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THE COVID-19 PANDEMIC ECONOMIC COSTS IN TERMS OF LABOUR FORCE LOSS

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Abstract:

Within a broader context of economic costs of the recent pandemic we calculate the excess deaths during the COVID-19 pandemic over the whole population and split them into age subgroups. Further, we estimate the cost of the labor force lost due to the pandemic. We employ a general additive model to set up a counterfactual time series of weekly deaths to count the number of deaths if the pandemic did not occur. Subtracting counterfactual series from the actual number of fatalities provides us with the excess deaths. The amount of excess deaths in the whole population is not statistically different from the COVID-19 victims reported by the Ministry of Health. However, we find excess deaths that are substantially higher than the reported COVID-19 causalities in the age group from 35 to 59 years. We estimated the costs of the lost labor force to be approximately 0.03% of the Czech 2021 GDP.

Keywords:

Covid 19, labour force, GDP, excess deaths

JEL Classification: C59, J21

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Introduction

The paper computes the premature mortality caused by the pandemic of COVID-19 in the Czech Republic over the whole population as well as split into age groups. Further, we estimate the costs associated with the increased loss of lives in the working labor force. The paper employs an innovative forecasting model and answers three essential questions about the COVID-19 pandemic in the Czech Republic

On the 1st of March 2020, the Czech Ministry of Health confirmed the first cases of COVID-19 in the Czech Republic. In the very first days of the pandemic spreading, most patients were infected people who arrived from Italy. Still, soon the community spreading prevailed and the government of the Czech Republic imposed lockdown and border closures in the second half of March. Eventually, the infection took the highest death toll in the winter of 2020-2021. Another large wave of fatalities occurred in the autumn of 2021. The government enforced many measures protecting against COVID-19, such as curfews, mandatory face-mask wearing, prohibiting social events, or closing restaurants and bars (Zubikova, 2022). In addition, the sheer number of hospitalized people often overstretched the health system due to the infection. Overall, everyday life in the Czech Republic altered substantially. Such limitations in the country's working might impact the population's health and mortality, even among those who were not infected or had recovered long ago. Therefore, we decided to analyze the weekly death rate data rather than the COVID-19 fatalities provided by the Ministry of Health. *Another reason yet, COVID-19 fatalities reported by many countries might not correspond to the excess death rates.*

Based on the historical death rates before the pandemic, we forecast the period from 2020. The forecast is then used as a counterfactual series to assess the date rate if the pandemic did not occur. Finally, subtracting the counterfactual series from the actual number of deaths series gives us the excess death rate for every reported week. Then, we compare the excess deaths with reported COVID-19 fatalities and z-test for significance. We employ this algorithm as for the whole population, so for the age subgroups. Excess deaths under 65 are assumed to be active labor force. By involving the mean earnings for respective age groups in the Czech Republic, we can infer the cost of premature deaths.

According to the model, the population from 2020 suffered approximately 41 713 COVID-19 reported fatalities which are well within the 95% confidence interval calculated by our model. Our estimate of excess deaths for the period is about 41400. However, in the short period from November 2020 to late December 2020, we noted a substantial disparity between the calculated excess deaths and the reported COVID-19 fatalities. Dividing the population into age groups shows us that people between 35 and 50 years old have significantly higher excess deaths then the reported COVID-19 fatalities. COVID-19 had an asymmetric impact on the age groups, where most casualties were older than 65. Therefore the larger than reported excess deaths in the age group from 35 to 50 could not translate into a significant difference for the whole population. The impact of the excess deaths in the population account for almost 0.03% of the Czech Republic's 2021 GDP.

Literature Overview

The literature that inspired and interested us and that we used for this paper can be broadly divided into three categories. The first category is articles that deal with computations of premature mortality and its economic consequences. The second category is literature that researches impact of COVID-19 on economies. Finally, the third category is literature that describes forecast techniques and causal inference, i.e., the methodology.

1. Premature Mortality

A remarkable study by Islam et al. (2021) estimates a counterfactual time series by Lee-Carter model to establish expected mortality and compare it to the observed mortality in 31 upper-middle-income countries. They conclude that life expectancy has diminished in most countries while the most significant decrease was observed in Russia, the United States, and Bulgaria. While in Russia, Bulgaria, and the United States, the mortality significantly increased even within age groups under 65 years. Altogether, they concluded 28 million excess years of life were lost in 2020 in the 31 observed countries.

