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Business cycle sensitivity of Statutory Health Insurance: evidence from the Czech Republic

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Abstract

Background The Statutory Health Insurance scheme is one of two main schemes of health care system financing in Europe. This scheme mainly relies on wage-based contributions from employers and employees and is thus prone to business cycle fluctuations. This turned out to be a problem especially after the 2008 crisis. We estimate the magnitude of the effect of the business cycle on health insurance funds' revenues in the Czech Republic where the health care system financing is based on the Statutory Health Insurance scheme. The relationship between the business cycle and healthcare system's revenues has not been quantified to this date.

Methods We use static and lagged regression models to estimate the impact of business cycle on health care system's revenues. The business cycle is proxied by eight different indicators (nominal GDP, unemployment, industrial production, recession index, business cycle index, GDP gap, consumer price index and consumer expenditure). Using quarterly data from 2000–2017, we examine the effect of business cycle on total revenues and its two main components: the employer-employee contributions and state contributions.

Results Health insurance funds' revenues display significant pro-cyclicality, which is mainly driven by employer-employee contributions. Out of all eight business cycle indicators, nominal GDP has the largest effect. In particular, the model estimates that if quarter-over-quarter GDP increases by 1%, then quarter-over-quarter healthcare system's revenues increase by 0.7% and quarter-over-quarter employer-employee contributions increase by 1.1%. The lagged effect of business cycle on healthcare system's revenues is smaller in magnitude. State contributions on behalf of economically inactive people do not display a significant relationship with business cycle in the static nor lagged model. The effect is consistent across different business cycle indicators, although the magnitudes of the effect vary.

Conclusion The results show large pro-cyclicality in healthcare system's revenues in Statutory Health Insurance schemes. Counter-cyclical mechanisms are needed to offset this loss of revenues during economic downturns to ensure sufficient resources in healthcare.

Keywords Health system financing, Business cycle, Czech Republic, Statutory Health Insurance

JEL Classification E32, G28, I13, I18

Introduction

Achieving sustainable financing of the health care sector is challenging in the context of ageing populations and health and economic shocks. Sufficient resources are crucial to ensure the long-term sustainability of health care systems and to achieve availability and affordability of health services. In this article, we focus on business cycle sensitivity of Statutory Health

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Insurance (SHI) schemes which are among two dominant health care financing schemes in the European Union [1]. Although the relationship between the business cycle and healthcare system's revenues has been frequently discussed, it has not yet been quantified neither in the SHI (Bismarck model) nor in the general taxation (Beveridge model) scheme.

The financial crisis of 2008 has pointed out the weaknesses of healthcare financing in many countries, especially in those where financing relies to some extent on employer-employee contributions, have large out-of-pocket payments, or have a significant part of population paying private health insurance (PHI). During the crisis, healthcare systems' revenues decreased significantly in Greece, Lithuania and Estonia, which are countries where financing relies on the SHI scheme [2–4]. Each country responded in its own way to handle the consequences. In Greece, public expenditures were significantly reduced [4]; in Lithuania, the loss was covered by increasing state contributions thanks to counter-cyclical mechanism that had been already implemented [4]; and in Estonia, financial reserves were used along with budgetary cuts [5].

The aim of this article is to quantify the effect of the business cycle on SHI revenues of the Czech health care system, which has not been done before. Our data span from Q1 2000 to Q4 2017 and cover the period around the financial crisis of 2008 which was a shock that started the debate about resilience of healthcare systems. We test eight different business cycle indicators, with nominal GDP being evaluated as the most sensitive indicator of business cycle for Czech health insurance funds' revenues. We examine the cyclicality of total revenues and the main revenue components (employer-employee contributions and state contributions).

While we lack systematic evidence on the effect of business cycle on the revenues, the effect on the expenditures has been examined by several studies [6–9]. They suggest that cyclicality depends on country's level of development: pro-cyclical pattern has been found in developing countries [6] and counter-cyclical pattern has been found in developed countries [7]. A study in the EU-27 countries has shown that healthcare expenditures (both public and private) displayed counter-cyclical patterns at least initially after the 2008 financial crisis [8]. Another study in the EU-27 countries found a decrease in healthcare expenditure and an increase in pharmaceutical expenditure and in the number of medical consultations during the crisis [9]. A systematic review of studies about the impact of the crisis on the use of healthcare services in Europe showed that austerity measures lead to increasing inequality in access to healthcare and the crisis contributed to rising unmet needs, reduction in hospital beds and privatization of services [10].

The SHI scheme has a relatively narrow revenue base, relying mainly on the working population [11]. In the Czech Republic, its main features are as follows. All permanent residents are entitled to SHI coverage [12]. SHI is heavily regulated by the government and there are seven public insurance funds acting as purchasers and payers of care [13]. SHI covers a broad range of benefits, leaving a small room for voluntary or private health insurance [12]. The health insurance funds in the Czech Republic collect revenues from four sources: (i) employers and employees (70% of revenues), (ii) economically inactive individuals who are defined by law (22% of revenues), (iii) self-employed individuals (6% of revenues) and (iv) individuals without taxable income (1% of revenues) [12]. All four groups are obliged to pay the contributions set as 13.5% of the assessment base defined by law (Act No. 592/1992). The assessment base is the gross monthly income for employers and employees, while for state contributions, it is defined by law. The Minister of Finance is able to provide financial assistance and change the magnitude and frequency of state contributions in case of seasonal fluctuations, which has been rarely used in the past. 70% of SHI revenues in the Czech Republic are raised through employer-employee contributions, but this comes from only about 40% of Czechs [12]. Additionally, when a person becomes unemployed and falls in the group of state insured individuals, the contributions made on behalf of him/her are on average 2–5 times lower. This dicrepancy makes the SHI revenues susceptible to workforce fluctuations and it proved to be a problem in the aftermath of 2008 financial crisis, when the losses in revenues had to be compensated by loans from government and slight increase in contributions for state-insured individuals [14].

Data and methods

Macroeconomic indicators

Economic recession is usually defined as a period of declining economic activity that lasts for more than two consecutive quarters [23]. National Bureau of Economic Research (NBER) defines economic recession as a significant decline in economic activity, which is visible in decline in real GDP, retail sales, employment, real income and production and lasts for more than a few months [24]. Most commonly used proxies of business cycle in literature are GDP, debt as percentage of GDP, gross national product (per capita), unemployment rate, industrial production, average real earnings and consumer prices, the deviation from the GDP trend, the industry capacity utilization and the industry confidence indicator [25–28]. Di Matteo and Di Matteo [29] claim that general economic activity (as represented by GDP) remains the most consistent and widely used predictor

Table 1 Data sources

Data	Source
Health insurance fund's revenues	Ministry of Health [15]
Macroeconomic indicators	
Nominal GDP	Eurostat [16]
Unemployment	OECD [17]
Industrial production	OECD [18]
Recession index	FRED [19]
Business cycle index[a]	CNB [20]
GDP gap	CNB [20]
Consumer price index	CSO [21]
Consumer expenditure	Eurostat [22]

[a] Business cycle index is computed from GDP gap

of over-time developments in health care expenditures. We use eight different macroeconomic indicators (nominal GDP[1], unemployment, industrial production, recession index, business cycle index, GDP gap, consumer price index and consumer expenditure), with nominal GDP being chosen as the primary business cycle indicator. The other indicators will serve for comparison of the size of the effect. Table 1 summarizes the data sources[2] used in the analysis. All the data have quarterly frequence in years 2000 to 2017.

Healthcare system's revenues

The data from the Ministry of Health [15] contain information about health insurance funds' revenues from four resources: employers and employees, self-employed individuals, individuals without taxable income and state on behalf of state insured individuals.

