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Zarządzanie finansami firm – teoria i praktyka

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Spis treści

Wstęp

Działalność gospodarcza, w skali zarówno makroekonomicznej, jak i mikroekonomicznej, składa się z gospodarki realnej wytwarzającej dobra i świadczącej usługi, w której kluczową rolę odgrywa szeroko rozumiana sfera finansów, obejmująca trzy zasadnicze grupy zagadnień: racjonalnego wyboru celów jednostek (organizacji) gospodarczych w aspekcie finansowym, optymalnych źródeł ich finansowania, a także efektywnego wykorzystania zgromadzonych zasobów finansowych.

Procesy globalizacyjne, a także kryzysy polityczne i wojskowe, sytuacja gospodarcza w Unii Europejskiej spowodowana falą imigracji, załamanie w gospodarce chińskiej muszą być uwzględniane przy podejmowaniu bieżących i strategicznych decyzji finansowych. Ponadto okoliczności te przyczyniają się do powstawania niekorzystnych warunków gospodarowania przedsiębiorstw w sferze pozyskiwania kapitałów, a w skali makro mogą prowadzić do powiększania deficytu i długu publicznego. Warunki zewnętrzne i wewnętrzne wymuszają jeszcze większą koncentrację teorii i praktyki zarządzania finansami na problemach zarówno finansów publicznych, jak i finansów przedsiębiorstw. Chodzi mianowicie o takie zarządzanie finansami, które powoduje pomnażanie bogactwa właścicieli kapitału i jednocześnie prowadzi do wzrostu dobrobytu całych społeczności. Zagadnieniom tym poświęcone są artykuły opublikowane w niniejszym zeszycie Prac Naukowych. Problematyka poruszana w przedstawionych opracowaniach dotyczy między innymi następujących obszarów zarządzania finansami: pozyskiwania kapitałów przez inicjatywy partnerstwa publiczno-prywatnego, udziału *venture capital*, zarządzania finansami w jednostkach sektora publicznego, np. w służbie zdrowia, zarządzania ryzykiem w podmiotach gospodarczych, sterowania strukturą kapitału i płynnością finansową przedsiębiorstwa, finansowania działalności innowacyjnej przedsiębiorstw, oceny efektywności inwestycji w odnawialne źródła energii, finansowych aspektów zamówień publicznych, finansów sektora bankowego oraz efektywności rynku kapitałowego.

Artykuły wchodzące w skład niniejszej publikacji są związane z coroczną konferencją „Zarządzanie finansami – teoria i praktyka", organizowaną przez Katedrę Finansów Przedsiębiorstwa i Zarządzania Wartością oraz Katedrę Finansów Publicznych i Międzynarodowych Wydziału Zarządzania, Informatyki i Finansów Uniwersytetu Ekonomicznego we Wrocławiu z udziałem pracowników naukowych z najważniejszych ośrodków akademickich w Polsce, przedstawicieli praktyki gospodarczej i gości zagranicznych. Konferencja ewoluowała od wąskiego niegdyś ujęcia zarządzania finansami firm do ujęcia szerszego, którego istotą jest objęcie różnych sfer działalności gospodarczej, w których zarządzanie finansami ma duże znaczenie. Dotyczy to finansów międzynarodowych, w tym finansów Unii Europejskiej, finansów centralnych (rządowych), finansów lokalnych (w tym jednostek samorządowych), finansów służb publicznych, jak również finansów wielu innych podmiotów gospodarczych.

Jako redaktorzy naukowi książki w imieniu autorów i własnym wyrażamy głęboką wdzięczność recenzentom – Paniom Profesor: Agacie Adamskiej, Aurelii Bielawskiej, Krystynie Brzozowskiej, Teresie Famulskiej, Małgorzacie M. Hybkiej, Wacławie Starzyńskiej, Paulinie Ucieklak-Jeż, oraz Panom Profesorom: Jerzemu Kitowskiemu, Jakubowi Marszałkowi i Jerzemu Różańskiemu – za wnikliwe recenzje i cenne uwagi, które przyczyniły się do powstania publikacji na odpowiednio wysokim poziomie naukowym.

Mamy nadzieję, że niniejsza lektura będzie inspiracją nie tylko do dalszych badań naukowych, ale również do wdrażania innowacyjnych rozwiązań w zakresie finansów zarówno w sektorze przedsiębiorstw, jak i w sektorze publicznym.

Adam Kopiński, Paweł Kowalik

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RISK OF PUBLIC FAMILY FIRMS

RYZYKO GIEŁDOWYCH FIRM RODZINNYCH

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Summary: This article tests the Value at Risk (VaR) model and its improvements to measure the risk approach of family firms and their nonfamily peers at the Warsaw Stock Exchange. The paper analyses the construction portfolio of firms listed at the Warsaw Stock Exchange between 2006 and 2012. This time period was used to compare the performance of these two portfolios in three sub-periods: during the crisis times as well as before and after the crisis. This article is based on historical and parametric Value of Risk to compare the performance of these two portfolios. In addition, it uses the Conditional Value at Risk to exhibit what happens beyond Value at Risk. This article finds that by using historical Value at Risk, family firms were on average less risky than their nonfamily peers before the latest crisis of 2008-2009. In the crisis, family firms bore more risk whereas after the crisis they were almost equally risky as nonfamily firms.

Keywords: family firm, risk, Value at Risk, Warsaw Stock Exchange.

