THE ECONOMETRIC ANALYSIS OF THE MUSEUM AUDIENCE IN POLAND

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Analysing the tourist attractions the role of museums is of great importance. To study the museum attractiveness the questionnaire surveys are often conducted with focus on recognition of visitors and factors influencing the reception of the museum exhibitions. However there are also quantitative measures of museum attractiveness like the museum audience. The purpose of the paper is to analyse the museum audience in Poland (on the example of chosen museums), to forecast it and to indicate the perspectives of development in museum tourism.

Keywords*: tourism, econometric analysis, museum audience*

1. Introduction

In literature the attention is paid to the role of museums in tourism, e.g. the essence of "*experience*" of museum visitors. For those visitors the experience resulting from visiting the museum is considered as a touristy product that reflects the attractiveness of a given object (see [2], [5]). In this context the question can be raised, whether Poles who have Internet and MTV, want to have such type of experience. The results of the CBOS research concerning the habits of going to museums in Poland and visitors' opinion on museums seem to be rather pessimistic (see [4]).

To describe the attractiveness of a museum and find the way to increase the number of visitors the methods of questionnaire research directed to know visitors and factors influencing the reception of exhibitions are used. However, another quantitative measure of attractiveness of museums is the museum audience which is the subject of the paper.

The aim of the paper is to conduct the econometric analysis of regularities existing in the museum audience for different museums in Poland, forecast the museum audience and describe the perspectives of development in museum tourism.

The research includes the museum audience in the following museums: the National Museum in Gdańsk, the National Museum in Szczecin, the National Museum in Warsaw, the National Museum in Wrocław, the Regional Museum in Toruń, the Museum in Bielsko-Biała, the Central Museum of Textile Industry in Łódź. We would like to thank the management and the staff of these museums, people with passion and engagement, ready to devote their time for activities going much beyond their duties. Cooperation with these people made us clearly aware that behind the collections, behind the numbers of audience the people and their achievements are hidden. That is worth remembering when visiting the museum. We would like to thank for making statistical data on museum audience free of charge available.

The chosen museums belong generally to artistic and historical category (see [6]). In spite of presenting the museum audience for different museums together, there is not the purpose of this paper to compare these museums because each museum is unique and it should be like that. By the "unique museum" we understand the museum which is characteristic with regard to geographical location, not imitating "globalisation", different in its own way. This includes also the different way of financing what undoubtedly influences the realization of museum tasks and its functioning. Museums registered in the State Register of Museums are subsidized from the Ministry of Culture and National Heritage (the National Museum in Warsaw, the National Museum in Gdańsk, the Regional Museum in Toruń), the others receive no subsidies from the Ministry, but they are financed only by local government.

The paper is divided into two parts. In the first part we characterize the museum audience. In the second one we show the results of econometric analysis of museum audience. At the very end there is given a summary.

2. The Museum Audience

In the paper the museum audience is measured by the number of sold tickets per 1000 inhabitants, however statistical data from studied museums differ with regard to number and frequency of observations, and also categories of sold tickets. The following data are used:

– in the National Museum in Gdańsk: quarterly data total tickets sold in whole museum during 2004–2006 and monthly data on tickets sold in the Department of Old Craft during 2004–2007;

– in the National Museum in Szczecin: monthly data on normal tickets for adult groups (individual, local, outsider), reduced tickets for young groups (individual, local, outsider), foreign groups (individual, outsider) from January 2002 till October 2006;

– in the National Museum in Warsaw: monthly data on tickets in total, museum lessons, individual tickets, free tickets from January 2002 till December 2007;

– in the National Museum in Wrocław: quarterly data on tickets in total, reduced tickets, free tickets from January 2001 till October 2007;

– in the Regional Museum in Toruń: monthly data on tickets in total, normal tickets, reduced tickets, free tickets from January 2000 till December 2007;

– in the Museum in Bielsko-Biała: monthly tickets in total, normal tickets, reduced tickets, free tickets from January 2001 till October 2006;

– in the Museum in Łódź: monthly data on tickets in total in 1992-2007 and also annually data 1992-2007 on tickets in total, free tickets, tickets for individual and organized groups.

The museum audience is shown in Figures 1-9.

The behavior of the museum audience is considerably different in studied museums. Strong seasonal fluctuations oscillating around the stable level are observed in the Regional Museum in Toruń (Figure 6), i.e. the increase in the museum audience from May till August, and in the Museum in Bielsko-Biała (Figure 7), i.e. the increase in the museum audience in summer and autumn months. It coincides with the bigger touristic movement that is registered in these months in Toruń and Bielsko-Biała. In the case of reduced tickets the increase of the museum audience in October can be observed what may result from the bigger number of visits by the school children who since September start a new school year. It should be emphasized that the sale of reduced tickets has the main share in total sale what suggests that people buying reduced tickets create the largest group of visitors.

Additionally the museum audience displays the untypical increases: in August, September, October 2004 and – in January, February 2005 in Gdańsk, in October 2003 in Szczecin and in May 2007 in Toruń.