Hanly et al. (2020) strive to undertake a similar task to our paper but with different methods and countries. They estimate premature mortality costs associated with COVID-19 in several countries across Europe. They linearly intrapolate the mean for previous periods for each age group and calculate years of potential productive life lost. Based on this method, they provide premature mortality costs for nine European countries.

Menzin et al. (2020) estimate the indirect cost associated with health interventions across 29 countries. They use the human capital approach that estimates productivity cost caused by premature mortality discounted to their present values. They also demonstrate how the premature deaths caused by smoking burden the economy and society.

Ghude et al. (2016) estimate the economic burden of air pollution in India. They model the distribution of the pollutants across the country and associate them with higher mortality in the regions. They estimate that in 2011 there were more than a half million premature deaths directly attributable to the air pollution.

Chen (2019) research drug overdose mortality in developed countries. They show that the United States suffer from an epidemic of drug overdoses comparing to other highly developed countries, concluding that with the right health economic policies, such as in Norway, Spain, and Denmark, premature mortality can be rapidly limited.

Mohanty et al. (2020) present results from the years of potential life lost in the USA, Italy, Germany, and Sweden from the beginning of the COVID-19 pandemic. They selected the countries that were the worst affected at the time. Until May 2020, the years of potential life lost were 1.5 in the US, 0.5 in Italy, 0.1 in Germany, and 0.5 in Sweden.

2. COVID

Nicola et al. (2020) summarize the impact of the COVID-19 pandemic across all economic sectors. Welfens et al. (2020) find a link between the healthcare GDP ratio and rising US export tariffs and emphasize healthcare systems' role in economies and their implications on an effective workforce. They also promote cooperation in international healthcare policy in the wake of the increasing threat of pandemics. Acikgoz(2020) presents early explanations of how the pandemic will translate into the recession around the world and Turkey. Elginet al.(2020) provide extensive results of early COVID-19 impact on the world economy.

3. Method

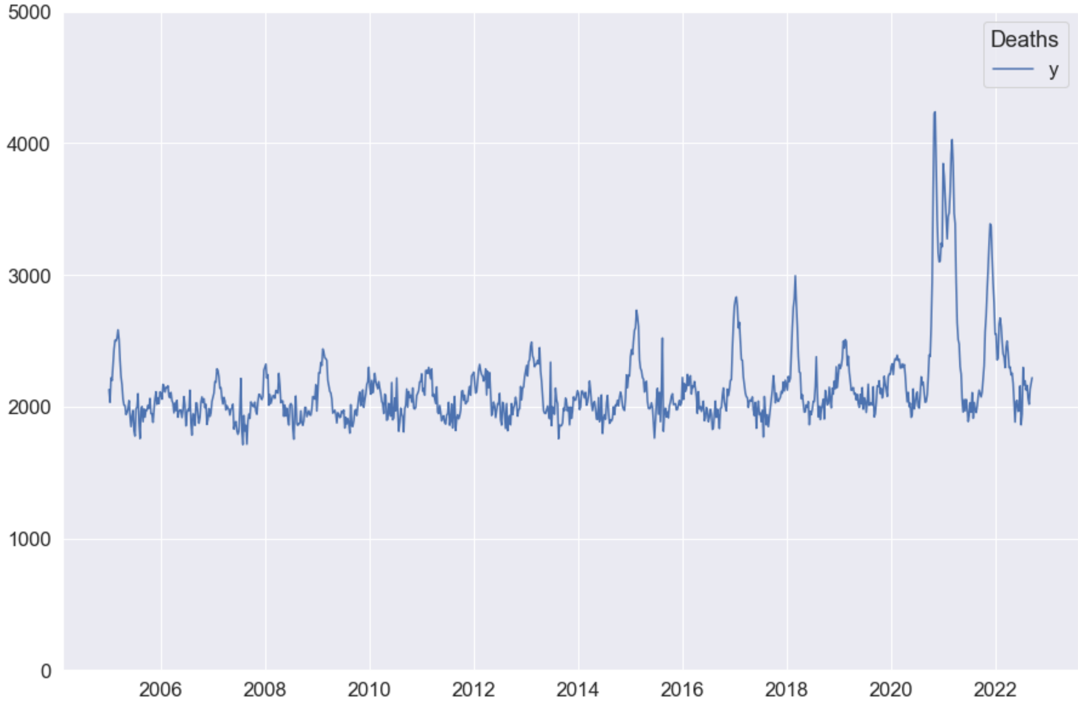
The method of forecasting the counterfactual series is formally described by Harvey(1991), who outlines the general additive model(GAM) as a specific version of structural time series models. Taylor&Letham(2017) from the Facebook inc. developed a Prophet model with a package for R and Python that employs GAM for univariate time series forecasting. Fotiadis at al.(2021) uses the Prophet model to predict tourism demand during COVID times. Battineni et al.(2020) employed the model at the beginning of the pandemic to predict the number of fatalities. Dash et al.(2022) use the Prophet model to assess the Chinese and Indian government measures on spreading the disease.