Streszczenie: Niniejszy artykuł omawia model *Value at Risk* (VaR) oraz jego odmiany umożliwiające zbadanie nastawienia do ryzyka grupy firm rodzinnych oraz nierodzinnych notowanych na Giełdzie Papierów Wartościowych w Warszawie. W niniejszym artykule poddano analizie portfel firm budowlanych notowanych na giełdzie w latach 2006-2012. Okres ten podzielono na trzy podokresy w celu zbadania efektywności firm w czasach: przedkryzysowych, kryzysowych oraz pokryzysowych. Ryzyko obu grup firm zmierzono, wykorzystując historyczne oraz parametryczne metody VaR. W analizie dodatkowo wykorzystano warunkowy Var (CVaR). Z artykułu wynika, że firmy rodzinne wykazały średnio mniejsze ryzyko niż firmy nierodzinne w okresie przedkryzysowym. W czasie kryzysu firmy rodzinne obciążone były większym ryzykiem, natomiast w okresie pokryzysowym wykazały podobny stopień ryzyka jak ich nierodzinne odpowiedniki.

Słowa kluczowe: firma rodzinna, ryzyko, *Value at Risk*, Giełda Papierów Wartościowych w Warszawie.

1. Introduction

The process of globalization has brought many business opportunities as well as perils. In the aftermath of the most recent crisis, companies began to pay more attention to risk. In general, there are three categories of risk: (1) market risk,

(2) operational risk and (3) credit risk. In particular, Value at Risk (VaR) is used to predict market risk, but it may be useful in analyzing the other risk categories. As a consequence, the role of managers has been challenged for controlling a specific risk(s) in a similar way as returns. Markovitz [1952] who laid the foundations for the modern portfolio theory, rephrased this approach in the following way: "You should be interested in risk as well as return". Markovitz proved that a volatility of portfolio equals less than total volatilities of securities in this portfolio (we have measured and proved this effect with respect to family and nonfamily firms). This way of thinking imposed a challenging duty on financial managers to measure and monitor the risk of their holdings. In addition, the quantification of risk began to play a pivotal role. Markovitz perceived risk as standard deviation. However, this measure was later criticized for its drawbacks [e.g. Markowitz 1959; Mao 1970] and attention was paid to more refined risk measurements. In the 1990s, banks vastly adopted the concept of Value at Risk as a portfolio risk and became advocates of the VaR approach. The term was coined by Till Guldimann, head of global research at J.P. Morgan in the 1980s [Jorion 2007]. It was provoked by an interesting debate at J.P. Morgan on whether risk managers should focus on generating constant earnings or cash. The disputants concluded that firms should focus on cash, which triggered the development of the Value at Risk concept. In particular, VaR was expected to be a remedy for firms after the market turbulences caused by Barings, Daiwa or Metallgesellschaft and other firms in the early 1990s. This led to the formalization of that approach under the Basel Accord in 1996 and, as a consequence, VaR became a regulatory instrument used by financial institutions, quickly adopted by other firms [Bodnar et al. 1998].

The Value at Risk bases on statistics in its definition. Philippe Jorion, who wrote a seminal book on VaR that became an industry standard, defines VaR as follows: "VaR summarizes the worst loss over a target horizon that will not be exceeded with a given level of confidence" [Jorion 2007, p. 17]. This worst loss is reflected by the lower quantile of return distribution that may be surpassed with a given probability. Kaplanski and Kroll [2002] used the term of downside risk measure that referred to this lower part of the distribution. As an example, the one-day 1% VaR of $10 million trading portfolio denotes that a daily portfolio loss may be worse than VaR only 1% of the time. In other words, there is only 1 chance in a 100 that loss will be greater than $10 million. As a consequence, two important quantitative factors ensue from VaR: (1) the length of the holding horizon, and (2) the confidence level. The holding period reflects the liquidity of a firm while confidence level reflects the degree of risk aversion. The relation between these two factors is such that VaR is higher, with either a longer horizon or a greater level of confidence. Basel Committee on Banking Supervision specified VaR criteria recommended for banks as follows [Basel Committee on Banking Supervision 1995]:

– 99% one-tailed confidence interval,
– the holding period should be two weeks (10 business days),
– a bank uses risk categories in a flexible way.

Securities and Exchange Commission [SEC 1997] referred to VaR and proposed to use this metrics as a reporting of market risk exposure. However, SEC left the choice of the model to the registrant arguing that it may be adopted to non-trading and trading activities as well as to non-financial and financial institutions.

In general, family firms intend to operate over many generations because of family coherence. They rather expect moderate returns and avoid excessive risk. We focused on quantification of market risk in this article by inferring on two populations: family firms and nonfamily firms. We intended to find out if family firms were more or less risky than their nonfamily peers. We used the data of public companies to decide on this issue. In particular, we analyzed the portfolio of construction companies listed under the WIG-Construction Index[1] between 2006 and 2012. We divided this period into three sub-periods to capture the risk approach of companies during three different periods: (1) pre-crisis period: 2006–2007, (2) crisis period: 2008–2009, and (3) post-crisis period: 2010–2012. We decided to use the Value at Risk measure because it captures the risk approach and goes even beyond, as argued by Jorion [2007, p. IX]: "VaR provides an aggregate view of a portfolio's risk that accounts for leverage, correlations, and current positions. As a result, it is truly a forward-looking risk measure". Therefore it seems to be interesting to analyze family firms and their nonfamily peers in this forward-looking approach, in particular their behavior during adverse market movements.

This article is structured as follows. The next section analyzes the existing literature on Value at Risk. Then we focus on the methodology where we structure two portfolios of family and nonfamily companies listed at the Warsaw Stock Exchange. We also offer a formulae indispensable for Value at Risk calculation. We conclude with arguing on risk approaches exhibited by family and nonfamily firms and suggest further discussion on risk management.