All these outliers were caused by the large number of visitors connected to especially attractive exhibitions; i.e. in Gdańsk – "*Paris lesson. Impressionism and postimpressionism from the collection of Milwaukee Art Museum*", which was presented from August 2004 till October 2004 and "*Transalpinum – from Georgian and Dürer to Titian and Rubens. The European paintings from the collections of the Kunsthistorisches Museum in Vienna, the National Museum in Warsaw and the National Museum in Gdańsk*", which was shown from December 2004 till February 2005, in Szczecin - "*Magic, sub aqueous world – the mysteries of coral-reef*" (August 2003–June 2004), in Toruń – "*Faces of the secret police in 1945-1999*" which attracted much more number of visitors than it was expected.

In the Museum in Łódź strong fluctuations especially from 1998 till 2005 can be noticed. This is connected with exhibitions and competitions being organized by the museum, which attracted many visitors and caused the increase of the museum audience especially from 1998 till the end of 2005.

In three cases (Warsaw, Wrocław, Łódź) the behaviour of the museum audience is considerably different, i.e. two periods can be distinguished (Figure 4, 5, 8, 9).

In Warsaw in the first period (2002-2004) the biggest increase of the museum audience in January 2003 can be observed. The impact on such big increase in the audience had the exhibition: *Pablo Picasso. Transformations* (21.11.2002-9.02.2003). In November 2003 the next big increase of the audience can be observed what was connected with the exhibition*: The trendy world of the XVIII century* (23.09.2003-30.11.2003). Another big increase of the audience – in November and December 2004 was connected with the exhibition: *TRANSALPINUM. From Georgian and Dürer to Titian and Rubens. The paintings from the collections of Kunsthistorisches Museum in Vienna, National Museum in Warsaw and National Museum in Gdańsk* (17.09.2004–10.12.2004). However in the second period (2005-2007) the lack of periodicity of fluctuations in the total audience is observed, i.e. in 2005 the increase of audience was in March, May and June and in winter months, in 2006 – in March, May, November and December, in 2007 – from May till December the audience was increasing (with a decrease in October).

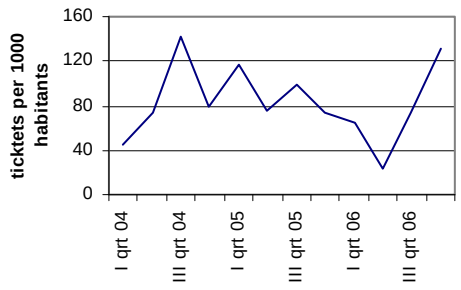

Figure 1. The tickets in total per 1000 inhabitants in the National Museum in Gdańsk (2004-2006)

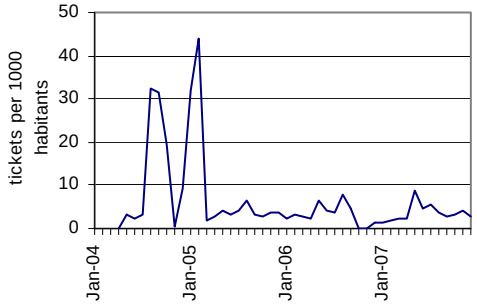

Figure 2. The tickets in total per 1000 inhabitants in the Department of Old Craft in the National Museum in Gdańsk in 2004-2007

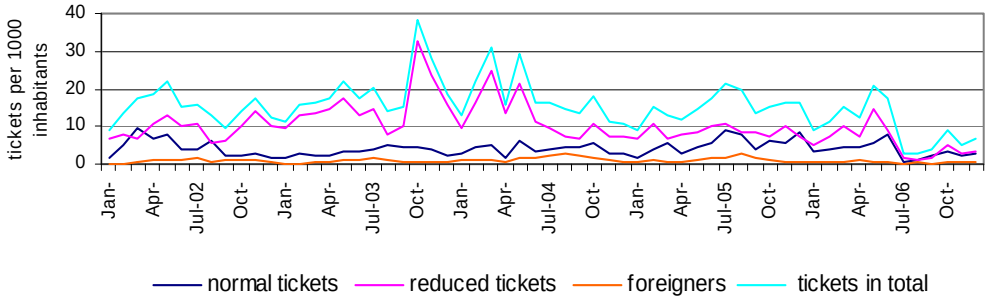

Figure 3. The museum audience in different categories in the National Museum in Szczecin

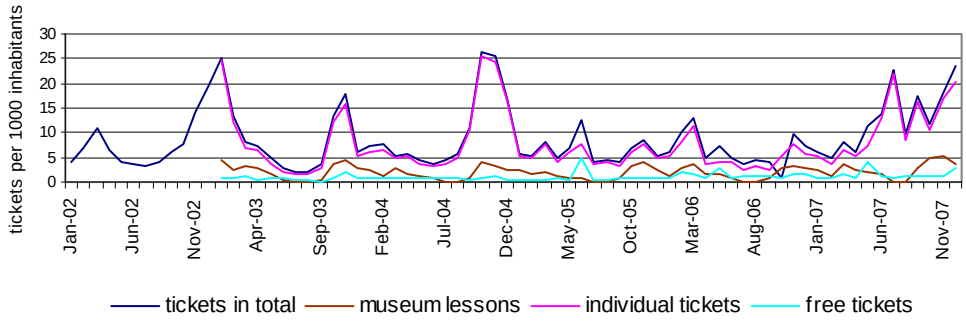

Figure 4. The museum audience in different categories in National Museum in Warsaw

