INSTITUTE
OF ECONOMIC STUDIES
Faculty of Social Sciences
Charles University

BUSINESS CYCLE SENSITIVITY OF STATUTORY HEALTH INSURANCE: EVIDENCE FROM THE CZECH REPUBLIC

Petra Landovská

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Institute of Economic Studies,
Faculty of Social Sciences,
Charles University in Prague

[UK FSV – IES]

Opletalova 26
CZ-110 00, Prague
E-mail : ies@fsv.cuni.cz
http://ies.fsv.cuni.cz

Institut ekonomických studií
Fakulta sociálních věd
Univerzita Karlova v Praze

Opletalova 26
110 00 Praha 1

E-mail : ies@fsv.cuni.cz
http://ies.fsv.cuni.cz

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Business Cycle Sensitivity of Statutory Health Insurance: Evidence from the Czech Republic

Petra Landovská[a]

[a]Institute of Economic Studies, Faculty of Social Sciences, Charles University
Opletalova 26, 110 00, Prague, Czech Republic

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Abstract:
Since the Czech healthcare system financing is based on Statutory Health Insurance scheme, it relies heavily on wage-based contributions from employers and employees and thus may be prone to business cycle fluctuations. This turned out to be a problem after the 2008 financialcrisis when the government had to issue loans to the insurance funds in order to cover the loss of revenue from the economically active population. This paper examines how the insurance funds' revenues react to economic downturns and expansions, and whether the e ect is visible immediately or with a lag. The data from Ministry of Health, Czech Republic, are used, as well as several macroeconomic variables representing the business cycle. The static and lagged regression models on log di erenced data are employed throughout the analysis. Significant pro-cyclicality in total health insurance funds' revenues and contributions from employers/employees is found, with the lagged effect being slightly stronger. On the contrary, contributions from state on behalf of economically inactive people do not display a significant relationship with business cycle. These results imply the need to increase state contributions during economic downturns in order to compensate for the loss of health insurance funds' revenues from economically active individuals.

JEL: E32, G28, I13, I18
Keywords: health system financing, sensitivity analysis, business cycle, Czech Republic, social health insurance

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Contents

1 Introduction

One of the challenges that the health care systems currently face is their vulnerability to business cycle fluctuations. In general, there are two types of health care financing schemes in Europe: Statutory Health Insurance (SHI) and National Health Service (NHS), and each country has its own specific mix of financing schemes (OECD, 2016; Liaropoulos & Goranitis, 2015). The main difference between these schemes stems in funding: SHI is mainly funded from compulsory wage-based contributions while NHS is mainly funded from general taxation (Mossialos *et al.*, 2016). The Czech health care system serves as an example of the SHI scheme and is mainly financed by: (i) wage-based contributions from employers and employees and (ii) state contributions on behalf of economically inactive people. Since contributions from employers/employees make a principal part of total health insurance revenues, the SHI systems may be very vulnerable to work force fluctuations. This turned out to be a problem after the financial crisis of 2008 when the Czech government had to issue loans to the insurance funds. Additionally, the assessment base for the computation of state contributions was slightly elevated to increase insurance funds' revenues. Studying the impact of business cycle fluctuations on health care system revenues is important because it goes beyond the financial terms – it also affects health and the amount of health care services provided to the population (Portela & Thomas, 2013).

The objective of this paper is to examine how and to what extent is the financing of the Czech health care system (as a representative country of SHI scheme) prone to business cycle fluctuations, which, to the best of our knowledge, has not been studied before. Principally, we focus on insurance funds' revenues from two main sources: employer-employee contributions and contributions from state. There are two other sources: contributions from self-employed individuals and individuals without taxable income, which are excluded from the analysis as these only make about 6–7% of total revenues. In particular, we intend to test whether contributions from employers and employees are pro-cyclical and whether contributions from state are counter-cyclical. Furthermore, we examine whether the revenues are affected immediately by economic changes, or react with a lag. We use quarterly data in years 2000–2017 about health insurance funds' revenues that were obtained from the Ministry of Health, Czech Republic, as well as several indicators of business cycle from the FRED or OECD database (e.g. nominal GDP, industrial production or unemployment). To test our hypotheses, we fit the static model and lagged regression model to inspect whether health insurance funds' revenues react with a lag to business cycle fluctuations. We find a significant procyclical relationship in total health care system's revenues and contributions from economically active population.

The remainder of this paper is structured as follows: section 2 contains review of relevant literature. In section 3, the data are described, hypotheses to be tested are presented and methodologies used in the paper are explained. Section 4 gives description of results of our analysis. Section 5 provides discussion and Section 6 summarizes our findings and provides suggestions for further research.

2 Literature Review

The issue of resilience of health care system financing has been frequently discussed in the context of aging population, but also in the aftermath of the 2008 financial crisis. A stable source of revenues is crucial for the system to work properly in order to cover the population's needs. If the revenues are volatile, the budget needs to be cut and provision of healthcare is likely to be restricted, which can project into population's health.

The degree of volatility of particular health care system revenues varies across countries and depends on the composition and relative importance of system's revenues (Pisu, 2014). In general, SHI is funded mainly through wage-based contributions of employers and employees, while NHS is funded through general taxation. SHI is thus likely to be the most vulnerable to work force fluctuations as the budget tends to decrease with the rise of unemployment, while NHS is likely to be vulnerable to GDP shocks (Portela & Thomas, 2013).

The main problem of SHI is that it has relatively narrow revenue base and relies mainly on wages. It does not include other sources of revenues such as wealth generated through savings or investment (Mossialos *et al.*, 2002). However, experience shows that the system can be subsidized by state to cover the loss of revenues (Portela & Thomas, 2013).

Resilience of health care systems has become a subject of debate especially in countries that were severely hit by the crisis, such as Lithuania and Greece, where the sharp rise in unemployment proved that relying mainly on contributions from employers and employees does not provide a stable source of financing (Murauskiene *et al.*, 2013; Simou & Koutsogeorgou, 2014).

2.1 Country experience

Greece was hit by the crisis especially severely. Between 2008 and 2012, GDP declined by 17.8% in real terms and unemployment increased from 7.7% to 24.3% (Maresso *et al.*, 2015). Social health insurance revenues decreased significantly between 2008 and 2013 (from €30.7 to €24.4 billion) as a result of increasing unemployment and lower wages (Maresso *et al.*, 2015). Besides the financial aid from the Troika, Greece had to implement extensive austerity measures aiming at reducing public expenditure. From 2009 onwards, salaries in public sector as well as pensions were significantly reduced and household savings began to decline (Maresso *et al.*, 2015). With the decrease in personal income, the crisis led to a shift from private to public services (Portela & Thomas, 2013). Government spending on health was also reduced sharply, with the largest decrease in spending on pharmaceuticals and other non-durable products (by 44.2%) (Maresso *et al.*, 2015). From 2009 to 2013, Greece experienced an average drop in health expenditures per capita by 8.7% annually. This was one of the biggest reductions in health care expenditures in OECD. These budgetary cuts resulted in deterioration of health status, especially among vulnerable groups (Kentikelenis *et al.*, 2011).

Similarly as Greece, Ireland belongs to countries that were hit by the crisis heavily. Between 2008 and 2011, the GNP declined by 20%, resulting in the need of external financial support and cuts in public spending, including the health sector. Number of staff in healthcare was cut as well as their salaries. Between 2005 and 2011, increasing prices in health sector (hospital charges, fees) were putting a further financial pressure on financing of the health system. The crisis thus served as an impulse to initiate several reforms aimed at achieving greater efficiency and cost saving, for instance the commitment of government to introduce universal health insurance by 2016 (Maresso *et al.*, 2015).

The financial crisis also left its marks on the Estonian economy, leading to drop of GDP (by 4.2% in 2008 and 14.1% in 2009) and increase in unemployment, which contributed to increasing poverty. Estonia is a country where health care system revenues used to rely almost exclusively on contributions from wages. As unemployment rose and salaries decreased, the SHI contributions declined by 11% in 2009 and by 5% in 2010 (Maresso *et al.*, 2015). However, thanks to large reserves that had been accumulated by EHIF (Estonian Health Insurance Fund) during periods of economic growth, Estonia was well-prepared to handle the consequences of the crisis. Nevertheless, as the primary goal of the country was to meet the Eurozone criteria in order to adopt Euro in 2011, the reserves remained mostly unused in healthcare sector and the crisis led to budgetary cuts in healthcare, e.g. temporary reductions in tariffs paid to health care providers and reform of sickness benefits scheme reducing expenditures by 7% of EHIF's total budget (Habicht *et al.*, 2019). 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 and face the challenge of financial sustainability of health care system revenues. Before the reform, nearly half of the population was eligible for the health insurance without no contributions made on behalf of them (OECD, 2019; Habicht *et al.*, 2019).

