

**METHODS OF EVENT HISTORY ANALYSIS  
IN THE ASSESSMENT OF CRISIS IMPACT ON SECTORS RELATED  
WITH THE REAL ESTATE MARKET IN POLAND**

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**Abstract**

The subject of the article is the use of methods of event history analysis to assess the fall of prices and the subsequent increase of share prices of companies operating in the construction industry, developers (real estate) and building materials industry compared to other industries. The 328 examined companies were listed on the continuous market and the parallel market on the Stock Exchange in Warsaw. Share prices were observed in the period from 1 January 2008 to 31 December 2009 which was based on the earlier observations of stock quotes and the WIG index, the latter reaching its minimum in February 2009. The closing price of a share was taken into account. The 60% decrease and 80% growth in shares prices in particular sectors were analysed. What was assessed was the risk of fall in share prices and their chance for recovery. Additionally, the intensity of the increase of share prices and the probability of failure to reach the limit were examined.

**Keywords:** crisis, event history analysis, shares of companies related with real estate market

**JEL classification:** C51, G01

## **Introduction**

Systematic and dynamic increase in real property prices in the USA between 2002 and 2006 resulted in pumping up the speculative bubble on the real property market. The slowing down growth rate of the American economy, increasing unemployment, problems with mortgage servicing as well as falling property prices, that led to losses in the banking sector in 2007, were at the root of the financial crisis (Nazarczuk, 2013). The crisis developed on a wider scale much later. In the second half of 2008 information about bankruptcies or the near-failures of important national and international financial organizations began to appear. In Poland the negative impact of the crisis started with a lag, no earlier than at the end of 2008 and the beginning of 2009. The downturn affected different industries to a different extent. Globally, the areas that suffered the most were the banking and financial sectors, the construction and real estate sectors, the automobiles industry, transport and the energy sector (Gorzelać, 2009). The Polish banking and financial sectors were less heavily impacted by the crisis, but the mutual confidence of financial institutions dwindled and the willingness to grant new loans decreased. That reduced the demand for mortgage lending and made investment in real estate development difficult. The slump in construction output in 2008–2009 was relatively short as it continued only for 2–3 quarters (Stryjewski, 2011). In 2009 the market saw a plunge followed by a steady recovery on the number of new investments in relation to the number of dwellings given over for use. Yet, the index of the general business climate in the construction industry, published monthly by the Polish Central Statistical Office, which had been positive in 2005–2008, fell to negative values in 2009 and remained low in the subsequent years (in the second halves of 2010 and 2011 it rose slightly above zero) (Tarczyńska-Łuniewska, Foryś, 2015).

The world stock markets were affected by the crisis. At the end of 2008 and the beginning of 2009 prices on the Warsaw Stock exchange went down. In February 2009 the WIG and WIG20 reached their lowest levels since the beginning of the decline. The purpose of this article is the assessment of the downturn and the subsequent recovery of the prices of companies in the construction, developers (real estate) and the building materials sectors in comparison to other sectors. In the first phase of the study the authors assessed the risk of the decline in company prices that took place between January 1, 2008 and December 31, 2009. In the second phase the authors examined the chance and intensity of recovery, i.e. on the chance of the share price increase. The analysis used the encoding of the independent variable  $-1; 0; 1$  that made it possible to compare the risk/chance for the analysed sectors with the average risk/chance for all the groups (Hosmer, Lemeshow, 2000; Markowicz, Stolorz, 2009).

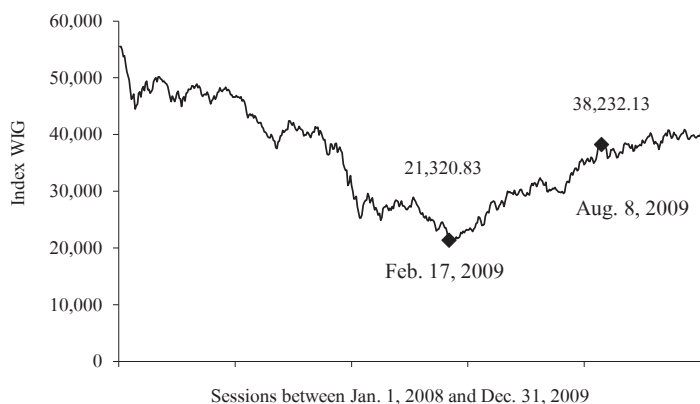


Figure 1. WIG between Jan. 1, 2008 and Dec. 31, 2009

Source: own study based on: <http://bossa.pl>.

