Is Job Preservation too Expensive? An Estimate of the Effects of the Covid Pandemic and the Economic Policy Response on the Labour Market

Karel Šafr[1] | *Prague University of Economics and Business, Prague, Czech Republic*
Jan Čadil[2] | *University of West Bohemia, Pilsen, Czech Republic*
Tomáš Pavelka[3] | *Prague University of Economics and Business, Prague, Czech Republic*

Received 30.9.2024, **Accepted** (reviewed) 24.10.2024, **Published** 13.12.2024

Abstract

The Covid-19 pandemic triggered a massive economic policy response in all developed countries. There were various approaches that governments adopted with a variety of possible aims and outcomes. In our research we focus on estimating the effects of Covid-19 on the Czech Republic, a small open economy, which was typical in that it had high mortality, a long lockdown and a focus on job preservation. Using three different methods – input-output, CGE and ADL, we estimate the industry-level impact of the pandemic, taking induced effects into account. We show that, besides industries that were explicitly harmed like accommodation or transportation, some industries like construction seem to be implicitly vulnerable as well. This is an important finding especially for any future policy responses. Regarding the economic policy itself, we conclude that it was successful in terms of preserving jobs, but the expenditures were probably too high to call it an efficient policy response.

Keywords	***DOI***	***JEL code***
Labor market, economic policy, Covid pandemic, CGE model, econometrics	*https://doi.org/10.54694/stat.2024.53*	*E17, E24, E65*

[1] Department of Statistics and Probability, Faculty of Informatics and Statistics, Prague University of Economics and Business, W. Churchill Sq. 1938/4, 130 67 Prague 3, Czech Republic. Corresponding author: e-mail: karel.safr@vse.cz. ORCID: <https://orcid.org/0000-0003-3108-6540>.

[2] Department of Economics and Quantitative Methods, Faculty of Economics, University of West Bohemia, Univerzitní 22, 306 14 Pilsen, Czech Republic. E-mail: cadil@kem.zcu.cz. Also Unicorn University, Prague. ORCID: <https://orcid.org/0000-0001-7043-796X>.

[3] Department of Managerial Economics, Faculty of Business Administration, Prague University of Economics and Business, W. Churchill Sq. 1938/4, 130 67 Prague 3, Czech Republic. E-mail: tomas.pavelka@vse.cz. ORCID: <https://orcid.org/0000-0002-0939-4566>.

INTRODUCTION – LITERATURE REVIEW

The Covid-19 pandemic is still having serious effects on the global and local economies and society. A sharp economic downturn was witnessed in many developed countries in 2020 (Lucchese and Pianta, 2020; Coibion et al., 2020) and some researchers believe that the economic crisis can be even longer and worse than the GFC (Global Financial Crisis) that struck between 2007–2009 (Baker et al., 2020; Brown and Rocha, 2020). In June 2020, the World Bank anticipated the global GDP to shrink by 5.2%, which would be among the worst results since the Second World War (World Bank, 2020). The severity of the Covid-fueled crisis has also been demonstrated in a sharp decrease in new business startups, a fast increase in actual and expected firm dissolutions (Bartik et al., 2020; Bosio et al., 2020; Fairlie, 2020), high liquidity risks (Brown et al., 2020) and a rapid decline in world-wide trade (CCSA, 2020). This situation is further reinforced by a limited access to bank finance (Demirgüc-Kunt et al., 2020) and other sources of finance such as venture capital (Howell et al., 2020). EU member states were of course no exception – the EU witnessed a sharp –5.9% drop in GDP in 2020, accompanied by a decrease of employment by 1.7% (Eurostat, 2020). Nevertheless, the data show quite an asymmetric impact of the Covid-19 on economies around the world including the EU. Spain, Portugal, Greece and Italy were hit hard in comparison to other member states, while Ireland even had a positive GDP growth. The Czech Republic with its –5.8% GDP growth rate and –1.1% fall of employment was rather around the average among the EU countries. Such an asymmetric impact on national economies was of course inevitable for many reasons. Some of them are even out of the economic area (social, cultural or demographic conditions). From the economic reasons, contemporary studies mainly point at the structure of the economy, the openness of the economy and the extent of lockdowns and regulations along with fiscal stimuli. These factors probably played (and are still playing) key roles in the impact of Covid-19 on the economy.

Not surprisingly, the estimation of the economic impacts of Covid-19 has become a priority for many governments and scholars alike. Various methodological approaches have been used so far, with a clear dominance of input-output based models and CGE models. The main advantage of these models is their structural orientation that considers supply chains and demand linkages. As Covid-19 impacts the economy asymmetrically regarding the industries (some are under lockdown, some are not) the economic structure plays a crucial role in modelling the crisis' impact. Moreover, the Covid-19 crisis is a supply-demand crisis, therefore both sides must be considered.