In Lithuania, the situation was similar to that in the Czech Republic in many aspects. Financial reserves accumulated during period of economic growth were not large enough. During the crisis, GDP fell by 15% and unemployment more than tripled in one year. However, Lithuania did not use the help of IMF or ECB and instead made large cuts in public expenditures and used reserves to soften the impact of the crisis in 2009. Health system revenues were partially protected thanks to countercyclical mechanisms. Similarly as in Czechia, there are two main sources of SHI revenue in Lithuania: contributions from economically active individuals and contributions of state on behalf of certain groups defined by law. As unemployment rose and wages decreased, the government increased the contributions by state made on behalf of economically inactive individuals. These contributions have been increasing since 2008 and helped to maintain relatively stable source of revenues. One important aspect of countercyclical mechanism in Lithuania is that contributions by state are tied to those of economically active individuals – in particular, they 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 and even more in 2010, compared to 2008, 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 (Maresso *et al.*, 2015).

2.2 Czech experience

The health insurance funds in the Czech Republic collect revenues from four sources: (i) employers and employees, (ii) self-employed individuals, (iii) individuals without taxable income and (iv) economically inactive individuals who are defined by law. 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 set by law, but in case of seasonal fluctuations, the Minister of Finance is able to provide financial assistance and change the magnitude and frequency of state contributions.

Regarding the Czech experience after the 2008 financial crisis, the situation was not as severe as in countries mentioned above concerning the effects of financial crisis on GDP and unemployment. The health system's revenues rely mainly on economically active people and state contributions. The majority of population (almost 6 million people, or 60%) in the Czech Republic fall in the category of state-insured individuals. The problem is that contributions on behalf of state-insured individuals are on average significantly lower (2–5 times) compared to those of economically active individuals, which means they may not be sufficient to cover losses in revenues resulting from a rise in unemployment and/or decreasing wages (Fall & Glocker, 2018). In fact, 70% of SHI revenues are raised through employer-employee contributions, but only a minority of Czechs (about 1/3) pay the contributions from their payroll, which makes the system suscebtible to workforce fluctuations. This 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 (Fall & Glocker, 2018). This shows that there are some counter-cyclical mechanisms set in Czechia, however, they are not as robust as in Lithuania where the magnitude of state contributions is tied to average wage and thus better reflects the economic situation in the country.

3 Data and Methodology

3.1 Data

The data used in the analysis were obtained from the Ministry of Health, Czech Republic (2018) and contain information about health insurance funds' revenues from 2000 to 2017. The data were extracted from quarterly reports of insurance funds and contain information about:

- total health care system revenues (millions CZK)
- revenues from employers and employees (millions CZK)
- revenues from self-employed individuals (millions CZK)
- revenues from individuals without taxable income (millions CZK)
- revenues from state insured individuals (millions CZK)

Furthermore, macroeconomic data for the Czech Republic were obtained from the OECD database, Czech Statistical Office and FRED, specifically: nominal GDP (seasonally adjusted), unemployment rate, industrial production, average wage and crisis indicator. Seasonally adjusted potential GDP was obtained from the Czech National Bank, which was used to compute GDP gap by subtracting seasonally adjusted GDP from it. Lastly, dummy variable *cycle* was created from GDP, which is equal to 1 if GDP is growing and 0 otherwise.

Table 1 shows the summary statistics of aggregated data on all insurance funds from 1$^{\text{st}}$ quarter 2000 to 4$^{\text{th}}$ quarter 2017. Figure 1 shows the evolution of the total revenues, payments from employers and employees (*employees*), self-employed individuals (*se*), individuals without taxable income (*wti*) and state insured (*si*) over the period 2000 to 2017, reported quarterly. We can observe that contributions paid by employees and employers 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 25% of the total revenues, even though they cover more than half of the population.

The plot of the health care system revenues (Figure 1) shows that total contributions, employer-employee contributions and contributions from state are increasing over time, but there are several sharp changes in the time series. The most abrupt changes are in the series describing contributions from state. The first one occurs in 2006 and results in increase in state contributions by around 3 million CZK. This sharp increase was due to advanced payment of state to the largest insurance fund in the Czech Republic (VZP) because it did not have enough resources to fulfil its liabilities in time, which led to delay in payments to hospitals. The change in 2010 was caused by increase in the assessment base from which the contributions per person per month are computed. Last but not least, very significant changes occurred in years 2013 – 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 then again in 2014. Other than that,

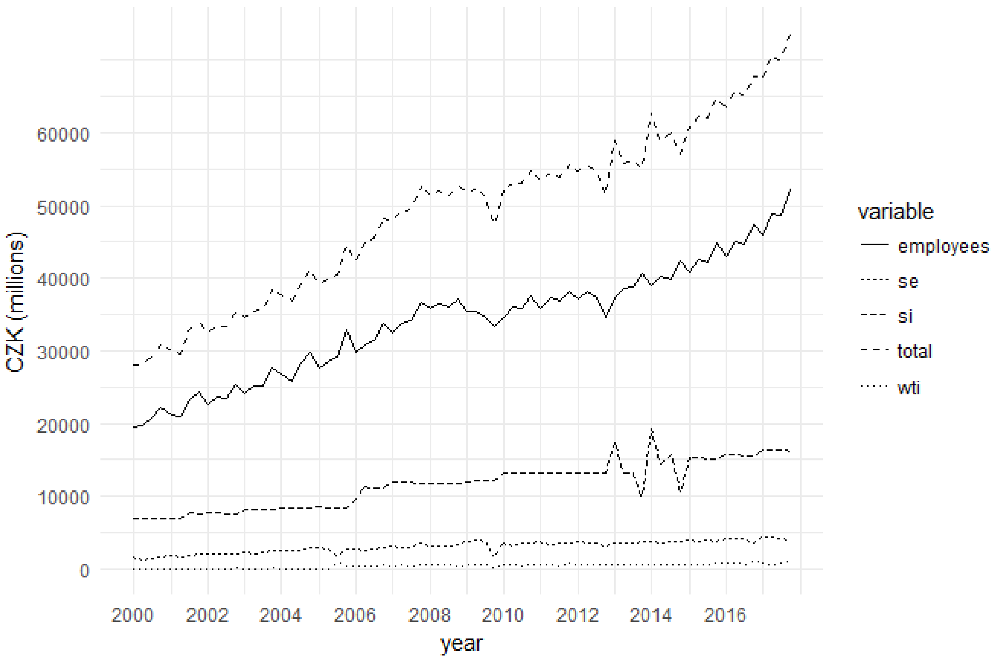
Table 1: Inflows of insurance funds, in millions CZK (2000 – 2017)

Statistic	N	Mean	St. Dev.	Min	1st Qu.	3rd Qu.	Max
total	72	49,089	11,863	28,008	38,937	55,936.8	73,530
employees	72	34,000	7,875	19,449	27,716.8	38,606.2	52,221
*se**	72	3,058	805	1,336	2,455.8	3,675.8	4,430
*wti**	72	457	298	30	88.8	638.8	1,207
*si**	72	11,573	3,199	6,816	8,345.8	13,274	19,223

Source: Ministry of Health, Czech Republic

**se*: self-employed, *wti*: without taxable income, *si*: state insured

Figure 1: Composition of insurance funds' inflows



Note: *se*: self-employed, *si*: state insured, *wti*: without taxable income

contributions from employees are growing until the crisis when they slightly stagnate or drop, but then continue growing until 2017 thanks to economic growth. The other two sources of revenues (contributions from individuals without taxable income and from self-employed individuals) are rather negligible.

3.2 Choice of variables to proxy business cycle

Economic recession is usually defined as a period of declining economic activity that lasts for more than two consecutive quarters (Claessens & Kosse, 2009). 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 (NBER, 2010).

The aim of this paper is to examine the effect of business cycle fluctuations on health care system financing. To do this, we need to find a good proxy for business cycle. There is a wide variety of variables to choose from according to other studies. Most commonly used variables 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 (Messina *et al.*, 2009; Carneiro *et al.*, 2012; Gerdtham & Johannesson, 2005; Oyesanya *et al.*, 2015). In this paper, we work with several macroeconomic variables. The primary business cycle indicator will be nominal GDP since all the health insurance funds' inflows are also in nominal terms. Furthermore, Di Matteo & Di Matteo (1998) claim that general economic activity (as represented by GDP) remains the most consistent and widely used predictor of over-time developments in health care expenditures. The other macroeconomic indicators will be used for comparison as robustness check.

3.3 Baseline analysis

The aim of this paper is to test the following research hypotheses:

1. Contributions from government on behalf of state insured individuals are counter-cyclical – they increase during recessions and decrease during periods of economic growth.
2. Economic recession has negative impact on total health care system revenues, which is mainly caused by decline of employer-employee contributions. In other words, insurance funds' inflows are pro-cyclical.
3. Health care system revenues do not decline immediately when the recession starts, but react with a lag.

To test these hypotheses, we use quarterly data from 2000–2017 on health insurance funds' revenues with a focus on two major resources: employer-employee contributions and contributions from state.

