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TRENDS IN CIGARETTES CONSUMPTION IN POLAND ACCORDING TO EXPOTENTIAL SMOOTHING AND AUTOREGRESSIVE MODELS

Abstract. Polish tobacco industry has been recently changing significantly due to accession of Poland to EU. It is one of the prime sector of polish economy. It generates every year about 7% of budget incomes on average. The aim of this paper is to compare some forecast methods of cigarettes consumption in 2006–2010. The models used exponential smoothing and autoregression theory. The forecasts were estimated on historical data from 1995–2005. The main attention was focused on the trends in prediction. Identification, the most crucial stage in fitting autoregressive models exploited different approach such as the corner method and extended sample autocorrelations. The outlier selection techniques were also applied to get more reliable estimates. The results were compared to the predicted values obtained from Central Statistical Office and to the results of forecasts taking cigarettes production into consideration due to prewhitening technique. The advantages and drawbacks of different methods are discussed.

Key words: cigarettes consumption, forecasting, expotential smoothing models, autoregressive models, corner methods, prewhitening technique.

I. INTRODUCTION

Polish tobacco industry is a significant branch of national economy, which generates 7.5% of budget incomes. In 2004 the greatest Polish tobacco company – Phillip Morris has paid 4.4 billion PLN taxes (2.8% budget incomes). According to AC Nielsen report from 2006, Polish tobacco industry has been divided by 6 foreign corporations: Philip Morris (38.9%), Scandinavian Tobacco (16.8%), British American Tobacco (16.3%), Imperial Tobacco (14.4%), Altadis Polska (8.7%), Gallaher (4.7%). Summary participation of the greatest tobacco companies in Polish market is situated on the level of 99.8%. Participation in market of

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the greatest Polish tobacco company – Zakłady Tytoniowe w Lublinie S.A. is an about level of 0.1%. In Poland, from among 5 main categories of tobacco products: cigarettes, cigars, cigarillos, cigarette tobacco and pipe tobacco, the greatest participation in market have cigarettes (about 90%) and cigarette tobacco (about 7%). The other tobacco products are bought in small amounts.

Nowadays, according to different estimations from 9 to 10 millions inhabitants of Poland smoke cigarettes. A statistical smoker in Poland consumes 13 cigarettes daily, that is 4745 cigarettes yearly. A consumption of cigarettes in Poland was amounted on the yearly level of 2500–2650 cigarettes per statistical inhabitant in the first half of 90s, 2300–2400 pieces in the second half of 90s. Definitely decreasing of cigarettes consumption level was observed after 2000 year, when an amount of legal produced cigarettes consumed by statistical inhabitant fluctuated from 1920 to 2010 pieces in the year. According to AC Nielsen reports, a consumption of cigarettes in Poland in 2006 year in comparison to 2005 decreased by 3.5%.

Despite the fact that consumption of cigarettes in Poland decreases, the smoking is still very serious problem. Every year cigarettes-related diseases are the reason of about 70000 premature deceases. It is more than the sum of deceases related from AIDS, alcohol and drugs consumption together. In the other countries the cigarettes consumption is also very serious problem. According to WHO study results, more than 10 millions people dies due to cigarettes-related premature deceases (Zatoński et al., 2002).

II. AIM OF STUDY AND METHODS

The aim of this paper was a preparation of cigarettes consumption in Poland forecasts based on 1970–2005 historical data in order to confirmation of decreasing trend observed from 1995 to 2005. Forecasts were prepared according to exponential smoothing models for yearly and monthly data, autoregressive models due to ARIMA (AutoRegressive Integrated Moving-Average) methodology for monthly data. Additionally, forecasts with taking cigarettes production into consideration due to prewhitening technique were prepared. Identification, the most crucial stage in fitting autoregressive models exploited different approach such as the corner method and extended sample autocorrelations. The outlier selection techniques were also applied to get more reliable estimates. Identified outliers are signed by white points on all figures. The main criterion of model assessment were AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion). The auxiliary criterion was MAPE (Mean Absolute Percent Error). Calculations and results preparations were performed with using The SAS System and MS Excel software.

