Wyższa Szkoła Bankowa
we Wrocławiu

The Wroclaw School of Banking
RESEARCH JOURNAL

On conformance of legal merger duration with Burr type III and XII distribution

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Abstract

We consider the concept of a legal merger process definition as an element of its transaction phase. The legal merger duration definitions are presented together with the system of Burr probability distributions as a part of stable heavy-tailed probability distribution family. A characteristics and reasons of choosing Burr distributions of type III and XII are presented too as well as the data collected about Polish merger process market. Finally, statistical reasoning for obtained results and some conclusions and suggestions for future research are presented in the paper.

Introduction

Merger of two or more companies is very complex process which consists of many stages occurring subsequently. In the first preliminary phase the potential acquiring company needs to decide if it should concentrate on internal or external economic growth. If it chooses to move towards the external one, the next step would be to determine a list of target companies which exist on the market. The further actions within this phase are concentrated around the analysis of the chosen target candidates, seeking the potential economic synergies and sometimes hiring experienced external merger consultants. Once that is done and the list of target companies is shortened to few entities which business models are the most attractive, acquiring company representatives can start establishing contacts which allow assessing if the potential counterparts in the transaction are interested in merger. Then the buyer company needs to choose the best merging option(s) and start preparing the schedule of the next phase. Very often, some formal written agreement is stipulated between entities to confirm formally their interest in merging. In majority of cases this document is signed in the form of a letter of intent or investment agreement.

Existing literature often does not make a distinction between merger process and acquisition process and as a consequence analyse them conjointly. That is not only the case for Iannotta (2010: 117-140), but also for DePamphlis (2005: 131-252), Frąckowiak (2009: 49-51) and Reed et al. (2007: 1-784).

The analysis presented in this paper is devoted to the legal consolidation phase duration. The research in this area is still not very broad and concentrates around two streams.

The first stream treats merger and acquisition duration as a measure characterizing market for corporate control in a given country or region. European market is described by Campa and Moschieri (2008: 22-23), while United States is chosen for the analysis by Netter et al. (2011: 2341-2342). Furthermore, the latter region is analysed by Branch and Yang (2003: 7-9). Their research is especially interesting in the context of this article as they do not take into

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consideration acquisition transactions and briefly summarize the merger duration trends in the United States between 1991 and 2000.

The second stream tries to determine the factors which have influence on the merger and acquisition duration. Dikova et al. (2006: 1-6; 2010: 223-245) check the effect of formal and informal institutional differences as well as merging companies transaction completion and failure past experience on the transaction duration in the international business service industry. Deng et al. (2013: 100-102) decide to analyse the influence of the corporate social responsibility on the merger duration in United States between 1992 and 2007. In turn, Ekelund et al. (2001: 535-537) assess if there is a difference in merger duration between regulated and unregulated industries taking into consideration the level of their concentration. In addition, all the authors decided to include in their models control variables related to the transaction characteristics, e.g. deal size, payment type, tender offer dummy or hostile dummy. The influence of these kinds of factors was also assessed by Campa and Moschieri (2008: 22-23).

The article is set up as follows. The next section outlines the concept of a legal merger process definition. We also consider the concept of a legal merger process definition as an element of its transaction phase. Section 2 presents a legal merger duration definitions while section 3 presents the system of Burr probability distributions as a part of stable heavy-tailed probability distribution family. This section describes a characteristics and reasons of choosing Burr distributions of type III and XII. Section 4 presents the data collected about Polish merger process market. Section 5 presents statistical reasoning for obtained results. Finally, there are some conclusions and suggestions for future research.

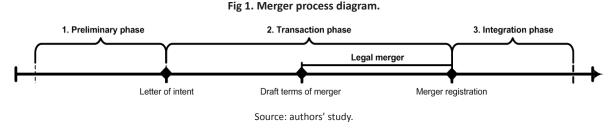## Legal merger process definition

After signing the agreement (mostly in the form of a letter of intent or investment agreement) the merger process steps into its transaction phase. This phase can be divided into two sub-phases: negotiations and legal consolidation. The former is initiated by the due diligence analysis focused on obtaining the complete picture of the company being acquired and assessing the magnitude of all kind of different risk drivers which are incorporated into the transaction by gathering all the required no publicly available information about this company. After due diligence process, the negotiation sub-phase enters into its defining stage in which the joint valuation of merging entities is prepared and all the important merger characteristics are determined: price, stock exchange ratio, merger type (takeover or formulation of a new company), financing to mention the most important ones. Often the negotiation phase ends in a formal way by signing the official document known as draft terms of merger or a merger plan.