We begin by computing the concordance index between two variables (one representing the business cycle and the other representing a source of revenues). This method has been proposed by Avouyi-Dovi *et al.* (2006), who define concordance index as the average number of periods in which two variables are at the same phase of the cycle. The formula to compute the concordance index is:

$$c_{xy} = \frac{1}{T}\sum_{t}\left[s_{x,t}\cdot s_{y,t} + (1-s_{x,t})(1-s_{y,t})\right],$$

where T is number of periods, $s_{x,t}$ is business cycle indicator, $s_{y,t}$ represents revenues, $s_{x,t} = 1$ or $s_{y,t} = 1$ if the variable is growing (value at $t+1$ is larger than value at t) and $s_{x,t} = 0$ or $s_{y,t} = 0$ if the variable is shrinking. $c_{xy} = 1$ if both variables are at the same phase of cycle for all t. In our case, this would mean that the series is pro-cyclical. If $c_{xy} = 0$, it means that variables are always at different phase of cycle, thus counter-cyclical (this holds for all variables except for unemployment, recession index and GDP gap where it is vice-versa).

3.4 Static model

Firstly, we estimate the following equation by OLS:

$$\Delta log(y_t) = \beta_0 + \beta_1 \Delta log(y_{t-1}) + \beta_2 \Delta log(m_t) + \epsilon_t, \quad t = 1, ..., T,$$

where Δ indicates first-difference[1], y_t represents health care system 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 of the model, m_t is a macroeconomic variable and ϵ_t is the error term. We are interested in the magnitude and significance of β_2. $\beta_2 > 0$ implies procyclical behaviour, i.e. an increase in health care system revenues is associated with a cyclical upturn. Value of $\beta_2 > 1$ indicates a more-than proportionate response of health care system revenues to business cycle fluctuations, and $\beta_2 < 0$ indicates counter-cyclical behavior (vice-versa relationships hold for unemployment, recession index and GDP gap, since these business cycle indicators move in the opposite direction). However, this model only captures a contemporaneous relationship between macroeconomic variables and health insurance inflows.

3.5 Lagged regression

To test our hypothesis that business cycle fluctuations affect health care system revenues with a lag, we estimate the following model:

$$\Delta log(y_t) = \beta_0 + \beta_1 \Delta log(y_{t-1}) + \sum_{k=0}^{4} \beta_k \Delta log(m_{t-k}) + \epsilon_t, \quad t = 1, ..., T,$$

where m_{t-k} is the k^{th} lag of the macroeconomic variable, so β_k represents the lagged effect. To determine which/how many lags to use in the regression, we first examine the cross correlation plots. Secondly, we include 4 lags and based on the goodness of fit and significance of each lag, we start dropping insignificant lags and decide which lag(s) should be kept. The best model is chosen based on model comparison using the Cox test and Davidson-MacKinnon test. It may happen that no lags are significant, which indicates that there is no lagged effect of the business cycle.

We start with including 4 lags of macroeconomic variable because we have quarterly data and moreover, we intuitively suppose that the lagged effect will not persist for more than one year. Furthermore, including more lags leads to many coefficients to be estimated which could pose a problem with only 72 observations.

3.6 Robustness check

To check the robustness of our results, we fit the models with different business cycle indicators (unemployment, industrial production, recession index, business cycle index and GDP gap) and compare the coefficients on macroeconomic variable. We focus mainly on their sign, significance and size. We expect that for all variables except for unemployment, recession index and GDP gap, the sign of macroeconomic variable should be positive if the series is procyclical and negative if it is countercyclical.

4 Results

4.1 Baseline analysis

The concordance indexes are shown in Table 2. Total revenues and employer-employee contributions always react in a similar way – in all cases, they are both either below 0.5 or above 0.5. On the other hand, the concordance index of state contributions is always on the other side

[1]All series are non-stationary in levels (see results of ADF test in Table A1 in the Appendix).

of the scale. This suggests that total revenues and employer-employee contributions are procyclical while contributions from state are counter-cyclical. For instance, the concordance index for state contributions and unemployment is equal to 0.61 which means that when unemployment increases, contributions from state increase as well. Nevertheless, a lot of the concordance indexes are close to 0.5 which means that the relationships are not very strong and no reliable conclusions can be made based on these results.

Table 2: Concordance index

	total	*employees*	*state insured*
nominal GDP	0.514	0.542	0.333
industrial production	0.569	0.597	0.444
unemployment	0.458	0.431	0.611
GDP gap	0.444	0.417	0.514
business cycle index	0.556	0.528	0.458
recession index	0.458	0.458	0.500

$c_{xy} = \frac{1}{T} \sum_t [s_{x,t} \cdot s_{y,t} + (1 - s_{x,t})(1 - s_{y,t})]$

4.2 Static model

Table 3 shows results of the static model which depicts the contemporaneous relationship between the business cycle and health care system revenues. All variables are used in log-differences. q_1, q_2 and q_3 are dummy variables for the first, second and third quarter, respectively, to account for seasonality[2].

The results indicate that there is a positive and moreover significant relationship between GDP and total health insurance funds' revenues as well as employer-employee contributions. On the other hand, contributions from state do not exhibit a significant relationship with the cycle, although the sign on GDP is negative which suggests countercyclicality of state contributions. The size of β_2 (coefficient on $\Delta\log(\textit{nominal GDP})_t$) in the first regression is smaller than one, which indicates less than proportionate response of overall health care system revenues to business cycle. The size of β_2 in the second regression is larger than one, indicating more than proportionate response of employer-employee contributions to business cycle. Negative coefficients on seasonal dummy variables in regression with employer-employee contributions indicate that revenues are lower in the first three quarters compared to the fourth quarter of the year. This probably reflects bonuses that are paid to employees in the last quarter, which increases salaries and the health insurance contributions. On the other hand, significant coefficient on first (and second) quarter in the case of state contributions probably reflects the advanced payments that occured in 2013 and 2014.

Next, we check the models' specification. Figure B1 shows residual analysis for total revenues, Figure B2 for employer-employee contributions and Figure B3 for state contributions. The first two figures indicate that the models with total contributions and employer-employee contributions are well-specified and there are no issues with non-linearity, non-normality, heteroskedasticity or outlying observations. However, in case of state contributions, there may be some problems. Although the model is functionally well-specified and the residuals are normally

[2] These dummy variables are omitted in the first regression since they were jointly statistically insignificant.

Table 3: Contemporaneous relationship

	Dependent variable y_t:		
	$\Delta\log(total)$	$\Delta\log(employees)$	$\Delta\log(si)$
Constant	0.013^{**}	0.042^{***}	-0.033
	(0.006)	(0.012)	(0.023)
$\Delta\log(y)_{t-1}$	-0.511^{***}	-0.407^{**}	-0.568^{***}
	(0.066)	(0.180)	(0.155)
$\Delta\log(nominal\ GDP)_t$	0.647^{**}	1.112^{***}	-0.631
	(0.363)	(0.318)	(0.837)
q_1	–	-0.070^{***}	0.127^{***}
		(0.015)	(0.036)
q_2	–	-0.042^{**}	0.081^{**}
		(0.018)	(0.034)
q_3	–	-0.033^{***}	0.033
		(0.012)	(0.029)
Observations	70	70	70
R^2	0.243	0.523	0.474

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

distributed, the third plot shows that residuals are heteroskedastic. Therefore, heteroskedasticity-robust SE are computed. The fourth plot helps in finding influential points (outliers) that can influence the regression. We can see that there are one or two influential points, which are probably due to advanced payments in 2013 and 2014.

Whether these outliers should be treated or not is a subject of discussion. On the one hand, the advanced payments reflect that the economy was doing badly and insurance funds did not have enough resources to pay to hospitals. On the other hand, one could argue that the advanced payments should be averaged out because the advanced payments had nothing to do with business cycle. We therefore fit the static model with adjusted state contributions and see how it changes. We adjust the state contributions as if there was no advanced payment. The advanced payment was made in the 1^{st} quarter of year 2013 and 2014, while in the 4^{th} quarter, the insurance funds got lower amount of contributions to compensate for the advanced payment. Thus, we take the contributions from the 1^{st} and 4^{th} quarter and average them, which smooths the series. The results are summarized in Table A3. With adjusted state contributions, the effect of GDP has positive sign, but remains insignificant. Therefore, the results for state contributions in Table 3 are driven by these advanced payments. The static model with adjusted state contributions performs better which can be seen from residual analysis in Figure B4.

We also perform Durbin-Watson test for autocorrelation in residuals. The results are reported in Table A2 and indicate that there is no autocorrelation in residuals.

4.3 Lagged regression

To test our hypothesis that there is lagged effect of business cycle on health care system revenues, we next estimate a model with lagged values of GDP. We include 4 lags of GDP to begin with (because we have quarterly data), and adjust the lags as we try to fit the best model. Choosing the optimal lag length is not always straightforward and one has to rely on economic intuition (how long can we suppose that variables can have some effect on the dependent variable) and statistical tests to arrive to the best model, given the variables and dimension of data.

The results of lagged regression are reported in Table 4. Total health insurance funds' revenues and employer-employee contributions have a positive and significant relationship with second lag of GDP, while the best model for state contributions is the one with first lag of GDP. The coefficient is positive and larger than one, however, it is not significant. Both coefficients on second lag of GDP in the first two regressions are also smaller than 1, indicating less than proportionate response of revenues to business cycle.