2. Literature review

Abundant literature exists on Value at Risk and this article does not attempt to refer to all sources. It rather focuses on highlighting the major findings and improvements, in particular quoting sources that may be adequate for the analysis of family firms.

The focus on risk in finance may be attributed to Hardy [1923] and Hicks [1935] who discussed the diversification of portfolio but without referring to mathematics and econometrics. Leavens [1945] used quantitative data and employed binomial distribution to analyze the default of bond portfolio. As outlined in the introduction, Markovitz [1952] in his portfolio theory and Roy [1952] almost simultaneously outlined the importance of dealing with risk in the framework of what became later known as the modern portfolio theory. Initially, they perceived risk in the standard deviation. In 1959 Markovitz refined this approach by proposing semi-variance as

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[1] WIG stands for *Warszawski Indeks Giełdowy* − Warsaw Stock Exchange Index.

a measure of risk [Markovitz 1959]. Since it was criticized for its drawbacks, a search for a new risk measure began [e.g. Markowitz 1959; Mao 1970]. Baumol [1963] argued that the standard deviation used separately was not a good predictor of risk and combined standard deviation with lower confidence limit at some probability level in a formula that predicted risk. Baumol included a mean in his approach. Therefore it did not capture pure risk. However, his formula was a precursor of a new approach termed as the Value at Risk launched by J.P. Morgan as Riskmetrics™ [J.P. Morgan/Reuters 1996]. Riskmetrics™ represents the variance/covariance methodology to predict the risk and uses of a parametric GARCH (1,1) [see also Alexander, Leigh 1997; Boudoukh et al. 1997]. Banks were among the first to adopt VaR in their risk management practice. Berkowitz and O'Brien [2002], Perignon, Deng and Wang [2008] and Perignon and Smith [2006] confirmed that VaR became the industry standard used by banks. They also confirmed that for the longer (ten-day) horizons required by supervisory institutions, banks had been using scaling to calculate VaR. Since its vast adoption by banks, VaR became an industry standard and many improvements and variants have appeared in risk management practice. As a consequence, Danielson and de Vries [1997] and Hendricks [1996] proved that normally distributed VaR underestimated risk. This underestimation became more relevant with heavy-tailed distribution and excess kurtosis [Yamai, Yoshiba 2002]. In addition, Andersen and Sornette [1999] suggested focusing on heavy tails as it led to increased returns and lower large risks. Artzner et al. [1999] proposed four axioms (translation invariance, positive homogeneity and monotonicity) that led to risk measure coherency:

- translation invariance $\rho(X + \alpha \cdot r) = \rho(X) - \alpha$,
- subadditivity $\rho(X_1 + X_2) \leq \rho(X_1) + \rho(X_2)$,
- positive homogeneity $\rho(\lambda X) = \lambda \rho(X)$,
- monotonicity $If\ X \leq Y, then\ \rho(Y) \leq \rho(X)$.

Britten-Jones and Schaefer [1999] developed Quadratic Value at Risk measures (aka delta-gamma models) to relax the assumption of linearity between portfolio and risk factors [see also Wilson 1999; Duffie and Pan 2001]. Blanco and Blomstrom [1999] discussed applying the VaR methodology to effectively set position and trading limits for businesses with commodity portfolios. Rockafeller and Uryasev [2000] argued that when using the nonparametric method in risk assessment, it is more useful to optimize portfolio risk using expected tail loss rather than Value at Risk. Glasserman et al. [2000] improved VaR method with a portfolio heavy-tailed distribution of risk factors by using multivariate *t* distributions. Hallerbach and Menkveld [2004] proposed a wider perspective on VaR and suggested implying multiple market risks. There were cases where some companies experienced interim losses but ended up above VaR therefore some VaR revisions were needed. Boudoukh et al. [2004] came up with the MaxVaR proposition to alleviate this problem. They revised the definition of VaR by capturing the worst losses during the horizon and using continuous observation. They argued the difference between MaxVaR and VaR might exceed 40%. Brummelhuis and Kaufmann [2007] proved the validity of $\sqrt{10}$ rule to predict unconditional 10-day VaR at the 99% confidence level even in a small data set by using AR(1)-GARCH(1,1) return processes without autoregressive effects that would be too large in returns. Cuoco, He and Isaenko [2008] proved that if VaR was recomputed dynamically then risk implied in VaR would be lower than the market.

Another stream of VaR development came with Conditional Value at Risk (CVaR) which was introduced by Embrechts, Klüppelberg and Mikosch [1997], Artzner et al. [1997; 1999], Basak and Shapiro [2001] and Longin [2001]. They argued that VaR may incur excessive risk-taking and proposed an improvement by averaging VaRs. This approach was termed alternatively as Accumulated (Average) VaR (AVaR), Expected Tail Loss (ETL) or Expected Shortfall. CVaR was then improved by Rockafellar and Uryasev [2000] who argued that for nonparametric losses of portfolio CVaR yielded better results in optimizing portfolio than VaR. They offered a technique for calculating VaR and optimizing CVaR simultaneously. Acerbi and Tache [2001] proved that CVaR satisfied the four axioms of risk measure coherency within the framework proposed by Artzner et al. [1999]. In particular, it met the subadditivity axiom in opposition to VaR [see: Beder 1995; Artzner et al. 1999]. Alexander and Baptista [2004] proved the superiority of CVaR over VaR except for the absence of a risk-free asset. In summary, CVaR gained particular interest among insurance companies [Embrechts et al. 1997].