Then the transaction phase moves into its final legal consolidation sub-phase which ends once the merger process is registered (so called day of merger). The merger process ends with the integration phase. In this period formally joined companies need to synchronize and optimize their organizational structure, corporate culture, human resources policy, investment strategy and many other important business areas. Without effective integration, expected economic synergy will not emerge. The potential reward of the merger will be lost then.

Fig. 1 summarizes the general timeline structure of the merger process.

The merger process described in the previous paragraphs was based on the following assumptions:

- In the preliminary phase the acquiring company do not cooperate with potential target companies;
- Transaction phase starts when the merging entities start to interact in order to reach the final agreement and complete the deal;
- Integration phase begins when the company or companies being acquired cease to exist and all the consolidation activities are performed again by the single entity.

Fig 1. Merger process diagram.

Source: authors' study.

In literature, the same merger process structure was presented by Herdan (2008: 29-46) and Zadora (2011: 217-263) except that due diligence analysis was classified as a part of pre-transaction (preliminary) phase. The former classifies negotiation phase as the period which starts right after the due diligence and lasts till the time all the legal merger requirements are fulfilled. In turn, the latter introduced the consolidation phase which covers all activities which take place once due diligence analysis is completed. The authors of this article understand due diligence as a process which involves all the counterparts of the transaction and as a result classify it as an initial part of the transaction phase.

The high level overview of the process presented in the fig. 1 can be easily extended to cover not only the mergers, but also to the majority of acquisitions. Iannotta (2010: 121) states that every transaction is unique but there are recurrent steps which are common for all the mergers and acquisitions. This is true when tender offers are not taken into consideration as their process is different from the other merger and acquisition techniques and highly dependent on the country jurisdiction of the entities involved. The main difference between mergers and acquisitions can be seen in their legal consolidation phase. In case of the merger, all the assets and liabilities of the companies being acquired are transferred to the acquiring or new company and the company itself ceases to exist. By contrast, acquisition cause that the ownership structure of the company being acquired changes depending on the percentage stake bought,
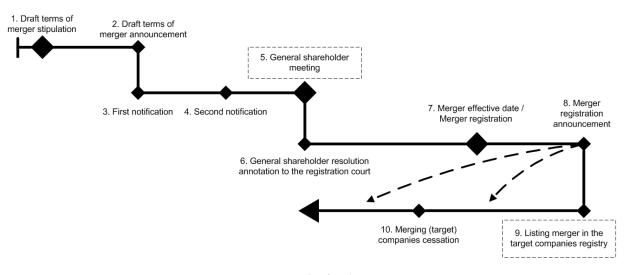
but the company still exists, at least from the legal point of view.

In case of Polish legislation *The Code of Commercial Partnerships and Companies* (2000: 127-144) regulates merger consolidation phase (so called legal merger) in the articles 491-527 which are a direct transposition of European Union directive 78/855/EEC of 9th October 1978 (1978: 36-43) and directive 2005/56/EC of 26th October 2005 (2005: 1-9). The former provides legal framework when joining companies are from the same country while the latter one regulates the process when such companies are from different countries. As the empirical part of this article concentrates solely on Polish market, the elements of intra-national legal merger will be presented in the next paragraphs.

Legal merger consolidation can be effected in the following two modes (*The Code of Commercial Partnerships and Companies* 2000: 128):

1. **Merger by takeover** – understood as transfer of all assets of a company or partnership (the target one) to another company (the bidding one) in exchange for the shares that the bidding company issues to the shareholders or partners of the target company or partnership;

2. **Merger by formation of a new company** – understood as formation of a company to which the assets of all merging companies or partnerships devolve in exchange for shares of the new company.