Method and Analysis

The epidemy of SARS-CoV2, which causes the disease known as COVID-19, spread around the world and became a pandemic at the beginning of 2020. Now, with hindsight, we can analyze data more thoroughly. Many have been written on the measures taken by different governments and their effectiveness. (Nicola et. Al.,2020)(Welfens, 2020) (Polyzos et al., 2020),(Borio, 2020), (Kaderabkova, 2021). In this paper, we focus on quantifying the excess deaths caused by COVID and strive to measure the number of deceased people by calculating excess deaths as opposed to taking the number of deaths by COVID-19 reported by the authorities. By analyzing the number of excess deaths in age groups, we can infer the explicit losses of premature deaths in the Czech economy. The Czech Republic datased was chosen as a benchmark for a country with medium life expectancy in the European context, as it has been confirmed that the long term life expectancy affects negatively the Covid mortality (higher the life expectancy, lower the excess mortality due to Covid for an economy), as confirmed by Tamas (2022). As far as we know, no one has employed such an approach in the Czech environment. The analysis aims to determine if excess deaths occur and on what scale. If the excess deaths occur within specific age categories and how much the economy lost in the productive labor force.

The Czech Ministry of Health reports the deaths with COVID-19 since the pandemic's inception. Yet, we believe this number does not necessarily need to paint the whole picture. Firstly, the statistics do not include deceased who have not been tested before they died. Secondly, the pandemic made acute treatment less accessible and more difficult for doctors to treat other conditions. Thirdly, the pandemic may have discouraged people from going to doctors and hospitals. To account for these methodological shortcomings, we intend to view the pandemic numbers from above and measure them by so-called 'excess deaths.'

Figure 1: Number of weekly deaths in the Czech Republic since 2005. Eurostat (dataset: demo_r_mwk_ts)



By setting up a counterfactual time series of weekly deaths in the Czech Republic, we obtain a 95% confidence interval of deceased persons in any given category. We predict what would have happened had the COVID pandemic not occurred.

In this paper, we employ econometrics methods to identify whether and how the pandemics of COVID-19 affected the population. We measure excess deaths for the whole population and age subgroups. To calculate the counterfactual series, we set up a Generalized Additive Model(GAM) in Python 3.0. The package we use is Prophet[1]. This approach differs from standard structural time series such as ARIMA in being a curve-fitting problem of Baysiean structural series(Karel&Hebák, 2018). The GAM is a linear autoregressive model with potential non-linear smoothers of the regressors system. The model is formalized in Hastie&Tibshirani(1986). The Prophet package version of the model is described by Taylor&Letham(2018). Fotiadi et. Al. (2021) employ this model to forecast international tourism demand during the time of COVID-19.

The model consists of trend, seasonality, and irregular term:

$$y(t)= g(t)+s(t)+h(t)+\varepsilon(t) \qquad (1)$$

where *g(t)* is the trend function that models non-periodic changes in the time series, s(t) represents periodic changes also known as the seasonality function, *h(t)* stands for impact effects that can be incorporated into the model, and finally, *ε(t)* that represents idiosyncratic changes that cannot be captured by the model.

Hence, we split the time series into the above-mentioned components. The trend component we used is the simple linear growth where:

[1] https://github.com/facebook/prophet

$$y=mx+b \quad (2)$$

where *m* stands for slope and *b* for the offset. However, unlike standard linear regression, the *m* and *b* are variables and change at every point.