In previous approaches to risk, VaR assumed homoscedasticity of standard deviations of returns that encouraged Engle and Manganelli [2004] to introduce the Conditional Autoregressive Value at Risk (CAViaR). CAViaR assumed the evolution of the quantile over time (heteroskedasticity). They based their model on an autoregressive process and estimated the parameters with regression quantiles (Generalized Autoregressive Conditional Heteroskedasticity − GARCH). Instead of modeling the whole distribution, they focused on modeling quantiles.

The Monte Carlo method with multivariate distribution to estimate and simulate risk factor was also employed in the practice of Value at Risk. It was based on the variance/covariance method with improvements in simulating risk factors instead of computing variances and covariances [Jamshidian and Zhu 1997; Picoult 1999; Shaw 1999]. This method solved non-linearity approximation with not significant errors.

Value at Risk was also based on historical distribution as introduced by Boudoukh et al. [1998] and Barone-Adesi et al. [1998; 1999]. The main advantage of historical distribution was pure reliance on historical observations without making any parametric assumptions about distributions. It meant that evolution and complexities of risk factors were captured directly from historical data without following any linearity assumptions. VaR was estimated by rebalancing daily returns that might be further scaled to any given horizon. The historical VaR gained a predominant implementation in banks [Hendricks 1996; Perignon, Smith 2010] because a data-intensive requirement might cause problems with its accuracy [Pritsker 2006]. Taylor [2005] underlined the forward-looking nature of VaR and Hendricks [1996] argued that historical simulation captures risk accurately under normal distribution conditions but remained weak with capturing extreme events.

The importance of VaR and its accurate results may not be observed thus some emphasized the verification process termed as backtesting [e.g. Basel Committee 1996; Kupiec 1995; Lopez 1998; Yamai, Yoshiba 2002]. Backtesting is an ex-post comparison of the risk measure predicted by VaR with factual data. Kupiec [1995] offered a vastly used model based on a comparison of observed and predicted violation rates.

This section outlined the variety of approaches to VaR that demonstrated an immense interest in risk measure developments. In the next section, we focused on some selected methodologies to find out if family-owned companies would bear more risk than nonfamily peers by using the data retrieved from the Warsaw Stock Exchange.

3. Methodology

The concept of Value at Risk seems quite easy to comprehend, but the computation is quite challenging as it requires a vast amount of data to process. Alexander [2008, p. 141] stated that around three-quarters of banks preferred to use historical simulation rather than the parametric linear or Monte Carlo VaR methodologies according to the data from the recent survey. It seems to be evident because in portfolios with a high quantity of data that banks undoubtedly possess, the central limit theorem may be applied in assessing risk as well as other parameters. Another research effectuated by Perignon and Smith [2006] showed that 73% of firms surveyed had reported the use of historical simulation (out of 64.9% of firms that disclosed their methodology). The dominance of historical VaR prompted us to use this methodology as the first choice to analyze the risk of family versus nonfamily firms. We also decided to use parametric methods to verify if normal distribution of securities would hold at the Warsaw Stock Exchange. In general, we wanted to find out whether family firms bore higher risk than non-family firms in given investment horizons.

3.1. Data description

The data for risk computation was retrieved from the Warsaw Stock exchange. In particular, we analyzed 24 firms that belong to the Warsaw Stock Exchange Construction Index (WIG-Construction). We screened out definitions of family firms and selected the one that was referred to most as suitable for public family firms, i.e. Villalonga and Amit [2006]. This definition assumes a family firm that possesses “a minimum control threshold of 20% of the votes, being the largest shareholder or voteholder, having family officers or directors, or being in second or later generation". By applying this definition we retrieved the following family firms:

Table 1. WIG-Construction portfolio in PLN (family-controlled firms in italics)

Company	Market Cap		Family	
	Market Cap	%	Shares %	Votes %
Budimex	1,303,762,250	36.62%	-	-
Elektrobudowa	498,435,000	14.00%	-	-
Trakcja PRKII	322,712,640	9.06%	-	-
Mostostal Zabrze	190,973,650	5.36%	-	-
Erbud	163,726,800	4.60%	-	-
Polimex-Mostostal	134,416,620	3.78%	-	-
Ulma-Construccion Polska	121,458,400	3.41%	-	-
Instal Kraków	117,900,450	3.31%	-	-
Unibep	*101,347,200*	*2.85%*	*26.98% ** * *17.83%*	*26.98%* *17.83%*
P.A. Nova	*94,367,000*	*2.65%*	*18.19%* *9.13%*	*20.80%* *10.88%*
Prochem	66,588,900	1.87%	-	-
Mirbud	*63,918,020*	*1.80%*	*43.19%*	*43.19%;*
Herkules	*62,118,000*	*1.74%*	*18.99%*	*18.99%;* *93.31% ***
Elektrotim	61,625,740	1.73%	-	-
ZUE	*58,560,000*	*1.64%*	*72.75%* *0.01%*	*72.75%* *0.01%*
Projprzem	50,534,820	1.42%	-	-
Mostostal Warszawa	39,325,140	1.10%	-	-
Centrum Nowoczesnych Technologii	34,203,650	0.96%	-	-
Tesgas	*20,029,750*	*0.56%*	*40.58%*	*55.66%*
Mostostal Płock	14,261,400	0.40%	-	-
Energoaparatura	13,069,400	0.37%	-	-
Bipromet	12,009,900	0.34%	-	-
Mostostal Export	7,941,450	0.22%	-	-
Awbud	7,413,450	0.21%	-	-
Non-family cap	3,160,359,660	88.76%	-	-
Family-controlled cap	400,339,970	11.24%	-	-
TOTAL CAP	3,560,699,630	100.00%	-	-

* two owning families, ** % in the Extraordinary General Meeting.