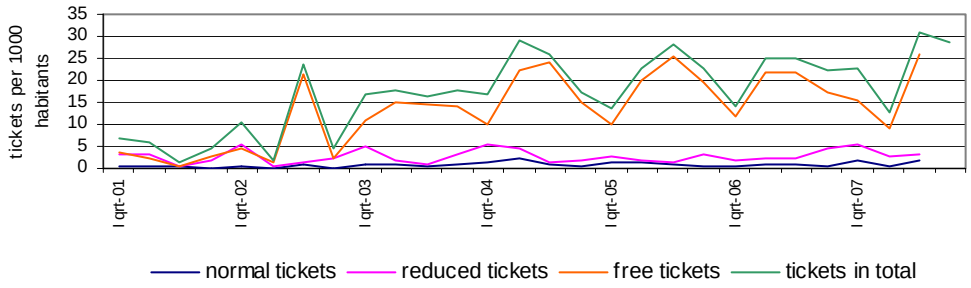

Figure 5. The museum audience in the National Museum in Wrocław

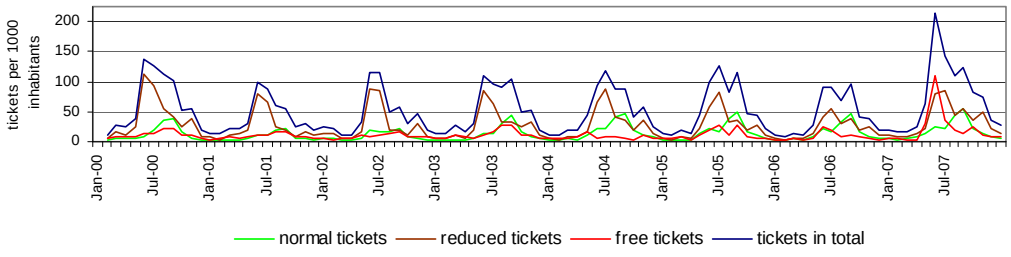

Figure 6. The audience of the Regional Museum in Toruń

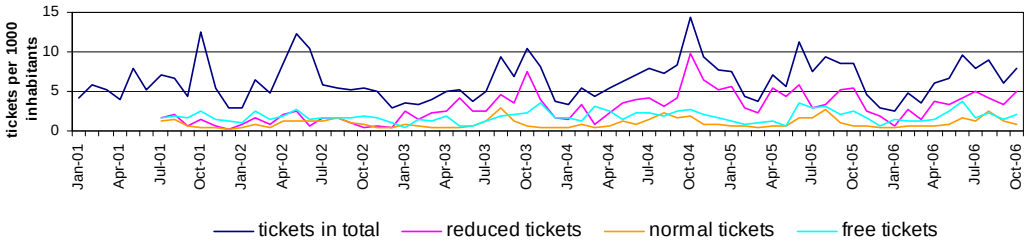

Figure 7. The museum audience in the Museum in Bielsko-Biała (total, normal, reduced, free tickets)

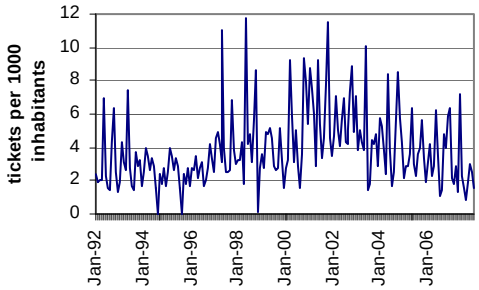

Figure 8. The total museum audience in the Central Museum of Textile Industry in Łódź (monthly data)

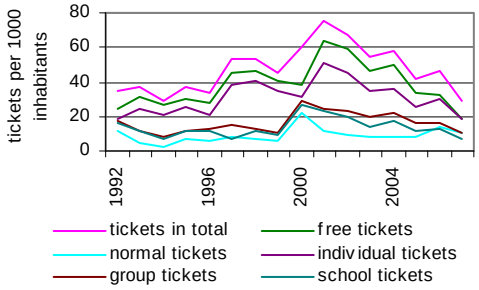

Figure 9. The museum audience (annually data 1992-2007) in the Central Museum of Textile Industry in Łódź

In Wrocław in the first subperiod (2001-2002) the irregular fluctuations around the stable level of the audience can be observed (Figure 5). In the second subperiod beginning from the first quarter of 2004, the average level of the museum audience is three times bigger than the average level of the museum audience in the first period. It can be supposed that the influence on the increase of the audience had the exhibition „*Manners of Silesian Guilds*" (25.X.2002–2.III.2003) which was honoured in May 2003 by the Ministry of Culture and National Herritage with the Grand Prix. From 2004 the irregular seasonal fluctuations with the amplitude from 15 till 30 tickets quarterly per 1000 inhabitants can be observed.

