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## SEASONAL ANALYSIS OF TOTAL PREMIUMS WRITTEN OF THE MOTOR THIRD PARTY LIABILITY INSURANCE IN THE CZECH REPUBLIC IN YEARS 2000 - 2016 FROM THE MARKETING PERSPECTIVE

*The insurance sector is in many ways unique, because insurance companies must use specific marketing tools to satisfy their customers and insurance companies have with customer's long-term relationships. Insurance companies must continuously monitor the insurance market, especially type of demand for insurance products and customer requirements. The number of registered vehicles in the Czech Republic is annually increasing, which causes an increase of total premiums written of the motor third party liability insurance and insurance companies must monitor this insurance product and analyse demand for it. The aim of this article is to analyse the seasonality of total premiums written of motor third party liability insurance in the Czech Republic in years 2000 - 2016.*

**Keywords:** non-life insurance, motor third party liability insurance, seasonal analysis of time series, Henderson moving average filter

### 1. Introduction

The insurance sector is a set of specialized financial activities, otherwise insurance sector has many specifics, for example selling invisible products, high degree of trust between the insurance company and the customer, active approach to the customer and customer relationship management, consulting services for customers and insurance intermediaries have an important role in the insurance sector [1, 2].

The insurance market is influenced by many factors that can be divided into external and internal factors. External factors consist of development and volume of gross domestic product, inflation rate, unemployment rate, demography of the population, average wage, volume of expenditures of households, enterprises and institutions. Internal factors consist of demand for insurance products (the size and type of demand and its variability over time), activities of insurance companies and reinsurance undertakings, regulation of the insurance market, activities of the Czech Insurance Association, mediatory activities of insurance intermediaries etc. [3, 4].

There is a number of studies that emphasize the need to analyse and monitor the demand for insurance products and its variability over time with respect to use of the marketing tools and campaigns [5, 6]. Many businesses find that their working capital is fluctuating over time due to fluctuations in

demand and seasonality of demand [7]. Some authors stated that seasonality of demand dictates business and marketing strategy in highly seasonal services such as accounting, tourism, advertising, construction, amusement parks, beauty salons, restaurants, car rentals, cinemas, communications, construction materials, education, public utilities, employment agencies, logistics services and financial services [8 - 11].

Insurance services can be divided from the marketing perspective into life insurance and non-life insurance, where the motor third party liability insurance belongs to the non-life insurance [12]. Nowadays insurance companies use some modern digital marketing tools for getting potential customers (blogging, social media and direct e-mail marketing) [1, 3]. Price is frequently the most important attribute for customers, but in insurance customers buying process are also relevant insurer, bundling strategy and intermediary's recommendation [13].

The motor third party liability insurance is one of the most important lines of insurance business in developed and in developing countries and motor third party liability insurance is a best - selling insurance product in developing countries [14]. The number of the road vehicles registered in the Czech Republic is annually increasing and total written premiums of the motor third party liability insurance absolutely increased in years 2000 - 2016 [15].

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## 2. Methods

The time series represents a chronological sequence of data that are spatially and materially comparable [16]. The financial time series are concerned with the theory and practice of financial market over time [17]. The time series can be modelled using different approaches. The commonly used for modelling the time series is one-dimensional model of real value [18]. The model has the shape of an elementary function of time:

$$Y_t = f(t), t = 1, 2, \dots, z \quad (1)$$

where  $z$  is the length of the series and  $Y_t$  denotes the value of the series recorded in time unit  $t$  [19].

The model can be created using two basic ways. The first way is to use the Box-Jenkins methodology. This methodology considers the basic element of the construction of the model time series random component, which may be taken as correlated random variables. Another option is to use the classical (formal) model of the time series decomposition into four components of time motion [20]: trend component ( $T_t$ ), seasonal component ( $S_t$ ), cyclical component ( $C_t$ ) and random component ( $\varepsilon_t$ ). Another possibility of expression describes Chan [21] - the time series is decomposed into a time trend part ( $T_t$ ), seasonal part ( $S_t$ ) and a microscopic part given by the noise ( $N_t$ ).

The time series decomposition into individual components can be done by adding the individual components of the time series where components are considered in their actual values. Or, as a result of the individual components of the time series, if it can be considered in the actual value of trend and other components are in relative terms against the trend.

When the seasonal component  $S_t$  is present in equation, we can use the methods to determine this seasonality. The seasonal component can be described either by an additive model ( $Y_t = T_t + S_t + N_t$ ) or by a multiplicative model ( $Y_t = T_t \times S_t \times N_t$ ) [21].