So far published input-output and CGE based studies differ mainly in their purpose – the spectrum ranges from worldwide large macroeconomic studies to nationally oriented and specifically industry-oriented analyses. For example, Mandel and Veetil (2020) used input-output data on 56 industries in 44 countries concluding that the reduction of the world GDP was about 7% at the early stage of the crisis.

Walmsley et al. (2020) focused on the macroeconomic impact of mandatory business closures in the U.S. and other countries as well. They utilized modified GTAP model, dealing with the impact without countermeasures being accounted for (which is, however, typical even for most of other similar studies). They estimated that without supportive policies the impact of lockdowns and other Covid regulations would result in a huge 20.3% decrease in GDP and a 22.4% decrease in employment in the U.S. They only calculated the length of closures to 3 months, while doubling the length would also more than double the economic losses. They stressed that the impact on employment was so strong because services that are labor-intensive were more negatively impacted by the closures than was industry.

Richiardi et al. (2020) used dynamic input-output model with parametrization based on survey among 250 UK economists. They concluded that almost one quarter of all jobs in UK were at risk, with the Accommodation & Food industry contracting by over 80%, Transport & storage by over 40%, and Manufacturing by almost 30%.

Giammetti et al. (2020) identified key "sectors" in the Italian economy´s supply chain. Their results suggest that closing down those key sectors led to a loss of 52% of the total value added of the Italian economy, out of which 30% has been indirect. Havrlant et al (2021) used input-output framework with three possible scenarios, in which the middle scenario estimated that the GDP decreased by 7.2 % due to the economic lockdown in Saudi Arabia.

Guan et al. (2020) used enhanced regional input-output model concluding that even those countries that are not directly affected by Covid-19 and lockdowns will suffer great losses due to global supply chains. Such cascading impacts will often take place in low- and middle-income countries. Open and highly specialized economies will probably suffer large losses according to their study, too.

Mariolis et al. (2020) focused solely on Greek tourism, which has been severely hampered during the Covid-19 crises, and its impact on the total economy. They estimated the impact to be about a 2.0% to 6.0% decrease in GDP followed by the decrease in the levels of employment of about 2.1% to 6.4%.

Of course, structural analysis makes sense not only for assessing the pure economic impact but also regarding the spread of the virus and the health working population itself. Osotimehin and Popov (2020) divide the U.S. economy into "essential" and "non-essential" sectors showing that the "cascading effects" that are actually based on supply chain and demand linkages increase the health but also economic risks substantially in both groups, but mainly in certain industries (like retail, textile or transportation). Keogh-Brown et al. (2020) used a CGE model to estimate the economic burden of Covid-19 including the cost caused by school closures, that alone could reach 7.3 % of the United Kingdom's GDP even after pandemic suppression.

Besides the input-output based estimates and CGE, several different approaches have occurred as well, mainly based on standard prediction VAR, ADL or ARIMA models. An interesting contribution in this area comes from Fezzi and Fanghella (2020) who use high frequency data from the Italian power market to quickly assess the impact of Covid measures (lockdowns). Similarly, Pragyan et al. (2022) used high frequency data about Nitrogen Dioxide emissions and found a 10 percent decrease of industrial production following the containment measures.

Microeconomic based models are still very scarce as the microeconomic data availability is still quite limited. An interesting study based partly on microeconomic data comes from Cakmakli et al. (2021). They quantified the Covid-19 macroeconomic effects using a combination of a virus spreading model and sectoral linkages, and they pinned down the magnitude of demand shocks by real time credit card purchases. In line with findings of Guan et al. (2020) they estimate the economic costs of Covid-19 to be much larger for an open economy because of the low external demand that amplifies the loss by international input-output linkages.

As described above, usually input-output framework or CGE models are being used for assessing the impact of external shocks like Covid-19 on the economy. Nevertheless, both these methods have their strengths and weaknesses. I-O models are quite straightforward, easy to interpret and able to analyze the impact in deep detail, regarding the industries or products. However, the input-output method is based on fixed proportions of intermediate use to production, meaning that it does not allow for an analysis of the changes in the production function's structure, and it does not allow for any substitution. Moreover, lack of supply side constraints along with the absence of household and government budget constraints and fixed prices are usually put forward as other critical issues (Gretton, 2013). Therefore, CGE models are often treated as superior to I-O for impact evaluation purposes. CGE models allow for substitution in functions (being often of CES nature) and are also generally presented as more reasonable abstractions with higher flexibility in comparison to standard I-O (Partridge and Rickman, 2010). On the other hand, CGE models are difficult to handle, especially in the case of a detailed economy breakdown where researchers face missing data or elasticity estimation problems. Such situations often yield inaccurate results, and a need for systematic ex post evaluations of CGE simulations arises (Kehoe et al., 2017; Kehoe, 2003). From this point of view, it seems reasonable to employ both methods to assess the impact of Covid-19, with emphasis on industrial breakdown and international trade. However, as both methods are rather static, it seems reasonable to employ at least one dynamic estimate to cross validate the results. As stated above, VAR, ARIMA or ADL models are typical examples of such a dynamic approach that could bring the missing dynamic piece into our estimation puzzle.