Source: [Lipiec 2014, p. 272].

In the next step, the data was aggregated to compose two portfolios with a weighted average of continuously compounded returns (Equation 1) and variances (Equation 2) by using the following matrices:

$$R_p = [w_1, w_2, ..., w_n] \begin{bmatrix} R_1 \\ R_2 \\ \vdots \\ R_n \end{bmatrix}$$

where R_p − Rate of Return of the portfolio; w_n – weight of the asset n, R_n − Rate of Return of the asset n. The portfolio variance $\left(\sigma_p^2\right)$ calculates as (Equation 2):

$$\sigma_p^2 = [w_1, w_2, ..., w_n] \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{1n} \\ \vdots & \vdots & \vdots \\ \sigma_{n1} & \sigma_{n2} & \sigma_n^2 \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix}$$

or in a more convenient notation (Equation 3):

$$\sigma_p^2 = w'\Sigma w$$

where: w' − transposed matrix and Σ – covariance matrix.

Then both these portfolios were divided into three time series to exhibit the risk approach of public companies taking into account the most recent crisis: (1) 2006--2007 with 2 family firms and 16 nonfamily firms, (2) 2008-2009 with 5 family firms vs. 18 nonfamily firms and (3) 2010-2012 with 6 family firms vs. 18 nonfamily firms.

3.2. Methodology and results

As outlined in the introduction, Value at Risk yields the worst expected loss on the market over a given time interval and confidence level. Therefore VaR has two basic characteristics: (1) confidence level and (2) time interval measured in trading days (not in calendar days). Confidence level describes the risk attitude of firm. In other words, the higher the confidence level (or lower significance level) the more the firm exhibits a conservative approach toward risk management. This means that a firm is focused on hedging against risk. In this respect banks are the most conservative users of VaR as they apply 99% confidence level according to the recommendation of Basel Accord. Time interval denotes the period of exposure to the loss (10 days under the Basel Accord). As a general principle, the more liquid the assets the shorter time interval should be applied. However, during turbulent times markets become less liquid and time interval increases, say to 10 days or more. In addition, lower liquidity may also mean capital allocation needs. Thus the time interval should even be extended into months.

Value at Risk measurement seems to be a simple concept but challenging in statistics due to its future prediction conditional on current information and changing distribution of returns. In particular, the challenge is to predict a movement of quantiles while VaR only informs about the point of downside risk without anticipating the amount of loss. To quantify Value at Risk we set out with Fishburn [1977] who proposed *α-t* model that described the class of mean-risk models (Equation 4):

$$F_{\alpha}\left(t\right)=\int_{-\infty}^{t}\left(t-x\right)^{\alpha}dF\left(x\right)$$

where: t − a specified target return, α – risk approach.

This model captures special cases of risk methods when particular parameters are used: Roy's Safety-First with Fishburn's $\alpha \rightarrow 0$ [1952], Domar and Musgrave's [1944] risk measure with $\alpha = 1$ and Markowitz's [1959] semi-variance risk measure with $\alpha = 2$. The variability of the risk factors may be reflected in the following equation (Equation 5):

$$P(Loss > VaR) \leq 1-\alpha\ ;\ c=\int_{VaR}^{\infty} f(x)dx \text{ or equivalently, } 1-c=\int_{-\infty}^{-VaR} f(x)dx$$

where c denotes a confidence interval and $f(x)$ the probability distribution of a portfolio. In the case of normally distributed returns, Equation 5 may be adjusted for the portfolio P as follows (Equation 6):

$$1-c=\int_{-\infty}^{-VaR}\frac{1}{\sigma_{p}\sqrt{2\pi}}e^{-(x-\mu_{p})^{2}/2\sigma_{p}^{2}}dx\,.$$

Next, we verified the data for normal distribution by using Jarque-Berra test. When returns follow the distribution $X \sim N(\mu,\sigma^2)$ then Equation 6 may be transformed to calculate VaR as follows (Equation 7):

$$P\left(Loss < -VaR\right)=P\left(Z<\frac{-VaR-\mu_{p}}{\sigma_{p}}\right)=\alpha.$$

Because $P\left(Z<\Phi^{-1}\left(\alpha\right)\right)=\alpha$ then (Equation 8)

$$\frac{-VaR-\mu_{p}}{\sigma_{p}}=\Phi^{-1}\left(\alpha\right).$$

Due to the symmetry of the standard normal distribution $\Phi^{-1}\left(\alpha\right)=-\Phi^{-1}\left(1-\alpha\right)$, we arrive at (Equation 9):

$$VaR=-\sigma_{p}\Phi^{-1}\left(1-\alpha\right)+\mu_{p}.$$

In a short horizon the mean may be skipped thus by adjusting Equation 9 and employing time horizon projection, the revised formula for VaR is as follows (Equation 10):

$$VaR=-\sigma_{p}\Phi^{-1}\left(1-\alpha\right)\sqrt{\Delta t}.$$

where σ_p is calculated by using Equation 3.

