Dividend Payout Ratio Follows a Tweedie Distribution: International Evidence

Victor Dragotă, Daniel Traian Pele and Hanaan Yaseen

Abstract

Dividend policy is still a largely discussed issue in corporate finance literature. One of the main indicators used in analysing the dividend policy is the dividend payout ratio. Using a database consisting of 12,085 companies operating in 73 countries, for the period 2008-2014, we found that the dividend payout ratio follows a Tweedie distribution, and not a normal one. This distribution is stable over time for the entire analysed period. In addition, it describes the case of almost all the countries included in the sample. Thus, a better estimation of the probability that dividend payout ratio is lower or higher than a benchmark can be provided. Also, an analysis of dividend policy, distinctly considering payer versus non-payer companies, can offer additional important information for both practitioners and academics.

JEL Codes: G35, C01, C51, C55

Keywords dividend policy; dividend payout ratio; Tweedie distribution

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1 Introduction

Corporate finance literature discusses dividend policy from different perspectives (Lintner 1956, Miller and Modigliani 1961, Bhattacharya 1979, Easterbrook 1984, Holder et al. 1998, La Porta et al. 2000, Fama and French 2001, Fidrmuc and Jacob, 2010, Floyd et al, 2015, Jiang et al. 2017, etc.). Different viewpoints on dividend policy are contradictory, from its neutral impact on firms' value (Miller and Modigliani 1961) to normative advices to increase (Graham and Dodd 1951) or to decrease (Walter 1956) the amount paid to shareholders, or to explain this financial decision through agency problems, asymmetrical information, socio-cultural or institutional factors, etc. (Bhattacharya 1979, Easterbrook 1984, La Porta et al. 2000, Fidrmuc and Jacob 2010, etc.). Among them, the studies concerning the factors determining dividend policy are an important direction (see, among others, La Porta et al. 2000, Fidrmuc and Jacob 2010, Nicolosi 2013, Ye et al. 2019).

Different indicators are used for modelling dividend policy, each of them with its informative power. One of the most important is the dividend payout ratio (Holder et al. 1998, La Porta et al. 2000, Ye et al. 2019) (hereafter, DPR), respectively the part of the net earnings paid to shareholders, as dividends, considering the firms which record net profits (and excluding those which record losses)[1]. In a sense, DPR reflects exactly the interest expressed by one profitable company for paying dividends to its shareholders. Analysed for one period, a DPR equal to 100% reflects a totally dedicated policy to pay dividends to shareholders, and one of 0% a reflection of a non-interest to dividends (argued in many cases as the company's interest for investing). DPR is used in a large variety of studies, as dependent variable (e.g., Holder et al. 1998, La Porta et al. 2000, Faccio et al. 2001, Fidrmuc and Jacob 2010, Jiang et al. 2017, etc.), but also as explanatory variable in different contexts (e.g., Lintner 1956, Lamont 1998, Lettau and Ludvigson 2001, Arnott and Asness 2003, Cincotti et al 2010, Baker et al. 2012, He et al. 2017). In such studies, the average DPR is often considered representative, as in the case of a Gaussian distribution.

Many papers analyse the determining factors of DPR using a classical regression (e.g., La Porta et al. 2000, Fidrmuc and Jacob 2010, Jiang et al 2017). Other papers analyse the propensity to pay dividends[2] and its determinants (e.g., Denis and Osobov 2008, von Eije and Megginson 2008, Fatemi and Bildik 2012, Kuo et al. 2013, Banyi and Kahle 2014, Jiang et al 2017). One missing link between considering the averages DPR and the propensity to pay dividends in modelling dividend policy can be somehow intuited. DPR does not follow a normal distribution. Figure 1 depicts DPR distribution for a number of 12,085 companies from 73 countries, in the period 2008-2014. In this study, we show that this empirical distribution may be fitted at best by a Tweedie distribution (Tweedie 1984). Moreover, this distribution is

[1] DPR can be also calculated as ratio between dividend per share and earnings per share. This second expression is the most familiar for investors on capital market. At a macroeconomic level, Ferris et al. (2009) use in their analysis an aggregate DPR, respectively a ratio between the value of total dividends and the total earnings for a country.

[2] Denis and Osobov (2008) define the propensity to pay dividends, respectively the characteristic of one company to be a dividend payer or not. If DPR = 0, the company is a dividend payer. If DPR > 0, the company is not a dividend payer.

stable in time for the entire analysed period. In addition, it describes the case of almost all the countries included in the sample and the most part of the years (some more detailed statistics are provided in Appendix 1). As far as we know, finding the distribution for DPR is a new contribution for financial literature.