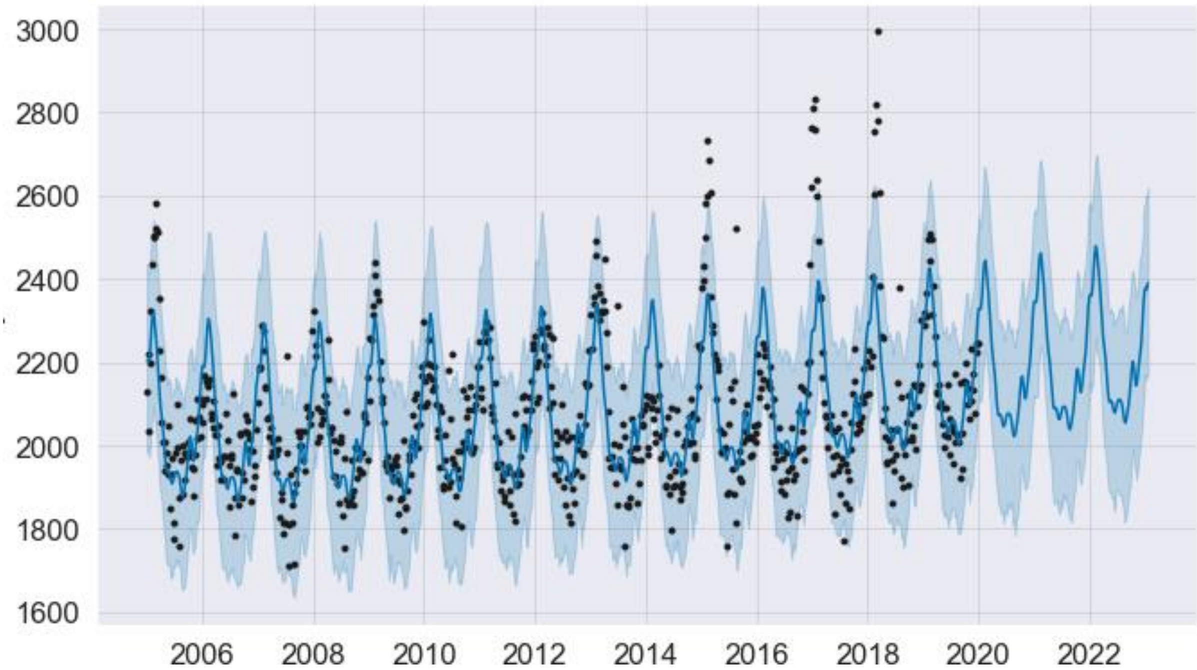
The seasonality function is a Fourier series. In this manner, we can approximate almost any curve alas seasonality. We assume annual seasonality and therefore the component formula based on (Harvey & Shephard, 1990) is:

$$s(t)= \sum_{n=1}^{N} \left[\varphi_n \cos \frac{2\pi nt}{12} + \omega_n \sin \frac{2\pi nt}{12}\right] \quad (3)$$

Where the φ stands for seasonal parameters normally distributed around zero means. Taylor&Letham (2017) recommend using N=10 for yearly seasonality and that is what we used.

We trained the model on the maximum length of the data. It starts in 2005 and the end is in 2019. The forecast of the model is our counterfactual series. It means the series that forecast how many people would die if the pandemic did not occur.

Figure 2: Number of weekly deaths in the Czech Republic since 2005. Trained model on the data from 2005 to the end of 2019. Eurostat (dataset: demo_r_mwk_ts)