III. DATA SOURCE AND CHARACTERISTICS

Time series used in cigarettes consumption forecasts were prepared on the basis of historical data from Central Statistical Office. Data includes 36 yearly observations of 1970–2005 years, and 120 monthly observations of 1995–2005 years. Yearly data are publishing every year in Polish Statistical Yearbook. Monthly data originates from prepared every year data bases, which include characteristics, incomes and outcomes of households. These data bases have been preparing from 1993 on the basis of surveys in about 31000 polish households. Monthly data were calculated by authors on the basis of amount of person and expenses for cigarettes. On the basis of these data Households Budgets publications are preparing every year.

IV. FORECASTS ACCORDING TO EXPOTENTIAL SMOOTHING MODELS

From expotential smoothing forecasts prepared on the basis of yearly data, the best assessment characteristics were for a forecast according to linear exponential smoothing Holt model ($AIC = 339,61$; $MAPE = 3,41$; $R^2 = 0,71$) presented on figure 1. According to forecast results, cigarettes consumption in Poland in 2008 year is estimate on 1892, and in 2010 year on 1845 pieces for a person level.

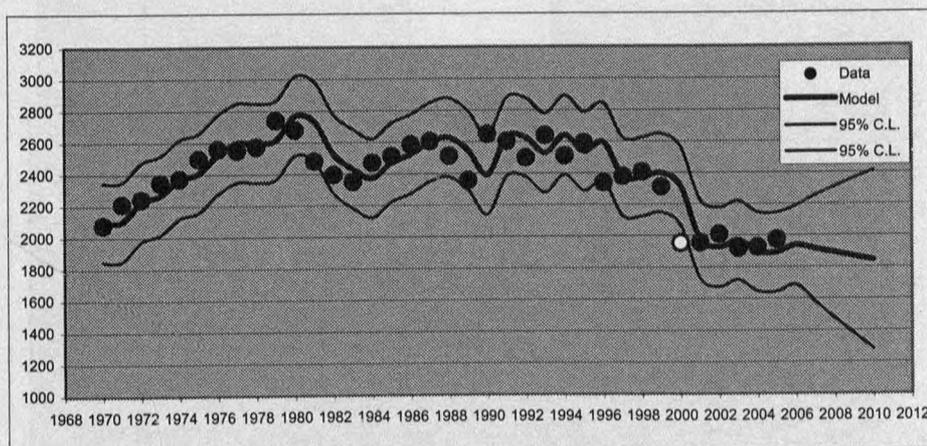


Figure 1. Forecast results according to Holt model for yearly data

Source: Own preparation.

From exponential smoothing forecasts prepared on the basis of monthly data, the best assessment characteristics were for a forecast according to seasonal multiplicative Winters model (AIC = 519,30; MAPE = 3,54; $R^2 = 0,88$) presented on figure 2 and according to Holt model for seasonal adjusted data (AIC = 498,15; MAPE = 2,90; $R^2 = 0,89$) presented on figure 3. According to results of monthly forecasts, cigarettes consumption in Poland in 2008 year is estimate from 108 to 129 pieces for a person due to multiplicative Winters model, and 120 pieces for a person due to Holt model.

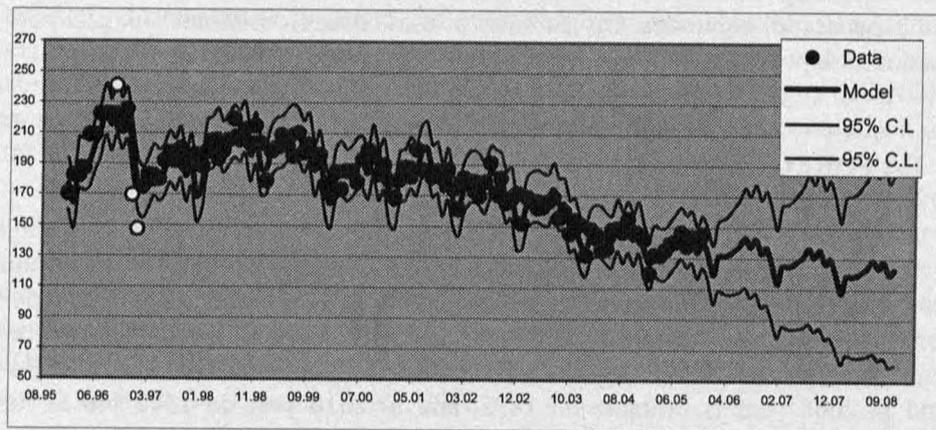


Figure 2. Forecast results according to multiplicative Winters model for monthly data
Source: Own preparation.

