1} + \varsigma_{2(\tau)} * \Delta PF_{t+1} + \varsigma_{2(\tau)} * \Delta EX_t + \varepsilon_\tau \quad (26)$$

$$Q_\tau(\Delta EX_t) = \varpi_{0(\tau)} + \varpi_{1(\tau)} * \Delta EX_{t-1} + \varpi_{2(\tau)} * \Delta(\pi_{t+2} - \pi f_{t+2}) + \varpi_{3(\tau)} * (i_t - if_t) + \varepsilon_\tau \quad (27)$$

$$Q_\tau(YE_t) = \delta_{0(\tau)} + \delta_{1(\tau)} * YE_{t-1} + \delta_{2(\tau)} * YF_t + \delta_{3(\tau)} * CT_t + \varepsilon_\tau \quad (28)$$

$$Q_\tau(il_t) = \kappa_{0(\tau)} + \kappa_{1(\tau)} il_{t-2} + \kappa_{2(\tau)} RP_t + \kappa_{3(\tau)} * [k_{t-1} * i_{t-1} + (1 - k_{t-1}) * if_{t-1}] + \varepsilon_\tau \quad (29)$$

$$Q_\tau(RP_t) = \chi_{0(\tau)} + \chi_{1(\tau)} RP_{t-1} + \chi_{2(\tau)} \tilde{Y}_t + \chi_{3(\tau)} * S_{t-1} + \varepsilon_\tau \quad (30)$$

$$Q_\tau(L_t) = (\rho_{0(\tau)} + \rho_{1(\tau)} \frac{L_{t-1}}{Y_{t-1}} + \rho_{2(\tau)} * il_t) * Y_t + \varepsilon_\tau \quad (31)$$

The indicators enter quantile regression in level (natural logarithm) or differentiated (first difference of natural logarithm). The choice was made upon diagnostics. Lags are specified according to statistical significance. The rest of explanatory indicators may enter in lags, leads, or contemporaneously given the empirical soundness. We elaborate further about the diagnostics in the following section.

Furthermore, we generate uncertainty bands for gross domestic product and consumer price index indicators. These indicators are expressed by an identity. Thus, their uncertainty bands are derived from the respective estimations of 10th and 90th quantiles explanatory variables. Inflation and growth specification is given respectively in *(eq. (32))* and *(eq. (33))*

$$\pi_{t(\tau)} = -\Theta_t * \Omega^{hc}\left(\lambda^{hc} * PD_{t-1(\tau)} + \left(1 - \lambda^{hc}\right) * PM_{t-1(\tau)} - \phi^{hc}\right) + \varepsilon \quad (32)$$

$$Y_{t(\tau)} = YC_{t(\tau)} + YG_t + YIP_{t(\tau)} + YIG_t + YE_{t(\tau)} - YM_{t(\tau)} + Y_\varepsilon \quad (33)$$

Where, Θ is a time varying parameter relating household consumption deflator with consumer price index, the index '*hc*' stands for household consumption deflator, YG is public consumption, YIG is public investment, and Y_ε is statistical discrepancy and change in inventories. The terms that are not subscribed with '*tao*' take the values as generated in the pre-pandemic simulation.

4. Results

4.1 The pre-pandemic simulation

Starting before the pandemic outbreak, the pre-pandemic macroeconomic scenario for 2020-2021 is based on the following external assumptions:

- a positive growth of foreign economy with moderate inflation;
- a moderate increase of oil prices;
- a positive inflow of remittances in line with the foreign economy developments;
- a positive fiscal impulse due to reconstruction plan;
- an unchanged demographic development, therefore stable labour force.

Based on these assumptions and latest data of 2019, the pre-pandemic simulation estimates that the economic growth would accelerate during the first year and gradually stabilize in the second year of the horizon. The economic activity is supported by the domestic demand and the accommodative monetary policy. Household consumption accelerates due to positive developments in disposable income and government support schemes. Disposable income evolves in line with increasing economic activity and higher remittances. Government support schemes are related to the compensation of earthquake damage. Low interest rates lower household saving behaviour. Employment increase reflecting expanded economic level. As labour supply is assumed unchanged unemployment rate decline.

Investments increase significantly driven by the public investment. Private investments are simulated by the positive spill overs of reconstruction plan and the favourable lending conditions (capital costs). Capital accumulation also benefits from the high level of public expenditures for reconstruction. Investments provide the main driver of the economic acceleration. Exports of goods and services grow in line with the foreign demand development. The competitiveness terms and the stable exchange rate also support exports. Imports are expected to grow high to sustain the high domestic demand. Thus, the trade balance deteriorates and provides a negative contribution to economic growth. Inflation, calculated on the bases of domestic and foreign components, rises gradually. The pick-up of inflation mainly reflects the trend of the domestic component. Domestic supply prices are stimulated by the acceleration of ULC. High ULC are driven by higher level of average wage and better cyclical condition. The foreign component is attenuated by the foreign prices developments and the stable exchange rate.

Monetary policy rate is estimated to ease in the beginning of the simulation as inflation rate fluctuate under the target. Improved cyclical condition and accelerated inflation rate ask for tightening of monetary policy. Inflationary pressures lead to a slight depreciation of domestic currency. The deprecation is partly attenuated by the monetary policy reaction.

In the credit market, the financial conditions are eased in line with the accommodative monetary policy and low government bond yields. Lending rate remains below the average levels recorded in 2018-2019. The decline reflects also the fall in private sector risk premia. The default probability is estimated to decrease as cyclical conditions are improving, leading to better borrowers' solvency. The stock of loans evolves according to the economic activity, reflecting the financing needs.

The overall economic outlook is illustrated in Figure 2 and compared with the outturn which was hugely influence by the covid-19. The differences show how large the covid-19 shock actually was.