Both procedures differ in the way the assets are exchanged for the shares but they still have many common elements. They are presented in the order of appearance in the fig. 2.

Fig 2. Elements of legal merger procedure.

Source: authors' study.

Merger consolidation is initialized with the draft terms of merger document stipulation by the merging entities. This action should be then publicly announced in the *Journal of the Ministry of Justice* (*Act of 22 December 1995 on issuing the Journal of the Ministry of Justice* 1995: 3; *The Code of Commercial Partnerships and Companies* 2000: 131) at least one month before the (general) shareholders' meeting. What is more, the management boards of the merging companies should inform the shareholders twice (first and second notification) at the interval not shorter than two weeks about the planned merger. First notification should happen at least one month before the shareholders' meeting.

General meeting of each merging company is the core part of the legal merger process. Shareholders gather together in order to vote for the approval of the proposed draft terms. The approval is granted with the resolution of a shareholder's meeting(s) adopted by a three-fourths majority of votes which represent at least one half of the initial capital. It is possible that more stringent rules are applied if stated in the companies' memorandums of association (*The Code of Commercial Partnerships and Companies* 2000: 133). After the meeting, shareholder's resolution on the company merger should be reported to the registration court in the form of an annotation with an indication whether given company is the buying or target side of the transaction.

The effective day of merger happens on the day when the transaction is entered in the register competent for the seat of the bidding company or the newly formed one. This entry shall cause automatically that all target companies or companies forming a new company are dissolved without conducting liquidation proceedings. Before that merger transaction should be listed in their registries. At the same time, acquiring company or the newly formed one are responsible for the public announcement of the merger completion in the *Journal of the Ministry of Justice* (*Act of 22 December 1995 on issuing the Journal of the Ministry of Justice* 1995: 3; *The Code of Commercial Partnerships and Companies* 2000: 134).

The legal merger procedure presented in the fig. 2 can be simplified when the acquiring company is a private corporation and it possesses more than 90% of the target company initial capital (*The Code of Commercial Partnerships and Companies* 2000: 135-136). In this case the acquiring company shareholder's resolution on the merger is not need. However this resolution is still required from the shareholders of the target company.

Legal merger duration definition

Legal merger characteristics in Polish legislation presented in the previous section allows defining diverse frameworks for measuring its duration time. The analysis of the legal merger key elements has led the authors to propose the following definitions:

1. **Standard (full) legal merger duration** – as the time which elapses between draft terms of merger stipulation date and registration announcement date. This definition will be applied in the empirical part of this article (sections 4 and 5);
2. **Private legal merger duration** – as the difference between the registration date and the draft terms of merger stipulation date;
3. **Public legal merger duration** – as the difference between the registration announcement date and the draft terms of merger announcement date;
4. **Maximal legal merger duration** – as the time elapsing between the legal merger events (elements) which happened at the earliest and the latest. In this case draft terms of merger stipulation will be an initialization event. Most often, registration announcement or companies being acquired cessation from the registry events will be a completion event.

In the present literature legal merger time until completion is an economic phenomenon which is neither well defined nor investigated. Usually existing research (Campa and Moschieri 2008: 22-23; Deng et al. 2013: 100-102; Dikova et al. 2006: 1-6; Dikova et al. 2010: 223-245; Netter et al. 2011: 2341-2342) conducts similar analysis for the joint universe of mergers and acquisitions inheriting transaction duration definition from commercial data providers[1]. Thus, the transaction duration is measured as the time which elapses between the negotiations and transaction closure announcements in the public media. Such approach causes that on the single transaction level, calculated time may include different merger or acquisition phases depending on the information disclosure strategy assumed by the management boards of the merging entities.

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[1] Thomson Reuters SDC Platinium is the most common choice.