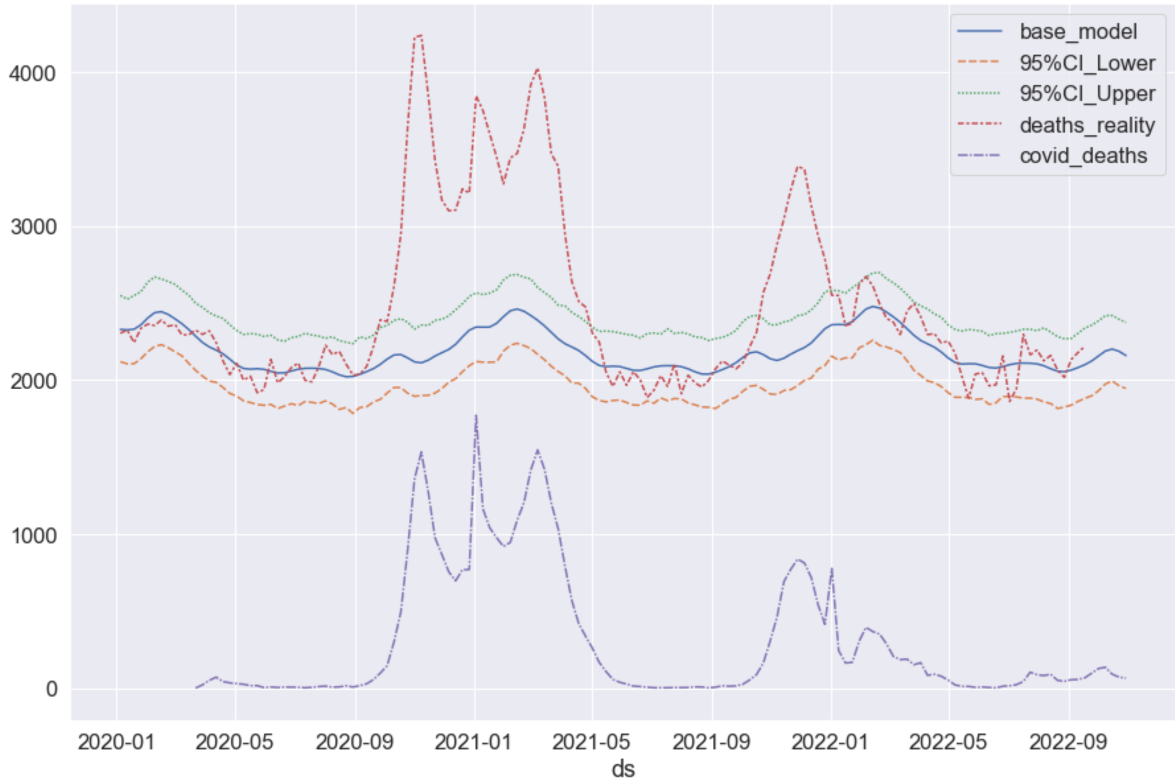
Results

4. Altogether

Subtracting the model prediction from the number of reported deceased, we obtain 41 405 excess deaths over the prediction that can be attributed to the COVID-19 pandemic and its overall impact on the population. We can compare excess deaths with the number of fatalities with COVID-19 reported by the Czech ministry of health over the same period, which is 41 713. To check the statistical difference, we ran a two-sample Z-test, which concluded that $p>0.05$. Hence, we conclude that on the whole population, we can not observe a difference in the excess deaths of the number of COVID-19 deceased, as reported by the Ministry of Health. It implies that not a significant number of people succumbed to COVID-19 without being tested.

Nor were there any significant amount of deaths due to health system overload or hesitancy to visit doctors.

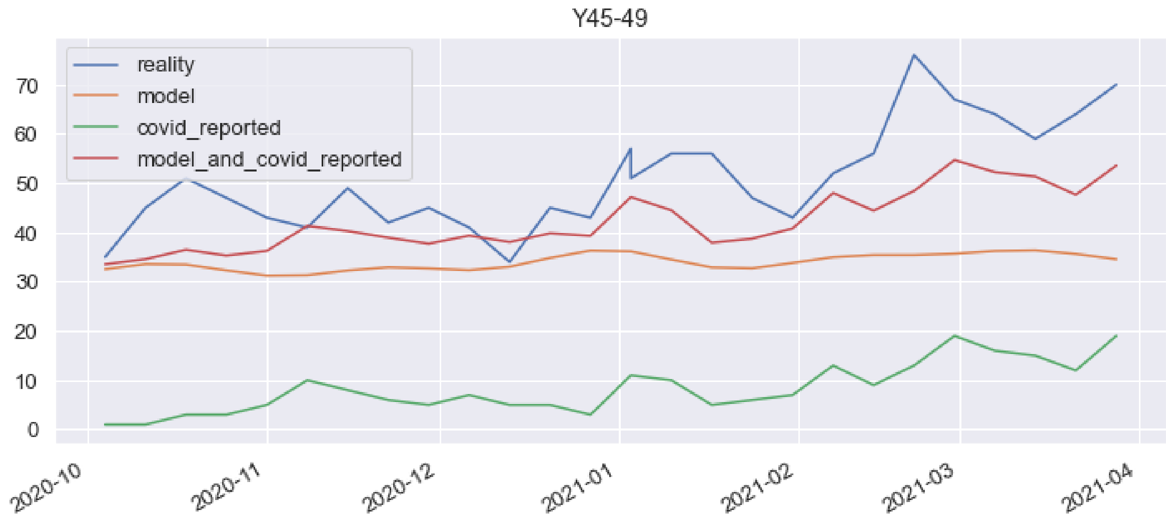
Figure 3: Number of weekly deaths in the Czech Republic since 2020. The base model is the forecast 95%CI_Lower is the lower limit of the 95% confidence interval, and 95%CI_Upper stands for the upper boundary of the 95% confidence interval. The deaths_reality is the actual deads reported by Eurostat(dataset: demo_r_mwk_ts). Covid_deaths shows the number of deceased with COVID-19 as reported by the Czech Ministry of Health.