In Łódź the museum audience displays different tendency, i.e. in 1992-2001 the increase of the museum audience is observed, while in 2002-2007 – the substantial decrease appears (Figures 8, 9).

The tickets sold for individuals (in museums in Łódź and Warsaw, comp. Figure 9, 4) and free tickets (in museums in Łódź and Wrocław, comp. Figure 9, 5) have the largest share in total tickets.

3. The Econometric Analysis of Total Museum Audience

3.1. Analysis of seasonality of total museum audience

To study the occurrence of seasonal fluctuations the seasonality model of the following form was estimated:

$$Aud_t = d_0 + \sum_{i=1}^{m} d_i Q_{it}^* + \eta_t, \quad \text{with the condition: } \sum_{i=1}^{m} d_i = 0, \tag{1}$$

where: Aud_t denotes the total museum audience, Q_{it}^* – seasonal dummies equal to 1 in the *m*-th subperiod of the year, and zero otherwise, d_i – seasonal coefficients measuring of seasonal effect in the *m*-th subperiod of year cycle. Because of the collinearity of seasonal dummies Q_{it}^* ($i = 1, 2, \ldots, m$) with the intercept the transformation of Q_{it}^* consisting in subtracting one dummy, e.g. Q_{mt}^*, from each of dummies Q_{it}^*, is being made, i.e. $Q_{it} = Q_{it}^* - Q_{mt}^*$.

Then the model (1) has the form:

$$Aud_t = d_0 + \sum_{i=1}^{m-1} d_i Q_{it} + \eta_t, \tag{2}$$

where missing seasonal coefficient d_m is calculated from the condition: $\sum_{i=1}^{m} d_i = 0$, hence

$d_m = \sum_{i=1}^{m-1} d_i$. The seasonal fluctuations occur if at least one seasonal coefficient is statistically significant.

In the estimated seasonality models besides seasonal dummies the additional dummies are included in order to eliminate outliers, being displayed as the increase of museum audience, and at the same time to improve the fit of model. These outliers in museum audience may be caused by the opening of a new and attractive exhibition. While the increase of visitors is expected, it is difficult for the museum to estimate the scale of this increase connected with a new exhibition. Therefore they are often surprised at the popularity of exhibitions. These additional dummies were introduced in the seasonality models of museum audience in:

– the National Museum in Gdańsk: dummy *wyst_LP* describes the increase of the audience caused by the exhibition "*Paris lesson…*", and is equal to 1 from August till October 2004 and zero otherwise; dummy *wyst_T* – describes the increase of the audience caused by the exhibition "*Transalpinum…*, and is equal to 1 from December 2004 till January 2005 and zero otherwise;

– the National Museum in Szczecin: dummy *wyst_MP* describes the increase of the audience caused by the exhibition "*Magic, subaqueous world…*", and is equal to 1 from August 2003 till June 2004 and zero otherwise;

– the National Museum in Warsaw: dummy *wyst*_1 is equal to 1 in December 2002 and January 2003 (the exhibition *Pablo Picasso*…), dummy *wyst*_2 is equal to 1 in October and November 2003 (the exhibition *The trendy world*…), dummy *wyst*_3 is equal to in October and November 2004 (exhibition *TRANSALPINUM*…), and zero otherwise;

– the Regional Museum in Toruń: dummy *wyst_TB* describes the increase of audience caused by the exhibition „*Faces of the secret police*" and is equal to 1 in May 2007, and zero otherwise.

The estimation results of seasonality model are given in the Table 3.1.

The estimation results in Table 3.1 show that the total museum audience in all museums displays strong seasonal fluctuations; however the scheme of seasonality is different.

In the case of Department of Old Art of the National Museum in Gdańsk the total museum audience increases in summer (comp. Table 3.1, A). The total museum audience in the National Museum in Szczecin decreases in January and increases in May (comp. Table 3.1, B). In the museum in Wrocław the largest increase in comparison to average level can be observed in the third quarter (comp. Table 3.1, D).

In the case of the National Museum in Warsaw the total museum audience increases considerably in November and December and slightly - in February and March. The largest increase of the total museum audience in comparison to the average level is observed in November (comp. Table 3.1, C). The total museum audience in the Regional Museum in Toruń increases comparing to the average level in summer months, i.e. from May till August, and decreases in winter and early-spring months (from November till April). The largest increase of the total museum audience can be observed in June (comp. Table 3.1, E). This scheme of fluctuations is caused by the tourist movement in Toruń which is much bigger in summer time and smaller in winter time.