Figure 2: Pre-pandemic simulation (blue) for 2020-2021 versus the outturn (black)

Note: Predictions are constructed as 2-term centred moving averages.

4.2 The pandemic simulation

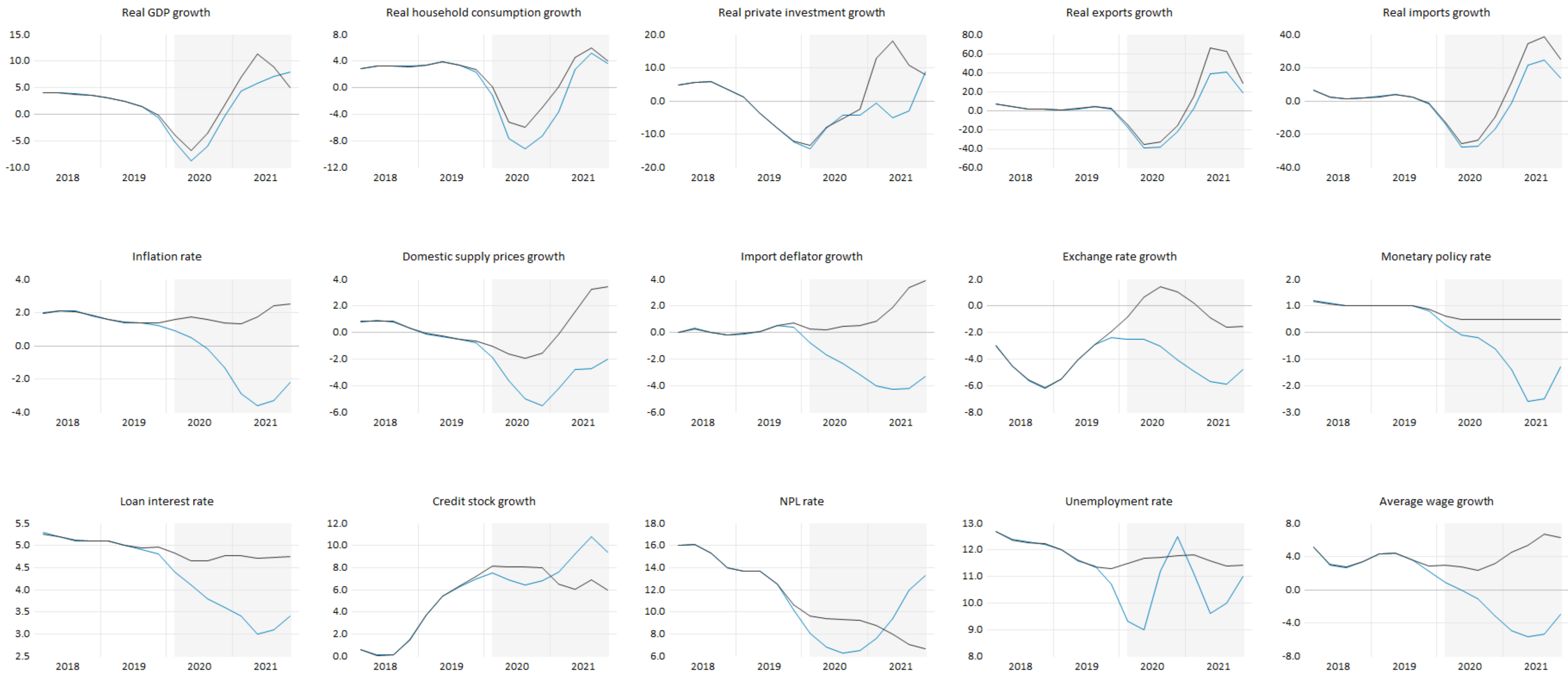
In this simulation, the external environment as captured by the development of exogeneous variables such as external demand is much worse that in the previous scenario, reflecting the global nature of the pandemic. Selected endogenous variables are complemented with add factors during the first 4 quarters of the forecast to capture the Covid-19 factors. The pandemic simulation results together with the outturn in 2020-2021 are shown in Figure 3.

We illustrate this simulation by the discussion of two variables - household consumption and exports of services. Households decreased their expenditures on consumption. On one side, they faced a decrease in revenues due to lower economic activity. While, on the other side, supporting schemes attenuated the decline of disposable income. Moreover, households decreased their consumption due to both lockdowns and high uncertainty surrounding Covid-19 pandemic. The uncertainty/lockdown shock experienced by the households is not captured by the explanatory variables entering the household equations. Hence, to properly simulate the behaviour of households, the model requires to impose this missing information. We fine tune the add factor to count for the negative shock.

A similar situation is the case of exports of goods and services. Especially the export of services (mostly related to tourism), the impact cannot by captured only by the decline in foreign demand. The lockdown policy and the travel restrictions ask for further adjustments in the model. Thus, this kind of information is added to the model through the add factors. Detailed information about the size of the shocks/add factors is provided in Figure A2 in Appendix.

The variables are expressed in terms of annual growth. As anticipated, real sector indicators feature a sharp reaction during the first year and a fast improvement during the second one, reflecting the base effect (starting from a lower level). The pandemic simulation trajectories fluctuate around the actual values except for the financial market indicators. While the real economy experienced a negative shock during the year 2020, the financial market was supported by schemes that resulted in an even improved condition. Given the significant support of borrowers, introduced in the model by large values of add-factors across indicators on one hand, and the vast persistence of financial indicators on the other hand, the simulation reveals a smoothed shock absorption. Indeed, financial market indicators feature a better position in the pandemic simulation versus the pre-pandemic simulation over the full timespan (for a direct comparison the two forecasts see Figure 3A in Appendix).