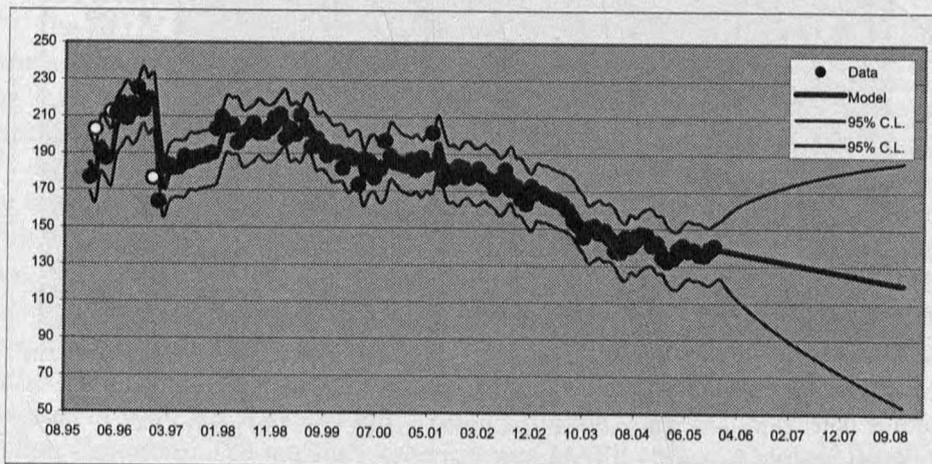


Figure 3. Forecast results according to Holt model for seasonal adjusted monthly data
Source: Own preparation.

V. IDENTIFICATION OF ARIMA MODELS WITH USING CORNER METHODS

An identification of ARIMA models were prepared with using of selected corner methods. In these methods a table of successive autoregressive orders in columns on moving average orders in rows (Gourieroux et al., 1997). In each cell of identification table there are values of test function used in concrete method. In this paper, ESACF (Extended Sample AutoCorrelation Function) [Tsay et al., 1984], SCAN (Smallest CANNonical autocorrelation) (Tsay et al., 1985) and MINIC (MINimal Information Criterion) (Hannan et al., 1982) methods were used.

In all corner methods, the order of ARIMA model is tentatively identified by finding of left, upper corner of pattern with statistically insignificant values (ESACF, SCAN methods) or maximal value of concrete criterion (MINIC method). A few the best ARIMA models may be identified by using of corner methods, then the final identification is doing according to selected information criterion. In this paper BIC (Bayesian Information Criterion) was used and ARIMA(1,1,1)s(0,1,1) model was identified. An identification of ARIMA model is presented on figure 4.

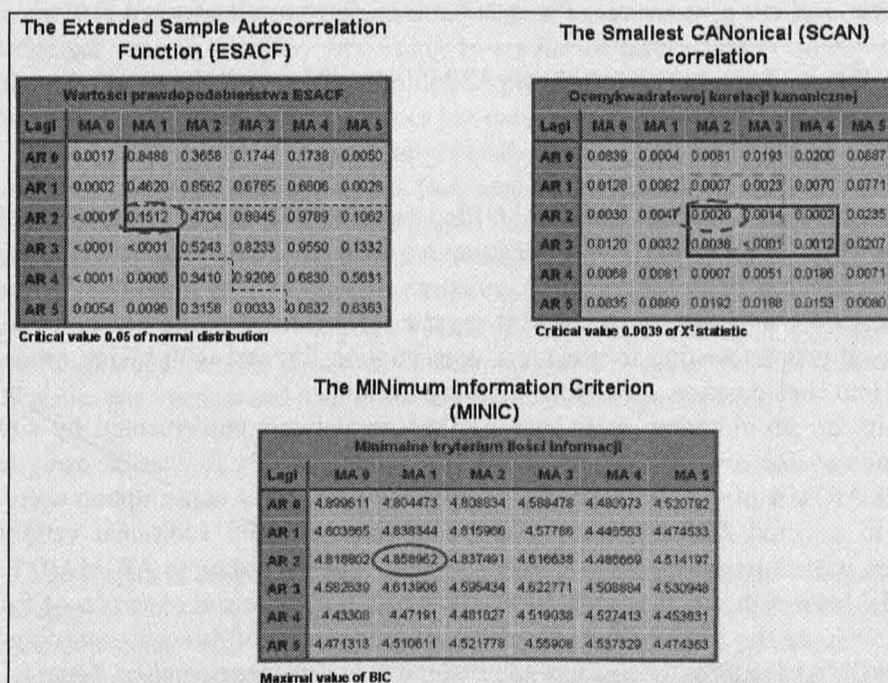


Figure 4. ARIMA model identification with using of ESACF, SCAN and MINIC method
 Source: Own preparation. with using of SAS System.