The purpose of this study is to estimate the effects of the Covid-19 pandemic on the economy of the Czech Republic using input-output framework along with the CGE estimation. The Czech Republic is quite a specialized (dominantly in the automotive industry) small and open economy, therefore it could have been in quite a risky situation according to previous findings of Guam (2020) or Cakmakli (2020). Moreover, the Czech Republic did not do well in Covid-19 mitigation – on the contrary, it was one of the worst countries regarding deaths per 100 000 or new cases per 100 000 in the world, consequently resulting in a long-lasting regulation policy (the Czech Republic was among the top 5 countries with the longest lockdowns in the world). The negative effects of lockdown on the economy can be even more severe due to such prolongation, as Walsmley et al. (2020) suggest.

From this point of view the analysis is quite unique. We are dealing with a small open economy with a high degree of specialization and a long and tight lockdown. That needs a detailed structured analysis on industry level as the pandemic and mitigation policy is likely to have an asymmetrical effect on the economy. For this purpose, we use three methods. The input output framework and modified CGE model should help us to uncover the effects of Covid-19 and subsequent mitigation policy on aggregate production and labor market, reflecting the Czech economy's structural specifics. To cross validate our findings we also estimate the effect by a rather traditional ADL estimate that focuses on the long term relationship between unemployment and production, allowing for a more dynamic approach in comparison to previous estimations. After that, we estimate the policy effects of government subsidy programs on the labor market.

1 DATA AND METHOD

In line with the studies outlined above, we use three different methods to assess the impact of Covid-19 on the Czech economy along with estimating the policy response effect – Input-Output analysis, modified CGE model and the autoregressive distributed lag (ADL) model.

Regarding the output variables we focus on general unemployment rate, jobs preserved and growth rate of the Gross Value added (GVA) in 2020. As the shock is assumed to be asymmetric, negatively affecting some parts of the economy more severely than others, we split the impact further among NACE Rev 2.1. industries (with partly aggregated services). An important task is to assess the impact of fiscal stimuli that have been undertaken during the Covid-19 pandemic. Their main purpose in the Czech Republic was to preserve employment. While the hours worked along with the GVA dropped down dramatically during the pandemic, because of closures and other pandemic measures, jobs/employment remained preserved by government policy. The difference between the real (official) change in unemployment and jobs and the estimated values should then yield the estimated policy effect.

At first, we use the standard multinational Input-Output model (based on world Input-Output tables; Timmer et al., 2015). It allows us to estimate the multiplicative effects of Final use changes on the economy by assuming the production structure (ratios of intermediate use to production on the level of each industry) is fixed over time. The model is calibrated onto the change of GVA from the reference figure. The reference figure is obtained from the prediction for the year 2020 at the end of 2019 by Czech National Bank (Czech National Bank, 2019), and the validation benchmark here is the officially published GDP growth rate (Czech Statistical Office, 2022). The gap between the growth estimate and real growth was 3.2 p.p. on the year-on-year rate. We assume that the effect of lockdowns and economic restrictions was similar all over the NACEs I-N (private services). We did the sensitive analysis of production (proportional decrease in output in I-N NACE) to fit the change of GVA to this value. Then, we analyze the effects on the final use, employment (and indirectly to unemployment) and structure of GVA.

Another advantage of this approach is that it will enable us to estimate the effects on GVA and employment for each industry. It takes into account the spillover/indirect and multiplier effects. Our model's primary data source are the official Input-Output tables estimated by the Czech Statistical Office for 2015 (Czech Statistical Office, 2022) and previously mentioned WIOT tables.

While more recent Input-Output tables for 2020 are available, we deliberately use the 2015 tables as our baseline. The 2020 tables already reflect the structural changes caused by Covid-19 and subsequent containment measures, which would distort our analysis. Using pre-Covid tables from 2015 allows us to capture the true impact of the pandemic by comparing the original economic structure with the Covid-induced changes.