In the Museum in Bielsko-Biała the total museum audience increases comparing to the average level in summer months (it is caused by touristic movement) and in early-autumn time. The largest increase of the total museum audience comparing to the average level occurs in June, August and especially in October (comp. Table 3.1, F), what can be caused by the bigger number of visits of school children in the museum (it is confirmed by the sale of reduced tickets − comp. Figure 7).

Table 3.1. The estimation results for seasonality models of total museum audience in chosen museums (trend and seasonality model for Central Museum of Textile Industry in Łódź)

	A. National Museum in Gdańsk 2004:01–2007:12		B. National Museum in Szczecin 2002:01–2006:12		C. National Museum in Warsaw 2002:01–2007:12	
Variable	Coefficients	t-statistics	Coefficients	t-statistics	Coefficients	t-statistics
const	3.105	4.922**	13.886	19.285**	7.725	13.500
Q_{1t}	-0.327	-0.163	-5.247	-2.436**	-0.949	-0.508
Q_{2t}	3.537	1.91*	-0.014	-0.006	0.286	0.159
Q_{3t}	-0.768	-0.394	2.996	1.391	1.167	0.646
Q_{4t}	-0.699	-0.359	-0.291	-0.135	-1.855	-1.028
Q_{5t}	2.49	1.279	6.162	2.86**	-1.246	-0.690
Q_{6t}	0.411	0.211	1.305	0.606	-0.854	-0.473
Q_{7t}	0.983	0.505	1.306	0.6	-0.981	-0.543
Q_{8t}	3.374	1.686	-2.797	-1.299	-2.576	-1.427
Q_{9t}	1.28	0.639	-4.445	-2.063**	-0.068	-0.037
Q_{10t}	-2.856	-1.427	3.327	1.544	-0.298	-0.152
Q_{11t}	-1.075	-0.552	0.178	0.083	4.257	2.171**
wys_LP	24.054	8.919**	–	–	–	–
wys_T	26.363	9.968**	–	–	–	–
wys_MP	–	–	8.228	4.852**	–	–
*wyst*_1	–	–	–	–	13.709	3.852**
*wyst*_2	–	–	–	–	5.733	1.578
*wyst*_3	–	–	–	–	16.272	4.48**
	$S(u)$=±4.047, n = 48 R^2=0.86, R^2_{sk} = 0.81 DW=1.93, $\hat{\rho}_{11}$ =0.03		$S(u)$=±6.36, n = 60 R^2=0.5, R^2_{sk} = 0.37 DW=1.29, $\hat{\rho}_{11}$ =0.35		$S(u)$=±4.6, n =72 R^2=0.54, R^2_{sk} = 0.42 DW=0.92, $\hat{\rho}_{11}$ =0.54	

*, ** denote significance at 10% and 5% level respectively.

Cont. Table 3.1

Variable	D. National Museum in Wrocław	
	Coefficients	t-statistics
const	20.100	13.130**
Q_{1t}	-3. 775	-1.614
Q_{2t}	-1. 212	-0. 521
Q_{3t}	4. 606	1.979*
t	-2. 133	-3.735**
	$S(u)$=±8.74 n = 28 R^2=0.44 R^2_{sk} = 0.39 DW=1.43 $\hat{\rho}_{11}$ =0.25	

*, ** denote significance at 10% and 5% level respectively. The time variable t in the period from 2001: quarter I till 2002: quarter IV takes values 1, 2,…, 8, and zero in others quarters, what is the reflection of the different tendency in the periods: 2001-2002 and 2003-2007 for the audience in the National Museum in Wrocław.

In the case of the Central Museum of Textile Industry in Łódź the total museum audience considerably increases in May and in October (comp. Table 3.1, G). In these months, in the museum the exhibitions-competitions are regularly organized which promote the modern textile art (for example, the International Triennale of Textile in Łódź and on this base an art competition for school children, exhibitions of art handicraft and historical competitions "White Factory - before and today"). Very atypically (comparing to the other analysed museums) the decrease of the total museum audience comparing to the average level in summer months (July and August) can be observed. During 1992-2001 there was the increase of the total museum audience, however from 2002 till 2007 there was rather the substantial decrease of audience, so in the econometric model the segmental trend was used (Table 3.1, G). Time variable t_{s1} takes values from 1 (Jan 1992) till 118 (Oct 2001) and zero otherwise; and time variable t_{s2} – takes values from 119 (Nov 2001) till 192 (Dec 2007) and zero otherwise.

The estimated models differ also in statistical properties. The model fit substantially differs among models, i.e. the adjusted determination coefficient R^2_{sk} oscillates from 0.34 (in the model of total museum audience in the Central Museum of Textile Industry in Łódź) till 0.88 (in the model of museum audience in the Regional Museum in Toruń). Generally the fit of seasonality models is not high because in the most cases the adjusted determination coefficient is lower than the critical value equal to 0.80. It suggests that the share of irregular and random fluctuations in the museum audience is substantial.

