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The determinants of output losses during the Covid-19 pandemic

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1. Introduction

The Covid-19 pandemic triggered a global recession in 2020 which even surpassed the one witnessed during the global financial crisis. A striking feature in this respect concerns the enormous heterogeneity in the economic contraction across countries. While some countries still experienced positive growth despite the global downturn, others report two-digit drops in economic activity. The key question in this respect concerns the factors aggravating the economic contraction in some countries more than in others.

We examine the role of distinct factors in shaping the extent of cross-country heterogeneity in economic activity by paying particular attention to the following ones: (i) initial conditions and (ii) intra-year factors involving policy and behavioural changes.

To determine the key drivers for the output losses, we employ a large data set involving 130 countries and several indicators on both macroeconomic conditions prior to the crisis and elements relevant for economic activity in the course of the pandemic. In order to alleviate over-parametrization problems, we use Bayesian model averaging (BMA) techniques to conduct inference on the determinants shaping the heterogeneity in the output contraction across countries.

2. Data and methodology

In this study we consider linear cross-country regressions. These are commonly plagued by the small number of observations (N) resulting in over-parametrization problems due to a large number of potential regressors (K). However, ignoring a set of regressors may induce severely flawed inference. To alleviate these problems, we use Bayesian model averaging (BMA) techniques (Fernandez et al., 2001b).

Model averaging considers a model space $\mathcal{M}$ consisting of $J$ individual models $M_j$ ($j = 1, \ldots, J$). With $\theta$ denoting the vector of unknown parameters and $y$ the endogenous variable, model-specific inference is given by $p(\theta|M_j, y)$. The model space $\mathcal{M}$ typically comprises combinations of the (non-constant) regressors, resulting in a cardinality of $J = 2^K$. Formally, based on the $J$ individual model outcomes, Bayesian model averaging aims at integrating out the inherent model uncertainty using the posterior model probabilities $p(M_j|y)$, which are proportional to the model-specific marginal likelihoods $p(y|M_j)$ and the prior model probabilities $p(M_j)$:

$$p(\theta|y) = \sum_{j=1}^{2^K} p(M_j|y)p(\theta|M_j, y).$$

1 This involves the intercept $\alpha$, slope coefficients $\beta$ and the variance of the error term $\sigma^2$ in case of a linear regression model.
Fig. 1. Countries in the sample.

| Table 1 | List of variables. |
|----------------|-------------------|
| **Variable** | **Description** | **Source** |
| **Dependent variable** | Growth rate of GDP in 2020 | IMF |
| **Variables for initial conditions (measured in 2019)** | | |
| GDP per capita | PPP adjusted, in logs | PWT 10.0 |
| Population density | in logs | World Bank |
| Human capital index | Human capital index based on years of schooling and returns to education | PWT 10.0 |
| **Consumption** | | |
| Government consumption | Share in GDP | |
| Exports | | |
| Imports | | |
| Mining, manufacturing, utilities | | |
| Construction | | |
| Hotels, restaurants and retailing | Share of value added in GDP | PWT 10.0 |
| Transport and communication | | |
| Other service activities | | |
| **Government debt** | General government gross debt to GDP | Eurostat; IMF |
| **Foreign exchange reserves** | Foreign exchange reserves to GDP | IMF |
| **Youth dependency ratio** | People younger than 15 (percentage of working-age population) | World Bank |
| **Old-age dependency ratio** | People older than 64 (percentage of working-age population) | |
| **Intra-year variables (measured in 2020)** | | |
| **Stringency** | | |
| **Economic support** | Number of days with index values > 50, in logs | BSG |
| **Government response** | | |
| **Containment health** | | |
| **Fiscal measures** | Fiscal measures to GDP(2019), in logs | BSG |
| **Income support** | Income support to GDP(2019), in logs | |
| **CM Index** | Interaction term of confirmed deaths and stringency index | |
| **Confirmed cases** | Number of confirmed Covid-19 infections per 10,000 inhabitants, in logs | BSG |
| **Confirmed deaths** | Number of confirmed deaths due to COVID-19 per 10,000 inhabitants, in logs | |

PWT and BSG refer to Penn world tables (Feenstra et al., 2015) and Blavatnik School of Government (Hale et al., 2020).

The endogenous variable of the linear regression model is given by the GDP growth rate in 2020. We follow Chudik et al. (2020) and use the most recent IMF forecasts (IMF, 2020; 2021). Fig. 1 depicts the \( N = 130 \) countries in our sample. Countries in white have been removed due to missing data. A list of the explanatory variables used along with a detailed description is presented in Table 1.

Concerning prior elicitation, we follow standard practice and consider non-informative and improper prior densities on \( p(\alpha) \propto 1 \) and \( p(\sigma) \propto \sigma^{-1} \). We use the Bayesian risk inflation criterion (BRIC) on the slope parameters \( (\beta) \) as proposed by Fernandez et al. (2001a), together with a uniform prior on the model space \( p(M_j) \propto 1 \). Estimation has been carried out using the R-package bms (Zeugner and Feldkircher, 2015) based on 100,000 posterior draws after discarding the first 10,000 draws as burn-ins.

3. Results

The results are summarized in Table 2, where the first block excludes continental fixed effects and the second includes them. Variables with posterior inclusion probabilities (PIP) larger than 50% are indicated in bold.