Figure 3: Pandemic simulations (blue) for 2020-2021 versus the outturn (black)



Note: Predictions are constructed as 2-term centred moving averages.

4.3 Quantile regression-based uncertainty bands

Figure 4 shows the add factors for both forecasts illustrating that if we want to capture at least part of the shock via add-factors in the pandemic scenario for 2020-2021, we need to use much larger magnitude of add factors compared to the average historical values in 2010-2019.

As every forecast has certain level of uncertainty around it, a natural question arises whether the actual outturn in 2020-2021 would at least be within the confidence bands of our forecasts. We construct these bands using quantile regression as described in the part 3 for both pre-pandemic and pandemic simulations. Table 1 shows the estimates of the quantile regression *(eq.22-eq31)* for the upper, the median and the lower percentile. Most parameters are statistically significant with correct signs and the pseudo-R^2 takes values from 20 per cent up to 95 per cent.

Table 1: Quantile regression estimates – 10th percentile, median, 90th percentile over 2010-2019

Indicator	Explanatories indicators for τ = .10, .50, .90																Pseudo-R^2		
YC	*AR*	.6***	.5***	.5***	*YI*	.4***	.5***	.4***	*i*	-1.0*	-.3	.0					.89	.88	.80
YIP	*AR*	.1	-.1	-.4***	*Y*	2.1***	1.9***	.2	*M2P*	-0.4	-.3	-.7	ic	-.4	-.2	-.1	.39	.26	.34
YE	*AR*	.4***	.6***	.6***	*YF*	3.3***	1.5***	1.3***	*CT*	1.0***	.9***	1.0***					.75	.84	.79
YM	*AR*	.2***	.3**	.3	*DM*	.8***	.6***	.5*	*RP*	2.2*	3.4*	5.0**					.83	.79	.68
PD	*AR*	.6***	.6***	.4***	*ULC*	.1***	.0	.1**	*PO*	.1***	.1***	.1***	$\tilde{Y}$	1.0	.5*	.6***	.83	.81	.75
PM	*AR*	-1.6**	-.8*	.1	*PF*	1	1.8**	0.9	*EX*	.6	.8**	1.0**					.26	.21	.33
EX	*AR*	1.0***	.8***	1.1***	*Δπ*	0.1	.2*	.0	*Δi*	-.2***	-.1**	.2***					.41	.36	.50
il	*AR*	.4***	.6***	.4	*iif*	.5***	.4***	1.1**	*rp*	.1**	.0	.0					.61	.67	.75
rp	*AR*	.8***	.9***	1.0***	$\tilde{Y}$	-4.8**	-1.1	-1.1	*S*	.3**	.2**	.2**					.76	.84	**.84**
L	*AR*	1.0***	1.0***	1.0***	*il*	.0	-.1	.1									.95	.94	.89

*The asterics indicates the p-value of parameter, statictically important * at 10%, ** at 5%, *** at %*

However, some parameters apart of not being statistically significant also feature a different sign, or do not affect at all the dependent indicator in the tails of the distribution. Such results are expected given the short sample.

Figure 4: In-sample (2010-2019) and pre-pandemic forecast (2020-2021) add factors (blue line), pandemic forecast (2020-2021) add factors (green line), black dotted line minimal and maximal values (2010-2019)

Figure 5 shows that for some variables, namely private investments, inflation, loan rate and NPL ratio – the actual trajectories are even within the pre-pandemic forecast uncertainty bands. This is understandable for the NPL ratio (which has been kept at a low level given the repayment moratoria) but more surprising for the other two variables. For the main components of GDP, household consumption went even temporarily above the upper band of the pre-pandemic forecast to return during 2022 to the area within the bands, suggesting that households absorbed quickly the uncertainty shock that they experienced in the begging of the pandemic. Also the recovery of the economic activity during the second year helped to restore the pre-pandemic consumption-GDP share. Given their volatile nature, private investments result in wide uncertainty bands even in normal times. Thus, their actual trajectory lies in the pre-pandemic uncertainty band. Exports and imports, on the other hand, experienced a large decline which was way out of the uncertainty bands of our pre-pandemic forecast. As a result, the GDP growth moves in and out of the bands, being difficult to make a prediction for.

Government measures such as loan repayment moratoria and direct support for the private sector stabilized the banking sector situation but broke the links in the model, which is partly the reason for the poor forecasting performance even in the case of pandemic forecast. During the pandemic, credit stock to GDP increased, interest rates continued to fall, and NPL ratio declined. This goes against the built-in linkages in the model - a decrease in economic activity would normally lead to lower credit and worse cyclical conditions would increase the default probability and thus also the loan interest rates. Higher borrowing costs would put additional negative pressures on credit.

When looking at uncertainty bands for the pandemic scenario, illustrated in Figure 6, most of the actual trajectories lie in the borders of the distributions or stay close. This result is expected given the materialization of Covid-19 pandemic shock. Although, fuelling the percentile regressions simply with the pandemic forecast data would not be enough to generate such pandemic uncertainty bands that would reflect the uncertainty that all the sectors experienced. That would be the case of foreign sector. Figure A4 in Appendix shows the pandemic uncertainty bands relying simply on the pandemic forecast data, without any added uncertainty from the pandemic add factors.

Again, the opposite behaviour is featured by the financial market indicators, namely credit stock, loan rate and NPL. As a matter of fact these variables reached during the pandemic times, such a good performance than was never experienced during 2010-2019 period. Moreover, breaking the transmission link of real sector to banking sector stay against model rationality.