In February 2009 the WIG fell by 60% in relation to its value at the beginning of 2008, to grow after six months by 80% (Figure 1). The values of 60 and 80% were adopted as the minimum/maximum limits. By means of the logit model the authors examined the risk of every company price decline by 60% and the chance of the 80% increase of these prices from their minimum value. They also analysed the intensity of recovery using the Cox regression model and the probability of failing to reach the upper limit by means of the Kaplan-Meier estimator. The study was based on data from 328 companies (listed on the after-hours and the second-tier markets over the whole period of study) grouped in 25 sectors.

### 1. Data used in the study

The study covered 328 companies listed on the Warsaw Stock Exchange after-hours and the second-tier market. The share prices were observed from January 1, 2008 to December 31, 2009. The period had been fixed and based on the observations of share price movements and the WIG index which reached its lowest level in February 2009. Also, the closing price was taken into account. The authors analysed the 60% decline and then the 80% rise in share prices in individual sectors. Over the period of study not all of the companies reached the border values (Table 1).

In the analysis the authors particularly concentrated on three sectors: construction, developers (real estate) and the building materials industry. The companies operating in these sectors in the period of study are shown in Table 2.

Table 1. Structure of companies by obtained border values and by sectors

Sectors	60% decline	80% rise	Average increase time
	%	%	days
Banking	85.71	92.86	97.14
Construction	66.67	73.33	142.33
Chemicals Industry	100.00	100.00	77.50
Developers (Real Estate)	100.00	100.00	105.00
Electro engineering	72.73	86.36	123.00
Energy	0.00	66.67	224.33
Pharmaceutical	71.43	85.71	187.71
Finance	85.00	55.00	153.25
Retail Trade	82.61	78.26	130.22
Wholesale Trade	89.29	92.86	110.89
Hotels & Restaurants	85.71	71.43	94.71
IT	73.33	56.67	158.73
Media	53.85	30.77	186.15
Wood & Paper Industries	57.14	85.71	100.86
Industry – others	100.00	0.00	13.50
Light Industry	87.50	62.50	114.50
Building Materials Industry	76.92	92.31	91.54
Metals Industry	88.89	77.78	138.33
Automobile Industry	100.00	100.00	85.20
Oil & Gas Industries	83.33	50.00	144.83
Food Industry	65.00	85.00	123.90
Plastic Materials Industry	50.00	66.67	162.33
Telecoms	37.50	50.00	156.63
Insurance	0.00	0.00	157.00
Services – others	50.00	68.75	123.88
Total	75.00	74.70	130.76

Source: own study.

Table 2. Companies operating in the construction, developers and building materials sectors

Sector	Companies
Construction	ABMSOLID, BIPROMED, BUDIMEX, BUDOPOL, ELBUDOWA, ELEKTROTI, ENAP, ENERGOPLD, ENERGOPN, ENERGOPOL, ERBUD, GASTELZUR, HBPOLSKA, INSTAL, INSTALKRK, MOSTALEXP, MOSTALPLC, MOSTALWAR, MOSTALZAB, NAFTA, PANOVA, PBG, PEMUG, POLAQUA, POLIMEXMS, PROCHEM, PROJPRZEM, RESBUD, STORMM, ULMA
Developers	08OCTAVA, BBIDEVNFI, DOMDEV, ECHO, GANT, GTC, IMMOEAST, JWCONSTR, LCCORP, ORCOGROUP, PLAZACNTR, POLNORD, REINHOLD, RONSON, TRITON, TUP, WARIMPEX
Building Materials Industry	ARMATURA, BARLINEK, BUDVARCEN, CERSANIT, DECORA, IZOLACJA, MERCOR, NOWAGALA, POLCOLORIT, ROPCZYCE, SNIEZKA, TRION, YAWAL

Source: own study.