Table 4: Lagged relationship

	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)
$\Delta\log(\textit{nominal GDP})_{t-1}$	–	–	1.304
			(0.803)
$\Delta\log(\textit{nominal GDP})_{t-2}$	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: SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$
si = state insured; y_{t-1} is the first lag of dependent variable

We also examine the residuals in all three regressions which are summarized in the Appendix in Figure B5, Figure B6 and Figure B7. As in the static model, residual plots do not indicate any problems except for the model with state contributions. Thus, we fit the lagged regression with adjusted state contributions. The results are summarized in Table A3. The coefficient on GDP is much smaller than with unadjusted state contributions and moreover insignificant, indicating that there is no significant lagged relationship between state contributions and business cycle. The residual plot of the adjusted model (Figure B8) looks much better now. Results of Durbin-Watson test for autocorrelation in residuals in lagged regressions are summarized in Table A4.

4.4 Robustness check

We check the robustness of our results using 5 different business cycle indicators: unemployment, industrial production, recession index, business cycle index and GDP gap. In the regression model with nominal GDP as representation of business cycle, we found that total revenues are procyclical. If this holds, then the coefficient on unemployment, recession index and GDP gap should be negative, while the coefficient on industrial production and business cycle should be positive. The results in Table 5 support the hypothesis of procyclical total revenues. The relationship between business cycle indicator and total revenues is only significant in case of unemployment and industrial production, however, the other business cycle indicators have expected signs. Although the magnitude of coefficients varies across different BC indicators, we can conclude that the results are robust to the choice of business cycle indicator for total revenues.

Table 5: Robustness check - contemporaneous relationship (total revenues)

	Business cycle indicator				
	unemployment	*ind. production*	*recession index*	*BC index*	*GDP gap*
Constant	0.030^{**}	0.030^{**}	0.034^{**}	0.023	0.032^{**}
	(0.013)	(0.013)	(0.014)	(0.015)	(0.013)
$\Delta\log(total)_{t-1}$	-0.504^{***}	-0.489^{***}	-0.469^{***}	-0.482^{***}	-0.476^{***}
	(0.117)	(0.119)	(0.096)	(0.104)	(0.112)
BC indicator[1]	$\mathbf{-0.136}^{**}$	$\mathbf{0.223}^{*}$	$\mathbf{-0.004}$	$\mathbf{0.016}$	$\mathbf{-0.000}$
	(0.052)	(0.118)	(0.009)	(0.009)	(0.000)
q_1	−0.011	−0.011	−0.013	−0.012	−0.012
	(0.017)	(0.017)	(0.020)	(0.018)	(0.017)
q_2	−0.019	−0.019	−0.019	−0.019	−0.019
	(0.014)	(0.014)	(0.014)	(0.013)	(0.014)
q_3	−0.017	−0.017	−0.017	−0.015	−0.017
	(0.014)	(0.014)	(0.013)	(0.013)	(0.014)
Observations	70	70	70	70	70
R^2	0.274	0.263	0.246	0.276	0.249

Note: [1] business cycle indicator (as indicated in the table header) in log difference (except for recession and BC index); SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

We check the robustness of results also for employer-employee contributions and state contributions. Employer-employee constributions behave procyclically and this is confirmed with different business cycle indicators. Moreover, the relationship is significant in case of unemployment, industrial production and also GDP gap, but in the last case, the coefficient is very close to zero (see Table A5). The other two business cycle indicators, recession index and business cycle index, have expected signs.

State contributions are a little problematic because we know they are outlier-sensitive. When we check the robustness using unadjusted state contributions, the results are mixed and there is no single significant relationship between the business cycle indicator and contributions from state (see Table A6). Even the signs are not as expected. If state contributions were to be counter cyclical, the coefficient on unemployment, recession index and GDP gap should be positive, while the coefficient on industrial production and business cycle index should be negative. When we check the robustness using adjusted state contributions, the coefficients on business cycle indicators remain insignificant, nevertheless the signs of all five indicators suggest procyclicality of state contributions (see Table A7).

Next, we check the robustness of the lagged regression. For total revenues, the regression with 2^{nd} lag of GDP was significant and positive. However, for each business cycle indicator, we may have different lags influencing the revenues. In general, if the relationship is procyclical and lagged, the lagged business cycle indicator should be positive for industrial production and business cycle index while it should be negative for unemployment, recession index and GDP gap. The results in Table 6 indicate that this holds except for GDP gap, where the coefficient is positive and significant, but it is very close to zero. We conclude that the results are robust concerning the direction of the effect. The same holds for employer-employee contributions (see Table A8 in the Appendix). Concerning the state contributions, we perform the robustness check for both unadjusted (Table A9) and adjusted (Table A10) contributions. We do not find any significant lagged relationship with business cycle, moreover, the signs of the effects do not clearly suggest neither procyclicality, nor countercyclicality of state contributions.

4.5 Summary of Results

The results indicate that there is a significant pro-cyclical relationship between the business cycle and total health insurance funds' revenues. This effect occurs contemporaneously and is slightly stronger in the lagged model. When we look at the two main components of health insurance funds' revenues – wage-based contributions from employers and employees and contributions from state on behalf of economically inactive people – we can see that the effect differs. The wage-based contributions, which make a major part of total resources, display a pro-cyclical pattern; on the other hand, contributions from state do not display a significant relationship with business cycle, and they are also outlier sensitive.

Robustness check using 5 different business cycle indicators confirms our conclusion that total health insurance funds' revenues and employer-employee contributions are pro-cyclical. The magnitude of the effect is smaller than when nominal GDP is used as economic indicator and less significant, which may be caused by the fact that nominal GDP is more linked to the magnitude of wages which determines the amount of contributions from employees sent to health insurance funds. This is quite common though, for instance, Messina *et al.* (2009) who examined how real wages vary over the business cycle, also found that the results were sensitive to the choice of business cycle indicator. In case of state contributions, the effect is not significant.

The results confirm our hypothesis that during economic downturns, when companies cut their budgets and lay off workers so the rate of unemployment increases, employer-employee

Table 6: Robustness check - lagged relationship (total revenues)

	Business cycle indicator				
	unemployment	*ind. production*	*recession index*	*BC index*	*GDP gap*
Constant	0.028^{**}	0.027^{**}	0.040^{***}	0.030^{**}	0.013^{***}
	(0.015)	(0.012)	(0.012)	(0.015)	(0.011)
$\Delta\log(total)_{t-1}$	-0.488^{***}	-0.519^{***}	-0.489^{***}	-0.476^{***}	-0.502^{***}
	(0.126)	(0.113)	(0.108)	(0.111)	(0.085)
BC indicator[1]	**−0.116**	**0.485****	**−0.016**	**0.004**	**0.000****
(lagged)	(0.141)	(0.187)	(0.009)	(0.009)	(0.000)
q_1	−0.010	−0.014	−0.014	−0.013	−0.012
	(0.017)	(0.016)	(0.018)	(0.017)	(0.020)
q_2	−0.017	−0.021	−0.019	−0.019	−0.020
	(0.014)	(0.013)	(0.013)	(0.014)	(0.013)
q_3	−0.016	−0.019	−0.018	−0.017	-0.018^{*}
	(0.014)	(0.013)	(0.013)	(0.014)	(0.011)
Observations	68	68	70	70	68
R^2	0.270	0.339	0.276	0.247	0.316

Note: [1] business cycle indicator (as indicated in the table header) in log difference (except for recession and BC index); SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

contributions decline. This occurs because wages decrease and people lose jobs and thus become eligible for the state coverage. The effect is stronger when lagged because companies usually do not respond to economic changes immediately, but gradually (this is caused for instance by long-term contracts which prevent employers to lay off workers immediately). Similarly, employer-employee contributions increase during periods of economic growth when less people are unemployed, wages rise and more money is sent to the insurance funds from deductions from payrolls. The same holds for total revenues because employer-employee contributions comprise a major part (about 3/4) of total health insurance funds' revenues.

5 Discussion

The results provide evidence that current financing of the health care system in the Czech Republic is not on its own resistant to business cycle fluctuations. In other words, we do not find empirical evidence of automatic countercyclical policy. 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.

Even though the possibility of countercyclical policy has long been embedded in the law, allowing the Minister of Finance to change the magnitude and frequency of state contributions, these contributions were not elevated enough to cover the loss of revenue from economically active population during the financial crisis. Rather, advanced payments were used as a one-off solution and ceiling on employer-employee contributions was increased in 2010 and then completely abolished from 2013, with the aim of mobilizing additional resources to support fiscal consolidation after the economic downturn (Alexa *et al.*, 2015).

There are several possible solutions what can be done before or during the crisis to offset the loss of revenues. Accumulating reserves during periods of economic growth is one example, however, experience shows that insurance funds have very small reserves (Mucalová, 2019). Even though reserves have been increasing since the 2008 financial crisis, they are not yet on the pre-crisis level (MFČR, 2019). Insurance funds have reserves for 5-49 days, with VZP (the largest insurance fund covering majority of population) having reserves for only 5 days (average between 2013 and 2017, Mucalová (2019)).