Figure 5: Pre-pandemic forecast uncertainty bands 2020-2021 and actual data (black line actual data, blue-shaded area 10-90 uncertainty bands; 2 terms centred moving averages)

Figure 6: Pandemic forecast uncertainty bands 2020-2021 and actual data (black line actual data, blue-shaded area 10-90 uncertainty bands)

Note: Added uncertainty on the 10th percentile for GDP components and on the 90th percentile for financial market variables according add factors as in pandemic scenario. Figure A4 in Appendix shows the pandemic forecast uncertainty bands without added uncertainty.

To finalize, we also calculate the forecast errors of both forecasts. Table 2 shows the Root Mean Square Error (RMSE) for the pre-pandemic simulation and the pandemic simulation. The errors that enter RMSE represent the difference between the outturn and simulated values under logarithm. By means of illustration, a RMSE of 0.08 in the pre-pandemic for real GDP simulation means that over 8 quarters the real GDP was miss-estimated on average by eight per cent. Table 4A in Appendix provides RMSE values calculated over year on year growth rates of variables (rather than log-level values).

Table 2: RMSE of pre-pandemic and pandemic simulations for 2020-2021

Indicator	Pre-pandemic simulation	Pandemic simulation
Real GDP	0.08	0.05 *
Real household consumption	0.08	0.04 *
Real private investment	0.14	0.13 *
Real exports	0.36	0.16 *
Real imports	0.22	0.12 *
Inflation rate	0.01 *	0.05
Domestic supply prices	0.07	0.06 *
Import deflator	0.03 *	0.07
Exchange rate	0.01 *	0.07
Monetary policy rate	0.52 *	0.90
Loan interest rate	0.03 *	0.32
Credit stock	0.05	0.02 *
NPL rate	0.29 *	0.45
Unemployment rate	0.30	0.22 *
Average wage	0.15	0.11 *

RMSE values are calculated over the logarithms
The asterics indicates the lower RMSE between the two forecasts

On average, the predicted errors are higher in the pre-pandemic simulation. As already discussed, financial market indicators feature the opposite performance given the regulatory measures.

6. Conclusions

This paper investigates the ability of a linear macro-financial model to provide reasonable macroeconomic forecasts in times of large shocks like the covid-19 pandemic. We construct a semi-structural multi-equation model for Albania and estimate its parameters using data for 2010-2019. Using the model, we construct two forecasts – a pre-pandemic forecast (without any information about the future pandemic) and a pandemic forecast (which is using some information about the impact of the pandemic in the first year) and compare the forecast performance by comparing the projections with reality. In order to capture the uncertainty around both forecasts, we construct uncertainty bands using quantile regression, a suitable approach for the pandemic simulations as it allows for changing model elasticities depending on the quantile of the distribution.

Our analysis suggests that the model is able to capture most of the turning points of indicator trajectories in the pandemic forecast. Simulated trajectories fluctuate around the actual values except for the financial market indicators, which differ due to the government interventions that prevented the increase in NPLs.

The shocks experienced during the Covid-19 pandemic are significantly different from the shocks occurred in the historical set-up of the model. This interpretation is also consistent with the evidence that the simulated trajectories of the pandemic forecast do not fall in the pre-pandemic conditional distribution. If we however run the pandemic forecast, prepare uncertainty bands based on quantile regression, and adjust them with add factors, we are able to include the outturn.

Regulatory measures broke the links in the model, which is partly the reason for the poor forecasting performance even in the case of pandemic forecast.

Overall, our results have several policy implications. Our analysis points out that a model estimated on pre-pandemic data can be flexibly used even in abnormal times. In particular, our exercise implies that a linear model may act as a quantifier for approximating the crisis. However, its flexibility should not be taken for granted, as it is heavily affected by regulations. Indeed, running an adequate simulation asks for a proper expert judgment.

These findings point to avenues for future research. For example, further analyses may explore the direct impact of regulatory measures (such as repayment moratoria or direct subsidies to private sector) on agents' behaviour both in Albania or in other countries with similar experience.

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Appendix

Table A1 List of Model Variables

Variable	Acronym	Source	Terms	Seas.adj	Frequency
Real sector					
GDP	Y	INSTAT	R/N	TS	Q
Household consumption	YC	INSTAT	R/N	TS	Q
Public consumption	YG	INSTAT	R/N	TS	Q
Gross fixed capital formation	YI	INSTAT	R/N	TS	Q
Public gross fixed capital formation	YIG	MoF	R/N	TS	Q
Private gross fixed capital formation	YIP	C	R/N	ITS	Q
Exports of goods and services	YE	INSTAT	R/N	TS	Q
Imports of goods and services	YM	INSTAT	R/N	TS	Q
Demand for imports	DM	C	R	ITS	Q
Disposable income	YDI	C	R/N	ITS	Q
Output gap	$\bar{Y}$	C	R	ITS	Q
Potential gdp	$\tilde{Y}$	C	R	ITS	Q
Total factor productivity	A	C	R	ITS	Q
Capital stock	C	C	R	NA	QL
Public capital stock	CG	C	R	NA	QL
Private capital stock	CP	C	R	NA	QL
Potential labor supply	$\bar{L}$	C	R	ITS	Q
Square meters inhabited per capita	M2P	C	R	NA	Q
Nominal side					
CPI index	PI	INSTAT	N	NA	QA
Oil price	PO	INSTAT	N	TS	QA
GDP deflator	PY	C	N	TS	Q
Household consumption deflator	PDDC	C	N	ITS	Q
Public consumption deflator	PDDG	C	N	ITS	Q
Gross fixed capital formation deflator	PDDI	C	N	TS	Q
Exports of goods and services deflator	PDDE	C	N	TS	Q
Import deflator	PM	C	N	TS	Q
Domestic supply prices	PD	C	N	TS	Q
Domestic deflator	PDD	C	N	ITS	Q
Competitivness term	CT	C	N	ITS	Q
Relative prices of imports	RP	C	N	ITS	Q
Labor market					
Labor demand	LD	INSTAT	R	TS	Q
Labor supply	LS	C	R	ITS	Q
Unemployment rate	UN	INSTAT	R	NA	Q
NAIRU	NAIRU	C	R	NA	Q
Average wage	PN	INSTAT	R/N	TS	Q
Compensation per employee	PE	C	N	ITS	QS
ULC	ULC	C	N	TS	Q
Labor productivity	LP	C	R	ITS	Q