For the simple additive model the procedure for calculating of seasonality effects is given as following steps [22]. We calculate  $Y_t^*$  for each time point, it is the difference between the original value ( $Y_t$ ) and the trend  $Y_t'$ , see Equation (2). We can determine the trend using the moving averages [23]:

$$Y_t^* = Y_t - Y_t' \quad (2)$$

For each season, in turn, we can find the average of the  $Y_t^*$  values - the value  $I_j^*$  represents the seasonal factor for each season  $j$  ( $j = 1, \dots, n$ ;  $n$  represents number of seasons). We can subtract the average seasonal factor:

$$I_j = I_j^* - \frac{I_1^* + \dots + I_n^*}{n} \quad (3)$$

The last step is to remove the seasonal component (see Equation (4)), to make seasonal adjustment.  $Y_t''$  represents the data without seasonal effects,  $j$  represents the season ( $j = 1, \dots, n$ ).

$$Y_t'' = Y_t - I_j \quad (4)$$

Seasonal models are often multiplicative rather than additive [24]. For the simple multiplicative model the procedure for calculating is given as following steps [22]. We calculate  $Y_t^*$  for each time point, it is the proportion between the original value ( $Y_t$ ) and the trend  $Y_t'$ , see Equation (5). We determine the trend using the moving averages [23].

$$Y_t^* = \frac{Y_t}{Y_t'} \quad (5)$$

For each season, in turn, we find the average of the  $Y_t^*$  values - the value  $I_j^*$  represents the seasonal factor for each season  $j$  ( $j = 1, \dots, n$ ;  $n$  represents number of seasons). We can use the average seasonal index (see Equation (6)).

$$I_j = \frac{I_j^*}{\sqrt[n]{I_1^* \cdot \dots \cdot I_n^*}} \quad (6)$$

The last step is to remove the seasonal component (see Equation (7)), to make seasonal adjustment.  $Y_t''$  represents the data without seasonal effects,  $j$  represents the season.

$$Y_t'' = \frac{Y_t}{I_j} \quad (7)$$

For a more detailed analysis and description of seasonal component can we use the following steps [25]: identification of the seasonal component, the seasonal component estimate (to quantify it), removing the seasonal component (to adjust the time series).

The first step is to get an idea about the character of the process, which is represented by the time series [26]. The simplest methods include visual analysis using time series graph. The second step is to use elementary statistical characteristics [27, 28].

The first difference characterizes the absolute change (increase or decrease) of the value of indicators point in time  $t$  compared to the previous period ( $t - 1$ ). Indicator  $t$  takes values from 2 to  $n$  ( $n$  is the number of observations). It can be calculated using the following equation:

$$\Delta^{(1)}y_t = y_t - y_{t-1} \quad (8)$$

The second difference (differential of acceleration), is based on the difference of the two adjacent first absolute differences in the time moments ( $t - 1$ ). Indicator  $t$  takes values from 3 to  $n$  ( $n$  is the number of observations). It can be calculated using the following equation:

$$\Delta^{(2)}y_t = \Delta^{(1)}y_t - \Delta^{(1)}y_{t-1} \quad (9)$$

The rate of growth (chain index number) indicates the percent increase of the time series at time  $t$  contrary to the previous time ( $t - 1$ ). Indicator  $t$  takes values from 2 to  $n$  ( $n$  is the number of observations). It can be calculated using the following equation:

$$k_t = \frac{y_t}{y_{t-1}} \quad (10)$$

It is necessary to identify whether these fluctuations are statistically significant. In some cases the existence of seasonality could be revealed intuitively. In the more complex cases the answer could be obtained by the statistical verification.

To verify the hypothesis of the existence of seasonality in the time series, the existence of seasonality test could be used. The test takes the form of the F - test with  $(n - 1)$  and  $(n - 1) \cdot (m - 1)$  degrees of freedom [29].

The null hypothesis  $H_0$  is tested. The hypothesis assumes that all indices in seasonal time series are zero. The form of hypothesis:  $H_0 : S_j = 0 \text{ for } j = 1, \dots, r$  (11)

Null hypothesis is against the alternative hypothesis  $H_1$ .  $H_1$  assumes that at least one index in the seasonal time series is non-zero. The form of hypothesis:  $H_1 : \text{non } H_0$  (12)

The test statistics has following form:

$$F = \frac{\frac{m \sum_{j=1}^n (\bar{y}_j - \bar{y})^2}{r - 1}}{\frac{S_R}{(n - 1) \cdot (m - 1)}} \quad (13)$$

$$S_R = \sum_{i=1}^m \sum_{j=1}^n (y_{ij} - \bar{y})^2 - n \sum_{i=1}^m (\bar{y}_i - \bar{y})^2 - m \sum_{j=1}^n (\bar{y}_j - \bar{y})^2 \quad (14)$$

where:

- $m$  the number of time intervals (years),
- $n$  the number of incremental time periods (seasons),
- $\bar{y}$  the average of time interval,
- $\bar{y}_j$  the average value in the  $j$ -th season,
- $\bar{y}_i$  the average value in the  $i$ -th interval.