Cont. Table 3.1

Variable	E. Regional Museum in Toruń 2000:01–2007:12		F. Museum in Bielsko-Biała 2001:01–2007:10		G. Central Museum of Textile Industry in Łódź 1992:01–2007:12	
	Coefficients	t-statistics	Coefficients	t-statistics	Coefficients	t-statistics
const	51.490	35.039**	6.346	25.988**	2.354	7.302**
t_{s1}	–	–	–	–	0.025	5.235**
t_{s2}	–	–	–	–	0.010	4.292**
Q_{1t}	-38.318	-7.904**	-2.303	-2.887**	-0.042	-0.100
Q_{2t}	-32.123	-6.627**	-1.316	-1.650	0.152	0.357
Q_{3t}	-34.151	-7.045**	-2.102	-2.634**	0.313	0.737
Q_{4t}	-12.306	-2.539**	-0.359	-0.450	-0.770	-1.811*
Q_{5t}	54.631	10.603**	0.983	1.232	2.489	5.854**
Q_{6t}	60.972	12.578**	1.516	1.901*	0.282	0.664
Q_{7t}	31.277	6.452**	0.565	0.708	-1.617	-3.804**
Q_{8t}	41.295	8.518**	1.459	1.828*	-1.814	-4.265**
Q_{9t}	-5.592	-1.154	0.179	0.225	0.040	0.094
Q_{10t}	-1.891	-0.390	3.520	4.412**	1.717	4.035**
Q_{11t}	-29.051	-5.993**	0.129	0.149	0.212	0.499
wyst_TB	108.210	7.072**	–	–	–	–
	$S(u)$=±14.3, n = 96 R^2=0.90, R^2_{sk} = 0.88 DW=0.77, $\hat{\rho}_{11}$ =0.62		$S(u)$=±2.54, n = 70 R^2=0.46, R^2_{sk} = 0.36 DW=1.14, $\hat{\rho}_{11}$ =0.43		$S(u)$=±2.19, n = 192 R^2=0.39, R^2_{sk} = 0.34 DW=1.47, $\hat{\rho}_{11}$ =0.26	

*, ** denote significance at 10% and 5% level respectively.

For all models (except the model of the museum audience in the National Museum in Wrocław) the first order autocorrelation of residuals occurs (the DW statistics is lower than the low critical values, and the estimate of partial autocorrelation coefficient of first order $\hat{\rho}_1$ exceeds the critical value $1.96/\sqrt{n}$. To eliminate the autocorrelation of residuals the lagged values of museum audience Aud_{t-q} should be introduced into seasonality

models, where q denotes the auto regression order (this order is equal to the auto regression order of residuals). In such a way the model fit will be improved and residuals will be random. To detect the auto regression order the Quenouille test will be used.

3.2. The seasonality and auto regression models of total museum audience

The detection of the autocorrelation order of residuals was realized by testing the significance of partial autocorrelation coefficients of τ order (the Quenouille test, see [1]). In the case of residuals from the seasonality model of the total museum audience in the National Museum in Warsaw the autocorrelation order is equal to 2, because the estimate of partial autocorrelation coefficient of second order $\hat{\rho}_{22} = 0.24$ is bigger than the critical value $1.96/\sqrt{n} = 1.96/\sqrt{72} = 0.23$ (the number of observations n is given in Table 3.1), so the partial autocorrelation coefficient of second order is statistically significant. The detected in such a way the auto regression order of residuals in the seasonality models of the total museum audience for given museums equals respectively: Museum in Bielsko-Biała – 4, Museum in Gdańsk (Department of Old Art) – 2, Museum in Łódź – 7, Museum in Szczecin – 1, Museum in Wrocław – 0, Museum in Toruń – 1.

To remove the autocorrelation of residuals the lags of museum audience are introduced into seasonality models, where the number of lags is equal to the autocorrelation order of residuals in seasonality models. The estimation results of seasonal and auto regression models are shown in Table 3.2.

The estimation results of seasonality and auto regression models of the total museum audience (comp. Table 3.2) show that the highest fit of model occurs in the models for the National Museum in Gdańsk (Department of Old Arts) and the Regional Museum in Toruń for which the adjusted determination coefficients equal respectively: $R^2_{sk} = 0.86$ and $R^2_{sk} = 0.93$. For those models the model fit can be treated as high because the determination coefficient R^2_{sk} exceeds the critical value 0.85. The other models have the moderate and low fit what suggests substantial share of irregular fluctuations in the total museum audience. In all models there is no autocorrelation of residuals because the estimates of partial autocorrelation $|\hat{\rho}_{11}|$ are lower than the critical value $2/\sqrt{n}$ (comp. Table 3.2) and the structural parameters are statistically significant.