Population	P	INSTAT	R	NA	QI
Financial market and exchange rate					
Credit stock granted to business	L	BoA	N	Na	QL
Credit stock granted to business to GDP	L_Y	C	N	ITS	QL
Financial burden of borrowers	BB	C	N	Na	QL
Leverage of borrowers	S	C	N	ITS	QL
NPL for loans granted to business	rp	BoA	N	NA	QL
Loan interest rate to business	IL	BoA	R/N	NA	QA
Cost of capital rate	IC	C	R/N	NA	QA
Monetary policy rate	IR	BoA	R/N	NA	QA
Treasury bill 12-months	I	MoF	R/N	NA	QA
Exchange rate	EX	BoA	N	NA	QA
Foreign sector					
EA Inflation	PIF	EUROSTAT	N	NA	QA
Foreign demand	YF	EUROSTAT	R	NA	Q
Implicit deflator of export EU	PFE	EUROSTAT	N	NA	Q
Implicit deflator of imports EU	PFI	EUROSTAT	N	NA	Q
Foreign interest rate	IF	EUROSTAT	N	NA	QA
Remitances	R	BoA	N	TS	Q
Other transfers BoP	RO	BoA	N	TS	Q

Accronyms: BoA - Bank of Albania; C - calculated; INSTAT - Institute of Statistics; ITS - Indirect seasonal adjustment; N - Nominal; NA - None; Q/A/I/L/S - Quarterly/ monthly average/Interpolated/Last month/Monthly sum; R - Real; TS - Tramo seats

Table A2 List of pre-pandemic simulation assumptions

Variable	Type	Source
Real sector		
GDP	EN	NA
Household consumption	EN	ADDF
Public consumption	EX	MoF
Gross fixed capital formation	EN	NA
Public gross fixed capital formation	EX	MoF
Private gross fixed capital formation	EN	ADDF
Exports of goods and services	EN	ADDF
Imports of goods and services	EN	ADDF
Demand for imports	EN	NA
Disposable income	EN	NA
Output gap	EN	NA
Potential gdp	EN	NA
Total factor productivity	EX	CS
Capital stock	EN	NA
Public capital stock	EN	NA
Private capital stock	EN	NA
Potential labor supply	EN	NA
Square meters inhabited per capita	EX	CS
Nominal side		
CPI index	EN	NA
Oil price	EX	CF
GDP deflator	EN	NA
Household consumption deflator	EN	ADDF
Public consumption deflator	EN	NA
Gross fixed capital formation deflator	EN	NA
Exports of goods and services deflator	EN	NA
Import deflator	EN	ADDF
Domestic supply prices	EN	ADDF
Domestic deflator	EN	NA
Competitivness term	EN	NA
Relative prices of imports	EN	NA
Labor market		
Labor demand	EN	NA
Labor supply	EX	CL
Unemployment rate	EN	NA
NAIRU	EX	Est.
Average wage	EN	ADDF
Compensation per employee	EN	NA
ULC	EN	NA
Labor productivity	EN	NA
Population	EX	CL
Financial market and exchange rate		
Credit stock granted to business	EN	NA

Credit stock granted to business to GDP	EN	NA
Financial burden of borrowers	EN	NA
Leverage of borrowers	EN	NA
NPL for loans granted to business	EN	ADDF
Loan interest rate to business	EN	NA
Cost of capital rate	EN	NA
Monetary policy rate	EN	ADDF
Treasury bill 12-months	EN	NA
Exchange rate	EN	ADDF
Foreign sector		
EA Inflation	EX	CF
Foreign demand	EX	CF
Implicit deflator of export EU	EX	CF
Implicit deflator of imports EU	EX	CF
Foreign interest rate	EX	CF
Remitances	EX	CF
Other transfers BoP	EX	CF

Accronyms: ADDF - Add Dactor; CF - Consensus Forecast; CL - Kept constat at 2019Q4; CS - Kept constant at average value 2010-2019; EN - endogenous variable; Est - Estimated; EX - Exogeneous variable; MoF - Ministry of Finance; NA - None;

Table A3 Model selected estimated and calibrated parameters

Equation		Parameter value				
parameter subscription		*_0*	*_1*	*_2*	*_3*	*_4*
Real sector						
Household consumption	*(eq.2)*	-0.22[c]	0.84[c]	0.01[c]	-0.23[c]	
Private gross fixed capital formation	*(eq.3)*	-0.18[e]	1.00[c]	-0.83[c]	-1.00[c]	0.58[e]
Exports of goods and services	*(eq.4)*	-0.12[e]	1.00[c]	6.91[e]	0.40[c]	
Imports of goods and services	*(eq.5)*	-0.41[e]	1.00[c]	0.08[e]	-0.36[c]	
Potential gdp	*(eq.1)*	0.30[c]				
Nominal side						
Import deflator	*(eq.7)*	-0.27[c]	0.52[c]	0.91[c]	0.61[e]	
Domestic supply prices	*(eq.6)*	-0.22[c]	0.16[c]	0.62[e]	0.04[e]	0.48[e]
Domestic deflator						
Labor market						
Labor demand	*(eq.9)*	-0.20[c]	0.74[c]	1.58[e]	0.46[c]	-5.53[e]
Average wage	*(eq.10)*	-0.27[e]	1.17[e]	-5.15[e]		
Financial market and exchange rate						
Credit stock granted to business	*(eq.16)*	-0.57[e]	1.00[c]	-0.27[e]		
NPL for loans granted to business	*(eq.15)*	-0.90[e]	0.85[e]	-0.51[e]	1.10[e]	
Loan interest rate to business	*(eq.14)*	1.97[e]	0.27[e]	0.08[e]	1.00[c]	
Monetary policy rate	*(eq.11)*	0.00[c]	0.88[e]	0.16[e]	0.46[e]	
Treasury bill 12-months	*(eq.13)*	0.29[e]	-0.16[e]	0.20[e]	0.67[e]	
Exchange rate	*(eq.12)*	-0.04[e]	-0.33[e]	0.38[e]	-0.10[e]	