Result of the test will be compared to the critical F-value distribution. If the value of the F-test statistics is greater than the critical value, the null hypothesis is rejected. If there is a seasonal time series component, it is necessary to quantify the seasonal variations and describe the seasonal component. The most common technique is the construction of indexes and seasonal differences, or the classical regression approach to the seasonal component.

We can use an additive model [22]; there are two options. If there is a trend in the series and the size of the seasonal effect appears to increase with the mean, then it may be advisable to transform the data so as to make the seasonal effect constant (this concept of seasonality is called the constant seasonality, the

concept of constant seasonality can be described either by the linear trend or stepped trend). Or the size of the seasonal effect is said to be multiplicative (this concept of seasonality is called the proportional seasonality) [30, 31].

The model of the constant seasonality and the seasonal differences ( $b_j$ ) can be described using the following equations: [32]

$$Y_{ij} = T_{ij} + S_{ij} + \varepsilon_{ij} \quad (15)$$

$$S_{ij} = b_j \quad (16)$$

$$\sum_{j=1}^n b_j = 0 \quad (17)$$

$$\bar{b}_j = \frac{1}{m} \sum_{i=1}^m (Y_{ij} - T_{ij}) \quad (18)$$

where:

- $m$  the number of time intervals (years),
- $n$  the number of incremental time periods (seasons),
- $i$  the time intervals (year),  $i = 1, 2, \dots, m$ ,
- $j$  the time periods (season),  $i = 1, 2, \dots, r$ ,
- $b_j$  the seasonal difference,
- $\bar{b}_j$  the average seasonal difference.

The model of the proportional seasonality, the seasonal parameters ( $c_j$ ) and seasonal indexes ( $1 + c_j$ ) can be described using the following equations:

$$Y_{ij} = T_{ij} + S_{ij} + \varepsilon_{ij} \quad (19)$$

$$S_{ij} = c_j \times T_{ij} \quad (20)$$

$$Y_{ij} = (1 + c_j) T_{ij} + \varepsilon_{ij} \quad (21)$$

$$(1 + \hat{c}_j) = \frac{\sum_{i=1}^m y_{ij} \cdot T_{ij}}{\sum_{i=1}^m T_{ij}^2} \quad (22)$$

where:

- $m$  the number of time intervals (years),
- $n$  the number of incremental time periods (seasons),
- $i$  the time intervals (year),  $i = 1, 2, \dots, m$ ,
- $j$  the time periods (season),  $i = 1, 2, \dots, r$ ,
- $(1 + c_j)$  the seasonal index,
- $(1 + \hat{c}_j)$  the estimated seasonal index.

The choice of the model can be confirmed by analysis of the empirical data - the index of determination [33].

The last step is the seasonal adjustment of the time series. Methods of seasonal adjustment are usually based on different types of moving averages. Furthermore, the regression methods or special filters is used. We can use the Equation (4) for the additive model or Equation (7) for the multiplicative model and we can use special filters, as well. We can adjust the time series by a Henderson moving average filter. Filter values for quarterly data are (- 0.073, - 0.294, 0.558, 0.294, - 0.073). We use special filter for the first

Table 1 Total written premiums (CZK)

Year	Quarter			
	I.	II.	III.	IV.
2000	8 238 250 051	1 280 894 987	1 939 802 791	1 302 995 043
2001	8 551 967 975	2 435 886 956	2 429 250 249	2 107 394 158
2002	8 785 018 870	2 635 259 903	2 940 351 869	3 321 244 275
2003	9 017 700 717	3 387 194 231	3 768 388 913	3 525 820 090
2004	8 585 094 323	4 020 838 244	4 204 559 935	4 150 365 492
2005	8 165 886 283	4 315 786 804	4 649 390 901	4 565 761 580
2006	7 533 299 839	4 879 077 613	4 835 398 027	4 859 864 426
2007	7 316 111 159	5 284 682 766	5 131 876 172	5 217 300 715
2008	7 377 390 462	5 528 561 938	5 369 001 117	5 433 909 496
2009	7 304 281 899	5 588 876 693	5 433 887 480	5 447 997 444
2010	6 574 423 103	5 510 400 176	5 089 435 430	5 169 296 336
2011	5 977 322 299	3 468 702 668	4 686 205 694	3 261 509 297
2012	5 433 731 712	4 865 010 097	4 568 434 435	4 604 652 313
2013	5 315 651 506	4 867 612 572	4 466 550 550	3 125 507 531
2014	5 440 668 934	5 065 328 774	4 647 015 809	4 887 662 401
2015	5 423 764 786	5 240 604 470	4 868 146 979	5 034 794 468
2016	5 518 494 871	5 420 106 857	4 933 182 417	5 099 435 130