Figure 1 depicts the evolution of total revenues and its components from 1st quarter 2000 to 4th quarter 2017. Contributions paid by employers and employees comprise a major part of total inflows, as opposed to contributions from self-employed individuals or individuals without taxable income. Contributions on behalf of state insured people make up around 22% of total revenues, even though they cover more than half of the population.

Figure 1 shows an increasing trend in all sources of revenues. In contributions from state, several changes occured that deserve a note. In 2006, the largest insurance fund in the Czech Republic (General Health Insurance Fund, GHIF) received an advanced payment (interest-free) from the state because it did not have enough resources to fulfil its liabilities in time, leading to delay in payments to hospitals. This loan was repaid in 4 instalments in the second half of 2006 [30]. The change in 2010 was caused by increase in the assessment base from which the contributions per person per month are computed. Significant changes occurred in years 2013 and 2014 where the state again provided advanced payment to the insurance funds due to their unfulfilled liabilities. This occurred in the first quarter of 2013 and 2014, with the size of advanced payment 4.8 and 4 billion, respectively [31]. Other than that, contributions from employees are growing quite steadily except for a short period of stagnation during the economic crisis in 2008. The other two sources of revenues (contributions from individuals without taxable income and from self-employed individuals) are rather negligible and are left out from the analysis.

Hypotheses

Several studies have already examined the relationship between the health care system's expenditures and the business cycle [6–9]. The relationship between the business cycle and healthcare system's revenues in the countries with the SHI scheme has not been tested yet, even though it is equally important as illustrated by the revenue shocks to SHI systems in Greece, Lithuania and Estonia [2–5]. We will test three hypotheses using standard econometric methodology for time series analysis:

H1: Total health care system's revenues are pro-cyclical.
H2: The employer-employee contributions are the most procyclical component.
H3: The effects are lagged by one or multiple quarters.

First, based on the case studies from SHI systems [2–5], we expect that during crises, the revenues of health insurance funds decrease due to stagnating wages, higher unemployment and decreased tax collections (H1). Second, the responsiveness of real wages to economic cycles [32] indicates that labor market fluctuations directly impact wage-based contributions to healthcare funding. When economic conditions worsen, wage stagnation or declines among the workforce could reduce employer-employee contributions (H2). Third, based on New Keynesian theory about wage stickiness and nominal rigidity, we expect that wages adjust with a delay, thus macroeconomic fluctuations do not immediately translate into wage-based contributions, but the effects span over several quarters (H3) [33]. We also examine and compare the magnitudes of the effects.

[1] All the health insurance funds' inflows are also in nominal terms.

[2] The data that support the findings of this study are available from the Ministry of Health, Czech Republic, but restrictions apply to the availability of these data, which were used under licence for the current study, and so are not publicly available. Data are however available from the author upon reasonable request and with permission of the Ministry of Health. Macroeconomic indicators are available in electronic supplementary material.

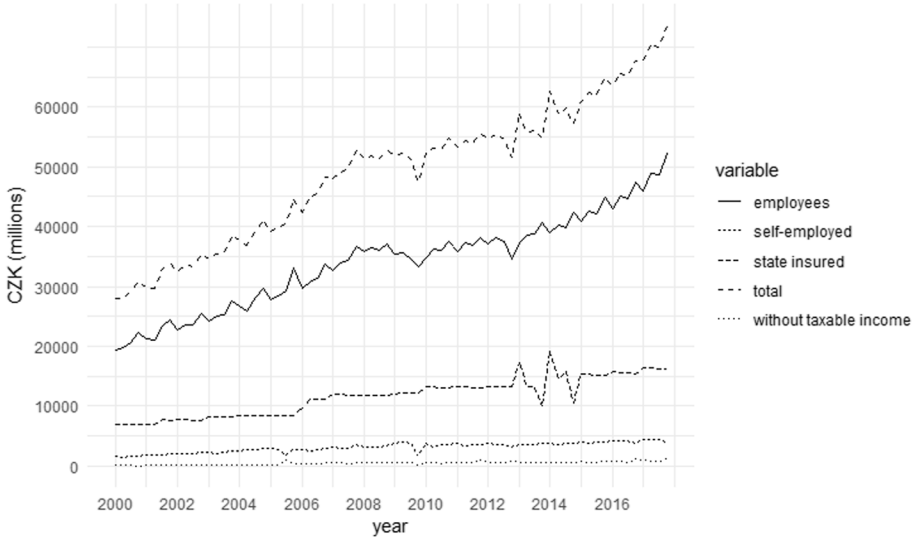

Fig. 1 Composition of insurance funds' inflows

Model specification

This study employs a regression framework to examine the impact of business cycle (represented by macroeconomic indicators) on healthcare system's revenues in the Czech Republic. The effect on three dependent variables is examined: overall healthcare system's revenues, revenues from employer-employee contributions, and revenues from state contributions. The independent variables include the macroeconomic variable, seasonal dummies, and a lagged dependent variable to account for temporal autocorrelation and revenue persistence.

Endogeneity is a critical concern in this model, given the possible bidirectional relationship between healthcare system's revenues and macroeconomic conditions, and the inclusion of a lagged dependent variable. The following paragraphs outline potential sources of endogeneity and steps taken to address them.

Firstly, a possible bidirectional relationship may exist between healthcare system's revenues and macroeconomic variables, as while macroeconomic fluctuations are expected to influence healthcare revenues, substantial changes in healthcare funding could, in turn, impact economic performance. This endogeneity issue may lead to biased estimates, as healthcare revenues and macroeconomic variables could simultaneously affect each other within the same period. Although an instrumental variable approach could mitigate this issue, finding a valid instrument correlated with macroeconomic variables but unrelated to healthcare revenues is challenging in this context.

Secondly, the inclusion of a lagged dependent variable aims to capture the persistence in healthcare revenues over time and reduce serial correlation in the error term. However, adding a lagged variable can induce dynamic panel bias, especially in small sample contexts where the lagged dependent variable correlates with the error term, potentially skewing coefficient estimates. To evaluate the robustness of the lagged model, alternative lag structures were tested to verify consistency in the results.

Thirdly, omitted variables that influence both the macroeconomic variables and healthcare revenues could create spurious correlations, leading to biased estimates. For example, factors such as inflation rates or broader fiscal policy changes may simultaneously affect economic growth and public sector revenues, introducing omitted variable bias. Several variables (e.g. inflation, average wage) have been incorporated as independent variables when fitting the model and did not lead to significantly better fit, so they were ommited. Seasonal dummy variables for each quarter were included to control for predictable seasonal fluctuations in healthcare revenues, which reduces some sources of omitted variable bias.

In summary, while endogeneity poses challenges to causal interpretation, the inclusion of lagged dependent variables and seasonal dummies helps mitigate some potential biases. By considering endogeneity sources and conducting robustness checks, this study presents conditional associations that offer valuable insights into the relationship between the business cycle and healthcare system's revenues.

Static model

Firstly, to test H1 and H2, we estimate the following equation by ordinary least squares (OLS):

$$\Delta log(y_t) = \beta_0 + \beta_1 \Delta log(y_{t-1}) + \beta_2 \Delta log(m_t) + \beta_3 q_1 + \beta_4 q_2 + \beta_5 q_3 + \epsilon_t, \quad t = 1, ..., T, \tag{1}$$

where Δ indicates first-difference,[3] y_t represents health care system's revenues in year t (we perform the analysis separately for overall revenues, revenues from employers and employees and revenues from state), β_0 is the constant term of the model, m_t is a macroeconomic variable representing the business cycle, q_1, q_2 and q_3 are dummy variables for the first, second and third quarter which account for seasonality and ϵ_t is the error term. We are interested in the magnitude and significance of β_2. $\beta_2 > 0$ implies pro-cyclical behaviour, $\beta_2 < 0$ indicates counter-cyclical behavior.[4] Value of $\beta_2 > 1$ indicates a more-than proportionate response of health care system's revenues to business cycle fluctuations.