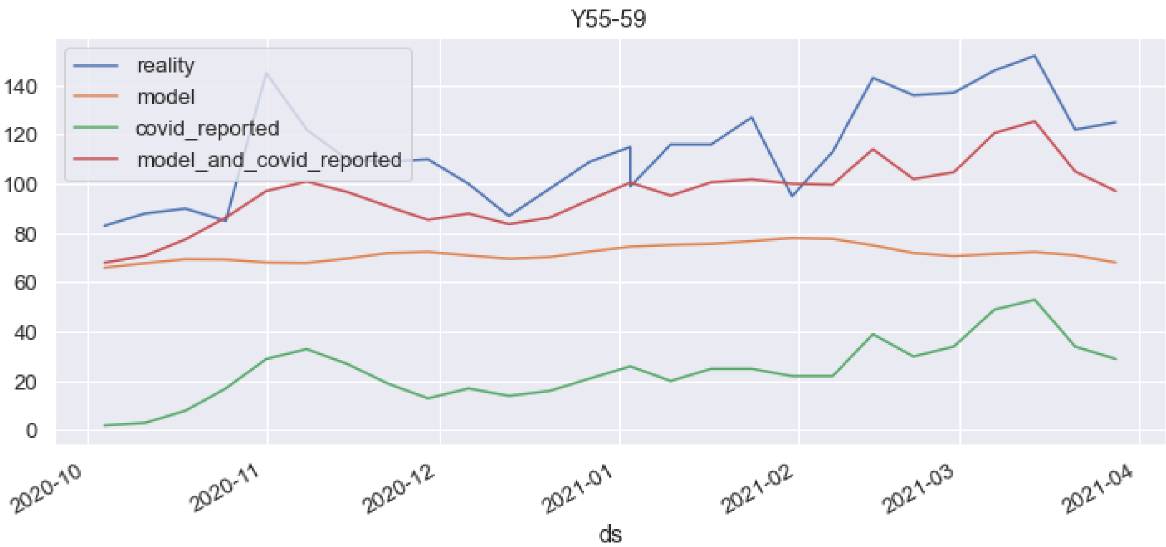


5. By age group

We ran analogous calculations when we split the whole population into age groups by five years in the period of the first pandemic wave, which we tethered from 2020-09-01 to 2021-04-01. The results show significant (two sample Z-test with $p<0.05$) differences in the age group from 45-49 years old, where we found 491 excess deaths over 230 deceased reported by the Ministry of Health. No other age group proved to have any significant results. The younger groups have small amounts of casualties with high variations, and the older groups have excess deaths similar to COVID-19 reported fatalities.

Figures 4 and 5: Number of weekly deaths in the Czech Republic since October 2020 in the respective age groups. Eurostat (dataset: demo_r_mwk_ts) Model line is the forecast on the data from 2005 to the end of 2019. Covid_reported is based on the data reported by the Czech Ministry of Health.[2] Model_and_covid_reported is a sum of model and covid_reported. The graphs show that sum of the counterfactual series and covid reported deaths is still less than the reality. It means more people died than is only attributed to the official data.