In addition to measuring Value at Risk in family and nonfamily portfolios, we were interested in analyzing the amount of the loss after surpassing VaR by both portfolios. As mentioned in the Literature review section, Value at Risk does not comply with the subadditivity formulated by Artzner et al. [1999] while Conditional Value at Risk does. *CVaR* would also be more informative about capital allocation and regulatory compliance. Thus we used *CVaR* to compare the risk approach of two populations. We used the following formula of CVaR (Equation 11):

$$CVaR = -E(X|X < -VaR)$$

and (Equation 12):

$$CVaR = -\alpha^{-1} \int_{-\infty}^{-VaR} xf\left(x\right)dx$$

and by using a standard normal density function X~N(μ,σ^2) CVaR equals (Equation 13):

$$CVaR = \alpha^{-1}\varphi\left(\Phi^{-1}\left(\alpha\right)\right)\sigma_p - \mu_p.$$

To calculate VaR and CVaR of family and nonfamily firms at Warsaw Stock Exchange, we used log-normally distributed returns. The results were provided in percentages and termed as the relative VaR [see Wong et al. 2003]. In our case, the relative VaR represents the percentages of portfolio values that may be lost after one and ten days with given probabilities. As short time analyses make VaR sensitive to abnormal results, some institutions recommended analyzing at least one-year periods [e.g. Finansinspektionens författningssamling 2004]. We truncated historical data according to this recommendation. In addition, we intended to reflect different return conditions, i.e. sensitivity to the recent economic crisis. Therefore, we used two two-year periods and one three-year period after the crisis. Next, we used the data to calculate risk exposure of family firms vs. non family firms by using historical VaR, Parametric and Conditional Value at Risk. Our intention was to verify the accuracy of parametric methods. We used 1-day and 10-day horizons to exhibit the difference of securities to be liquidated immediately and with a 10-day delay. We also used four confidence levels to find out about the risk attitude of firms, i.e. we were interested in knowing if they had followed the conservative attitude toward risk (α=0.1%) or a more liberal one (α = 10%).

In the two-year period before the most recent crisis hit, the portfolio of family firms exhibited lower risk by around 30-40% than their nonfamily peers with almost all analyzed confidence levels. Only at 1% confidence level was the difference lower by around 4%.

During the crisis period, family firms were more risky than nonfamily peers with the highest difference of almost 170% at α=0.1%. The differences at remaining confidence levels were significantly lower. However, family firms were still by 10-17% riskier. In the after-crisis period, risk was unevenly distributed: family firms

Table 2. Historical Value at Risk with 1-day horizon

	2006-2007		2008-2009		2010-2012	
α	*FF*	*NFF*	*FF*	*NFF*	*FF*	*NFF*
0.1%	7.71%	13.34%	17.41%	6.44%	6.44%	9.47%
1%	4.24%	4.39%	4.74%	4.05%	4.49%	4.45%
5%	1.98%	2.69%	3.16%	2.75%	2.17%	2.35%
10%	1.35%	1.97%	2.05%	1.90%	1.61%	1.47%

Source: author's own.

were less risky at α=0.1% and α=5% and more risky at the two remaining levels. However, the differences were minor except for α=0.1% where family firms were outstandingly less risky than their nonfamily counterparts by 32%.

Next, we compared the risk attitude of the two portfolios by using parametric Value at Risk. The parametric VaR yielded the relative risk higher for family firms than their nonfamily peers by around 19% on average (see Table 3). We also calculated differences between portfolios of family firms and nonfamily firms and the individual returns of all firms. In other words, we wanted to know how much an investor would have gained if s(he) had invested in buying all the securities falling within each portfolio and we had compared these results with all these securities if they had been bought separately by individuals. The advantage of the portfolio averaged 1-6%.

Table 3. Parametric Value at Risk with 1-day horizon

2006-2007								
α	0.1%		1%		5%		10%	
	FF	*NFF*	*FF*	*NFF*	*FF*	*NFF*	*FF*	*NFF*
Portfolio	7.80%	6.57%	5.87%	4.95%	4.15%	3.50%	3.23%	2.72%
Individual	9.77%	11.47%	7.35%	8.63%	5.20%	6.10%	4.05%	4.76%
Diff.	1.97%	4.90%	1.48%	3.69%	1.05%	2.61%	0.82%	2.03%
2008-2009								
α	0.1%		1%		5%		10%	
	FF	*NFF*	*FF*	*NFF*	*FF*	*NFF*	*FF*	*NFF*
Portfolio	7.09%	4.96%	5.33%	3.74%	3.77%	2.64%	2.94%	2.06%
Individual	12.50%	8.18%	9.41%	6.16%	6.66%	4.36%	5.19%	3.39%
Diff.	5.42%	3.22%	4.08%	2.43%	2.88%	1.71%	2.25%	1.34%
2010-2012								
α	0.1%		1%		5%		10%	
	FF	*NFF*	*FF*	*NFF*	*FF*	*NFF*	*FF*	*NFF*
Portfolio	5.13%	4.27%	3.86%	3.22%	2.73%	2.27%	2.13%	1.77%
Individual	9.86%	7.49%	7.42%	5.64%	5.25%	3.99%	4.09%	3.11%
Diff.	4.73%	3.22%	3.56%	2.43%	2.52%	1.71%	1.96%	1.34%

Source: author's own.

When comparing the results obtained by using historical VaR vs. parametric VaR, we observed no pattern (see Table 4). For example during 2006-2007, the parametric VaR overestimated historical results for family firms where the difference was larger for higher confidence levels (at α = 10% the difference amounted to 140%). On the other hand, we observed the underestimation of parametric VaR for nonfamily firms for the period between 2008 and 2012 except for α = 10%.

Table 4. The difference between Historical and Parametric VaR with 1-day horizon

	2006-2007		2008-2009		2010-2012	
α	*FF*	*NFF*	*FF*	*NFF*	*FF*	*NFF*
0.1%	1.17%	-50.75%	-59.28%	-22.98%	-20.34%	-54.91%
1%	38.44%	12.76%	12.45%	-7.65%	-14.03%	-27.64%
5%	109.60%	30.11%	19.30%	-4.00%	25.81%	-3.40%
10%	139.26%	38.07%	43.41%	8.42%	32.30%	20.41%

Source: author's own.