Burr system of distributions characteristics

The reason why we try to adopt Burr probability distribution to present duration of the legal merger process lies directly in the nature of time: it is positively valued and mostly distorted at the right end because of different nature of economical processes (and consequently merger process). In 1942 Irving Burr published „Cumulative Frequency Functions" article (Burr 1942: 215-232) in which he presented the new system of twelve continuous distributions that are usually referred by the number. Among them, the most popular one is type XII distribution often called simply as the Burr distribution[2]. Its probability density function is defined in the following way:

$$f(x) = \frac{\alpha \beta x^{\alpha-1}}{(1+x^\alpha)^{\beta+1}} \qquad (1)$$

Burr system of distributions contains one distribution closely related to the Burr type XII, namely the Burr type III[3]. It has very similar probability density function:

$$f(x) = \frac{\alpha \beta x^{\alpha\beta-1}}{(1+x^\alpha)^{\beta+1}} \qquad (2)$$

where $x > 0, \alpha > 0, \beta > 0$.

Burr type XII and type III distributions defined in the equations (1) and (2) are closely related to each other in the following way (Kleiber and Kotz 2003: 212; Kleiber 2008: 100):

$$X \sim BXII(\alpha, \beta) \Leftrightarrow \frac{1}{X} \sim BIII(\alpha, \beta) \qquad (3)$$

If a random variable X originates from Burr type XII distribution, then its inverse random variable follows Burr type III distribution. That is the

reason why the latter distribution is often known in the literature as inverse Burr distribution.

In general both distributions are the special cases of a Generalized Beta distribution of the second kind which probability density function is defined as (Kleiber and Kotz 2003: 184; Kleiber 2008: 100):

$$f(x) = \frac{a x^{ap-1}}{b^{ap} B(p,q)(1+(x/b)^a)^{p+q}} \qquad (4)$$

where $x > 0, a > 0, b > 0, p > 0, q > 0$

and $B(p,q) = \int_0^1 t^{p-1}(1-t)^{q-1} dt$ denotes Beta function.

Burr type III is Generalized Beta distribution of the second kind with shape q and scale b parameters equal to 1, whereas Burr type XII converges to this distribution when shape p and scale b parameters are equal to 1 (Kleiber and Kotz 2003: 198, 212; Kleiber 2008: 100):

$$GBII(a = \alpha, b = 1, p = \beta, q = 1) \equiv BIII(\alpha, \beta) \qquad (5)$$

$$GBII(a = \alpha, b = 1, p = 1, q = \beta) \equiv BXII(\alpha, \beta) \qquad (6)$$

Probability density functions of Burr type III and XII distributions from the equations (1) and (2) contain only two shape parameters α and β. When these functions are extended with an additional location μ and scale θ parameters, the following parameterizations are obtained:

$$f(x) = \frac{\alpha \beta \left(\frac{x-\mu}{\theta}\right)^{\alpha-1}}{\theta \left(1 + \left(\frac{x-\mu}{\theta}\right)^\alpha\right)^{\beta+1}} \qquad (7)$$

for Burr type XII and

$$f(x) = \frac{\alpha \beta \left(\frac{x-\mu}{\theta}\right)^{\alpha\beta-1}}{\theta \left(1 + \left(\frac{x-\mu}{\theta}\right)^\alpha\right)^{\beta+1}} \qquad (8)$$
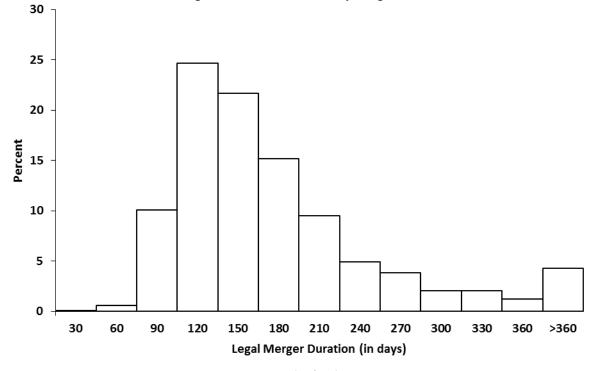
for Burr type III, where $x \geq \mu, \alpha > 0, \beta > 0$,

$\theta > 0$, and $\mu \in R$. When location parameter $\mu = 0$, then equations (7) and (8) simplify to the three parameter versions of these distributions. Till now in the literature Burr and Inverse Burr distributions have been mainly used in income and wealth analysis and in actuarial losses estimation (Kleiber and Kotz 2003: 197-222). In the empirical part of this article, it will be shown that they can be very useful when it comes to characterizing legal merger duration.