Table 3.2. The estimation results for seasonality and auto regression models of total museum audience in chosen museums

	A. National Museum in Gdańsk, Department of Old Art, 2004:01–2007:12		B. National Museum in Szczecin 2002:01–2006:12		C. National Museum in Warsaw 2002:01–2007:12	
Variable	Coefficients	t-statistics	Coefficients	t-statistics	Coefficients	t-statistics
const	3.34	4.799**	7.857	3.738**	4.055	4.307*
Q_{1t}	-0.574	-0.272	-4.661	-2.084**	-1.399	-0.788
Q_{2t}	3.129	1.635	2.311	1.075	-0.225	-0.145
Q_{3t}	-2.020	-1.100	3.051	1.519	1.139	0.734
Q_{4t}	1.365	0.733	-1.542	-0.752	-2.289	-1.472
Q_{5t}	2.208	1.266	6.336	3.154**	-0.285	-0.182
Q_{6t}	-0.651	-0.371	-1.319	-0.603	-0.174	-0.111
Q_{7t}	1.160	0.668	0.032	0.015	-0.482	-0.310
Q_{8t}	3.615	1.988 *	-2.601	-1.295	-2.018	-1.295
Q_{9t}	-0.448	-0.243	-3.184	-1.552	1.226	0.776
Q_{10t}	-2.164	-1.192	5.303	2.512**	0.793	0.465
Q_{11t}	-0.500	-0.284	-1.216	-0.59	3.762	2.227*
wys_LP	21.348	7.773**	–	–	–	–
wys_T	24.629	9.622**	–	–	–	–
wyst_MP	–	–	4.448	2.204**	–	–
*wyst_*1	–	–	–	–	11.377	3.648*
*wyst_*2	–	–	–	–	5.237	1.677**
*wyst_*3	–	–	–	–	11.040	3.329*
Aud_{t-1}	0.250	2.836**	0.434	3.028**	0.462	4.657*
Aud_{t-2}	-0.226	-2.969**	–	–	–	–
	$S(u)$=±3.59, R^2=0.9, R^2_{sk} = 0.86, n = 46		$S(u)$=±6.36, R^2=0.58, R^2_{sk} = 0.46, n = 59		$S(u)$=±3.9, R^2=0.67, R^2_{sk} = 0.57, n = 70	
	DW=2.46, $\hat{\rho}_{11}$ = -0.23		DW=2.03, $\hat{\rho}_{11}$ =0.02		DW=1.75, $\hat{\rho}_{11}$ =0.063	

*, ** denote significance at 10% and 5% level respectively.

Cont. Table 3.2

Variable	E. Regional Museum in Toruń 2000:01-2007:12		F. Museum in Bielsko-Biała		G. Central Museum of Textile Industry in Łódź	
	Coefficients	t-statistics	Coefficients	t-statistics	Coefficients	t-statistics
const	20.709	5.119*	4.177	3.719**	0.755	1.757*
t_{s1}	–	–	–	–	0.006	2.096**
Q_{1t}	-17.188	-3.663*	-1.598	-1.549	-0.181	-0.382
Q_{2t}	-10.718	-2.221*	0.912	0.879	0.420	0.891
Q_{3t}	-13.639	-2.984*	-1.171	-1.339	0.645	1.400
Q_{4t}	7.9149	1.773**	0.708	0.804	-0.716	-1.640
Q_{5t}	67.956	14.79*	0.937	1.166	2.150	4.887**
Q_{6t}	35.909	4.891*	0.949	1.189	-0.270	-0.584
Q_{7t}	-5.3637	-0.89	-0.751	-0.927	-1.551	-3.382**
Q_{8t}	18.056	3.315*	0.823	1.083	-1.806	-3.910**
Q_{9t}	-27.561	-5.993*	-0.289	-0.378	0.652	1.352
Q_{10t}	-6.550	-1.254	3.577	4.683**	1.581	3.265**
Q_{11t}	-26.766	-7.221*	-1.395	-1.480	0.565	1.128
wyst_TB	95.045	8.057*	–	–	–	–
Aud_{t-1}	0.408	4.874*	0.385	2.859**	0.204	2.741**
Aud_{t-2}	0.180	2.174*	0.180	1.252	0.080	1.060
Aud_{t-3}	–	–	0.050	0.345	0.139	1.856*
Aud_{t-4}	–	–	-0.273	-2.020**	0.009	0.120
Aud_{t-5}	–	–	–	–	0.155	2.077**
Aud_{t-6}	–	–	–	–	-0.111	-1.473
Aud_{t-7}	–	–	–	–	0.267	3.605**
	$S(u)$=±10.8, R^2=0.94, R^2_{sk}= 0.93, n = 94		$S(u)$=±2.58, R^2=0.60. R^2_{sk}= 0.48, n = 66		$S(u)$=±2.19, R^2=0.50. R^2_{sk}= 0.45, n = 185	
	DW=1.77, $\hat{\rho}_{11}$=0.112		DW=1.96, $\hat{\rho}_{11}$=0.007		DW=2.02, $\hat{\rho}_{11}$=-0.009	

*, ** denote significance at 10% and 5% level respectively.