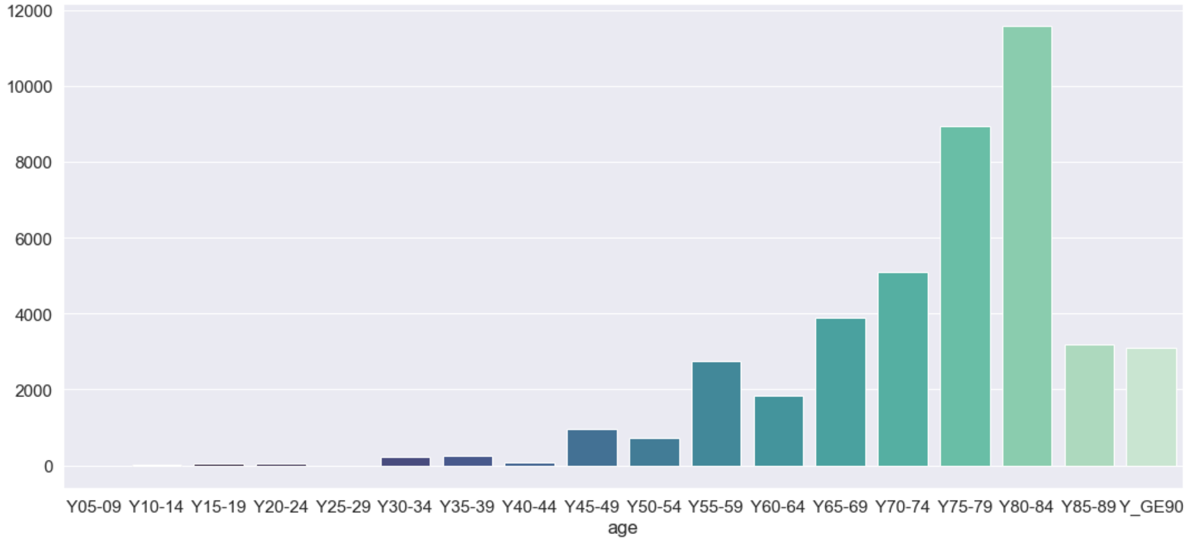


6. The economic cost of a lost labor force

The Czech population lost in excess deaths from January 2020 to October 2022 eighty-seven inhabitants aged 15 to 30 years old. Five hundred twenty-six people died in excess in the age group of 30-50 years. We calculated three thousand four hundred fifty-eight excess deaths in the age group from 50-65 years. Figure 6 shows that the oldest age groups, older than 65, suffered the large majority of excess deaths.

[2] https://onemocneni-aktualne.mzcr.cz/covid-19

Figure 6: Shows excess deaths across the 5-year age groups



To calculate the loss to the Czech GDP, we used data on mean annual earnings by age issued by Eurostat(earn_ses18_27). The data is divided into three age groups, up to 30 years old, 30-50 years old, and older. We multiplied the respective age groups by their mean earnings, adjusted for inflation(Eurostat: prc_hicp_aind), and evaluated in Czech Korunas(CZK) by the average exchange rate in 2021[3]. The loss on the population earnings is thus 1.8 billion CZK, which is approximately 0.03% of Czech GDP in 2021[4]

Conclusion

The paper's goal was to calculate the excess deaths from the COVID-19 pandemic period, compare these numbers with official COVID-19 reported fatalities and calculate the economic cost of premature deaths. We used a general additive model to set up a counterfactual time series of deaths if the pandemic had not occurred.

Overall, the COVID-19 reported fatalities from 2020 to November 2022 are in line with excess deaths. However, we get the most surprising results when we split the population into age groups, and we identify a statistically significant larger amount of excess deaths in the 35 to 59 years than the reported COVID-19 fatalities. The excess deaths amounted to over 4700 casualties in this age group, while the reported COVID-19 deaths were less than 2300. This is a remarkable difference, and we should identify what led to the significant excess deaths that are not registered as COVID-19 fatalities. As the majority of the COVID-19 fatalities are within the age groups over 65, the notable excess deaths in the younger categories do not translate into the population numbers. Therefore, we estimated the cost of premature mortality at the value of 0.03% of the Czech GDP in 2021.

References

Açikgöz, Ö. and Günay, A., 2020. The early impact of the Covid-19 pandemic on the global and Turkish economy. Turkish journal of medical sciences, 50(9), pp.520-526.