## 2. Methods

The study employs models used in the event history analysis (Yamaguchi, 1991). It is a set of methods to examine the duration of the phenomena in various domains of human activity such as social, economic and political lives. In order to assess the chance/risk of the relative occurrence of an event the authors used the logit model (Kleinbaum, Klein, 2002) given by:

$$\text{logit}(p) = \ln\left(\frac{p}{1-p}\right) = \alpha_0 + \sum_{i=1}^n \alpha_i x_i,$$

where  $p = P(Y = 1 | x_1, x_2, \dots, x_n)$  is the conditional probability of an event to occur.

The relative intensity of the event occurrence was assessed by means of the Cox (Cox, Oakes, 1984; Hosmer, Lemeshow, 1999) regression model, also called the proportional hazard model. The model can be written:

$$h(t : x_1, x_2, \dots, x_n) = h_0(t) \exp(a_1 x_1 + a_2 x_2 + \dots + a_n x_n),$$

where:

- $h(t : x_1, x_2, \dots, x_n)$  – hazard with the data of  $n$  independent variables  $x_1, x_2, \dots, x_n$  and the adequate survival time  $t$ ,
- $h_0(t)$  – reference hazard or baseline hazard,
- $a_1, a_2, \dots, a_n$  – model coefficients,
- $t$  – the time of observation.

The probability of the non-occurrence of the event was estimated by means of the Kaplan-Meier survival function estimator (Kaplan, Meier, 1958):

$$\hat{S}(t_i) = \prod_{j=1}^i \left(1 - \frac{d_j}{n_j}\right) \text{ for } i = 1, \dots, k,$$

where:

- $t_i$  – the point in time when at least one event occurred,  $t_1 < t_2 < \dots < t_k$ ,  $t_0 = 0$ ,
- $d_i$  – the number of events in the time  $t_i$ ,
- $n_i$  – number of units under observation in the time  $t_i$ ,  $n_i = n_{i-1} - d_{i-1} - z_{i-1}$ ,
- $z_i$  – number of observations terminated in the time  $t_i$ .

### 3. Results

The first phase of the study consisted in the assessment of the risk of relative price decline in individual sectors. Since in the period of study the WIG decreased by 60%, this value was adopted as the bottom value in the risk analysis. To this end the logit model given by (1) was used. The dichotomous dependent variable  $Y$  took the value of 1 when the share prices fell by at least 60%; otherwise it took the value of 0. The fall was made conditional on the sector. It was a qualitative trait that was transformed into dummy variables. The authors used  $-1; 0; 1$  coding, which enabled them to compare the risk of the price decline in a given sector to the average risk.<sup>1</sup> In the interpretation the authors used the terms of  $\exp(\alpha_i)$  called the hazard rate. The value of the hazard rate bigger than 1 (Figure 1) means that the risk of the share prices decline in a given sector is higher than the average risk. The risk being twice as high as the average risk was observed in such sectors as wholesale, the metal industry, light industry, banking, hotels and restaurants. At least half as high risk of the share price decline was seen by the telecoms, other services, media and wood and paper industries sectors. In the phase of estimating the logit model parameters six sectors were not taken into consideration. In the energy and insurance sectors the prices went down by less than 60%, while the remaining four (the chemicals industry, developers, other industries and automobile industry) consisted only of the companies in red. It is worth noting that those were the two sector groups where the probability of the share price decline was zero and one, respectively.

The second phase of the study includes the assessment of the odds and intensity of the share prices to rise by 80% in comparison to the minimum value in six months. It also deals with the evaluation of the time of recovery. The observation starting event was when the company saw the minimum share price in a given period of time, and the final event was when the share price rose by 80% in comparison to the minimum price. In this phase the relative odds were assessed with the use of the logit model (1). That time the dichotomous variable  $Y$  adopted the value of 1 when the 80% rise was observed. Otherwise its value was 0. Like before, the authors used the  $-1; 0; 1$  coding, which allowed for assessing the chance for the price to grow in relation to the average calculated for all the sectors. The comparison of chances was made by means of the expression  $\exp(\alpha_i)$ , in this case being referred to as the odds ratio. The exceptionally high chances for the share prices to grow in comparison to the sector average were observed in the companies from the banking sector and the building materials industry and wholesale trade sectors (the ratio being higher than 4). In such sectors as the media, the oil & gas industry,

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<sup>1</sup> In Figure 2 the average risk is represented by the line on the level of 1.

telecoms, finance and IT the chances for share price increase were low. Five sectors were excluded from the estimation of the logit model parameters. Two of them (other industries and insurance) embraced the companies whose prices had not reached the required 80% growth over the six-month observation. In the remaining three sectors (the chemicals industry, developers, and the automobile industry) the probability of the share price growth was 1 (all the companies in question reached the required growth level).