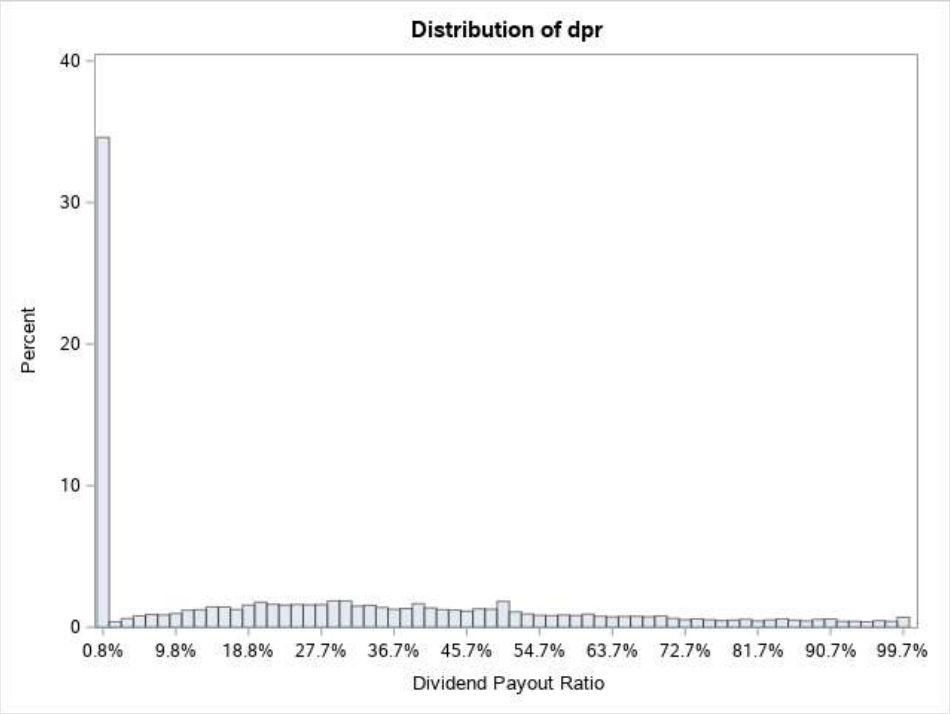


Figure 1: Dividend payout ratio for the companies included in the sample, in the period 2008-2014. All companies' financials were collected from the Thomson Research Worldscope database. DPR is computed as: $DPR = \frac{Dividends}{Net\ income}$.

The distribution depicted in Figure 1 suggests that dividend policy is mainly an issue of "to be or not to be" a dividend payer, some authors suggesting the decrease in dividend payments in time (Fama and French 2001, Fatemi and Bildik 2012, Kuo et al. 2013), which can be modelled through the propensity to pay dividends (Fama and French 2001, Denis and Osobov 2008, von Eije and Megginson 2008, Fatemi and Bildik 2012, Kuo et al. 2013, Banyi and Kahle 2014, Floyd et al. 2015, Jiang et al. 2017, etc.). As practical implication, a proper analysis of DPR should consider both components of the distribution – the 0 inflated component and the distribution for DPR > 0. However, as Figure 1 suggests, this is not a 0% / 100% dividend payout ratio policy! An analysis concerned only about the decision to pay or not to pay dividend can miss some important information.

The most appropriate distribution for modelling DPR is not the normal (Gaussian) one, but the less used Tweedie distribution, proposed by Maurice Tweedie (1984). Using a better fit for the distribution, a better estimation of the probability that the event to occur (e.g., DPR to be lower or higher than a benchmark) can be provided. This result can be useful for instance in the context of international portfolio management, especially if the investments are made in a large number of companies (with minority participations), and when forecasting of the future collected dividends is of interest.

One important contribution, comparative to previous research, is the large number of countries considered (73). For instance, the database used by La Porta et al. (2000) includes 33 countries, the one of Ferris et al. (2009) - 25, etc. Our sample is geographically diverse, including countries from Africa, North and South Americas, Asia, Australia, and Europe. From here, a large diversity regarding the cultural values, but also legal systems (our sample includes common law, but also civil law countries) can be noticed.

The remainder of our paper is structured as follows. Some related studies are discussed in Section 2. Section 3 presents the methodology. Section 4 describes the data. Section 5 presents and examine the results. In Section 6, we conclude.

2 Theoretical background. Modelling dividend policy through Dividend Payout Ratio

Different indicators are used for modelling dividend policy, in various contexts (see Table 1). Of course, each of these indicators expresses something else, but all of them can be used in analysing dividend policy. Two indicators are extensively used in studies on dividend policy, respectively dividend payout ratio (DPR) and the propensity to pay dividends (hereafter, PPD). They are somehow related, in the sense that PPD can be modelled as a particular case of DPR. Thus, PPD can be defined as: PPD = DPR if DPR = 0, and PPD = 1 if DPR > 0.