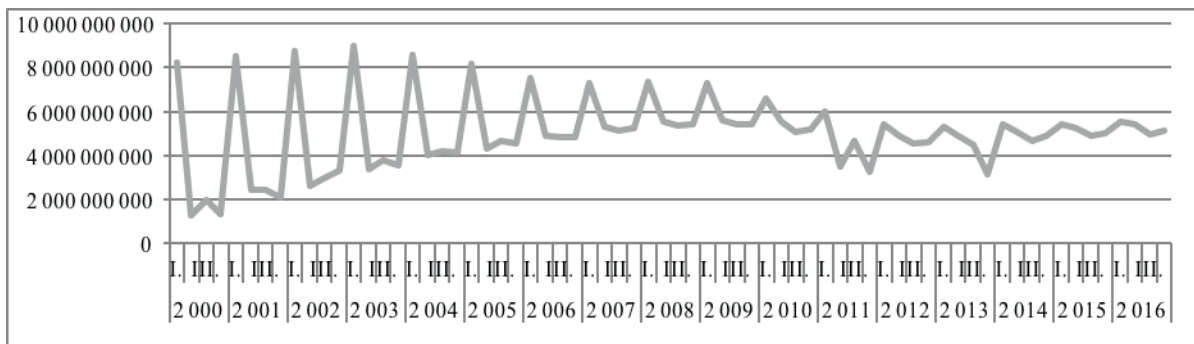


Figure 1 Total written premiums (CZK)

adjusted value ( $Y'_1$ ), the second adjusted value ( $Y'_2$ ), the last adjusted value ( $Y'_z$ ) and the penultimate adjusted value ( $Y'_{z-1}$ ): [34]

$$Y'_1 = 0.670Y_1 + 0.403Y_2 - 0.073Y_3 \quad (23)$$

$$Y'_z = 0.670Y_n + 0.403Y_{n-1} - 0.073Y_{n-2} \quad (24)$$

$$Y'_z = 0.257Y_1 + 0.522Y_2 + 0.294Y_3 - 0.073Y_4 \quad (25)$$

$$Y'_{z-1} = 0.257Y_n + 0.522Y_{n-1} + 0.294Y_{n-2} - 0.073Y_{n-3} \quad (26)$$

### 3. Data

The motor third party insurance was required by law until 2000 [35]. An Act No. 168/1999 Coll. - Motor Third Party Liability Insurance act on liability insurance for damage caused by operation of vehicle and on amendments to certain related

acts (the Motor Third Party Liability Insurance Act) coming into force in 2000 [36]. The motor third party insurance is mandatory according to the new law. The development of this type of insurance in the period 2000 to 2016 shows the following Table 1. The data in the table are given in Czech crowns and show the trend of total written premiums.

### 4. Results

Using visual analysis of time series (Figure 1) it can be said that the time series has each year a polynomial character with the effects of seasonality.

By using the elementary statistical analysis of the characteristics, it can be said that the time series recorded increase

Table 2 Seasonal factors and seasonal indexes

Season	Average seasonal factor - simple additive model [CZK]	Average seasonal factor - simple multiplicative model [-]
I.	2 004 576 118	1.4732
II.	- 536 399 222	0.9130
III.	- 634 430 530	0.8878
IV.	- 833 746 366	0.8374

Table 3 Seasonal differences and seasonal indexes

Season	Constant seasonality		Proportional seasonality - seasonal index [-]
	Linear trend - seasonal differences [CZK]	Stepped trend - seasonal differences [CZK]	
I.	2 120 294 316	2 100 087 671	1.3747
II.	- 644 014 018	- 650 749 566	0.8868
III.	- 647 717 290	- 640 981 742	0.8835
IV.	- 828 563 008	- 808 356 364	0.8563