As we said, the Input-Output models are based on fixed relationships. The key figure in this scheme are the technical coefficients. These coefficients can be calculated as the ratio of intermediate flow(x) from i-th industry to another one (j-th) to the production of j-th industry (z):

$$a_{ij} = \frac{x_{ij}}{z_j}. \tag{1}$$

These coefficients define the production functions of each industry. The matrix of these coefficients:

$$\mathbf{A}_{(nxn)} = a_{ij}. \tag{2}$$

The Input-Output system is closed, and there are two other essential relationships that help us define the relationship between GVA/production and final use. The closeness of the model to the production approach is:

$$\sum_{i=1}^{n} x_{ij} + \sum_{p=1}^{P} w_{pj} + imp_j = z_j, \tag{3}$$

where the w_{pj} items of GVA (p = 1, 2,… P, and it defines the level of detail of the GVA, e.g. the wages) and the imp_j is the import of j-th good. The closeness of expenditure approach:

$$\sum_{j=1}^{n} x_{ij} + \sum_{q=1}^{Q} f_{iq} + exp_i = \mathrm{z_i}, \tag{4}$$

where the f_{iq} is the items of final use (q = 1, 2, …Q, and it defines the level of detail of the final use, e.g. government consumption, household consumption…). From these equations, we can finally obtain the Leontief matrix:

$$L = (\boldsymbol{I} - \boldsymbol{A})^{-1}, \tag{5}$$

where $\boldsymbol{I}$ is the diagonal unit matrix (eye) and L is the Leontief matrix (column sums of this matrix are Leontief multipliers). This matrix defines the relationship between final use and production. When this matrix is multiplied by the proportion of GVA to production, it can determine the relationship between the final use and GVA.

We use the modified CGE model (Hosoe et al., 2015). This model is based on several agents, like the maximization of utility of households, government, firms, foreign and other components. It should be mentioned that the core of the domestically produced goods is based similarly on I-O tables – the technical coefficients (Leontief production function is there used) and the structure of the intermediate goods for domestic production is fixed. But another part of this is flexible (to calibrated coefficients) – for example, the relationship to capital, employment or the transfer from domestic goods to imported ones. We calibrate this model to relevant data from the Czech Statistical office (Czech Statistical Office, 2022). The CGE model is used in a very similar way. We did a sensitive analysis of its restrictions to analyze NACEs which fit the drop of GVA. It should be mentioned that the CGE model is more flexible, and we expect to obtain a milder effect than from the I-O model with a strictly fixed relationship. We use this model in a slightly untraditional way – we are looking for the size of the shock (restrictions into production which simulates the lockdown) that corresponds to the measured (real) shock into GVA. From this we calculate the effect on unemployment.

The crucial role in CGE models is the maximization of utility. Our model is the Standard CGE model by Hosoe et al. (2015). This model is a simultaneous system of 24 types of equations multiplied by a count of input factors and a count of industries, for eq. The model with two factors and ten industries leads to 296 equations to be solved. This model is based on the maximization of utility. Maximization of utility is quite a problematic concept from a practical point of view. This task is transformed into the maximization of consumption. One of the most used consumption functions is the Cobb-Douglas function; then, the utility maximization can be expressed as:

$$U = \prod_{i=1}^{n} f_{iH}^{\alpha_i} . \tag{6}$$

The f_{iH} is the consumption of i-th good of households, and α_i is the coefficient which defines the weight of each good in consumption functions and its equilibrium can be easily estimated as the ratio of that good to the total sum of consumption. Household consumption is limited by their income and savings minus taxes. In our set of equations, these results in demand:

$$f_{iH} = \frac{\alpha_i}{p_i} * INC_H , \tag{7}$$

where p_i is the price of i-th good and H is income of households (Income from wages, capital income, savings minus taxes).[4] We assume that the households are owners of companies (that's why their income is from capital).

The government and the investment is often based on the following fixed structure of consumption, which is ultimately the same as the maximization of utility of households:

$$f_{iG} = \frac{\mu_i}{p_i} * INC_G . \tag{8}$$

The INC_G is a government income. The INC_G represents government income which consists of tax revenues from multiple sources: import taxes, factor taxes (taxes on labor and capital income), production

[4] The household income (INC_H) in our model corresponds to the disposable income as defined in the System of National Accounts. It includes all household income sources (wages, mixed income, property income, social benefits) minus obligatory payments (taxes, social contributions). This definition ensures consistency with national accounting standards and provides a comprehensive measure of households' spending capacity and its aligned to our data.

taxes (including VAT and excise taxes), minus government savings. This comprehensive definition captures all main tax revenue streams in line with the standard CGE model structure. The savings in both (private and public) are defined as a fixed ratio of income.