Lagged regression

To examine whether the effects are lagged and test H3, we estimate the following model:

$$\Delta log(y_t) = \beta_0 + \beta_1 \Delta log(y_{t-1}) + \sum_{k=0}^{4} \beta_k \Delta log(m_{t-k}) + \beta_3 q_1 + \beta_4 q_2 + \beta_5 q_3 + \epsilon_t, \quad t = 1, ..., T, \tag{2}$$

where m_{t-k} is the k^{th} lag of the macroeconomic variable, so β_k represents the lagged effect. At first, 4 lags of macroeconomic variable are included because we have quarterly data and we suppose that the lagged effect will not persist for more than one year. The best model is chosen based on cross correlation plots and model comparison using the Cox test and Davidson-MacKinnon test.

All models satisfy the first three Gauss-Markov assumptions for time series data (*TS.1' Linearity and Weak Dependence, TS.2' No Perfect Collinearity, TS.3' Zero conditional mean*), which ensures that the estimators are consistent [34] (for more details, see Jeffrey Wooldridge, Introductory Econometrics: A Modern Approach). We also test for assumptions *TS.4' Homoskedasticity, and TS.5' No serial correlation* using the Breusch-Pagan test and Breusch-Godfrey test. In case that heteroskedasticity and autocorrelation in error terms is present, we compute the Newey West standard errors, which are heteroskedasticity and autocorrelation robust [34, 35].

[3] All series are non-stationary in levels (see results of ADF test in Table 4 in the Appendix A).

[4] Vice-versa relationships hold for unemployment, recession index and GDP gap, since these business cycle indicators move in the opposite direction.

Table 2 Static model

	Dependent variable y_t*:*		
	Δlog(*total*)	**Δlog(*employees*)**	**Δlog(*si*)**
Constant	0.025**	0.042***	−0.033
	(0.013)	(0.012)	(0.023)
$\Delta\log(y_{t-1})$	−0.518***	−0.407**	−0.568***
	(0.117)	(0.180)	(0.155)
$\Delta\log(nominal\ GDP_t)$	0.694**	1.112***	−0.631
	(0.339)	(0.318)	(0.837)
q_1	−0.013	−0.070***	0.127***
	(0.017)	(0.015)	(0.036)
q_2	−0.020	−0.042**	0.081**
	(0.014)	(0.018)	(0.034)
q_3	−0.018	−0.033***	0.033
	(0.014)	(0.012)	(0.029)
Observations	70	70	70
R^2	0.275	0.523	0.474

Note: Heteroskedasticity and autocorrelation robust SE are reported in parentheses; *si* = state insured; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; y_{t-1} is the first lag of dependent variable

Results

The results have shown that nominal GDP is the most sensitive business cycle indicator for health insurance funds' revenues. The models with nominal GDP are thus presented as a baseline model and models with the other business cycle indicators are shown for comparison.

Static model

Table 2 shows results of the static model which depicts the contemporaneous relationship between the business cycle and health care system's revenues. All variables are used in log-differences.

The results do not reject H1 and H2 and indicate pro-cyclical relationship in total health insurance funds' revenues and employer-employee contributions. In particular, the model estimates that if quarter-over-quarter GDP changes by 1%, then quarter-over-quarter total revenues will change by 0.7% in the same direction (i.e. total revenues are pro-cyclical). The effect on employer-employee contributions is larger and they respond more than proportionately to changes in nominal GDP: if quarter-over-quarter GDP changes by 1%, then quarter-over-quarter employer-employee contributions will change by 1.1%. Contributions from state do not exhibit a significant relationship with nominal GDP.

The models' specification is checked using the residual analysis (see Fig. 2 in Appendix B for total revenues, Fig. 3 in Appendix B for employer-employee contributions and Fig. 4 in Appendix B for state contributions). The Breusch-Pagan test and Breusch-Godfrey test show

Table 3 Lagged model

	Dependent variable y_t:		
	Δlog(*total*)	**Δlog(*employees*)**	**Δlog(*si*)**
Constant	0.012**	0.044***	–0.055**
	(0.006)	(0.015)	(0.026)
$\Delta\log(y_{t-1})$	–0.494***	–0.297*	–0.559***
	(0.076)	(0.176)	(0.150)
$\Delta\log(nominal\ GDP^{t-1})$	–	–	1.304
			(0.803)
$\Delta\log(nominal\ GDP_{t-2})$	0.682*	0.721*	–
	(0.365)	(0.419)	
q_1	–	–0.072***	0.129***
		(0.016)	(0.036)
q_2	–	–0.034*	0.080**
		(0.017)	(0.034)
q_3	–	–0.035***	0.032
		(0.013)	(0.029)
Observations	69	69	70
R^2	0.246	0.492	0.445

Note: Heteroskedasticity and autocorrelation robust SE are reported in parentheses; *si* = state insured; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; y_{t-1} is the first lag of dependent variable

heteroskedasticity and autocorrelation in error terms, so we compute heteroskedasticity and autocorrelation robust errors. Furthermore, outlying observations are found in state contributions which are due to advanced payments in 2013 and 2014. We include the original data in further models as we believe that the advanced payments reflect the economic situation.

Lagged regression

To test H3 and examine whether there is lagged effect of business cycle on health care system's revenues, we estimate a model with lagged values of GDP. The results are reported in Table 3. Total health insurance funds' revenues and employer-employee contributions have a significant pro-cyclical relationship with second lag of GDP. If quarter-over-quarter GDP lagged by two quarters changes by 1%, then total revenues change by 0.69% and employer-employee contributions change by 0.72% in the same direction. In regression with state contributions, the coefficient on lagged GDP is insignificant. Thus, we do not reject H3 in total revenues and employer-employee contributions, and we reject H3 in state contributions.

The Breusch-Pagan test and Breusch-Godfrey test show heteroskedasticity and autocorrelation in error terms, so we compute heteroskedasticity and autocorrelation robust errors. The residual analysis of lagged models is summarized in Figs. 5, 6 and 7 in Appendix B. As in the static model, residual plot of model with state contributions shows outlying observations which are due to advanced payments. Otherwise the models are well specified.

Other business cycle indicators

We examine the effect of other business cycle indicators on health care system's revenues, namely: unemployment, industrial production, recession index, business cycle index, GDP gap, consumer price index and consumer expenditure[5]. We compare the magnitude of the effects with the effect from the baseline model. The results in Table 5 in Appendix A support the hypothesis of procyclicality in total healthcare system's revenues. The relationship between business cycle indicator and total revenues is only significant in case of unemployment and industrial production. If quarter-over-quarter unemployment changes by 1%, quarter-over-quarter total revenues will change by 0.14% in the opposite direction. If quarter-over-quarter industrial production changes by 1%, quarter-over-quarter total revenues will change by 0.22% in the same direction. Both of these effects are much smaller in magnitude compared to the baseline model.

Employer-employee contributions are pro-cyclical with different business cycle indicators (see Table 6 in Appendix A). The effect is significant in case of unemployment, industrial production and also GDP gap, but in the last case, the coefficient is very close to zero. If quarter-over-quarter unemployment changes by 1%, the quarter-over-quarter contributions from employers and employees will change by 0.13% in the opposite direction. If quarter-over-quarter industrial production changes by 1%, the quarter-over-quarter employer-employee contributions will change by 0.33% in the same direction.

Lastly, Table 7 in Appendix A shows that there is no single significant relationship between the business cycle indicator and contributions from state and the signs do not suport the idea of counter-cyclicality.