Another possibility is to increase the state contributions arbitrarily when revenues from employers and employees decline, which is already implemented in the law but rarely used. However, a more systematic solution would be tying the state contributions to (lagged) minimum or average wage as in Lithuania. This way, the state contributions would increase at least two fold, which would increase total health insurance funds' revenues and could be used to cover the loss of revenue during crisis or to make reserves in times of economic growth. Additionally, increasing the state contributions per capita and linking them to minimum/average wage could translate into higher wages in healthcare, better quality of healthcare provision and more efficiency.

There are some limitations in our study. First of all, we only focus on the main sources of revenues in the health care system which are the SHI contributions, consisting mainly of wage-based contributions and state contributions from general taxation. We do not examine in detail the other two sources of revenues which are contributions from individuals without taxable income and self-employed individuals, as these are negligible in terms of total health insurance revenues. Concerning the state contributions, we are aware of the outliers in the series in years 2013 – 2014. These sharp changes in the contributions from state were caused by solvency problems in the aftermath of the 2008 financial crisis. The loss of revenues from employer-employee contributions was so large that the government had to issue loans to the health insurance funds and slightly increase the base for per capita state contributions (OECD, 2017). We thus estimate the effect of business cycle also on series of state contributions adjusted for the advanced payments. The results prove that the effect is outlier sensitive.

5.1 Impact of COVID-19

There is large disparity between payments of economically active vs. inactive individuals. State insured individuals make up around 60% of the population, but the contributions made on behalf of them make up only about 25% of total health insurance funds' revenues (state contributed only 1 067 CZK per capita in 2019/2020). On the contrary, employers and employees pay much higher contributions - almost 2 000 CZK for employees with minimum wage and almost 5 000 CZK for employees with average wage, which is 2 - 5 times higher than state contributions per person. Thus, the difference is enormous.

However, this is changing now due to the breakout of COVID-19 pandemic. As many businesses were shut down and a new economic crisis burst out in the spring of 2020, the government confirmed increasing the base for computation of state contributions. This will project into larger state contributions per capita by 500 CZK from June 1st, 2020, and by another 200 CZK from January 1st, 2021, which should generate extra 21 billion CZK this year (roughly 5 billion CZK per quarter) (MZČR, 2020). The state contribution per capita will thus be 1 767 CZK, which is still lower than average contribution of employed people, nevertheless it is definitely a change for the better. Such a sharp increase (by nearly 50%) in state payments has never occured in the history of the Czech Republic. However, there will be large losses from economically active population. If we employ our model's results and the estimate that quarter over quarter GDP will decrease by 8.7% in the second quarter of 2020 (ČSÚ, 2020), we predict that the overall healthcare system's revenues will decrease by 5.6-5.9% (4.3-4.5 billion) per quarter within the next two quarters. Therefore, depending on the economic situation (change in GDP), the increase in state contributions may still be insufficient.

The problem of long-term sustainable financing will also deepen with aging population as the amount of people eligible for state coverage will increase gradually (European Comission, 2019; Fall & Glocker, 2018). The system from the 20^{th} century was designed for people with lower life expectancy (65 to 70 years), ensuring enough resources to finance a health care system (Liaropoulos & Goranitis, 2015). With increasing life expectancy and retirement age not increasing much, the amount of people in retirement eligible for state coverage will increase gradually and pose a long-term financial sustainability risk (European Comission, 2019; OECD *et al.*, 2019). By 2040, every fourth person is projected to be 65 years or older compared with 18% of the population today, which will result in lower revenues from wage-based contributions (Fall & Glocker, 2018; OECD, 2018). Additionally, the share of population aged 80 years and over will more than double (from 4% to 9% by 2050), resulting in higher demand for long term care (Fall & Glocker, 2018).

6 Conclusion

As stated in Country Health Profile (OECD, 2017): "The Czech health care system faces several challenges concerning the financing due to aging population and its vulnerability to economic shocks." This study focuses on one of these challenges. Because the Czech health care system is based on the SHI scheme, the main sources of financing are: (i) the payroll deductions of employees and contributions by employers and (ii) the contributions of state on behalf of certain groups of people. Since the contributions from employers and employees make a major part of total health insurance funds' revenues, the system is very prone to work force fluctuations. This proved to be a problem in the aftermath of the financial crisis of 2008 when the revenues were so low that the government had to issue loans to health insurance funds and at the same time, it had to slightly increase the state contributions (OECD, 2017).

To examine the sensitivity of health care system financing to business cycle fluctuations, we use the data from Ministry of Health, Czech Republic, which contain detailed information about health insurance revenues. We focus only on three variables: total health insurance funds' revenues, state contributions and contributions from employees and employers (in real terms). Several methods are used in the analysis. First of all, the concordance index according to Avouyi-Dovi *et al.* (2006) is computed as preliminary analysis. Nominal GDP (seasonally adjusted) is chosen as the best indicator of business cycle which is in accordance with other studies. Secondly, the series are found to be first-difference stationary, so log-differences are used throughout the analysis. Finally, static model is fitted to examine the short-run impact of business cycle on the sources of revenues. To examine whether the revenues react with a lag to business cycle fluctuations, the lagged regression model is evaluated. We find that while contributions from employers and employees are pro-cyclical, state contributions do not exhibit significant relationship with business cycle and are very outlier sensitive. Total revenues exhibit a pro-cyclical pattern which is mainly driven by employer-employee contributions. The lagged relationships are slightly larger in magnitude than contemporaneous relationships. In particular, total revenues and employer-employee contributions respond less than proportinately to the change in lagged real GDP.

We also check the robustness of our results using various business cycle indicators: unemployment, industrial production, recession index, business cycle index and GDP gap. The direction of the effect is robust for total revenues and employer-employee contributions in both the static and lagged model. The results are thus robust to the choice of business cycle indicator concerning the direction of the effect, but not the magnitude and significance. We suppose that this discrepancy arises because the health insurance funds' revenues are more linked to the whole economy which is better represented by real GDP rather than the other indicators.

To conclude, we found evidence that the Czech health care system as a representative country of SHI scheme indeed faces the challenge of vulnerability to economic shocks. During economic downturns, when wages decrease and more people become unemployed and thus eligible for state coverage, the overall health care system's revenues decline. This proves our hypothesis that the Czech health care financing scheme is prone to workforce fluctuations. Our results are in accordance with empirical evidence from Greece or Lithuania (Simou & Koutsogeorgou, 2014; Murauskiene *et al.*, 2013). We contribute to current literature by being the first, to the best of our knowledge, to focus purely on health insurance funds' revenues. Several studies have examined the effect of business cycle fluctuations on health expenditures. However, no one has yet focused on the other part of the problem which is equally important – the income of the health care system. 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.

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Appendix A

Table A1: 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 A2: Durbin-Watson test (static models)

	total	*employees*	*si*	*adjusted si*
DW statistic	2.296	2.005	2.022	2.056
p-value	0.203	0.237	0.834	0.847

H_0: $\rho = 0$; H_1: $\rho \neq 0$; si = state insured

Table A3: Regressions with *adjusted* state contributions

	Dependent variable: $\Delta\log(si\_adj)$	
	static model	lagged model
Constant	-0.009^{*}	-0.009^{*}
	(0.005)	(0.005)
$\Delta\log(si\_adj)_{t-1}$	0.075	0.078
	(0.218)	(0.230)
$\Delta\log(nominal\ GDP)_t$	0.374	–
	(0.289)	
$\Delta\log(nominal\ GDP)_{t-1}$	–	0.368
		(0.263)
q_1	0.048^{***}	0.049^{***}
	(0.010)	(0.010)
q_2	0.009	0.009
	(0.008)	(0.008)
q_3	0.008	0.009
	(0.009)	(0.009)
Observations	70	70
R^2	0.267	0.267

Note: SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

si_adj = contributions from state adjusted for outliers

Table A4: Durbin-Watson test (lagged models)

	total	*employees*	*si*	*adjusted si*
DW statistic	2.302	2.261	2.020	1.972
p-value	0.197	0.237	0.814	0.968

H_0: $\rho = 0$; H_1: $\rho \neq 0$; si = state insured

Table A5: Robustness check - contemporaneous relationship (employer-employee contributions)

	Business cycle indicator				
	unemployment	*ind. production*	*recession index*	*BC index*	*GDP gap*
Constant	0.050***	0.049***	0.054***	0.046***	0.052***
	(0.013)	(0.012)	(0.012)	(0.015)	(0.012)
$\Delta \log(employees)_{t-1}$	−0.341**	−0.340**	−0.300**	−0.318**	−0.323***
	(0.164)	(0.166)	(0.115)	(0.132)	(0.088)
BC indicator[1]	**−0.134****	**0.331****	**−0.004**	**0.011**	**−0.000****
	(0.055)	(0.128)	(0.009)	(0.009)	(0.000)
q_1	−0.070***	−0.068***	−0.072***	−0.071***	−0.070***
	(0.016)	(0.015)	(0.017)	(0.017)	(0.018)
q_2	−0.037**	−0.038**	−0.035**	−0.036**	−0.037**
	(0.017)	(0.017)	(0.015)	(0.015)	(0.015)
q_3	−0.033**	−0.033**	−0.033**	−0.031**	−0.033***
	(0.014)	(0.014)	(0.013)	(0.013)	(0.012)
Observations	70	70	70	70	70
R^2	0.482	0.492	0.460	0.472	0.472