[3] Kurzy.cz
[4] data.worldbank.org

Battineni, G., Chintalapudi, N. and Amenta, F., 2020. Forecasting of COVID-19 epidemic size in four high hitting nations (USA, Brazil, India and Russia) by Fb-Prophet machine learning model. *Applied Computing and Informatics*.

Borio, C., 2020. The Covid-19 economic crisis: Dangerously unique. *Business Economics*, *55*(4), pp.181-190.

Dash, S., Chakraborty, C., Giri, S.K. and Pani, S.K., 2021. Intelligent computing on time-series data analysis and prediction of COVID-19 pandemics. *Pattern Recognition Letters*, *151*, pp.69-75.

Elgin, C., Basbug, G. and Yalaman, A., 2020. Economic policy responses to a pandemic: Developing the COVID-19 economic stimulus index. Covid Economics, 1(3), pp.40-53.

Fotiadis, A., Polyzos, S. and Huan, T.C.T., 2021. The good, the bad and the ugly on COVID-19 tourism recovery. *Annals of tourism research*, *87*, p.103117.

Ghude, S.D., Chate, D.M., Jena, C., Beig, G., Kumar, R., Barth, M.C., Pfister, G.G., Fadnavis, S. and Pithani, P., 2016. Premature mortality in India due to PM2. 5 and ozone exposure. *Geophysical Research Letters*, *43*(9), pp.4650-4658.

Hanly, P., Ahern, M., Sharp, L., Ursul, D. and Loughnane, G., 2022. The cost of lost productivity due to premature mortality associated with COVID-19: a Pan-European study. *The European Journal of Health Economics*, *23*(2), pp.249-259.

Harvey, A.C. and Peters, S., 1990. Estimation procedures for structural time series models. *Journal of forecasting*, *9*(2), pp.89-108.

Hastie, T. and Tibshirani, R., 1987. Generalized additive models: some applications. *Journal of the American Statistical Association*, *82*(398), pp.371-386.

Chen, Y., Shiels, M.S., Thomas, D., Freedman, N.D. and Berrington de González, A., 2019. Premature mortality from drug overdoses: a comparative analysis of 13 organisation for economic cooperation and development member countries with high-quality death certificate data, 2001 to 2015. *Annals of internal medicine*, *170*(5), pp.352-354.

Islam, N., Jdanov, D.A., Shkolnikov, V.M., Khunti, K., Kawachi, I., White, M., Lewington, S. and Lacey, B., 2021. Effects of covid-19 pandemic on life expectancy and premature mortality in 2020: time series analysis in 37 countries. *bmj*, *375*.

Kaderabkova, B., Jasova, E. (2021). How the Czech Government got the Pandemic Wrong. Proceedings of the 15th Economics and Finance Conference, Prague. DOI: 10.20472/EFC.2021.015.005

Karel, T. and Hebák, P., 2018. Forecasting Czech GDP using Bayesian dynamic model averaging. *Int. J. Econ. Sci*, *7*, pp.65-81.

Menzin, J., Marton, J.P., Menzin, J.A., Willke, R.J., Woodward, R.M. and Federico, V., 2012. Lost productivity due to premature mortality in developed and emerging countries: an application to smoking cessation. *BMC medical research methodology*, *12*(1), pp.1-9.

Mohanty, S.K., Dubey, M., Mishra, U.S. and Sahoo, U., 2020. Impact of COVID-19 attributable deaths on longevity, premature mortality and DALY: Estimates of USA, Italy, Sweden and Germany. *MedRxiv*.

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., Agha, M. and Agha, R., 2020. The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *International journal of surgery*, *78*, pp.185-193.

Tamaș, A. (2022). The Main Determinants of the Covid-19 Spreading in the European Union Countries. International Journal of Business and Management, Vol. X(1), pp. 93-117., 10.20472/BM.2022.10.1.005

Taylor, S.J. and Letham, B., 2018. Forecasting at scale. *The American Statistician*, *72*(1), pp.37-45.

Welfens, P.J., 2020. Macroeconomic and health care aspects of the coronavirus epidemic: EU, US and global perspectives. *International Economics and Economic Policy*, *17*(2), pp.295-362.

Zubíková, A., Smolák, P. (2022). Macroeconomic impacts of the COVID-19 pandemic in the Czech Republic in the period of 2020-2021. International Journal of Economic Sciences, Vol. XI(1), pp. 117-145. , DOI: 10.52950/ES.2022.11.1.008