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[2] In the statistical literature, it is also known under the name of Singh-Maddala as it was rediscovered in 1976 by Singh and Maddala in the article „A Function for Size Distributions of Incomes" (Singh and Maddala 1976: 963-970).

[3] This distribution is less widely known, although it was rediscovered by Dagum in the article „A New Model for Personal Income Distribution: Specification and Estimation" (Dagum 1977: 413-437) only one year after the Singh and Maddala article. Kleiber and Kotz (2003: 212; 2008: 98) claim that the potential reason of the relative unpopularity comes from the fact that Dagum's work was published in the French journal „Economie Appliquée", while Singh and Maddala's paper was submitted in the more widely known English journal „Econometrica".

Fig 3. Standard duration monthly histogram

Source: authors' study.

Collected data on legal merger on Polish market

In the majority of cases *The Code of Commercial Partnerships and Companies* (2000: 131-134) states that the draft terms of merger stipulation as well as the merger registration need to be publicly announced. As mentioned before, these announcements are always posted in *The Journal of the Ministry of Justice* (*Act of 22 December 1995 on issuing the Journal of the Ministry of Justice* 1995: 3). Obligation of the announcement causes that this journal is the best available source of the information about mergers in Poland as it contains all the required announcements for a significant subset of the successful mergers[4].

The journal allowed collecting the information about **3683** merger transactions which have taken place in the period between **1st January 2002 and 31st December 2013**.

We have decided to use standard definition to measure legal merger duration. Duration measurement concordant with this definition was not possible for **910** transactions as a draft term of merger stipulation date was not available.

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[4] Please refer to *The Code of Commercial Partnerships and Companies* [03] for the announcement exceptions.

Histogram from the fig. 3 reveals that legal merger standard duration has a bell-shaped distribution with longer right tail indicating the positive skewness. Moreover, its distribution is leptokurtic as it has an acute peak near the mean and a fat right tail. It does not have many extreme observations, merger durations which are shorter than one month or longer than two years consist only 1.2% of the overall sample. From the other hand, the biggest percentage of the transactions equal to 24.6% takes from 90 to 120 days to complete.

The most popular measures of central tendency are mean, median and mode presented in the tables 1 and 2. In case of the standard duration mean is equal to 171 days while not surprisingly median is bit lower and equal to 140. 127 days is the most frequent time to merger transaction completion.

Skewness and kurtosis confirm conclusions about the distribution shape drawn from the histograms analysis. High and positive values indicate that standard duration is leptokurtic and has a heavy right tail.

By looking at the minimum it is visible that the analyzed data does not have any legal merger transaction with non-positive duration which complies with the expectation that draft terms of merger stipulation happens before registration announcement and confirms that the

Table 1. Descriptive statistics of duration time of merge process in Poland – Basic measures.

	N	Mean	Variance	Std dev	Mode	Skewness	Kurtosis
Standard legal merger duration	2773	170,593	15003,006	122,487	127	4,944	38,752

Source: authors' study.

Table 2. Descriptive statistics of duration time of merger process in Poland – Quantiles and related measures.

	Min	1st Quartile	Median	3rd Quartile	Max	IQ Range	Range
Standard legal merger duration	28	110	140	188	1933	78	1905

Source: authors' study.

Table 3. Distribution parameters.

Distribution	Parameters	Parameters			
		Location (μ)	Scale (θ)	Shape (α)	Shape (β)
Burr Type III (Dagum)	3	--	85.111 (4.749)	3.080 (0.071)	3.620 (0.455)
	4	39.614 (0.786)	79.398 (3.896)	2.517 (0.066)	1.570 (0.139)
Burr Type XII (Singh-Maddala)	3	--	109.409 (1.773)	6.187 (0.231)	0.410 (0.025)
	4	58.419 (0.236)	86.721 (4.019)	2.216 (0.064)	1.053 (0.068)

Source: authors' study.

collected data is of the high quality. The shortest transaction took only 28 days to complete while the longest one took more than 5 years. Table 2 allows also to state that 50% of transactions lasted from 110 to 188 days.