In addition, we intended to observe the risk attitude of the portfolios with a 10-day liquidation period as recommended in the Basel Accord. In other words, we wanted to know how the firms would have behaved if they had been less liquid. If the firms had been exposed to higher risk and encountered problems with liquidating their assets, then the family firms would have been better off by 3%-7% during the period from 2006 to 2007 (Table 5).

Table 5. Historical Value at Risk with 10-day horizon

	2006-2007		2008-2009		2010-2012	
α	*FF*	*NFF*	*FF*	*NFF*	*FF*	*NFF*
0.1%	16.19%	22.78%	34.04%	21.86%	25.29%	23.77%
1%	13.67%	20.13%	30.99%	17.17%	18.32%	16.76%
5%	8.29%	11.98%	11.87%	12.06%	9.44%	8.79%
10%	5.23%	8.21%	8.55%	8.13%	6.77%	6.91%

Source: author's own.

During the remaining periods, these differences were minor except for the crisis period. In the crisis, the family firms with the more conservative risk attitude lost around 13% more than their nonfamily peers.

In the next step, we compared parametric 10-day VaR by adjusting returns by ten days and using the scaling factor as the comparison. We wanted to know if the scaling factor might be used to predict VaR (Table 6).

We observed that the scaling factor exhibited similar patterns for both portfolios. In the case of family firms, the scaling factor underestimated the historical VaR by

Table 6. Parametric 10-day Value at Risk with return adjustment and scaling

2006-2007						
	Family Firms			Nonfamily Firms		
	Adjusted	*Scaled*	*Diff.*	*Adjusted*	*Scaled*	*Diff.*
α = 0.1%	29.10%	24.67%	-15.22%	24.82%	20.78%	-16.28%
α = 1%	21.91%	18.56%	-15.29%	18.69%	15.65%	-16.27%
α = 5%	15.49%	13.12%	-15.30%	13.21%	11.07%	-16.20%
α = 10%	12.07%	10.21%	-15.41%	10.29%	8.60%	-16.42%
2008-2009						
	Family Firms			Nonfamily Firms		
	Adjusted	*Scaled*	*Diff.*	*Adjusted*	*Scaled*	*Diff.*
α = 0.1%	27.05%	22.42%	-17.12%	18.88%	15.68%	-16.95%
α = 1%	20.37%	16.85%	-17.28%	14.21%	11.83%	-16.75%
α = 5%	14.40%	11.92%	-17.22%	10.05%	8.35%	-16.92%
α = 10%	11.22%	9.30%	-17.11%	7.83%	6.51%	-16.86%
2010-2012						
	Family Firms			Nonfamily Firms		
	Adjusted	*Scaled*	*Diff.*	*Adjusted*	*Scaled*	*Diff.*
α = 0.1%	18.87%	16.22%	-14.04%	15.81%	13.50%	-14.61%
α = 1%	14.20%	12.21%	-14.01%	11.90%	10.18%	-14.45%
α = 5%	10.04%	8.63%	-14.04%	8.41%	7.18%	-14.63%
α = 10%	7.82%	6.74%	-13.81%	6.55%	5.60%	-14.50%

Source: author's own.

15.31% while for nonfamily firms by 16.29% during the period from 2006 to 2007. In the crisis, the scaling factor overestimated the historical VaR by 17.18% in the family firms and by 16.87% in the nonfamily firms. In the after-crisis period, the overestimation was lowest and amounted to 13.98% and 14.55% respectively.

Finally, we intended to investigate the amount of risk the firm would have been exposed to while exceeding VaR. In other words, we were interested in Conditional Value at Risk for both portfolios. The comparison was made with two horizons: 1-day and 10-day VaR. In addition, we calculated the weight of CVaR, i.e. its proportion to VaR (Table 7).

The Conditional Value at Risk exhibited a similar tendency throughout all the periods analyzed. The patterns were observed with respect to confidence levels. The loss beyond VaR equaled to around 9% more than VaR for α=0.1%, around 15% for α=1%, around 26% for α=5% and around 37% for α=10%. The same pattern was observed with 10-day CVaR (Table 8).

Table 7. Parametric VaR vs. CVaR with 1-day horizon

2006-2007								
α	0.1%		1%		5%		10%	
	FF	*NFF*	*FF*	*NFF*	*FF*	*NFF*	*FF*	*NFF*
VaR	7.80%	6.57%	5.87%	4.95%	4.15%	3.50%	3.23%	2.72%
CVaR	8.49%	7.16%	6.72%	5.67%	5.20%	4.39%	4.43%	3.73%
CVaR weight	*8.85%*	*8.98%*	*14.48%*	*14.55%*	*25.30%*	*25.43%*	*37.15%*	*37.13%*
2008-2009								
α	0.1%		1%		5%		10%	
	FF	*NFF*	*FF*	*NFF*	*FF*	*NFF*	*FF*	*NFF*
VaR	7.09%	4.96%	5.33%	3.74%	3.77%	2.64%	2.94%	2.06%
CVaR	7.72%	5.41%	6.11%	4.28%	4.73%	3.31%	4.02%	2.82%
CVaR weight	*8.89%*	*9.07%*	*14.63%*	*14.44%*	*25.46%*	*25.38%*	*36.73%*	*36.89%*
2010-2012								
α	0.1%		1%		5%		10%	
	FF	*NFF*	*FF*	*NFF*	*FF*	*NFF*	*FF*	*NFF*
VaR	5.13%	4.27%	3.86%	3.22%	2.73%	2.27%	2.13%	1.77%
CVaR	5.59%	4.66%	4.42%	3.69%	3.42%	2.85%	2.91%	2.43%
CVaR weight	*8.97%*	*9.13%*	*14.51%*	*14.60%*	*25.27%*	*25.55%*	*36.62%*	*37.29%*

Source: author's own.