The Cox regression model (2) was used for the assessment of the relative intensity (relative hazard) of the share price rise up to the baseline of 80%. If the growth had not been observed during the observation, the observation was regarded as censored. In the time analysis the authors omitted 2 sectors (other industries and insurance) because, as it was mentioned above, all of the observations concerning those sectors were censored. Having estimated the coefficients of the model (2), the authors calculated the hazard rate for individual sectors ( $n = 23$ ) written by  $\exp(\alpha_i)$ , that provided information which sectors were recovering at a faster and slower rate. The above-average growth intensity (represented by the value of 1 in Figure 2) was observed in companies belonging to 11 sectors. The most intensive recovery was seen by companies from the automobile and chemicals industries. The estimated rates of risk, odds and hazard are shown in Figure 2.

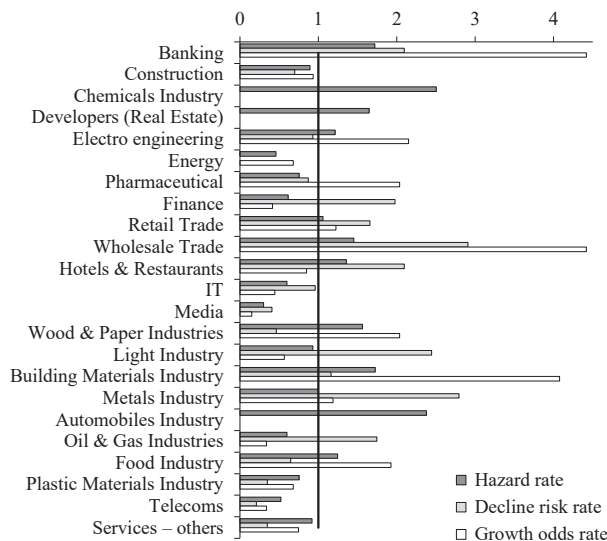


Figure 2. Estimated values of risk, odds and hazard rates

Source: own study.

Next, the analysis of the possibility of failure to reach the 80% share price growth in the observed period was made. Using the Kaplan-Meier estimator (3) the authors determined the duration curves for the companies listed on the WSE in general and by the three analysed sectors (Figure 3). After about 60 days the duration function reached 0.75, which means that approximately 25% of all the listed companies saw an 80% rise in the share prices. The median value was reached after 124 days, while the third quartile – after 206 days. Individual sectors also differed in the rate at which they reached the 80% growth. The log-rank test confirmed the relevance of the differences (at the level of 0.1) in the case of the construction and the building materials industries ( $p = 0.0950$ ). On the other hand, it did not show considerable differences between the duration curves representing the developers and the building materials companies ( $p = 0.6999$ ). The two latter sectors recovered at a faster pace than the construction companies.

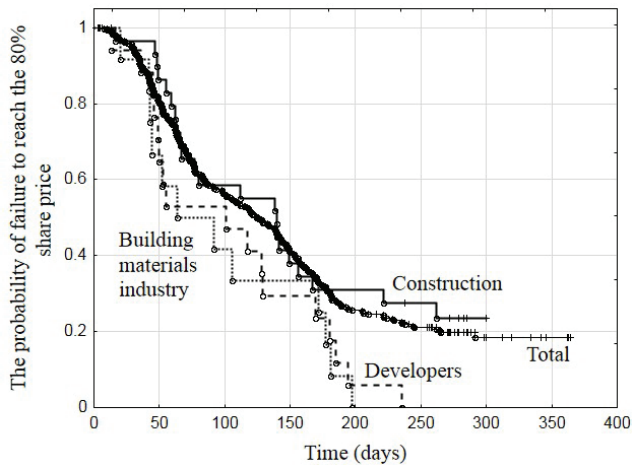


Figure 3. The Kaplan-Meier estimator – the probability of failure to reach the 80% share price growth by sectors: construction, developer and building materials industry

Source: own study.