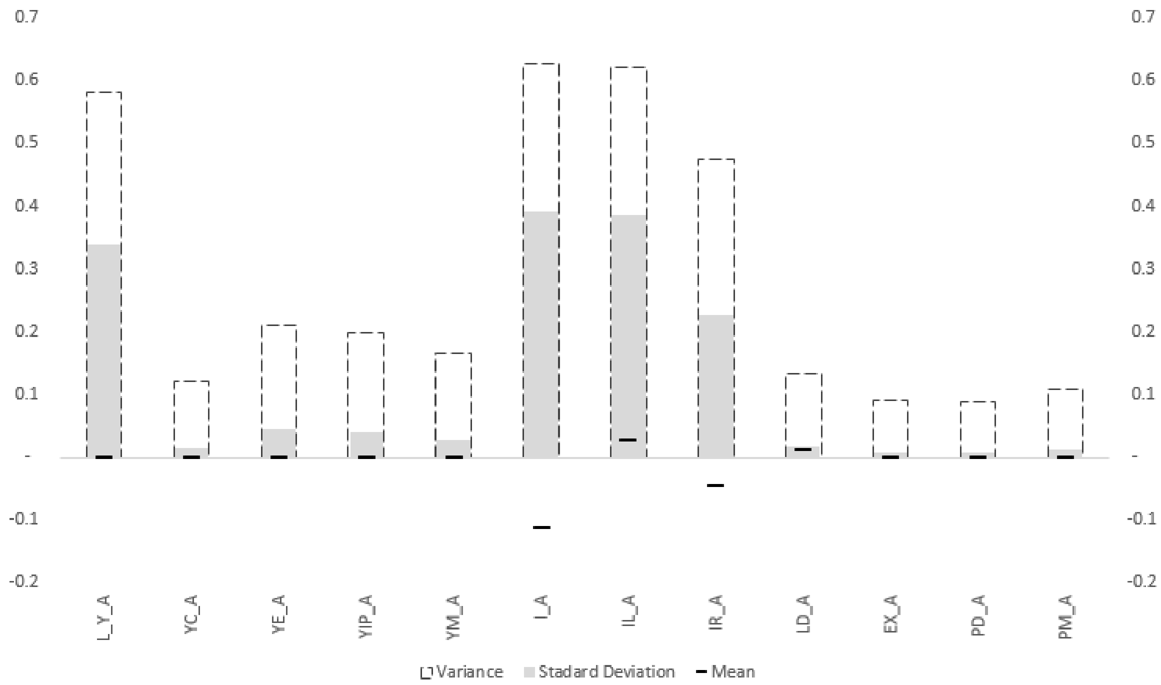
Note: c - calibratet; e – estimated.

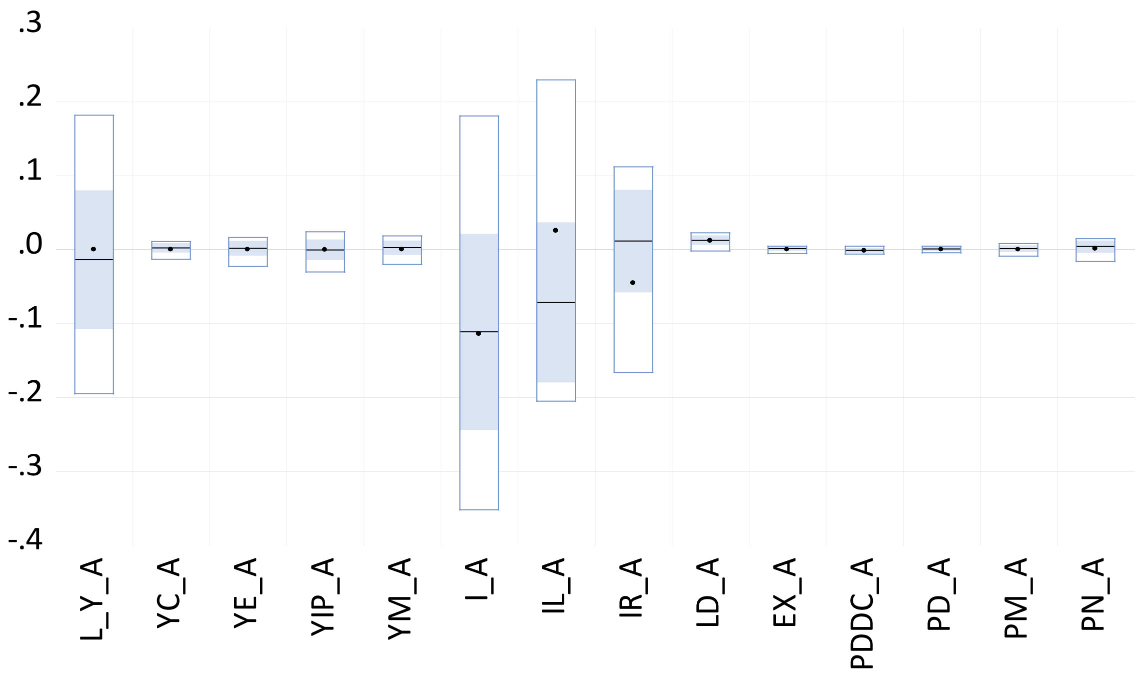
Table A4: RMSE of pre-pandemic and pandemic simulations for 2020-2021