The lagged regression with other business cycle indicators is shown in Table 8 in Appendix A for total revenues, Table 9 in Appendix A for employer-employee contributions and Table 10 in Appendix A for state contributions. For total revenues and employer-employee contributions, the results support the hypothesis of pro-cyclicality. The lagged effect of unemployment is no longer significant, whereas the effect of industrial production remains significant and is even larger compared to contemporaneous relationship in case of total revenues. Concerning the state contributions, we do not find any significant lagged relationship with business cycle and the signs of

[5] We intended to include average wage and interest rate as well, but these variables were not stationary even when log-differenced

the effects do not clearly suggest neither pro-cyclicality, nor counter-cyclicality of state contributions.

Summary of results

The results indicate that there is a significant pro-cyclical relationship between the business cycle (proxied by nominal GDP) and total health insurance funds' revenues in the Czech Republic. This effect is driven mainly by contributions from employers and employees that make a major part of total revenues. The pro-cyclicality in employer-employee contributions persists for two quarters, with the lagged effect being smaller. Contributions from state on behalf of economically inactive people do not display a significant relationship with business cycle in the Czech Republic.

The results of the baseline model are compared with the effect of seven different business cycle indicators. The magnitude of the effect with these indicators is smaller than the effect of nominal GDP and varies for different business cycle indicators. This is caused by the fact that the linkages between individual indicators and health insurance funds' revenues vary.

The results support our expectation that during economic downturns, employer-employee contributions decline. This occurs for two reasons: (i) wages decrease during economic downturns and (ii) people lose jobs and thus become eligible for the state coverage. The effect is significant and pro-cyclical in both the contemporaneous and lagged model for total revenues and employer-employee contributions. The reason why the effect persists for two quarters are for instance long-term contracts which prevent employers to lay off workers immediately or to decrease wages.

Discussion

The results provide empirical evidence that current financing of the health care system in the Czech Republic is pro-cyclical. This finding implies a possible problem during economic downturns, when employer-employee contributions decline, so there are fewer resources available in insurance funds to pay for health care provision. In case of severe crisis, this may pose a threat to health care providers and may lead to delayed care, which will have harmful consequences on the population in the long-term. The decrease in revenues occurs for two reasons: (i) employers release their employees during crisis, so individuals that used to contribute from their wages become eligible for state contributions, which are much lower and (ii) wages during crisis are stagnating, i.e. not growing. The analysis is based on data from the Czech Republic, one of the countries that rely on the SHI scheme. Our results are not directly applicable in other countries with SHI scheme as the resilience of the health care system's revenues depends on the relative importance of its sources.

Eight different business cycle indicators are used in the analysis. According to our results, the insurance funds' revenues are the most sensitive to nominal GDP, where the effect is the largest. This suggests that counter-cyclical policy could be determined based on the evolution of GDP. The next two indicators that are also statistically significant are the industrial production and unemployment.

The experience from the 2008 financial crisis has shown several possible mechanisms that European countries employed to effectively respond to the crisis and build resilience: counter-cyclical fiscal policies; adequate levels of public spending on health; no major gaps in health coverage; relatively low levels of out-of-pocket payments; etc. [4]. Some of these had already been in place in the Czech Republic prior to the crisis (e.g. low out-of-pocket payments, universal health coverage), but some could have been embraced in the aftermath of the financial crisis, such as counter-cyclical fiscal policies.

Focusing purely on countries relying on the SHI scheme, the decrease in healthcare system's revenues after the global financial crisis has been handled differently. In Estonia, the financial crisis led to decrease in SHI contributions by 11% in 2009 and by 5% in 2010 due to rising unemployment [4]. Estonia was well-prepared for the crisis thanks to large reserves that had been accumulated by the Estonian Health Insurance Fund (EHIF). Despite that, the reserves were not used to their full potential and budgetary cuts in healthcare were unavoidable [5]. As a consequence of the crisis, the Estonian government introduced a government transfer on behalf of pensioners as a part of the 2017 health reform to expand the revenue base. Before the reform, nearly half of the population was eligible for the health insurance with no contributions made on behalf of them [5, 36].

In Lithuania, unemployment more than tripled in one year, but health care system's revenues were partially protected thanks to counter-cyclical mechanisms. The state contributions are defined as a share of average gross monthly salary, lagged by two years, and this share has been increasing over time. Thus, while the contributions from economically active population declined by 20% in 2009, this loss of revenue was covered by increasing state contributions, which more than doubled between 2007 and 2010. As a result, financing for health care was affected much less than the rest of economy [4].

The economic crisis in Greece led to a rapid increase in unemployment, which resulted in significant decrease of social insurance revenues by 20.5% between 2008 and 2013. After receiving the financial aid from the Troika, Greece had to implement extensive austerity measures

aiming at reducing public expenditures. From 2009 to 2013, Greece experienced an average drop in health expenditures per capita by 8.7% annually, one of the biggest reductions in OECD [4]. Around 2.5 million people lost their health insurance coverage after 2009 due to unemployment and it took until 2016 to ensure access to healthcare for the vulnerable groups [2]. The crisis highlighted the need for restructuring the health care system [2]. These examples demonstrate that relying mainly on employer-employee contributions does not provide a stable source of financing unless counter-cyclical mechanism are implemented.

During the 2008 financial crisis, the Czech Republic, like many other countries, implemented fiscal policy measures to mitigate the impacts of the economic downturn. Automatic stabilizers included for instance progressive taxes, unemployment benefits and social programs. Discretionary policy included increased government spending on infrastructure projects, subsidies for industries affected by the crisis, and tax cuts to stimulate consumer spending and business investment [37]. Between 2001 and 2011, the fiscal discretion operated mostly pro-cyclically and in minor cases also counter-cyclically [38]. Similarly as many EU countries, Czech Republic did not accumulate sufficient budgetary reserves prior to the financial crisis. This limited the use of counter-cyclical automatic stabilizers and the discretionary policy had to respond to high government deficits by consolidation in a pro-cyclical manner [38].

The results of our analysis for total health insurance funds' revenues and employer-employee contributions are in accordance with other state activities: similarly as taxes, they also decrease during economic downturns and behave pro-cyclically. The state contributions do not display neither pro-cyclical, nor counter-cyclical pattern, even though we would expect them to copy the trend of unemployment or social benefits which are counter-cyclical stabilizers. Contributions from state should be increased to offset the loss of revenue from economically active individuals during economic downturn. Additionally, in such a pro-cyclical system, the revenues are expected to diminish also in the context of ageing population, as the number of economically active people will decrease while the number of state insured individuals will increase

We contribute to current literature by examining the relationship between the business cycle and health insurance funds' revenues, which has not been done before. We quantify the effect of nominal GDP on total revenues, revenues from employers and employees and state contributions. We find that while employer-employee contributions are pro-cyclical, the revenues from state do not display any significant relationship with business cycle, so there is no evidence of counter-cyclicality which could help to stabilize the health care systems' revenues during economic crisis.

Conclusion

The resilience of healthcare system's revenues to business cycle fluctuations has been discussed especially after the onset of 2008 financial crisis, but the exact effect has not been measured. In this article, we focus on one of the two principal financing schemes in Europe – the SHI, which is financed mainly by economically active population. This makes the system vulnerable to business cycle fluctuations, unless counter-cyclical measures are implemented. In particular, we provide empirical evidence based on data from the Czech Republic, a country with the SHI scheme.

We estimate the effect of business cycle (proxied by eight different indicators) on health care system's revenues, and its two main components: employer-employee contributions and state contributions. We analyse the contemporaneous and lagged effect of business cycle. The most sensitive business cycle indicator is nominal GDP. Total health care system's revenues are pro-cyclical, which is mainly driven by employer-employee contributions. Our model estimates that if quarter-over-quarter GDP increases by 1%, then quarter-over-quarter total revenues will increase by 0.7% and quarter-over-quarter contributions from employees will increase by 1.1%. The effect in lagged model is slightly smaller. State contributions do not exhibit any significant relationship with business cycle proxied by nominal GDP. We also estimate the effect of different business cycle indicators (unemployment, industrial production, recession index, business cycle index, GDP gap, consumer price index and consumer expenditure), where pro-cyclicality is also found for total revenues and employer-employee contributions, but the magnitude of the effect is smaller than for nominal GDP.