The domestic production of goods is calculated in several steps (stages). In the first stage is solved the problem of GVA inputs (factors). This is the maximization of profit subject to the C-D function. In the second stage is solved the maximization of profit subject to the Leontief production function (fix relationships), and in the third phase is solved the mixture of domestic and foreign goods in the final mix of goods. In the first stage is the firms' production functions used as constraints in profit maximization:

$$\max_{y_j, W_{qj}} \pi_j^y ; where\, \pi_j^y = p_j^y y_j - \sum_{q=1}^{Q} p_q^f w_{qj}, \tag{9}$$

subject to:

$$Y_j = b_j \prod_{q=1}^{1} w_{qj}^{\beta_{qj}}. \tag{10}$$

The β_{qj} is share coefficient of the q-th good in the production function of i-th goods. The second stage of the product is just a Leontief production function – proportionally mixes the goods from the first stage with fix ratio (by technical coefficients eq.) with intermediate input. Armington functions will solve the foreign entities. These functions introduce small differences between domestic and foreign goods by "cost" of transport/taxes. It's assumed that foreign goods are imperfectly substitutable with domestic.

The autoregressive distributed lag (ADL) models use the lagged dependent and independent variables to explain the dependent one. ADL models are one of the most used models for estimating the long term and short term relationship between the economic variables. For a final comparison we fit the ADL (5, 1) model of the relationship between unemployment and GVA. This model is based on seasonally adjusted rates. The model has a wide distribution of the error term (not typical) but without prevalent autocorrelation. Both variables (GVA and unemployment) have a unit root of 1 (we did the ADF test), and the residuals were stationary. According to the results, we can state a long-term relationship (Granger, 1969). This all was also proved by the standardised Granger test and ADF test in the t-series library (Trapletti and Hornik, 2022). The standard ADL(p, q) model can be written as:

$$Y_t = \beta_o + \beta_1 \mathrm{Y}_{\mathrm{t}-1} + \beta_2 Y_{t-2} + \cdots \cdots + \beta_p Y_{t-p} + \theta_1 X_{\mathrm{t}-1} + \theta_2 X_{t-2} + \cdots \cdots + \theta_q X_{t-\mathrm{Q}}$$

The Y_t (rate of unemployment) depended on the variable used as a lagged explanatory variable, and X_{t-1} independent explanatory variable – GVA growth rate (lagged). We used seasonally adjusted y-o-y rates published by the Czech Statistical Office (Czech Statistical Office, 2022).

2 RESULTS

Using three different methods to assess the impact of Covid-19 on the Czech economy including the estimation of policy effects yields heterogenous results. That is not very surprising. While I-O analysis is static with no allowance for input substitution, the CGE model is more complex and flexible based on agent's optimization, and it can be viewed as a corrected I-O model in a way. The ADL model is then not structured but dynamic, allowing us to capture the short term and long term relationship between production and labor. Table 1 illustrates the results.

Table 1 Share of positive answers to job search questions and item-response probabilities

	Input–Output	CGE	ADL
	% change of employment	% change of employment	% change of employment
Agriculture, forestry, fishing	–1.860	–0.202	–
Mining, manufacturing	–1.589	–0.422	–
Automotive industry	–1.582	–0.418	
Electricity, gas, water, waste	–1.092	–0.184	–
Construction	–1.013	–5.671	–
Trade	–1.107	–0.005	–
Transport	–1.400	–0.965	–
Accommodation	–10.575	–8.258	–
Services (private)	–6.356	–9.375	–
Services (public)	–0.125	–1.445	–
Other activities	–0.507	–0.006	**–**
Total estimated change of employment	**–2.270**	**–1.360**	**–**
Estimated unemployment rate	**4.02**	**3.49**	**3.16**
Official unemployment rate	**2.55**	**2.55**	**2.55**
Policy effect on unemployment	**–1.47**	**–0.94**	**–0.61**
Policy effect on jobs preservation	**19 527**	**14 387**	**10 308**

Source: Authors

Our results suggest that the Covid-19 pandemic and subsequent mitigation measures had expectedly asymmetric impacts on the economy. Obviously, the Accommodation and private service sector have been struck most severely. However, that is quite predictable as these industries have been locked down and heavily regulated. This holds true regardless of the method we use. Nevertheless, several results differ quite substantially depending on the method. We can see that the input-output model splits the impacts more evenly among industries that were indirectly affected in comparison to CGE, also with a higher estimated total effect on employment. The CGE model predicts a higher impact of the pandemic on Construction and Public services, but considerably lower on other industries including Automotive. As the Czech Republic is largely dependent on the automotive industry, this seems like good (and a bit surprising) news. Taking a look at the ADL model estimate, we may also assume that the CGE model probably offers more realistic results. The total effect on unemployment and employment alike is close for the ADL and CGE estimates. Employing the ADL as a sort of cross validation tool seems interesting even from the methodological point of view. We then may assume that the total effect but also the industry-level effects of CGE are likely to represent the impact of Covid-19 better in comparison to simple input-output analysis.