Indicator	Pre-pandemic simulation	Pandemic simulation
Real GDP growth	8.6	5.2 *
Real household consumption growth	6.4	2.8 *
Real private investment growth	12.0 *	13.6
Real exports growth	55.6	20.5 *
Real imports growth	28.3	11.0 *
Inflation rate	0.8 *	4.0
Domestic supply prices growth	5.0	4.4 *
Import deflator growth	2.2 *	5.3
Exchange rate growth	1.5 *	4.3
Monetary policy rate	0.4 *	2.0
Loan interest rate	0.1 *	1.2
Credit stock growth	3.3	2.7 *
NPL rate	2.6 *	4.2
Unemployment rate	3.0	2.2 *
Average wage growth	11.2	8.5 *

RMSE values are calculated over year on year growth rates
The asterics indicates the lower RMSE between the two forecasts

Figure A1. Add factors mean, variance and standard deviation over 2010 - 2019

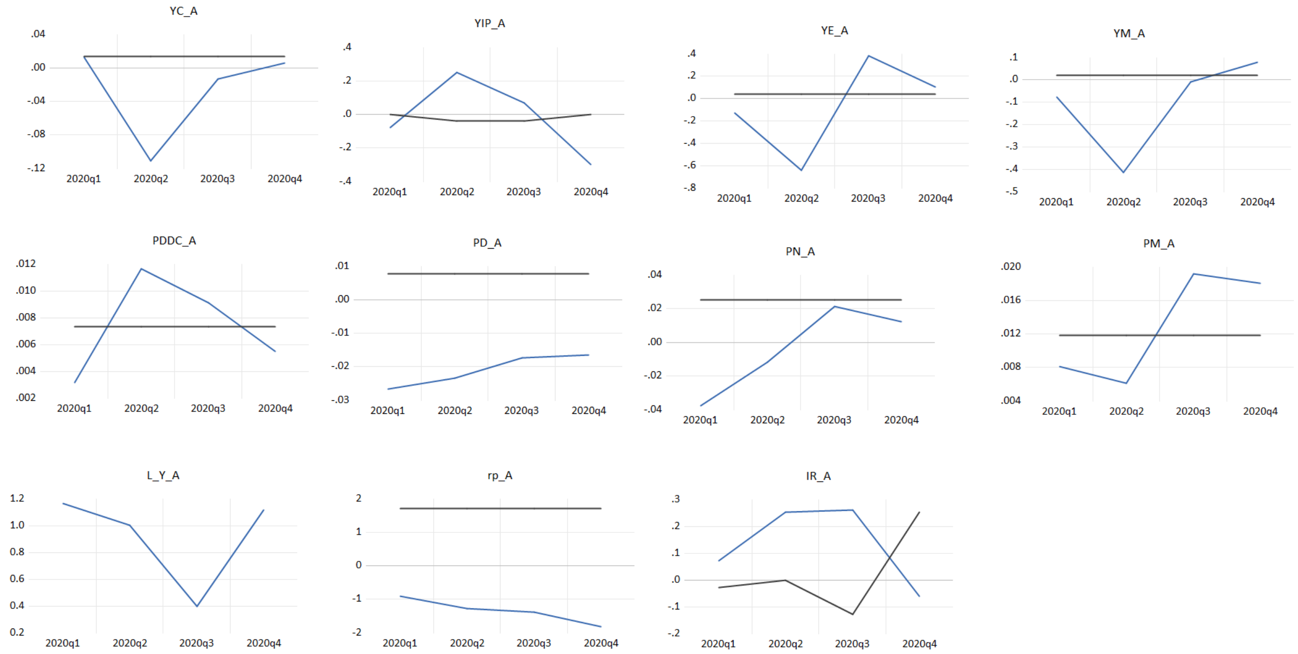




Note: Figure A6 shows a boxplots graph to summarize the distribution of add-factors for the main endogenous indicators. The box portion represents the first and third quartiles, and the difference between them represents the interquartile range. The black line in the centre of box represents the median and the shaded area approximates its 95% confidence interval. The black dot shows the mean. Most of the indicators feature a zero mean add factor (error) and small standard deviation. On contrast, financial market indicator appear with a non-zero mean. Moreover the mean is different from the median, indicating that the distribution of errors for financial market indicators is skewed. Partly, this outcome is influenced by the monetary policy rate indicator by means of being a policy toolkit. Monetary policy rate, which impacts financial market indicators, reacts to the decision making rather than to spontaneously macroeconomic indicators developments. Thus, monetary policy behaviour is reflected in the financial market indicators through loan rate channel.

Moreover, the period of interest is also characterized by increased banking market efficiency. These dynamics in financial market tend to produce un-robust estimations.

Figure A2. Add factors in pre-pandemic and pandemic simulations over the four quarters of 2020; black and blue line, respectively.



Note: In the IR_A chart, the black line is not flat because it is fine tuned to reflect the forward guidance policy

Figure A3. Comparison of pre-pandemic and pandemic simulations (blue and black line, respectively).