We find evidence that the Czech health care system as an example country with the SHI scheme faces the challenge of vulnerability to economic shocks. Our results are in accordance with evidence from other countries with the SHI scheme (Greece, Estonia, Lithuania), where health care system's revenues significantly declined during the 2008 financial crisis [5, 39, 40]. We contribute to current literature by being the first to focus purely on health insurance funds' revenues and to estimate the magnitude of the effect of business cycle. Our results imply the need to increase the magnitude of state

contributions in periods of economic downturns to compensate for the loss of revenue from economically active individuals in countries relying on the SHI scheme. The magnitude of the effect of economic downturn always depends on the relative importance of health care system's revenues.

Appendix A

Table 4 ADF test

	Level		First Difference	
	Intercept	Intercept, trend	Intercept	Intercept, trend
log(*total*)	1.42	−0.71	−8.52	−8.68
log(*employees*)	2.43	1.04	−4.42	−4.39
log(*si*)	−0.08	−3.46	−3.87	−3.97
log(*nominal GDP*)	−0.06	−1.21	−3.63	−3.65

The critical value of the ADF statistic at the 5% level for T = 50 is approximately -2.93 (intercept only) and -3.50 (intercept and trend). Lags are chosen based on AIC

Table 5 Other business cycle indicators - contemporaneous relationship (total revenues)

	Business cycle indicator						
	unem	*ind. prod.*	*recession index*	*BC index*	*GDP gap*	*CPI*	*cons. exp.*
Constant	0.030**	0.030**	0.034**	0.023	0.032**	0.032**	0.026
	(0.013)	(0.013)	(0.014)	(0.015)	(0.013)	(0.013)	(0.016)
Δ log ($total_{t-1}$)	−0.504***	−0.489***	−0.469***	−0.482***	−0.476***	−0.477***	−0.464***
	(0.117)	(0.119)	(0.096)	(0.104)	(0.112)	(0.118)	(0.120)
BC indicator[a]	**−0.136****	**0.223***	**−0.004**	**0.016**	**−0.000**	**0.563**	**0.229**
	(0.052)	(0.118)	(0.009)	(0.009)	(0.00000)	(0.797)	(0.345)
q_1	−0.011	−0.011	−0.013	−0.012	−0.012	−0.021	0.008
	(0.017)	(0.017)	(0.020)	(0.018)	(0.017)	(0.022)	(0.034)
q_2	−0.019	−0.019	−0.019	−0.019	−0.019	−0.022	−0.027
	(0.014)	(0.014)	(0.014)	(0.013)	(0.014)	(0.014)	(0.017)
q_3	−0.017	−0.017	−0.017	−0.015	−0.017	−0.019	−0.017
	(0.014)	(0.014)	(0.013)	(0.013)	(0.014)	(0.014)	(0.014)
Observations	70	70	70	70	70	70	70
R^2	0.274	0.263	0.246	0.276	0.249	0.251	0.249

Note: [a]Business cycle indicator (as indicated in the table header) in log difference (except for recession index and BC index). Heteroskedasticity and autocorrelation robust SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 6 Other business cycle indicators - contemporaneous relationship (employer-employee contributions)

	Business cycle indicator						
	unem	*ind. prod.*	*recession index*	*BC index*	*GDP gap*	*CPI*	*cons. exp.*
Constant	0.050***	0.049***	0.054***	0.046***	0.052***	0.053***	0.044***
	(0.013)	(0.012)	(0.012)	(0.015)	(0.012)	(0.012)	(0.015)
Δ log ($employees_{t-1}$)	−0.341**	−0.340**	−0.300**	−0.318**	−0.323***	−0.293*	−0.290*
	(0.164)	(0.166)	(0.115)	(0.132)	(0.088)	(0.167)	(0.172)
BC indicator[a]	**−0.134****	**0.331****	**−0.004**	**0.011**	**−0.000****	**1.286****	**0.326**
	(0.055)	(0.128)	(0.009)	(0.009)	(0.000)	(0.556)	(0.317)
q_1	−0.070***	−0.068***	−0.072***	−0.071***	−0.070***	−0.091***	−0.042
	(0.016)	(0.015)	(0.017)	(0.017)	(0.018)	(0.017)	(0.032)
q_2	−0.037**	−0.038**	−0.035**	−0.036**	−0.037**	−0.042**	−0.047**
	(0.017)	(0.017)	(0.015)	(0.015)	(0.015)	(0.018)	(0.020)
q_3	−0.033**	−0.033**	−0.033**	−0.031**	−0.033***	−0.037***	−0.034**
	(0.014)	(0.014)	(0.013)	(0.013)	(0.012)	(0.013)	(0.014)
Observations	70	70	70	70	70	70	70
R^2	0.482	0.492	0.460	0.472	0.472	0.485	0.466

Note: [a]Business cycle indicator (as indicated in the table header) in log difference (except for recession index and BC index). Heteroskedasticity and autocorrelation robust SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 7 Other business cycle indicators - contemporaneous relationship (state contributions)

	Business cycle indicator						
	unem	*ind. prod.*	*recession index*	*BC index*	*GDP gap*	*CPI*	*cons. exp.*
Constant	−0.043*	−0.037	−0.034	−0.054*	−0.039	−0.040	−0.039
	(0.026)	(0.024)	(0.031)	(0.031)	(0.025)	(0.025)	(0.032)
Δ log (si_{t-1})	−0.585***	−0.573***	−0.575***	−0.573***	−0.573***	−0.559***	−0.574***
	(0.157)	(0.158)	(0.147)	(0.073)	(0.106)	(0.145)	(0.160)
BC indicator[a]	**−0.204**	**−0.178**	**−0.011**	**0.027**	**0.000**	**−1.544**	**0.009**
	(0.133)	(0.320)	(0.023)	(0.023)	(0.000)	(1.839)	(0.738)
q_1	0.126***	0.125***	0.126***	0.126**	0.125***	0.149***	0.126*
	(0.035)	(0.035)	(0.040)	(0.048)	(0.042)	(0.050)	(0.064)
q_2	0.083**	0.081**	0.082**	0.082**	0.081**	0.088**	0.081
	(0.035)	(0.034)	(0.036)	(0.037)	(0.037)	(0.037)	(0.049)
q_3	0.031	0.032	0.031	0.035*	0.032	0.037	0.032
	(0.029)	(0.029)	(0.026)	(0.019)	(0.021)	(0.028)	(0.028)
Observations	70	70	70	70	70	70	70
R^2	0.479	0.473	0.473	0.482	0.473	0.477	0.471

Note: [a]Business cycle indicator (as indicated in the table header) in log difference (except for recession index and BC index). Heteroskedasticity and autocorrelation robust SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 8 Other business cycle indicators - lagged relationship (total revenues)