Regarding the policy effects we can see that there was a positive effect of government policy on preserving jobs and thus lowering possible unemployment. The effect varies according to the method we use from decreasing the unemployment rate by 1.47% to 0.61%. Focusing on the CGE model as a modest estimate, we may conclude that the government policy successfully preserved approximately 14 000 FTE jobs with its policy.

Considering the total cost for Programs Antivirus A and B, that have been major channels for preserving jobs in affected firms, we may at least approximately estimate the cost of one job that has been saved by this policy. Both programs spent 23.7 billion CZK (almost 1 billion EUR) on employee wage compensations, meaning that the average cost of one job preserved was almost 1.7 million CZK (71 thousand EUR). Knowing that the GDP per capita in 2020 was 532 180 CZK (21 thousand EUR) means that the cost of preserving the job was three times more expensive than the job's production. Such a situation is vastly inefficient and the policy measures undertaken in the Czech Republic should definitely be questioned.

The CGE model appears to provide more realistic results for several reasons. Unlike the I-O model, it captures price adjustments and allows for substitution between production factors, which is crucial during supply-side shocks like Covid-19 lockdowns. The CGE model also incorporates behavioral responses of economic agents to changing market conditions. This flexibility, combined with better alignment with ADL estimates, suggests that the CGE framework better reflects the actual adjustment mechanisms in the economy, particularly evident in sectors like Construction and Automotive.

It should be noted that our estimates for public services might overstate the employment effects, as these jobs would likely have been preserved through alternative government funding mechanisms in the absence of the Antivirus program. Therefore, the estimated impact on public services should be interpreted with caution as it represents more of a reallocation of government support rather than actual job losses.

CONCLUSION

The Covid-19 pandemic and the subsequent series of lockdowns and other containment regulations imposed by the Czech Republic and all developed countries worldwide started an inevitable economic downturn. In comparison to the crisis that struck a decade ago this one is not of an economic nature and is not purely demand-driven but more likely supply-demand driven. This makes the crisis unique as the solution does not depend on economic measures but on the ability to contain the virus and put the economies back into a normal situation. Governments on one hand were forced to impose various restrictions to contain the spread of the virus, on the other hand they used various fiscal stimuli to "soften the landing" and protect workplaces and companies from dissolution. Of course, governments but also other stakeholders are therefore highly interested in estimations of Covid-19 pandemic impact on the economy. Many various studies emerged since 2020 dealing with such estimates from different perspectives. In our contribution we combine three rather standard approaches. To deal with the structural nature of the Covid-19 shock, we employ input-output framework and then the CGE model, that is in fact an extension of input-output analysis. Truly, the shock is supply-demand led which needs to take both demand and supply linkages into account. Moreover, the shock is asymmetric, affecting some industries more than others (even due to specific nature of lockdowns themselves). To add some more dynamic perspective into our estimate we add an autoregressive distributed lag model (ADL) to estimate the relation between the unemployment rate and the gross value added. Such an addition also serves as a benchmark for our input-output and CGE estimates, which are rather static. On this ground we may conclude that the CGE model brings probably better results than the simple input-output estimate.

Our estimates suggest that the impact of the Covid-19 pandemic and its mitigation truly had asymmetric impacts on the Czech economy. While we naturally see the most severe negative effects on Accommodation, Transportation and Services, which have been directly hit by the mitigation policy, we may also anticipate quite substantial negative effects on Construction, while the Automotive industry may suffer less than has been expected.

From the policy impact point of view, we can say that the policy itself has been at least partially successful in preserving jobs in the economy. The unemployment rate could have reached 3.49 % but officially it was only 2.55 %. We may assume that the difference could be counted towards the government policy, that has been aimed mainly on job preservation after all (neglecting the estimation error). That means approximately 14 000 jobs have been saved by the government. Of course, the question of efficiency arises here as the fiscal stimuli have been enormous. Programs Antivirus A and B, which have been major channels for preserving the jobs in affected firms, spent 23.7 billions CZK (almost 1 billion EUR) on employee wage compensations, meaning that one average job place preserved cost 1.7 million CZK – three times more, that is the GDP per capita. Such a finding suggests a huge inefficiency in the economic measures that have been undertaken in the case of the Czech Republic. Moreover, as the domestic labor market has been probably above its potential with very low unemployment rates, we must ask if the jobs´ protection is not only temporary and if the financial aid has not been only postponing the labor market reversal to its natural rates. This problem opens space for further research.