Table 8. Parametric VaR vs. CVaR with 10-day horizon

2006-2007								
α	0.1%		1%		5%		10%	
	FF	*NFF*	*FF*	*NFF*	*FF*	*NFF*	*FF*	*NFF*
VaR	29.10%	24.82%	21.91%	18.69%	15.49%	13.21%	12.07%	10.29%
CVaR	31.71%	27.05%	25.10%	21.41%	19.43%	16.57%	16.53%	14.10%
CVaR weight	*8.97%*	*8.98%*	*14.56%*	*14.55%*	*25.44%*	*25.44%*	*36.95%*	*37.03%*
2008-2009								
α	0.1%		1%		5%		10%	
	FF	*NFF*	*FF*	*NFF*	*FF*	*NFF*	*FF*	*NFF*
VaR	27.05%	18.88%	20.37%	14.21%	14.40%	10.05%	11.22%	7.83%
CVaR	29.48%	20.57%	23.33%	16.28%	18.06%	12.60%	15.36%	10.72%
CVaR weight	*8.98%*	*8.95%*	*14.53%*	*14.57%*	*25.42%*	*25.37%*	*36.90%*	*36.91%*
2010-2012								
α	0.1%		1%		5%		10%	
	FF	*NFF*	*FF*	*NFF*	*FF*	*NFF*	*FF*	*NFF*
VaR	18.87%	15.81%	14.20%	11.90%	10.04%	8.41%	7.82%	6.55%
CVaR	20.56%	17.22%	16.27%	13.63%	12.59%	10.55%	10.71%	8.98%
CVaR weight	8.96%	8.92%	14.58%	14.54%	25.40%	25.45%	36.96%	37.10%

Source: author's own.

The CVaR weight provided relative adjustments to be employed when calculating the average losses beyond VaR. As a consequence, the more liberal the attitude toward risk a firm exhibits the more losses should be expected.

4. Conclusions

VaR was developed for normal distribution returns, but it may be also used in portfolios with asymmetric returns as argued by Jorion [1997b]: "A symmetric, normal approximation may be appropriate for large portfolios, in which independent sources of risk, by the law of large numbers, tend to create normal distributions". As a consequence, VaR is the versatile model that may be adapted by financiers depending on their firm's special characteristics. We set out this article with reference values recommended by the Basel Accord and also moved beyond them. Consequently, we used significance levels of 0.1%, 1%, 5% and 10% and 1-day and 10-day time intervals. In other words, we intended to investigate the risk that a firm may lose if it exhibits a risk-averse attitude (more capital needed thus higher confidence level employed) or a risk-taker attitude (less capital needed thus lower confidence level employed). In addition, we analyzed the risk an investor may incur while investing in a portfolio of family firms and nonfamily firms. We analyzed the risk attitude of family firms and their nonfamily peers by analyzing the construction portfolio retrieved from the Warsaw Stock Exchange during the period from 2006 to 2012. The Value at Risk was calculated by using the historical and parametric method. In general, family firms proved to be less risky than their nonfamily counterparts when using historical simulation. The difference was evident in the period from 2006 to 2007 before the most recent crisis hit. A similar risk pattern was observed both for 1-day and 10-day VaRs. It means that if securities of family firms are either liquid or face some market troubles, they are less risky than their nonfamily peers. VaR for family firms was lower by average 40% (47% for 10-day horizon) than for nonfamily firms during the period 2007-2007, higher by average 25% (respectively 21%) during the crisis and lower by 12% after the crisis (higher by 5% for 10-day horizon). The only different tendency was observed in the after crisis period for the 10-day horizon. A better performance of family firms was reported either in conservative or liberal attitudes.

When measuring risk by using parametric methods, family firms were exposed to higher risk than nonfamily firms. The risk exposure was deepest during the crisis times and amounted to around 30% higher than for nonfamily firms. In the period before the crisis this difference was higher by 16% and after the crisis by 17%. Therefore, it seems that family firms in the construction portfolio are riskier than their nonfamily peers where risk may double during crisis times. Investors may reduce risk on average by 1-6% when investing in all the securities of selected portfolio. The reduction does not exhibit any tendency and depends on the specific returns of a period.

We also calculated the Conditional Value at Risk to measure the average size of the loss of these two portfolios when VaR was exceeded. On the downside, the average loss beyond Value at Risk measured by the Conditional Value at Risk should be corrected by using as a base the Value at Risk adjusted by around 9% for α=0.1%, 15% for α=1%, 26% for α=5% and 37% for α=10%. This correction works both for 1-day and 10-day horizons.

In addition, we compared the accuracy of the time aggregation rule. In general, the scaling factor is not sensitive to confidence levels for both portfolios and underestimates the historical results by 14%-15%.

The overall results when using the parametric method may be limited due to the reliance on the assumption of i.i.d returns. In addition, parametric VaR does not capture volatility clustering. It seems that there is no tendency between historical and parametric VaR. During some periods, family firms may exhibit similar results with the parametric method but in majority periods, and with different confidence levels, the results do not yield comparable results. This may stem from assuming normal return distribution that is not supported in returns. In this case, it would be recommended to rely on historical VaR as the preferred method indicated by banks. On the other hand, a forward-looking approach based on historical data may not prove adequate even with abundant data. This calls for frequent data re-estimation by using more advanced models, e.g. The Monte Carlo which requires enormous simulations or the GARCH model.

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