	Business cycle indicator						
	unem	***ind. prod.***	***recession index***	***BC index***	***GDP gap***	***CPI***	***cons. exp.***
Constant	0.028**	0.027**	0.040***	0.030**	0.032***	0.029**	0.0001
	(0.013)	(0.012)	(0.012)	(0.015)	(0.011)	(0.013)	(0.016)
Δ log ($total_{t-1}$)	−0.488***	−0.519***	−0.489***	−0.476***	−0.502***	−0.474***	−0.506***
	(0.126)	(0.113)	(0.108)	(0.111)	(0.085)	(0.114)	(0.104)
BC indicator[a]	**−0.116**	**0.485****	**−0.016**	**0.004**	**0.000****	**0.965**	**1.235*****
(lagged)	(0.141)	(0.187)	(0.009)	(0.009)	(0.000)	(0.801)	(0.349)
q_1	−0.010	−0.014	−0.014	−0.013	−0.012	−0.009	−0.008
	(0.017)	(0.016)	(0.018)	(0.017)	(0.020)	(0.017)	(0.016)
q_2	−0.017	−0.021	−0.019	−0.019	−0.020	−0.030**	0.098**
	(0.014)	(0.013)	(0.013)	(0.014)	(0.013)	(0.014)	(0.039)
q_3	−0.016	−0.019	−0.018	−0.017	−0.018*	−0.018	−0.059***
	(0.014)	(0.013)	(0.013)	(0.014)	(0.011)	(0.013)	(0.013)
Observations	68	68	70	70	68	70	70
R^2	0.270	0.339	0.276	0.247	0.316	0.262	0.380

Note: [a]Business cycle indicator (as indicated in the table header) in log difference (except for recession index and BC index). Heteroskedasticity and autocorrelation robust SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 9 Other business cycle indicators - lagged relationship (employer-employee contributions)

	Business cycle indicator						
	unem	***ind. prod.***	***recession index***	***BC index***	***GDP gap***	***CPI***	***cons. exp.***
Constant	0.050***	0.049***	0.057***	0.052***	0.051***	0.050***	0.026*
	(0.013)	(0.013)	(0.012)	(0.015)	(0.012)	(0.013)	(0.016)
Δ log (*employees* $_{t-1}$)	−0.328*	−0.342**	−0.307**	−0.302*	−0.320**	−0.330*	−0.348**
	(0.173)	(0.168)	(0.121)	(0.168)	(0.141)	(0.166)	(0.159)
BC indicator[a]	**−0.126**	**0.218***	**−0.012**	**0.001**	**0.000****	0.814	1.025***
(lagged)	(0.095)	(0.129)	(0.009)	(0.008)	(0.000)	(0.669)	(0.317)
q_1	−0.071***	−0.072***	−0.071***	−0.072***	−0.071***	−0.068***	−0.067***
	(0.016)	(0.015)	(0.017)	(0.015)	(0.017)	(0.016)	(0.014)
q_2	−0.036**	−0.038**	−0.035**	−0.035**	−0.035**	−0.046**	0.060
	(0.017)	(0.017)	(0.015)	(0.017)	(0.015)	(0.018)	(0.037)
q_3	−0.034**	−0.034**	−0.031**	−0.033**	−0.032**	−0.034**	−0.067***
	(0.014)	(0.013)	(0.013)	(0.014)	(0.014)	(0.013)	(0.011)
Observations	69	68	70	70	69	70	70
R^2	0.481	0.477	0.475	0.458	0.492	0.468	0.536

Note: [a]Business cycle indicator (as indicated in the table header) in log difference (except for recession index and BC index). Heteroskedasticity and autocorrelation robust SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 10 Other business cycle indicators - lagged relationship (state contributions)

	Business cycle indicator						
	unem	***ind. prod.***	***recession index***	***BC index***	***GDP gap***	***CPI***	***cons. exp.***
Constant	−0.036	−0.046*	−0.033	−0.045	−0.040	−0.041	−0.071**
	(0.025)	(0.026)	(0.030)	(0.030)	(0.026)	(0.027)	(0.032)
Δ log (si_{t-1})	−0.572***	−0.573***	−0.576***	−0.580***	−0.568***	−0.571***	−0.577***
	(0.159)	(0.153)	(0.154)	(0.097)	(0.148)	(0.157)	(0.158)
BC indicator[a]	**0.120**	**0.439**	**−0.016**	**0.013**	**0.000**	0.513	1.210*
(lagged)	(0.109)	(0.360)	(0.022)	(0.022)	(0.000)	(1.462)	(0.614)
q_1	0.125***	0.126***	0.127***	0.124***	0.127***	0.125***	0.129***
	(0.035)	(0.036)	(0.036)	(0.044)	(0.037)	(0.038)	(0.036)
q_2	0.080**	0.083**	0.083**	0.081**	0.084**	0.080**	0.196**
	(0.034)	(0.035)	(0.035)	(0.036)	(0.035)	(0.037)	(0.075)
q_3	0.031	0.036	0.033	0.030	0.031	0.032	−0.010
	(0.029)	(0.029)	(0.028)	(0.019)	(0.029)	(0.031)	(0.033)
Observations	70	69	70	70	70	67	70
R^2	0.474	0.480	0.475	0.474	0.481	0.478	0.487

Note: [a]Business cycle indicator (as indicated in the table header) in log difference (except for recession index and BC index). Heteroskedasticity and autocorrelation robust SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Appendix B

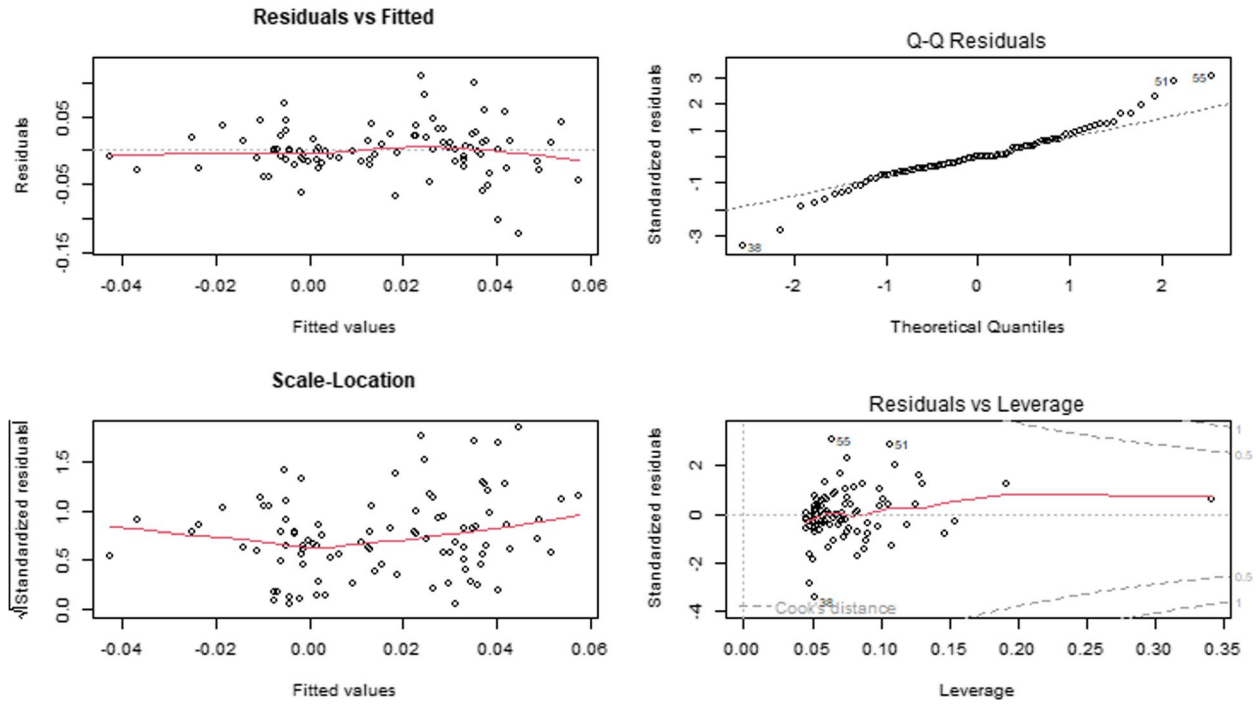

Fig. 2 Evaluation of residuals in static model with total revenues as dependent variable