Several limitations of our analysis should be acknowledged. First, our CGE model assumes household consumption is primarily constrained by disposable income, while during lockdowns, the main constraint was actually the inability to spend due to closed establishments, leading to forced savings. This might affect our estimates of consumption patterns and their subsequent effects. Second, the static nature of both I-O and CGE models limits our ability to capture dynamic adjustments in economic behavior, particularly the post-lockdown consumption rebounds. Third, while our ADL model adds some dynamic perspective, it cannot fully capture the structural breaks in economic relationships caused by unprecedented policy interventions. Additionally, our analysis focuses primarily on employment effects, while other important aspects like price level changes, long-term structural shifts, or the efficiency of alternative policy measures remain outside the scope of this study. These limitations suggest potential directions for future research, particularly regarding the dynamics of household consumption patterns during forced lockdowns and the long-term structural changes in the economy.

ACKNOWLEDGEMENT

This result was financially supported by institutional support for the long-term conceptual development of the research organization for the years 2023–2027 and is part of the research task "Impacts of the Targeted Employment Support Program Antivirus (70210)" (Dopady cíleného programu podpory zaměstnanosti Antivirus, 70210) solved by the Research Institute for Labour and Social Affairs (Výzkumný ústave práce a sociálních věcí, v. v. i.,) in the years 2024–2025.

References

BAKER, S. R., BLOOM, N., DAVIS, S. J., TERRY, S. J. (2020). *Covid-induced economic uncertainty*. NBER Working Paper 26983.

BARTIK, A. W., BERTRAND, M., CULLEN, Z. B., GLAESER, E. L., LUCA, M., STANTON, C. T. (2020). *How are small businesses adjusting to COVID-19? Early evidence from a survey*. NBER Working Paper w26989.

BOSIO, E., JOLEVSKI, F., LEMOINE, J., RAMALHO, R. (2020). Survival of Firms in Developing Economies during Economic Crisis. In: DJANKOV, S. PANIZZA, U. (eds.) *COVID-19 in Developing Economies*, London: Centre for Economic Policy Research, 157–174.

BROWN, R., ROCHA, A. (2020). Entrepreneurial Uncertainty during the Covid-19 Crisis: Mapping the Temporal Dynamics of Entrepreneurial Finance [online]. *Journal of Business Venturing Insights*, Vol. 14. <https://doi.org/10.1016/j.jbvi.2020.e00174>.

BROWN, R. ROCHA, A., COWLING, M. (2020). Financing entrepreneurship in times of crisis: Exploring the impact of COVID-19 on the market for entrepreneurial finance in the United Kingdom [online]. *International Small Business Journal*, online first. <https://doi.org/10.1177/0266242620937464>.

ÇAKMAKLI, C., DEMIRALP, S, KALEMLI-ÖZCAN, S., YESILTAS, S., YILDIRIM, M. A. (2020). *COVID-19 and Emerging Markets: a SIR Model, Demand Shocks and Capital Flows*. NBER Working Papers 27191, National Bureau of Economic Research, Inc.

CCSA. (2020). *How COVID-19 is Changing the World: a Statistical Perspective*. Committee for the Coordination of Statistical Activities.

COIBION, O., GORODNICHENKO, Y., WEBER, M. (2020). *The Cost of the Covid-19 Crisis: Lockdowns, Macroeconomic Expectations, and Consumer Spending*. NBER Working Paper 27141.

CZECH NATIONAL BANK. (2019). *CNB forecast – archive: CNB forecast – November 2019* [online]. <https://www.cnb.cz/en/monetary-policy/forecast/cnb-forecast-archive>.

CZECH STATISTICAL OFFICE. (2022). *GDP, National Accounts: Database of National accounts, Czech Republic* [online]. <https://apl.czso.cz/pll/rocenka/rocenka.index>.

DEMIRGÜÇ-KUNT, A., PERIA, M. S. M., TRESSEL, T. (2020). The global financial crisis and the capital structure of firms: Was the impact more severe among SMEs and non-listed firms? *Journal of Corporate Finance*, 60: 101514.

FAIRLIE, R. (2020). The Impact of COVID-19 on Small Business Owners: Evidence from the First 3 Months after Widespread Social-Distancing Restrictions. *Journal of Economics and Management Strategy*, 1: 1–14.