Statistical evaluation of proposed probability distribution

Presence of high and positive skewness gives a good indication that Burr type III and XII distributions are a proper choice to model the legal merger duration process.

We estimate the parameters of the probability density functions from the equations (7) and (8) with and without the location parameter with the use of Maximum Likelihood Method.

Let y_i for $i = 1, ..., N$ denote the sample of N values of the standard legal merger duration variable. If Ω is a following set: $\{\alpha, \beta, \theta, \mu\}$ and ω is a subset of Ω congruent with assumed probability density function parameterization, then the joint density function of independent and identically distributed sample is defined as:

$$L(\omega; y_1, ..., y_N) = \prod_{i=1}^{N} f(y_i|\omega)$$

(9)

Newton-Raphson Optimization with Line Search will be used to determine the parameter subset ω values for which the likelihood function L

from the equation (9) reaches its maximum if it exists. As all the calculations are performed with the use of SAS software and its native procedure SEVERITY, more information about the parameter estimation and optimization methods can be found in the documentation (SAS Institute Inc. 2011: 1519-1639).

Table 4 contains the results of the distributions parameters estimation. Standard errors are reported in the brackets. All parameters are significant - their standard errors are relatively small compared to the estimates.

It is worth taking a closer look at the location parameter estimates equal to 40 and 58 for Burr type III and XII distributions respectively. Their values can be interpreted as minimal amount of time needed to complete legal consolidation phase. These results are supported by the legal merger procedure construction which assumes that time interval between first notification and shareholders' meeting cannot be shorter than 30 days.

Fig. 4 shows how well the estimated Burr probability density curves fit to the empirical data. The level of conformance between considered Burr distributions and legal merger duration process will be determined through backtesting which verifies the following set of hypothesis:

$$H_0 : F_n(y) \in \hat{F}(y)$$

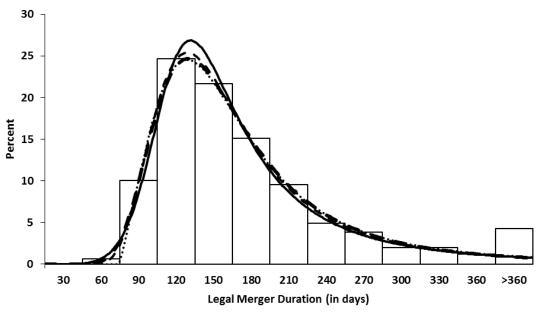$$H_A : F_n(y) \notin \hat{F}(y)$$

(10)

Fig 4. Standard duration monthly histogram with fitted density curves.

Source: authors' study.

where $F_n(x)$ is empirical cumulative density function and $\hat{F}(x)$ is the fitted theoretical cumulative density function of the considered distributions.

We decided to adopt three most popular measures of the distance between the empirical and hypothesized distributions, namely: **Kolmogorov-Smirnov** (KS), **Cramér-von Mises** (CvM) and **Anderson-Darling** (AD). They are computed in the following way:

$$KS = max\left(\max_i\left(F_n(y_i) - \hat{F}(y_i)\right),\right.$$

$$\left.\max_i\left(\hat{F}(y_i) - F_n(y_{i-1})\right)\right) \tag{11}$$

$$CvM = \frac{1}{12N} + \sum_{i=1}^{N}\left(\hat{F}(y_i) - F_n(y_i) - \frac{1}{2N}\right)^2 \tag{12}$$

$$AD = -N - 2\sum_{i=1}^{N}\left(\left(F_n(y_i) - \frac{1}{2N}\right)ln(\hat{F}(y_i)) +\right.$$