Note: [1] business cycle indicator (as indicated in the table header) in log difference (except for recession and BC index); Robust SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A6: Robustness check - contemporaneous relationship (state contributions)

	Business cycle indicator				
	unemployment	*ind. production*	*recession index*	*BC index*	*GDP gap*
Constant	−0.043*	−0.037	−0.034	−0.054*	−0.039
	(0.026)	(0.024)	(0.031)	(0.031)	(0.025)
$\Delta \log(si)_{t-1}$	−0.585***	−0.573***	−0.575***	−0.573***	−0.573***
	(0.157)	(0.158)	(0.147)	(0.073)	(0.106)
BC indicator[1]	**−0.204**	**−0.178**	**−0.011**	**0.027**	**0.000**
	(0.133)	(0.320)	(0.023)	(0.023)	(0.000)
q_1	0.126***	0.125***	0.126***	0.126**	0.125***
	(0.035)	(0.035)	(0.040)	(0.048)	(0.042)
q_2	0.083**	0.081**	0.082**	0.082**	0.081**
	(0.035)	(0.034)	(0.036)	(0.037)	(0.037)
q_3	0.031	0.032	0.031	0.035*	0.032
	(0.029)	(0.029)	(0.026)	(0.019)	(0.021)
Observations	70	70	70	70	70
R^2	0.479	0.473	0.473	0.482	0.473

Note: [1] business cycle indicator (as indicated in the table header) in log difference (except for recession and BC index); Robust SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A7: Robustness check - contemporaneous relationship (*adjusted* state contributions)

	Business cycle indicator				
	unemployment	*ind. production*	*recession index*	*BC index*	*GDP gap*
Constant	−0.006	−0.006	−0.001	−0.008	−0.005
	(0.004)	(0.004)	(0.005)	(0.007)	(0.004)
$\Delta\log(si\_adjusted)_{t-1}$	0.093	0.093	0.073	0.094	0.087
	(0.220)	(0.218)	(0.208)	(0.183)	(0.193)
BC indicator[1]	**−0.029**	**0.064**	**−0.008**	**0.006**	**−0.000**
	(0.047)	(0.099)	(0.007)	(0.007)	(0.000)
q_1	0.049^{***}	0.049^{***}	0.049^{***}	0.049^{***}	0.049^{***}
	(0.010)	(0.010)	(0.009)	(0.009)	(0.009)
q_2	0.008	0.008	0.010	0.008	0.008
	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)
q_3	0.009	0.009	0.009	0.010	0.009
	(0.009)	(0.009)	(0.010)	(0.011)	(0.011)
Observations	70	70	70	70	70
R^2	0.256	0.256	0.266	0.260	0.273

Note: [1] business cycle indicator (as indicated in the table header) in log difference (except for recession and BC index); Robust SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A8: Robustness check - lagged relationship (employer-employee contributions)

	Business cycle indicator				
	unemployment	*ind. production*	*recession index*	*BC index*	*GDP gap*
Constant	0.050^{***}	0.049^{***}	0.057^{***}	0.052^{***}	0.051^{***}
	(0.013)	(0.013)	(0.012)	(0.015)	(0.012)
$\Delta\log(employees)_{t-1}$	-0.328^{*}	-0.311^{*}	-0.307^{**}	-0.302^{*}	-0.320^{**}
	(0.173)	(0.174)	(0.121)	(0.168)	(0.141)
BC indicator[1]	**−0.126**	**0.218***	**−0.012**	**0.001**	**0.000****
(lagged)	(0.095)	(0.129)	(0.009)	(0.008)	(0.000)
q_1	-0.071^{***}	-0.071^{***}	-0.071^{***}	-0.072^{***}	-0.071^{***}
	(0.016)	(0.015)	(0.017)	(0.015)	(0.017)
q_2	-0.036^{**}	-0.035^{*}	-0.035^{**}	-0.035^{**}	-0.035^{**}
	(0.017)	(0.018)	(0.015)	(0.017)	(0.015)
q_3	-0.034^{**}	-0.032^{**}	-0.031^{**}	-0.033^{**}	-0.032^{**}
	(0.014)	(0.014)	(0.013)	(0.014)	(0.014)
Observations	69	69	70	70	69
R^2	0.481	0.477	0.475	0.458	0.492

Note: [1] business cycle indicator (as indicated in the table header) in log difference (except for recession and BC index); Robust SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A9: Robustness check - lagged relationship (state contributions)

	Business cycle indicator				
	unemployment	*ind. production*	*recession index*	*BC index*	*GDP gap*
Constant	−0.036	−0.046*	−0.033	−0.045	−0.040
	(0.025)	(0.026)	(0.030)	(0.030)	(0.026)
$\Delta\log(si)_{t-1}$	−0.572***	−0.573***	−0.576***	−0.580***	−0.568***
	(0.159)	(0.153)	(0.154)	(0.097)	(0.148)
BC indicator[1]	**0.120**	**0.439**	**−0.016**	**0.013**	**0.000**
(lagged)	(0.109)	(0.360)	(0.022)	(0.022)	(0.000)
q_1	0.125***	0.126***	0.127***	0.124***	0.127***
	(0.035)	(0.036)	(0.036)	(0.044)	(0.037)
q_2	0.080**	0.083**	0.083**	0.081**	0.084**
	(0.034)	(0.035)	(0.035)	(0.036)	(0.035)
q_3	0.031	0.036	0.033	0.030	0.031
	(0.029)	(0.029)	(0.028)	(0.019)	(0.029)
Observations	70	69	70	70	70
R^2	0.474	0.480	0.475	0.474	0.481

Note: [1] business cycle indicator (as indicated in the table header) in log difference (except for recession and BC index); Robust SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table A10: Robustness check - lagged relationship (*adjusted* state contributions)

	Business cycle indicator				
	unemployment	*ind. production*	*recession index*	*BC index*	*GDP gap*
Constant	−0.004	−0.008*	−0.002	−0.005	−0.005
	(0.004)	(0.005)	(0.005)	(0.006)	(0.004)
$\Delta\log(si\_adj)_{t-1}$	0.102	0.092	0.080	0.097	0.103
	(0.221)	(0.220)	(0.211)	(0.186)	(0.196)
BC indicator[1]	**0.049**	**0.199**	**−0.008**	**−0.0001**	**−0.000**
(lagged)	(0.031)	(0.122)	(0.007)	(0.007)	(0.000)
q_1	0.048***	0.049***	0.049***	0.049***	0.049***
	(0.010)	(0.010)	(0.010)	(0.009)	(0.010)
q_2	0.008	0.009	0.010	0.008	0.008
	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)
q_3	0.009	0.012	0.010	0.009	0.009
	(0.009)	(0.010)	(0.010)	(0.011)	(0.011)
Observations	70	69	70	70	69
R^2	0.259	0.274	0.265	0.254	0.259

Note: [1] business cycle indicator (as indicated in the table header) in log difference (except for recession and BC index); Robust SE are reported in parentheses; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Appendix B

Figure B1: Evaluation of residuals in static model with total revenues as dependent variable

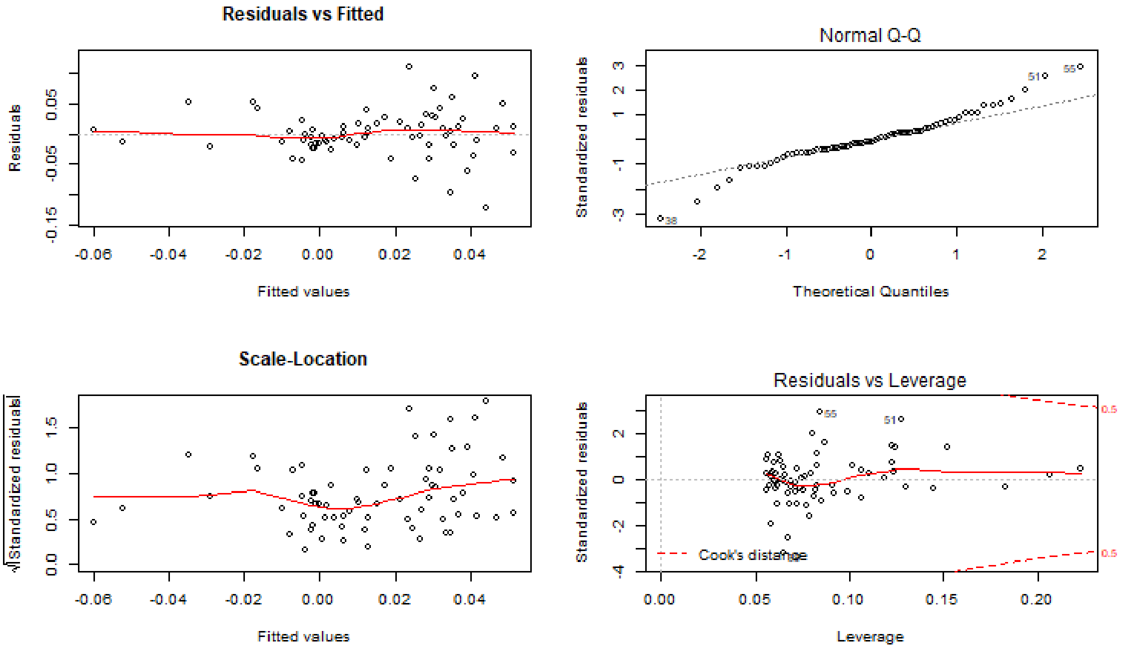


Figure B2: Evaluation of residuals in static model with contributions from employees as dependent variable