FEZZI, C., FANGHELLA, V. (2020). Real-Time Estimation of the Short-Run Impact of COVID-19 on Economic Activity Using Electricity Market Data. *Environmental and Resource Economics*, 76: 885–900

GIAMMETTI, R., PAPI, L., TEOBALDELLI, D., TICCHI, D. (2020) The Italian value chain in the pandemic: the input–output impact of Covid-19 lockdown [published online ahead of print, 6.6.2020]. *Journal of Industrial and Business Economics*, 1–15. <https://doi.org/10.1007/s40812-020-00164-9>.

GRANGER, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-Spectral Methods. *Econometrica*, 37(3): 424–38.

GRETTON, P. (2013). *On input–output tables: uses and abuses*. Productivity Commission, staff research note.

GUAN, D., WANG, D., HALLEGATTE, S. et al. (2020). Global supply-chain effects of COVID-19 control measures. *Nat Hum Behav*, 4: 577–587.

HAVRLANT, D., DARANDARY, A., MUHSEN, A. (2021). Early estimates of the impact of the COVID-19 pandemic on GDP: a case study of Saudi Arabia [online]. *Applied Economics*, 53(12): 1317–1325. <https://doi.org/10.1080/00036846.2020.1828809>.

HOSOE, N., GASAWA, K., HASHIMOTO, H. (2015). *Textbook of computable general equilibrium modeling – programming and simulations*. Palgrave Macmillan, UK.

HOWELL, S., LERNER, J., NANDA, R., TOWNSEND, R. (2020). Financial Distancing: How Venture Capital Follows the Economy Down and Curtails Innovation. *Harvard Business School Working Paper*, 20–115.

KEHOE, T. J., PUJOLAS, P. S., ROSSBACH, J. (2017). Quantitative trade models: Developents and challenges. *Annual Review of Economics*, 9: 295–325.

KEOGH-BROWN, M. R., TARP JENSEN, H., EDMUNDS, W. J., SMITH, R. D. (2020). The impact of Covid-19, associated behaviours and policies on the UK economy: a computable general equilibrium model. *SSM – Population Health*, Vol. 12.

LUCCHESE, M., PIANTA, M. (2020). The Coming Coronavirus Crisis: What Can We Learn? [online]. *Intereconomics*, 55: 98–104. <https://doi.org/10.1007/s10272-020-0878-0>.

MANDEL, A., VEETIL, V. (2020). The Economic Cost of COVID Lockdowns: an Out-of-Equilibrium Analysis [online]. *Econ. Disaster Clim. Chang*, 19: 1–21. Epub. ahead of print: PMID 32838118, PMCID PMC7304379. <https://doi.org/10.1007/s41885-020-00066-z>.

MARIOLIS, T., RODOUSAKIS, N., SOKLIS, G. (2020). The COVID-19 multiplier effects of tourism on the Greek economy [online]. *Tourism Economics*, 27(8). <https://doi.org/10.1177/1354816620946547>.

PARTRIDGE, M., RICKMAN, D. (2010). Computable General Equilibrium (CGE) Modelling for Regional Economic Development Analysis. *Regional Studies, Taylor & Francis Journals*, 44(10): 1311–1328.

PRAGYAN, D., FURCERI, D., OSTRY, J. D., TAWK, N. (2022). The Economic Effects of COVID-19 Containment Measures. *Open Economies Review*, 33: 1–32.

OSOTIMEHIN, S., POPOV, L. (2020). *Sectoral Impact of COVID-19: Cascading Risks*. WP 30, May 2020, Opportunity and Inclusive Growth Institute.

RICHIARDI, M., BRONKA, P., COLLADO, D. (2020). *The Economic Consequences of COVID-19 lock-down in the UK. An Input-Output Analysis Using Consensus Scenarios*. WP: ISER, University of Essex.

TIMMER, M. P., DIETZENBACHER, E., LOS, B., STEHRER, R., DE VRIES, G. J. (2015). An Illustrated User Guide to the World Input–Output Database: the Case of Global Automotive Production. *Review of International Economics*, 23: 575–605.

TRAPLETTI, A., HORNIK, K. (2022). *Tseries: Time Series Analysis and Computational Finance* [online]. R package version 0.10-51. <https://CRAN.R-project.org/package=tseries>.

WALMSLEY, T., ROSE A., WEI, D. (2020). Impacts on the U.S. Macroeconomy of Mandatory Business Closures in Response to the COVID-19 Pandemic [online]. *SSRN*. <https://ssrn.com/abstract=3570117 or http://dx.doi.org/10.2139/ssrn.3570117>.

WORLD BANK. (2020). *COVID-19 to Plunge Global Economy into Worst Recession since World War II*. Press Release, 8th June, Washington DC.