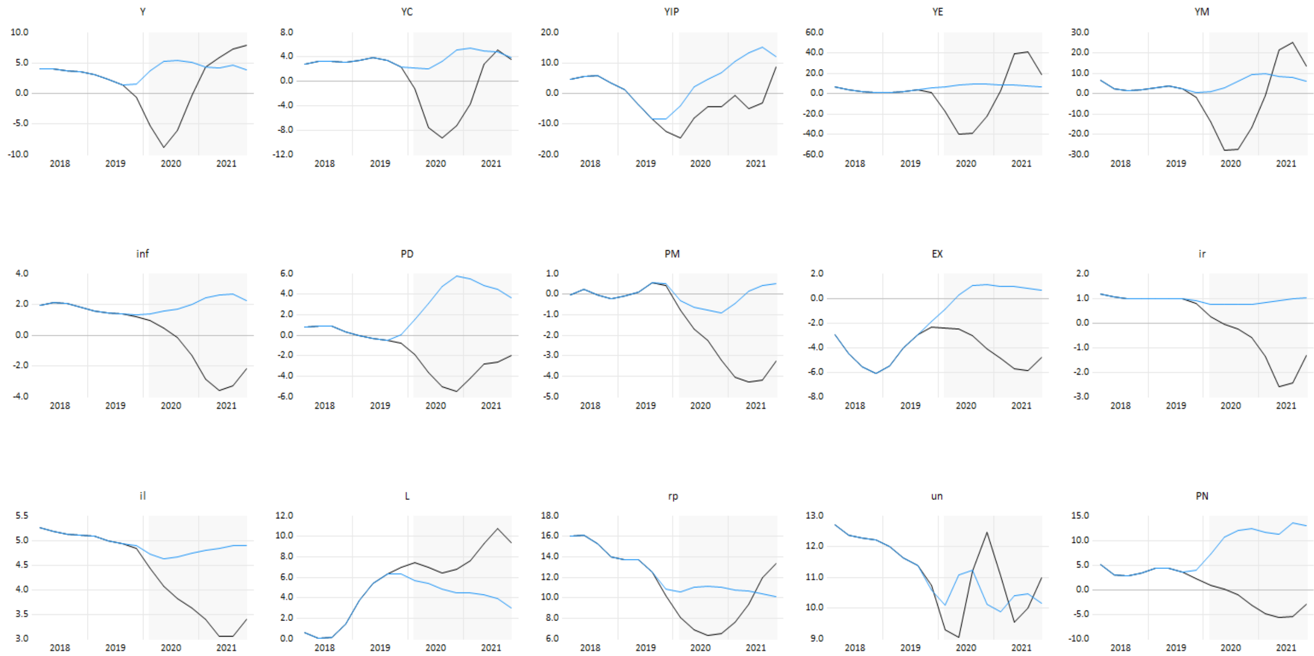
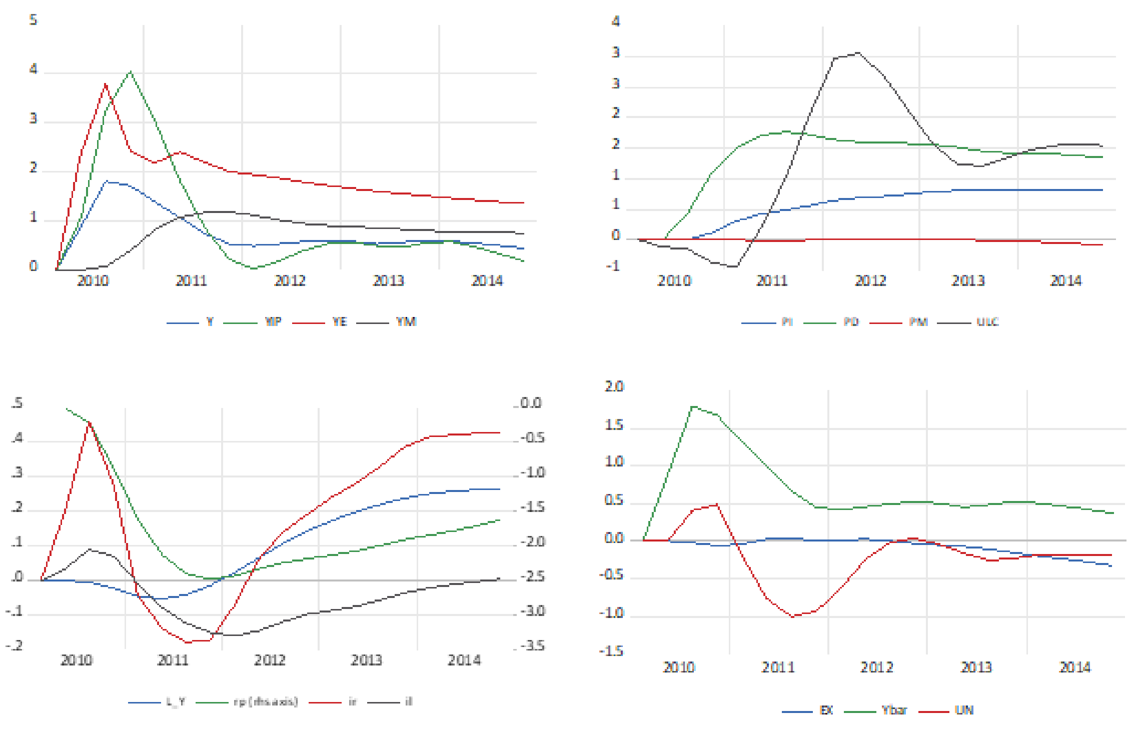


Figure A4: Pandemic forecast uncertainty bands 2020-2021 and actual data (black line actual data, blue-shaded area 10-90 uncertainty bands)

Figure A5: IRF of 1% increase in foreign demand over 2010-2014



Note: Figure A5 shows the impulse responses of a 1% increase in foreign demand. All indicators react as expected. The shock foreign demand is absorbed within 3 years.

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