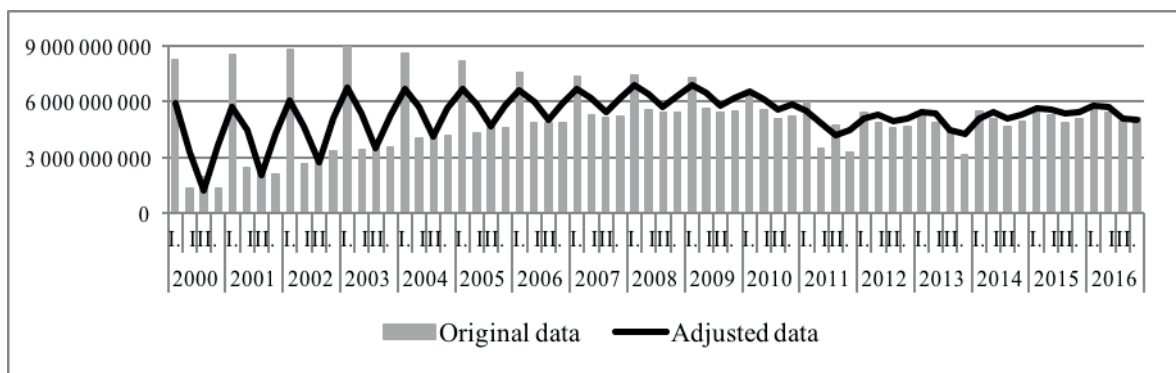


Figure 2 Adjusted data (CZK)

in the first quarter of each year, and conversely a decline in the second quarter of each year. This fact points to the same conclusion to be drawn from the analysis of the graph, the time series is affected by seasonal influences. The seasonal component  $S_t$  is described using the simple additive model (average seasonal factors) and the simple multiplicative model (average seasonal factor), see Table 2.

Seasonal influences in the time series with a periodicity of less than one year can be found almost always. We used the F-test for statistically significant confirmation. We chose significance level  $\alpha = 0.05$ , degrees of freedom are 3 and 48. The critical value is equal to 2.7985. The value of the test statistics F was higher than the critical value (26.637), the null hypothesis is rejected since there is a significant seasonality.

We used the concept of constant seasonality (we determined seasonal differences for linear trend and for the stepped trend) and the concept of proportional seasonality (we determined seasonal indexes), see Table 3.

The choice of appropriate model among other options was confirmed by analysis of empirical data-we used index of

determination. The value of the index of determination was: 0.52 (the concept of constant seasonality-linear trend), 0.69 (the concept of constant seasonality-stepped trend), 0.92 (the concept of proportional seasonality). The coefficient of determination generally takes values from the interval  $\langle 0, 1 \rangle$ . The more are functions apposite, the more is the coefficient of determination closer to one. The selected concept (the concept of proportional seasonality) explains 92 % of the values of variables.

The last step was the seasonal adjustment of the time series. We chose adjustment of the time series by a Henderson moving average filter. This method is commonly used in practice. The method allows adjustment of limit values and time series. The following graph shows the results-comparison of original and adjusted values (see Figure 2).

Seasonal adjustment is done because there is a need of continuous comparison of consecutive data. After elimination of the seasonal component, in the model remain the trend component, the cyclical component and a random component (if any).

## 5. Discussion

The problem of demand variability and seasonality is solved by many experts not only on the theoretical level, because demand seasonality affects some businesses and some sectors daily. There are currently many professional studies that focus on the problem of demand seasonality, especially in services such as accounting, tourism, advertising, construction, restaurants, communications, construction materials, education, public utilities, employment agencies, logistics services and financial services [8 - 11]. However, there is currently no relevant study or sources to analyse demand seasonality in the insurance sector or of the specific insurance product. Otherwise some authors emphasize the need to analyse and monitor the demand for insurance products and its variability over time related not only to the working capital [5 - 7]. Seasonality of demand is a very important parameter for marketing planning in general, especially for planning of marketing campaigns and activities, and for marketing and business strategy [8 - 11]. The seasonality of demand for motor third party liability insurance has been confirmed for the Czech Republic in years 2000 - 2016, based on the research results (Section 4). Insurance companies should reflect the results of research when developing the marketing strategy, preparing marketing campaigns or activities, because it is necessary to implement these activities in accordance with demand for insurance products.

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## 6. Conclusion

The current turbulent market environment is very competitive and insurance companies need information about demand for insurance products, as much as possible. This information can be used to increase the competitiveness of insurance companies and for more efficient planning of marketing activities, especially in the situation where the demand is growing (due to seasonality). If there is a seasonal demand in any given sector, companies need the most accurate information about the seasonality of the demand. The motor third party liability insurance in the Czech Republic in 2000 - 2016 is seasonal, based on the research results, which implies necessity to take this into account when planning any business activities, especially for marketing activities. The combination of an increase of demand (due to seasonality) and application of appropriate marketing strategy can get a better position on the market for insurance company.

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