The results highlight the role of adverse initial conditions as the dominant factors in driving the cross-country differences. In particular, contact-intensive service industries are at the core in this respect. This concerns both the sector Hotels, restaurants and retailing, which contains accommodation and food service sectors.
activities and the sector Other service activities, which contains arts, entertainment and recreation activities.\(^2\) The BMA analysis attaches the highest posterior inclusion probabilities to these two variables. The two identified variables concern the supply side.\(^3\) We find no evidence for a significant contribution of any component of the demand side. While a high government consumption share is perceived as mitigating excessive cyclical fluctuations on account of its stable temporal profile, our results do not support this hypothesis. The coefficient (though economically sizeable) even has the wrong sign but a PIP far below 50%.

Further variables in our group on initial conditions concern demography and income. We find no evidence for a significant contribution of any of these variables. The same applies also for the initial public debt ratio and the extent of foreign exchange reserves, both of which show up with negligibly small coefficients. Although these two variables have played a central role in many previous recessions, their presumed little relevance to the contraction in output in 2020 should be taken with caution, as delayed adverse feedback effects involving these two variables might put a drag on the economic recovery in the years ahead.

We barely find evidence for a significant contribution for the intra-year factors under scrutiny. This concerns especially policy measures, involving both policies related to containment measures to impair the spread of the virus, but also to economic support activities. However, the variable confirmed deaths emerges with a high PIP and a negative coefficient. This corroborates the finding in König and Winkler (2020). They interpret this variable as a proxy of the extent of increased voluntary spatial distancing driven by precautionary motives, which in turn reinforces the contraction in economic activity.

We have checked the role of further variables (not depicted in Table 1) related to country classifications (advanced versus emerging market economies, etc.), regional/geographical characteristics and alike. All these variables appeared to have little explanatory power. In addition to using the variables in singular form, we have exerted great effort to examine any kind of interactions of the variables listed in Table 1; however, none turned out to be of statistical significance. This also applies to the CM index.\(^4\) We also examined the stability of our results with respect to the measurement of the intra-year factors. To this purpose, we considered, among others, the mean, the median and the sum of the indicators’ values across the year, but also threshold values distinct to the value of 50 as considered in the baseline specification. Our results are robust to any of these extensions.

Finally, we assessed our results with respect to different measures for the output contraction. While our baseline results are based on IMF projections, we also considered those of the OECD and the World Bank (most recent projections in each case). Our results remain unchanged to these modifications.

### 4. Conclusion

We use BMA techniques to examine the cross-country heterogeneity of the output contraction in the wake of the Covid-19 pandemic in 2020. Our results underscore the significant role of

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\(^2\) A more detailed classification is available for some countries and would be advantageous within our evaluation. However, this would reduce the quality of the estimation, as the number of countries in the sample would be considerably smaller.

\(^3\) Since we have a full sectoral coverage on the supply side, we exclude the share of the agricultural sector in GDP to avoid collinearity. The same problem applies for the demand side where we exclude the investment share.

\(^4\) In contrast to our results, the evidence put forward in König and Winkler (2020) stresses the importance of this variable. The distinct results might be due to a different country coverage and a different data frequency.

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**Table 2**

| Variable                  | PIP  | mean  | SD   | PIP  | mean  | SD   |
|---------------------------|------|-------|------|------|-------|------|
| GDP per capita            | 0.060| −0.020| 0.144| 0.035| −0.008| 0.109|
| Population density        | 0.056| 0.011 | 0.075| 0.034| 0.001 | 0.052|
| Human capital index       | 0.051| −0.013| 0.171| 0.041| −0.006| 0.149|
| Household consumption     | 0.039| −0.014| 0.573| 0.042| −0.040| 0.631|
| Government consumption    | 0.163| −1.401| 3.730| 0.146| −1.258| 3.542|
| Export share              | 0.047| 0.007 | 0.564| 0.063| 0.020 | 0.805|
| Import share              | 0.072| 0.145 | 0.780| 0.171| 0.551 | 1.490|
| Mining, manufacturing, utilities | 0.065| −0.002| 0.014| 0.045| −0.001| 0.011|
| Construction              | 0.047| 0.003 | 0.025| 0.058| 0.006 | 0.033|
| Hotels, restaurants and retailing | 0.964| −0.252| 0.085| 0.903| −0.222| 0.100|
| Transport and communication | 0.044| 0.000 | 0.025| 0.029| 0.001 | 0.021|
| Other service activities  | 0.974| −1.149| 0.048| 0.721| −0.090| 0.068|
| Government debt           | 0.099| −0.001| 0.005| 0.236| −0.005| 0.011|
| Foreign exchange reserves | 0.045| −0.044| 0.398| 0.057| −0.092| 0.539|
| Youth dependency ratio    | 0.077| 0.002 | 0.010| 0.047| 0.001 | 0.007|
| Old-age dependency ratio  | 0.147| 0.011 | 0.032| 0.146| 0.011 | 0.033|

Stringency

Economic support

Government response

Containment health

Fiscal measures

Income support

CM index

Confirmed cases

Confirmed deaths

| Continent fixed effects | No   | Yes  |
|------------------------|------|------|
| Number of countries N  | 130  | 130  |
| Posterior model size   | 3.621| 8.541|
| Correlation model prob.| 0.997| 0.992|

PIP stands for posterior inclusion probability, and SD is the posterior standard deviation. Variables with a PIP ≥ 50% in bold. Correlation model prob. measures the correlation between analytical and simulated posterior model probabilities. High correlation indicates convergence of the sampler.
adverse initial conditions in the form of a high share of contact-intensive service industries. Heterogeneity is reinforced by behavioural changes on the part of residents owing to increased mortality fears, proxied by actual mortality rates, inducing them to voluntarily engage in progressive spatial distancing. We find no role for policy, both in the form of virus related containment measures and economic support activities. Our results are robust to a gamut of robustness checks.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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