## Conclusions

The results obtained in the individual phases of the study are presented in Figure 4. The diagram shows the values of the risk rate of share price decline (by 60%) and the odds rate of the share price recovery (by 80%) in individual sectors. For both the risk and odds rates the point of the axis intersection was determined at the level of 1. Four groups of sectors were identified:



1. The ‘low-low’ group embracing the sectors of (8): insurance, media, telecoms, energy, plastic materials industry, **construction** and other services where companies saw a low risk of the share price decline and low odds of recovery. Those were the companies that were less affected by the crisis (small decline followed by small rise in prices).
2. The ‘high-high’ group of such sectors as (8): the automobile industry, **developers**, the chemicals industry, banking, wholesale trade, the **building materials industry**, retail trade and metals industry where companies observed both a high risk of price decline and high odds of recovery. These were the companies that strongly responded to the crisis, but their chances of recovery were high.
3. The ‘low-high’ group consisting of such sectors as (4): electro engineering, pharmaceuticals, wood and paper industries, the food industry where companies observed a low risk of price decline, followed by the higher than average odds of recovery.

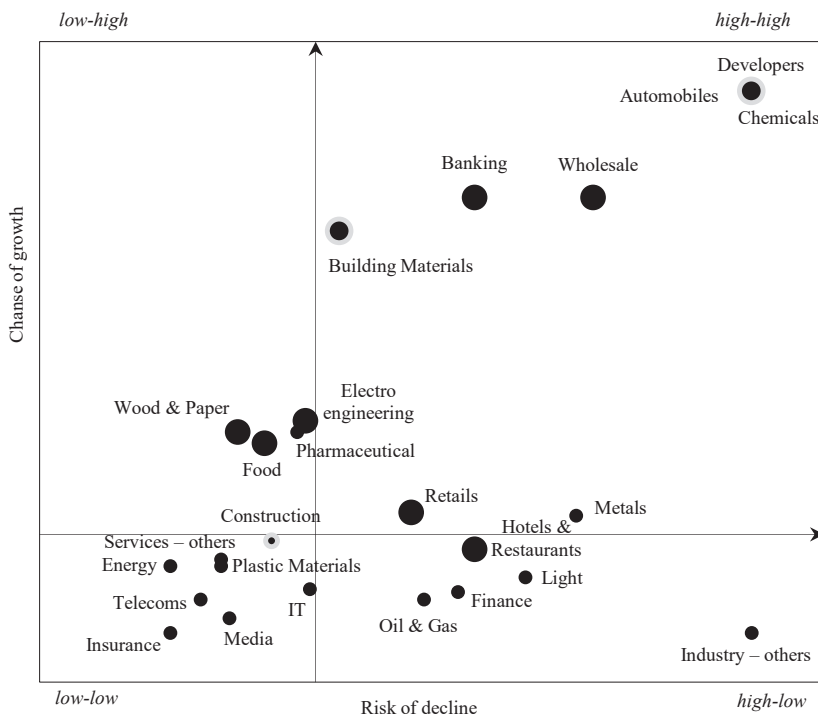


Figure 4. Risk of share price decline, recovery odds and growth intensity by sectors in 2008–2009

Source: own study.

4. The ‘high-low’ group of such sectors as (5): finance, hotels and restaurants, light industry, the oil and gas industries and other industries where companies saw a high risk of price decline and then low odds of recovery. Those companies were the most affected by the crisis.

Additionally, in Figure 4 a large dot represents those sectors whose companies recovered more intensively than the all-sector average (hazard rate over 1). Most of those sectors belonged to groups 2 and 3, i.e. to the groups with high share price recovery odds. The analysis presented above shows that two of the sectors that were examined in detail – developers and the building materials industry – belonged to group 2 where companies saw a quick and intensive recovery after a dramatic plunge in share prices. A reverse situation was observed in the construction sector. The companies reported a small decline followed by a small and low-intensive rise in share prices. As seen above, in Poland the financial crisis did not in fact affect the situation of listed construction companies. However, the companies belonging to the developers (real estate) and building materials industry sectors did suffer from the crisis, but only temporarily and they quickly recovered afterwards. The overall conclusion is that the companies operating on the real estate market were not hit by the long-term effects of the financial crisis.

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