Among presented models only two can be evaluated as models of high quality, and hence of usefulness in forecasting, i.e. models for the National Museum in Gdańsk (Department of Old Arts) and for the Regional Museum in Toruń. However for forecasting purposes only the model for the Regional Museum in Toruń will be used because of exceptionally high regularity of fluctuations in the total museum audience. Such regularity is not observed in the total museum audience in the National Museum in Gdańsk (Department of Old Art.), and moreover the behaviour of the museum audience was disturbed by the renovation (there were no visits from October till November 2006)

3.3. The forecasts of total museum audience

The forecasting model of the total museum audience in the Regional Museum in Toruń in period T (January-June 2008) takes the following form:

$$\begin{aligned} Aud_{Tp} = {} & 20.7 - 17.2Q_{1T} - 10.7Q_{2T} - 13.6Q_{3T} + 7.9Q_{4T} + 67.9Q_{5T} + 35.9Q_{6T} - 5.36Q_{7T} + \\ & + 18.1Q_{8T} - 27.5Q_{9T} - 6.5Q_{10T} - 26.7Q_{11T} + 95wys\_TB + \\ & + 0.41Aud_{T-1} + 0.18Aud_{T-2} \end{aligned}$$

The forecasts of the total museum audience per 1000 inhabitants and forecast errors *ex post* (absolute δ_T and relative δ_T*) are shown in Table 3.3.

Table 3.3. The results of forecasting for the total museum audience

Forecast period	The Regional Museum in Toruń			
			ex post errors	
	realization Aud_T	forecast Aud_{Tp}	δ_T	δ_T* (%)
Jan_2008	20.02	21.2	1.18	5.6
Feb_2008	38.23	23.6	-14.6	38.3
Mar_2008	25.94	20.5	-5.44	21.0
Apr_2008		41.2		
May_2008		109.2		
Jun_2008		108.6		

The direction of changes of the total museum audience forecasts and their values in the whole forecast period are economically reliable because the behaviour of forecasts is similar to the behaviour of the museum audience in previous years. However taking into account the relative forecast errors *ex post* (δ_T* – comp. Table 3.3) only the forecast for January 2008 is accurate (the error δ_T* does not exceed the critical value 15%, and the others relative errors ex post are higher than the critical value).

The better measure of forecast accuracy is the mean absolute percentage error – MAPE (*Mean Absolute Percentage Error*) which was equal to 21.7%. This means that forecasting the total museum audience in the Regional Museum in Toruń in period January-March 2008 the error averagely about 21.7% of real values of the total museum audience is being made. This error is still too high but is considerably lower than the forecast errors δ_T* in February and March 2008.

It should be noticed that the high value of these errors resulted from considerably bigger museum audience in February than it could be expected on the basis of the behaviour of the museum audience in previous years. This increase of the museum audience in February 2008 was connected with the exceptionally attractive exhibition of the Copernicus' work "*On the Revolutions of the Celestial Spheres*" and the exhibition "*The glitter of gothic books. Illuminated manuscripts in Pomerania*".

The above results of forecasting show that even for the series displaying such clear regularity as the total museum audience in the Regional Museum in Toruń, it is not easy to forecast because the audience is the specific phenomenon with variability disturbed by substantial irregular fluctuations.

Conclusions

The paper shows that each museum is unique according to geographical location, main subject matter, the way of its presentation and the museum audience. Visiting museums reflects on one hand the people's need of art watching, on the other hand it gives information about museum attractiveness. However, nowadays it is necessary to re-think the traditional role of a museum. The point is rather to concern the desires and expectations of visitors and enable them to find their own way than to educate them.

In XXI century museums are confronted with the necessity of doing new tasks connected with attracting massive visitor, arousing his interest in assembled collections, ensuring a contact with the art work and giving the access to information in a way which is satisfactory to visitors. It is not easy task because a museum should take care about its uniqueness which is different from the "industry of experiences" (see [3])) Museums should not treat themselves as a competition to commercial centre. On the other hand museums should sense the need of entertainment hidden in tourists, the need of interaction with presented works and arousing curiosity and imagination. It can be achieved by different ways: by the knowledge presented by qualified guides, appropriately prepared showpieces with accessible texts instead of long texts larded with difficult terminology, by using multimedia, by allowing people to touch showpieces, by organizing stage production, e.g. in the Museum of Gingerbread in Toruń the process of making gingerbread is being presented, i.e. from making pastry, baking it and eating.

Another model example of the educational and museum object is the Ontario Science Centre (Toronto, www.ontariosciencecentre.ca) – the place as well for children as for adults – in which everything can be touched, tested, compared, in which demonstrations explaining physical and chemical phenomena are conducted, where a lot of multimedia presentations, interactive plays stimulating intellect are available, where the entertainment is joined with science. Certainly not each subject matter can be presented in such way, however for sure this way of presentation attracts people what was confirmed by the success of the Warsaw Uprising Museum (www.1944.pl). This direction is also followed by the Polish History Museum (www.muzhp.pl) which is a museum of narrative type.

In the museum of future will be necessary to combine the traditional mission of a museum with the commerce and fulfilling of service functions to tourists who look for entertainment, enjoyment, note of adventure and losing touch with everyday life. Only in such way, by providing attractions, museums will be able to attract visitors and consequently their profits arise.

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