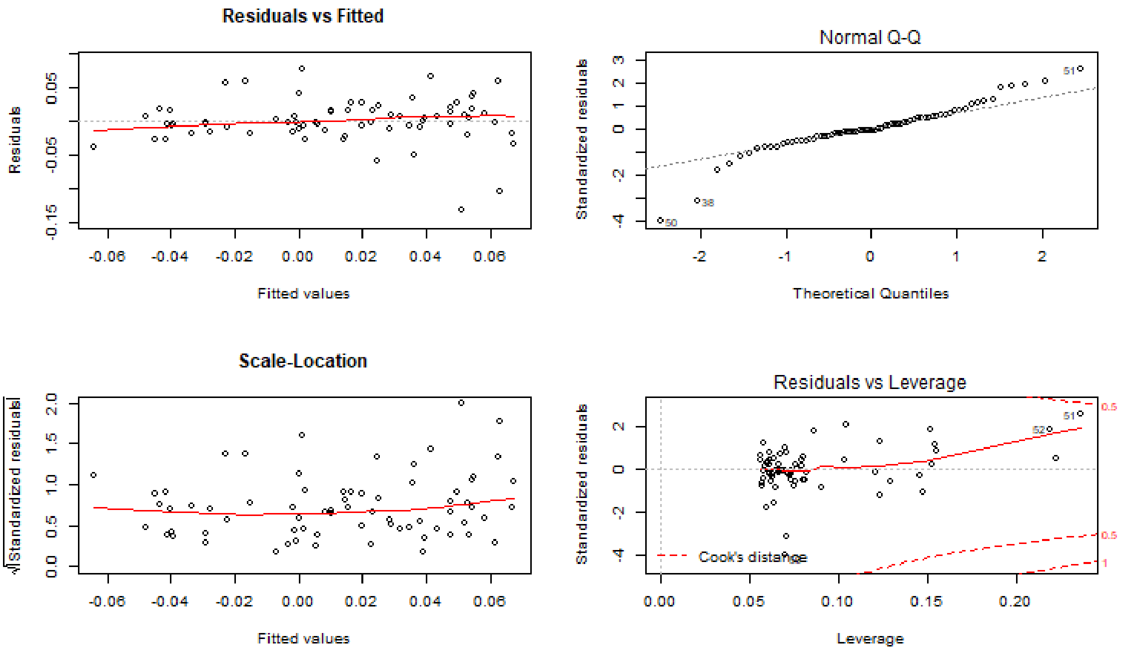


Figure B3: Evaluation of residuals in static model with state contributions as dependent variable

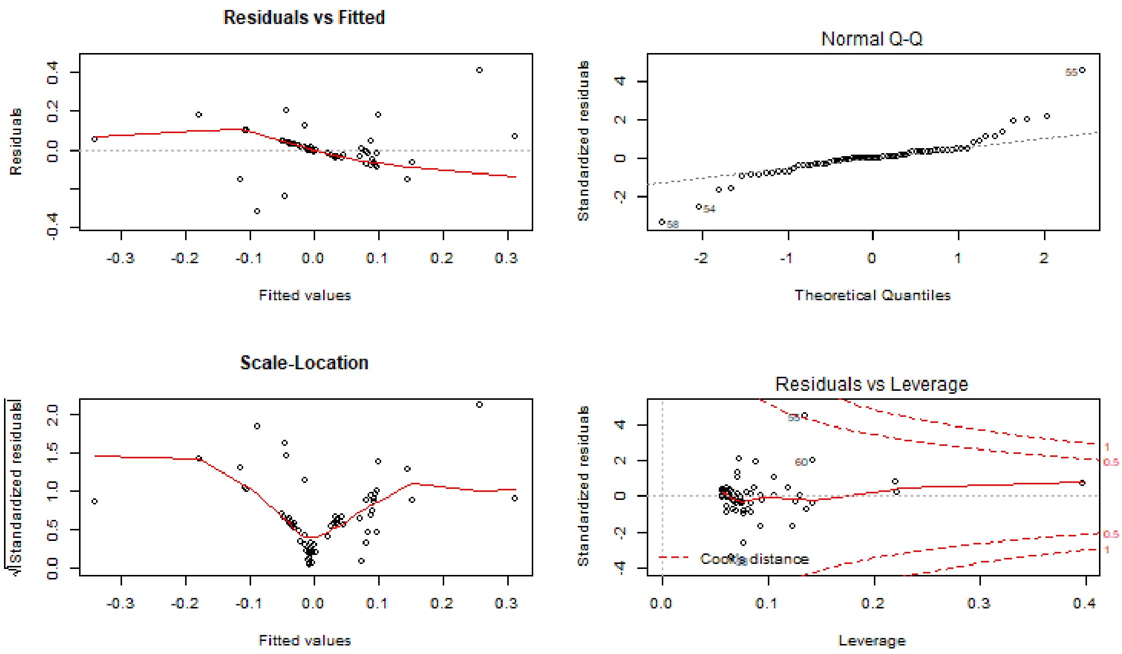


Figure B4: Evaluation of residuals in static model with *adjusted* state contributions as dependent variable

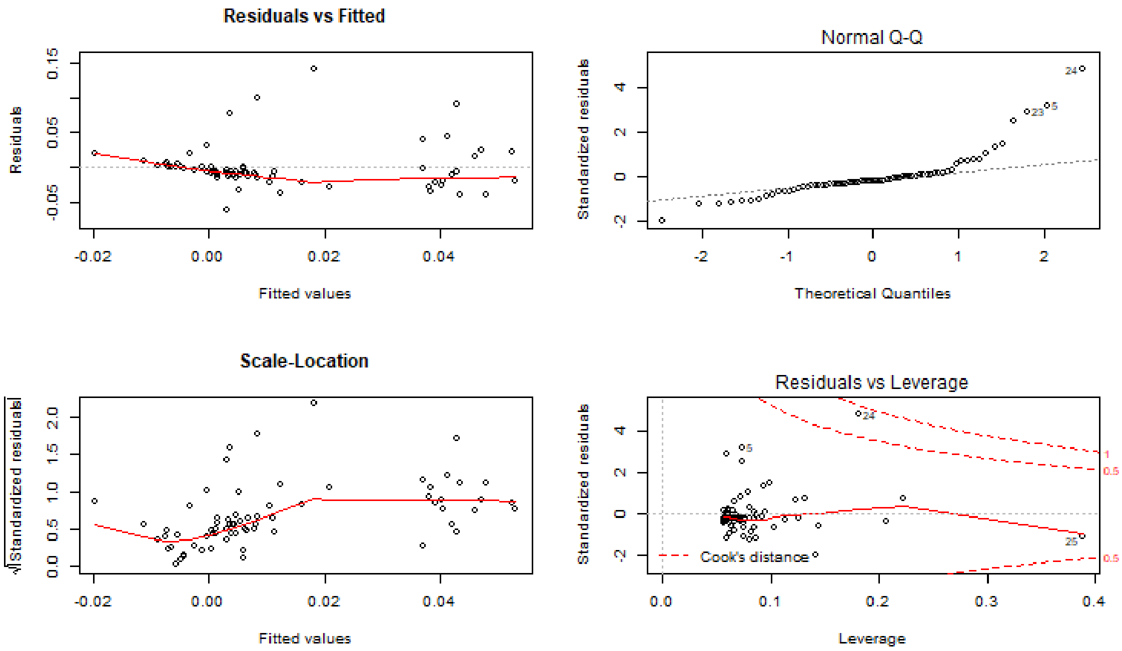


Figure B5: Evaluation of residuals in lagged model with total revenues as dependent variable