$$\left.+ \left(1 - F_n(y_i) + \frac{1}{2N}\right)ln\left(1 - \hat{F}(y_i)\right)\right) \tag{13}$$
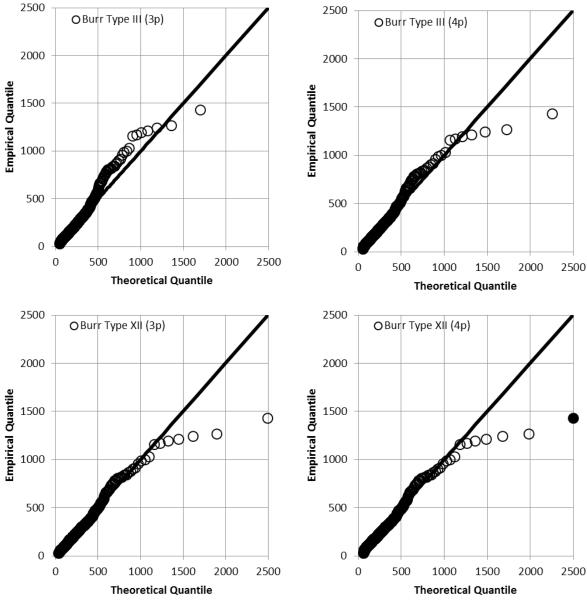
Since the parameters of the considered Burr distributions are estimated from the data, p-values need to be obtained from Monte Carlo simulations. We decided to use the algorithm proposed by Ross (2006: 227-230). The number of trials was set to 1000. 1% significance level was assumed when interpreting the results.

Table 4 presents the goodness of fit tests defined in the equations (11)-(13).

The tests reveal that the addition of location parameter increases significantly the quality of the fit. In this case Burr Type XII distribution passes all of them at 1% significance level, while Burr Type III distribution does not pass only the most conservative Anderson-Darling test. Location parameter omission causes that only for the Burr Type III distribution the null hypothesis is still not rejected for Kolmogorov-Smirnov measure. However, in this case the p-value is not much higher than significance level (1.8% against 1%).

Table 4. Goodness of fit tests.

Distribution	Parameters	Kolmogorov-Smirnov	Cramer-von Mises	Anderson-Darling
Burr Type III (Dagum)	3	0.017 (0.018)	0.194 (0.001)	8.889 (<0.001)
	4	0.016 (0.146)	0.088 (0.239)	8.278 (<0.001)
Burr Type XII (Singh-Maddala)	3	0.025 (<0.001)	0.170 (<0.001)	8.716 (<0.001)
	4	0.028 (0.334)	0.733 (0.287)	12.223 (0.066)

Source: authors' study.

Fig 5. Quantile-Quantile Plots.

Source: authors' study.

At this point question arises if the considered four parameters distributions are overfitted. The authors believe that the location parameter introduction makes sense from the economic point of view as in general legal merger procedure cannot last shorter than one month as there are inherent mandatory break intervals between its elements.

Fig. 5 presents Quantile – Quantile plots for considered distributions[5].

Plots confirm that Burr Type XII distribution with four parameters shows the best fit to the legal merger duration data. However, the remaining parameterizations of the Burr distribution still have acceptable quality of fit.

Conclusions

For Polish merger market it appears that the legal consolidation phase lasts for around 4.5 months (median is equal to 140 days) on average and three-fourths of the transactions close between 4 and 6.5 months (1st and 3rd quartile are equal to 110 and 188 days respectively). It is worth noting that these results were

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[5] Quantile – Quantile plot for Burr Type XII distribution with location parameter contains black point which original value is equal to 2650 days but for illustrative purposes it was located at the level of 2500 days.

obtained on the data which directly comes from the *Journal of the Ministry of Justice*. This implicates that the research and the results are based on the high quality data which is fully concordant with the assumed standard definition of the legal merger duration. Thereby the risk that the measured durations include partially other phases of the merger process (negotiation or integration phase) is minimized.

Empirical part of the article revealed that legal merger standard duration has bell shaped distribution with positive skewness and high kurtosis. That is the reason why we have decided to model this process with the use of Burr type III and XII distributions. Estimated 3 and 4 parameters density curves show a decent fit to the empirical data. According to the goodness of fit tests, the best fit is obtained with Burr type XII distribution with additional location parameter.

Thereby, the article extends Burr distributions application in the economic domain beyond the actuarial losses modelling and income and wealth analysis.

Legal merger duration is a phenomenon which is still not well investigated in the scientific literature. We believe that the future research should be concentrated on assessing how different measurement definitions and economic factors influence legal merger time to completion. As this process has highly non-normal distribution, the proper choice of the statistical techniques to conduct this assessment can be seen as a separate research problem.

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