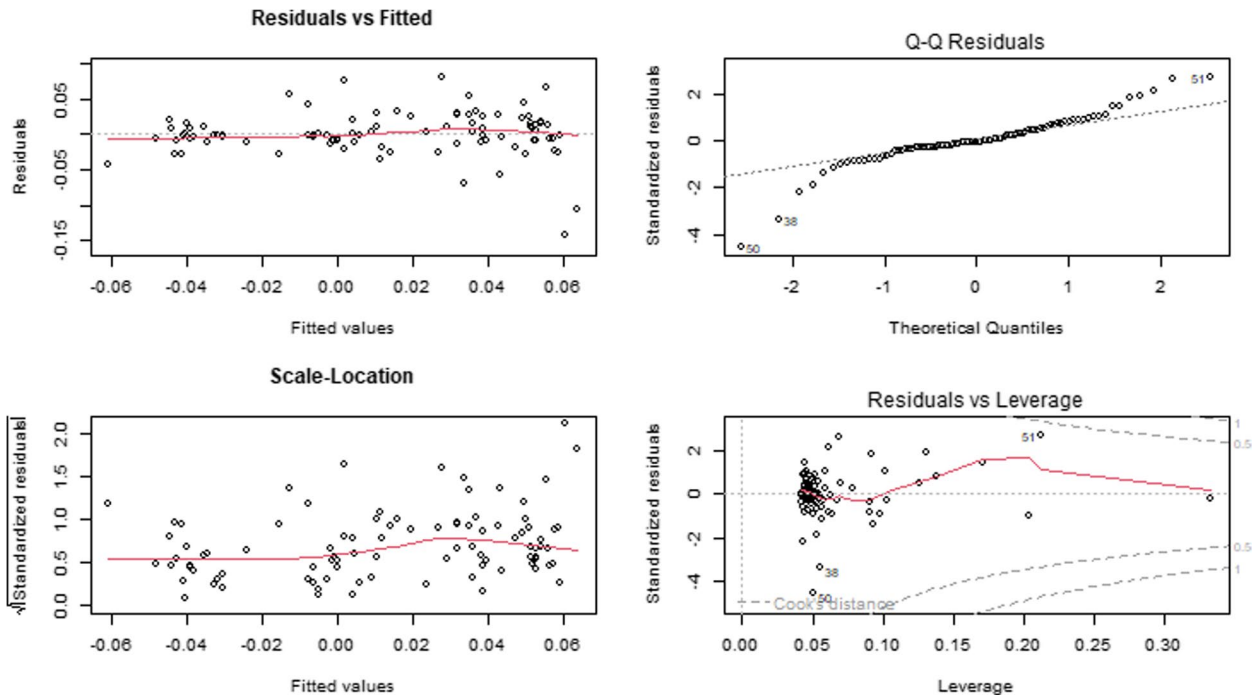

Fig. 3 Evaluation of residuals in static model with contributions from employees as dependent variable

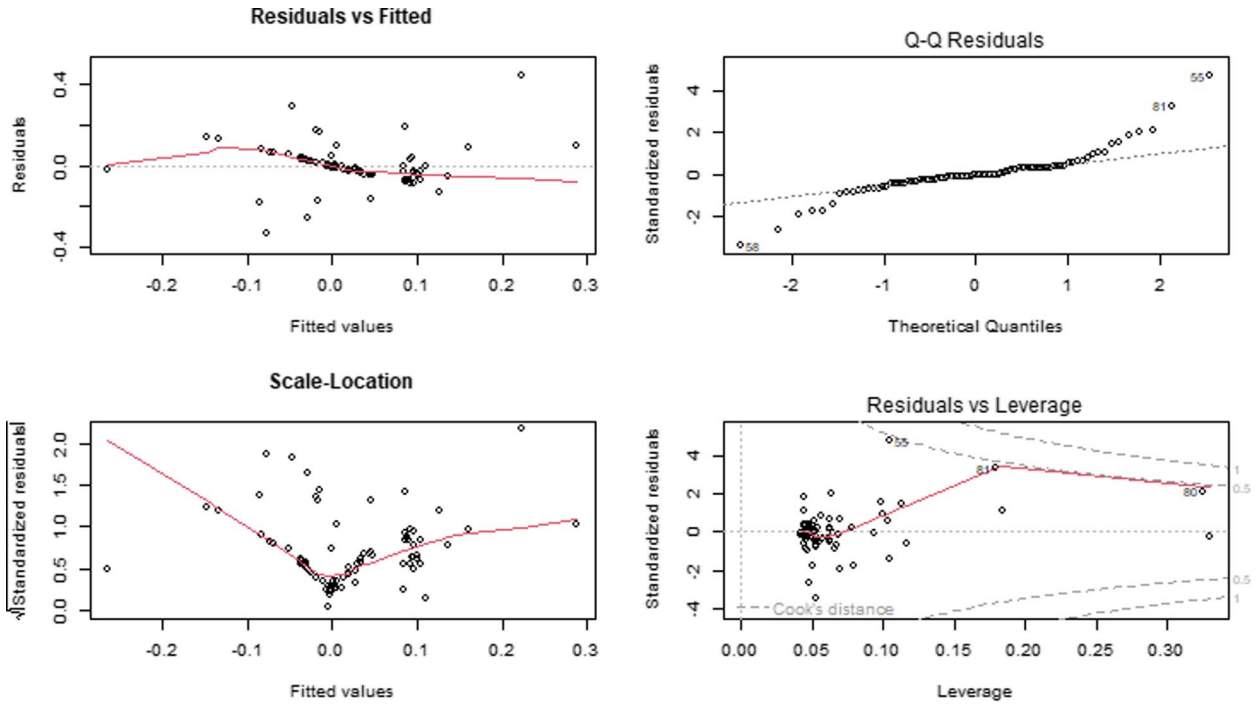

Fig. 4 Evaluation of residuals in static model with state contributions as dependent variable

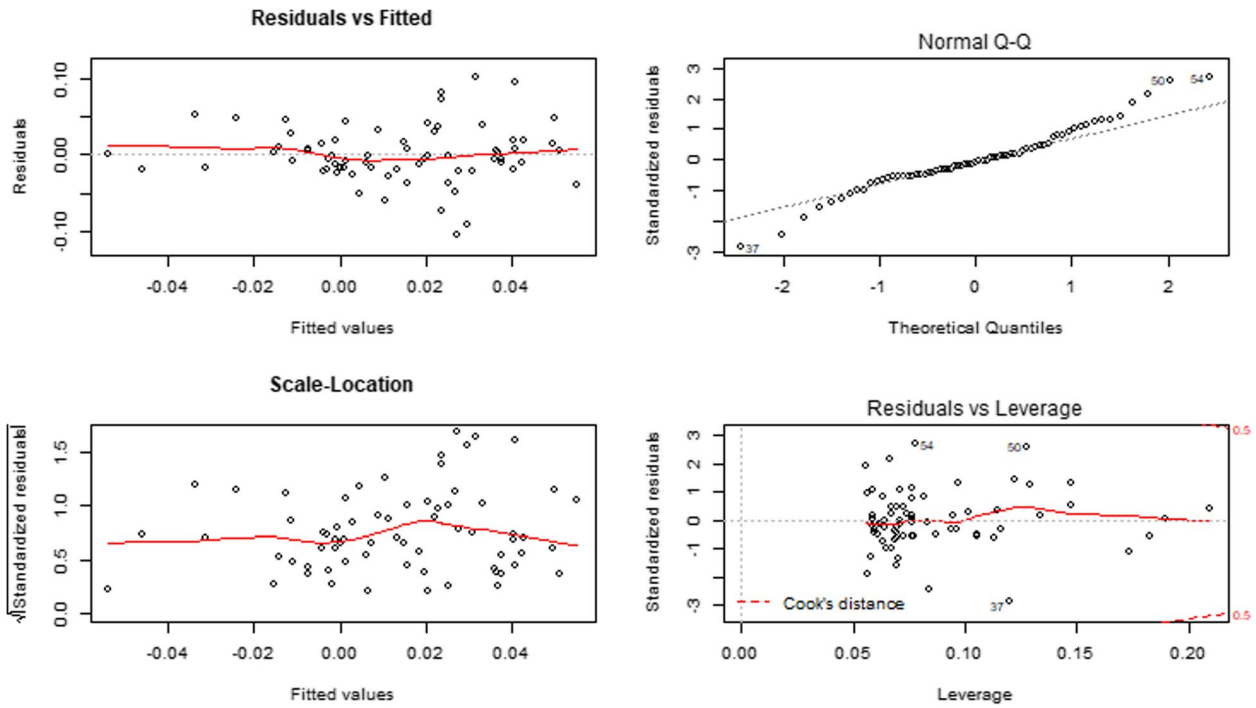

Fig. 5 Evaluation of residuals in lagged model with total revenues as dependent variable