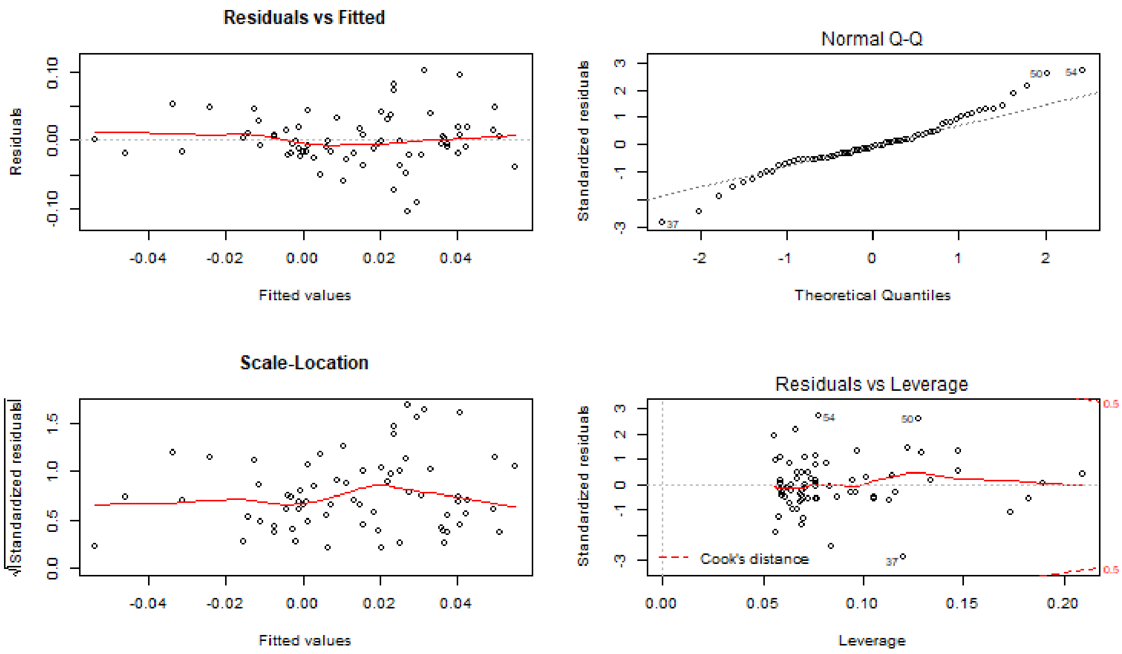


Figure B6: Evaluation of residuals in lagged model with contributions from employees as dependent variable

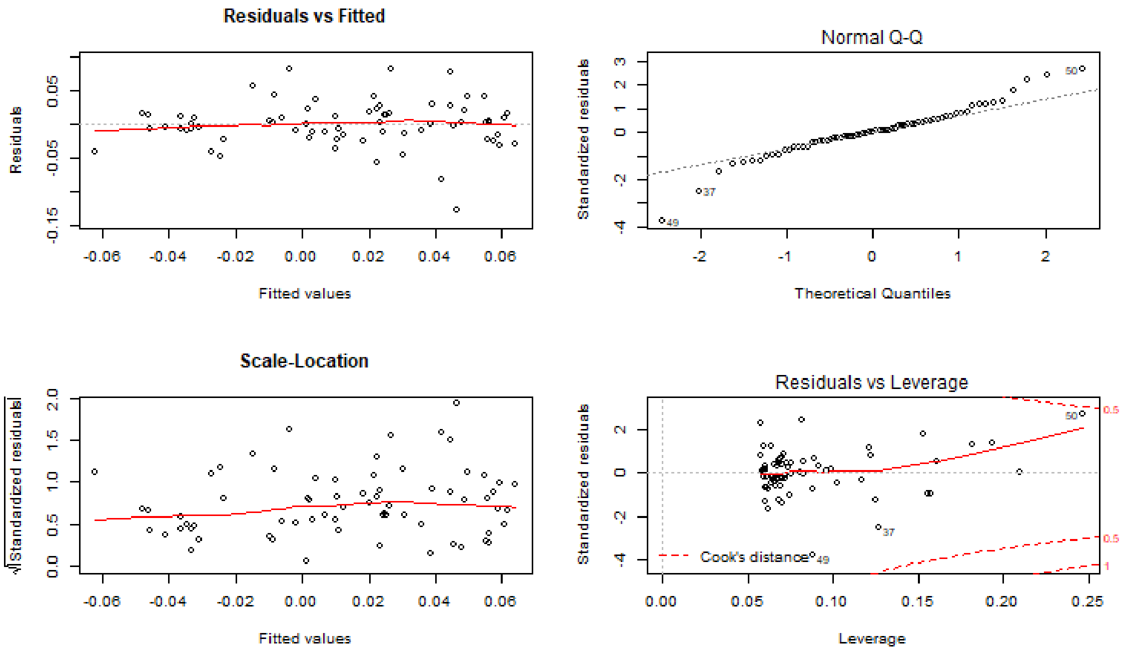


Figure B7: Evaluation of residuals in lagged model with state contributions as dependent variable

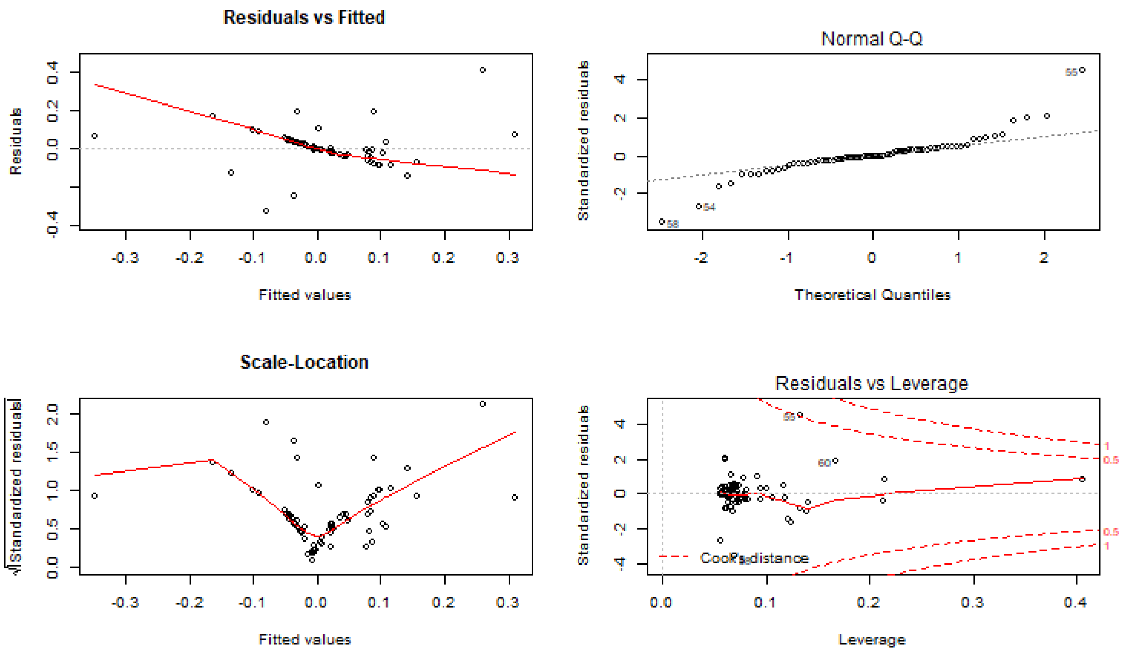
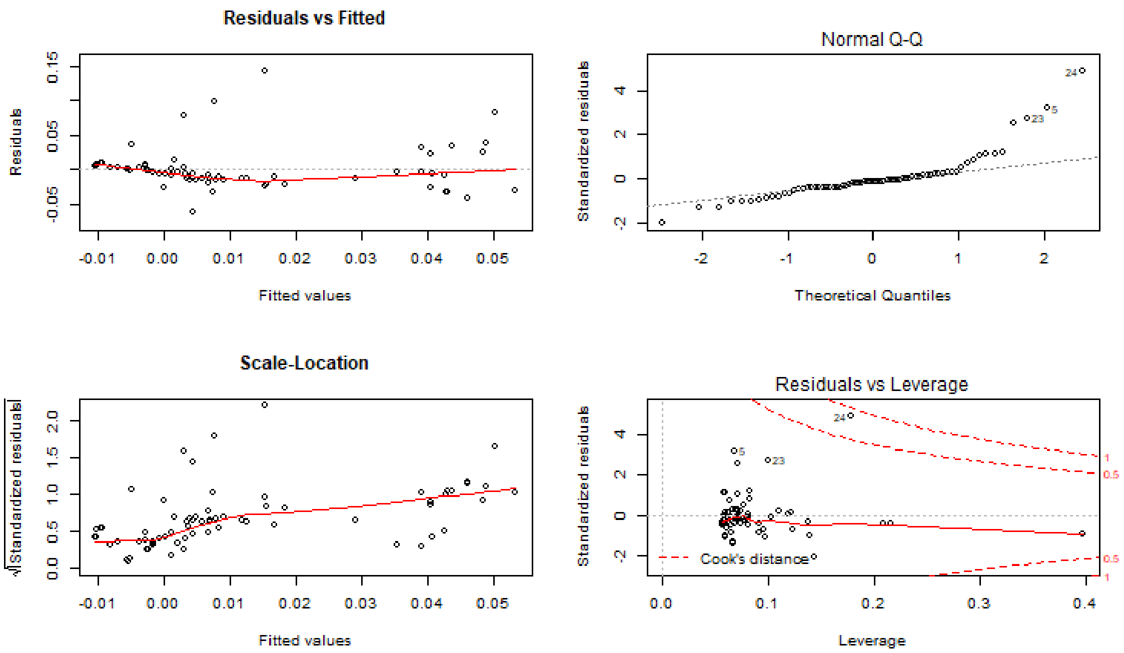


Figure B8: Evaluation of residuals in lagged model with *adjusted* state contributions as dependent variable



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Univerzita Karlova v Praze, Fakulta sociálních věd
Institut ekonomických studií [UK FSV – IES] Praha 1, Opletalova 26
E-mail: ies@fsv.cuni.cz http://ies.fsv.cuni.cz