VI. FORECASTS ACCORDING TO SELECTED ARIMA MODEL

A forecast of cigarettes consumption according to $ARIMA(1,1,1)s(0,1,1)$ ($AIC = 505,83$; $MAPE = 4,12$; $R^2 = 0,80$) is presented on figure 5. According to results of monthly forecast, cigarettes consumption in Poland in 2008 is estimate from 98 to 120 pieces per person.

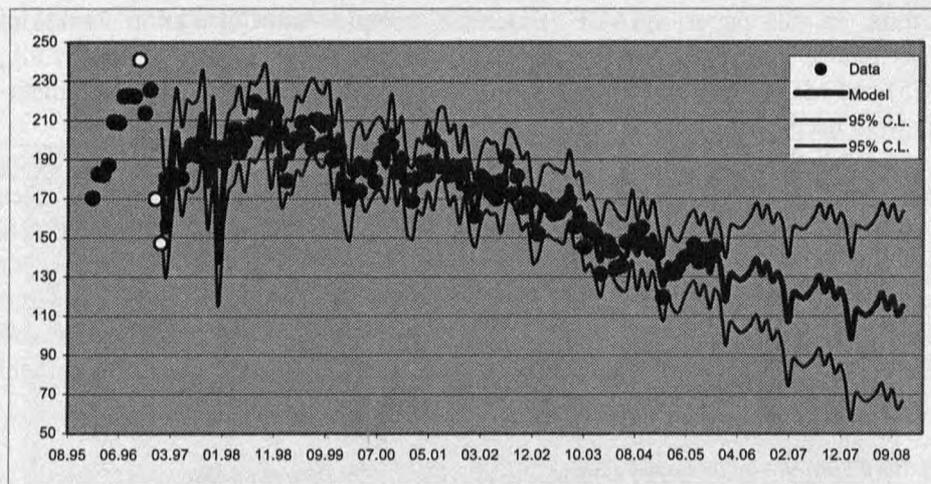


Figure 5: Forecast results according to $ARIMA(1,1,1)s(0,1,1)$ model for monthly data
Source: Own preparation.

According to Central Statistical Office data, from 2003 in Poland an obvious descending trend of cigarettes consumption and ascending trend of cigarettes production has been observing. A comparison with export, import and smuggling levels indicates to significant surplus of production over consumption. Then, it was interesting to prepare a consumption forecast with taking production into consideration due to prewhitening technique.

In the prewhitening technique ARIMA model is complemented by additional variable or variables. Its values are simultaneously forecasted using another ARIMA model. In this paper a forecast of cigarettes consumption according to selected $ARIMA(0,1,1)$ model was prepared with additional variable, which were forecast results of cigarettes production according to $ARIMA(0,1,1)$ model for monthly data from 1995–2005 years. A comparison of results of forecast with the use of prewhitening technique with results of forecast according to $ARIMA(1,1,1)$ model for seasonal adjusted monthly data is presented on figure 6.