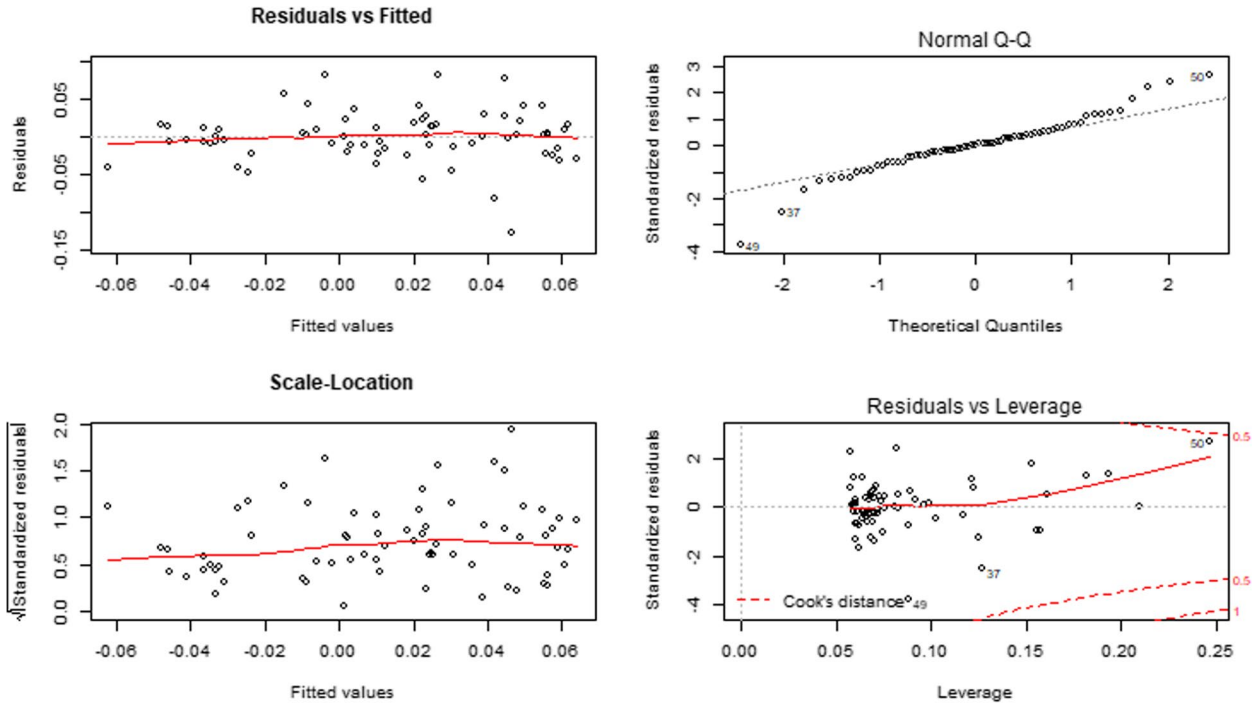

Fig. 6 Evaluation of residuals in lagged model with contributions from employees as dependent variable

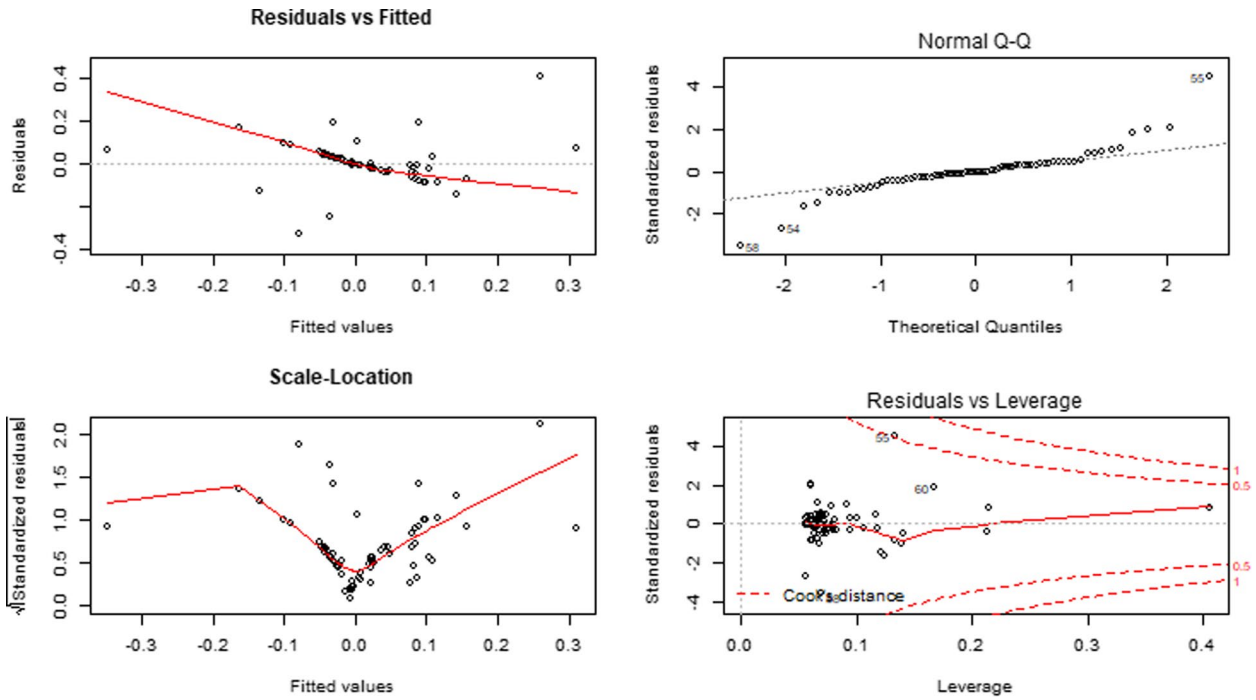

Fig. 7 Evaluation of residuals in lagged model with state contributions as dependent variable

Abbreviations

CNB	Czech National Bank
EHIF	Estonian Health Insurance Fund
EU	European Union
FRED	Federal Reserve Economic Data
GDP	Gross Domestic Product
GT	General Taxation
NBER	National Bureau of Economic Research
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
PHI	Private Health Insurance
SE	Standard Error
SHI	Statutory Health Insurance

Supplementary Information

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Supplementary Material 1.

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Authors' contributions
PL confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

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Data availability
The data that support the findings of this study are available from the Ministry of Health, Czech Republic, but restrictions apply to the availability of these data, which were used under licence for the current study, and so are not publicly available. Data are however available from the author upon reasonable request and with permission of the Ministry of Health. Macroeconomic indicators from various sources are available in electronic supplementary material.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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