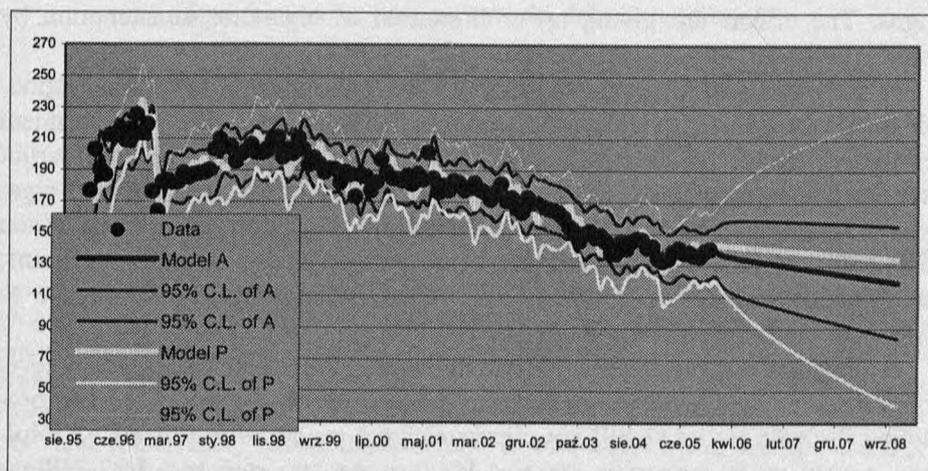


Figure 6. Comparison of forecasts results according to ARIMA(1,1,1) model with (P) and without (A) the use of prewhitening technique.

Source: Own preparation.

According to results of forecast without the use of prewhitening technique, a cigarettes consumption in Poland in 2008 year is estimate on the level of 119 pieces per person monthly. According to results of forecast with taking cigarettes production into consideration due to prewhitening technique, a cigarettes consumption is estimate on 134 pieces per person.

Forecasts prepared with using of prewhitening technique often have a wider confidence intervals than analogous forecasts prepared only on the basis of historical data like in case of forecasts presented on figure 6. It is a consequence of consideration necessity of additional variable variability. Nevertheless these forecasts enable to take into consideration the influence of another variables. On figure 6, the results of forecast prepared with the use of prewhitening technique are closer to average monthly cigarettes consumption level in 2006, which is situated on 167 pieces per a person and was calculated on the basis of yearly data.

VII. CONCLUSIONS

The results of all prepared forecasts confirm a descendent trend of cigarettes consumption observed in last years. Potential reasons are: a growth of cigarette prices connected with excise increases according to necessity of adaptation its level till the end of 2008 year to minimal level in European Union (64 EUR for 1000 pieces and 57% of price) and powerful anti-smoking advertising cam-

paigns. The effects are giving up or limitation of cigarettes consumption by smokers and a growth of cigarettes smuggling number.

At the other side, Central Statistical Office data indicates to an unquestionable growth trend of cigarettes production in Poland in last years. An ascendent trend of cigarettes production is confirmed by the results of prepared earlier forecasts (Jałowiecka et al., 2006; Jałowiecka et al., 2007). The results of cigarettes consumption forecast taking a cigarettes production into consideration show a slower, but still significant descendent trend of consumption. It means, that probably changes of production level have relatively poor influence to changes of consumption in Poland.

A comparison of production, import and smuggling of cigarettes yearly level from one side with consumption and export indicates on obvious surplus of production. In 2006 year 111 billions cigarettes were produced in Poland, 13.8 billions mostly most expensive luxuries kinds were imported and 11.2 billions mainly from former USSR countries were smuggled. A consumption of cigarettes in Poland in 2006 year were estimated to 76.7 billions and exported were 22.2 billions of cigarettes. A difference between supply and consumption and export is 12.1 billions of cigarettes.

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**BADANIE TENDENCJI SPOŻYCIA PAPIEROSÓW W POLSCE
Z WYKORZYSTANIEM MODELI WYRÓWNIANIA WYKŁADNICZEGO
I MODELI AUTOREGRESYJNYCH**

Polski przemysł wyrobów tytoniowych przechodzi w ostatnich latach znaczące przemiany związane z akcesją Polski do Unii Europejskiej. Stanowi on ważny sektor polskiej gospodarki generując 7,5% dochodów budżetu państwa. W pracy porównano prognozy spożycia papierosów w latach 2006–2010 przygotowane w oparciu o wybrane modele wyrównywania wykładniczego oraz autoregresyjne na podstawie danych historycznych z lat 1995–2005. Główną uwagę skoncentrowano na trendzie w prognozach. Identyfikację modeli autoregresyjnych przeprowadzono przy użyciu metod typu „corner” oraz rozszerzonej funkcji autokorelacji. W celu zwiększenia wiarygodności, prognozy przygotowano z uwzględnieniem zidentyfikowanych wartości odstających. Uzyskane wyniki porównano z danymi szacunkowymi uzyskanymi z Głównego Urzędu Statystycznego oraz z wynikami prognoz uwzględniających jako dodatkową zmienną produkcję papierosów przygotowanymi z zastosowaniem techniki „prewhitening”. Przeprowadzono dyskusję zalet i wad zastosowanych metod.