Table 1: Indicators used in modelling dividend policy

Indicator	**Studies**
Dividend payout ratio (dividend-to-earnings ratio)	Lintner (1956), Holder et al. (1998), La Porta et al. (2000), Faccio et al. (2001), Aivazian (2003), Renneboog and Trojanowski (2007), Fidrmuc and Jacob (2010), Fatemi and Bildik (2012), Floyd et al. (2015), He et al. (2017), Jiang et al. (2017), Chen et al. (2017), Dragotă and Yaseen (2019), Ye et al. (2019), Yaseen (2019)
Propensity to pay dividends (dummy variable, reflecting the quality of dividend payer / non-payer)	Fama and French (2001), Denis and Osobov (2008), von Eije and Megginson (2008), Bena and Hanousek (2008), Ferris et al. (2009), Fatemi and Bildik (2012), Kuo et al. (2013), Banyi and Kahle (2014), Zheng and Ashraf (2014), Floyd et al. (2015), He et al. (2017), Jiang et al. (2017), Dragotă and Yaseen (2019), Ye et al. (2019)
Dividends / sales	La Porta et al. (2000), Faccio et al. (2001), Shao et al. (2010), Fidrmuc and Jacob (2010), Chen et al. (2017)
Dividends / cash flow	La Porta et al. (2000), Faccio et al. (2001), Fidrmuc and Jacob (2010), Jiang et al. (2017)
Dividend / earnings before interest and taxes	Renneboog and Trojanowski (2007)
Dividends / market capitalization (Dividend yield)	Faccio et al. (2001), Aivazian (2003), Nicolosi (2013), Arnott and Asness (2003), Desai and Jin (2011), Nicolosi (2013), He et al. (2017), Yaseen (2019)
Dividends / total assets	Shao et al. (2010), Zheng and Ashraf (2014), Chen et al. (2017), Ye et al. (2019)
Dividend / equity	Yaseen (2019)
Dividend initiation	DeAngelo and DeAngelo (1990), Ferris et al. (2009), Huang et al. (2015), Chen et al. (2017), He et al. (2017)
Dividend omission	DeAngelo and DeAngelo (1990), Huang et al. (2015), He et al. (2017)
Dividend re-initiation	Chen et al. (2017)
Dividend per share	Bena and Hanousek (2008), Chen et al. (2017)
Dividend payments (total amount paid as dividend)	Lintner (1956), Renneboog and Trojanowski (2007)

DPR is defined as the ratio between net dividend paid to shareholders and net earnings (for instance, DPR in the year *t*, as a ratio between dividend per share and earnings per share, both recorded in the year *t*) and calculated only if the company records profit, and not loss (La Porta et al. 2000, Fidrmuc and Jacob 2010). Dividend is considered usually as total cash dividend paid to common and preferred shareholders (La Porta et al. 2000, Fidrmuc and Jacob 2010)[3]. DPR can be considered as explaining the interest of the shareholders for receiving dividends (or, in some cases, the interest of managers to protect the shareholders' interests). Share repurchases can be considered as an alternative to dividend payments (La Porta et al. 2000, von Eije and Megginson 2008, Fidrmuc and Jacob 2010, Banyi and Kahle 2014, Baker and Weigand 2015), and some studies correct DPR for accounting for this type of shareholders' remuneration (e.g., Renneboog and Trojanowski 2007, Floyd et al 2015, Ye et al. 2019). However, share repurchases imply the termination of the role as shareholder for the receiver of the payment, and this is why it should be analyzed independently by dividend payments.

Undoubtedly, as most of the financial indicators, DPR has certain limits. Net earnings depend on the countries' accounting conventions and are not always comparable from one country to another, being also easily manipulated by "accounting tricks". Also, "diversion of resources may occur before earnings are reported" (in this case, dividend payout ratio "overestimates the share of true earnings that is paid as dividends" (La Porta et al. 2000)[4]. It can be stated that DPR is also a classical, traditional indicator. It expresses the share of profit paid to shareholders. In this vision, profit is somehow considered having "a cash flow essence". As signalling theory notices (Bhattacharya 1979, Kalay 1980), in practice, one company can record profits, but having not enough cash for paying dividends. Also, if one company pays dividends from previous years earnings (from reserves), DPR can be higher than 100%. This non-synchronicity between dividends (an amount paid from the cash existent in one financial exercise) and net earnings (the result in previous year) can complicate also the financial interpretation of DPR.

DPR does not reflect a return (like dividend yield); it is a share of profit paid to shareholders. If dividends and retained earnings are considered as expressing opposite interests (see the literature regarding minority shareholders' protection, e.g., La Porta et al. 2000), DPR would reflect a higher interest for one issue or another or, maybe, a power in negotiation. However, the interpretation of the indicator should be made cautiously. If one company records 100 monetary units (m.u.) as earnings and pays 50 m.u. as dividends, it records only a 50% DPR, comparatively with another, which pays 100% as dividends from its

[3] In some cases, supplementary adjustments are made. For instance, "Earnings are measured after taxes and interest but before extraordinary items" (e.g., La Porta et al. 2000, Faccio et al. 2001).

[4] These problems are solved somehow using dividend-to-sales or dividend-to-cash flow ratios (La Porta et al. 2000, Faccio et al. 2001, Fidrmuc and Jacob 2010, etc.). However, these indicators do not reflect a portion from net earnings paid as dividend, dividends being defined as a part of the earnings distributed to shareholders.

1 m.u. earnings. Looking only to DPR, the second one seems to be more oriented to shareholders; however, it does not mean that its shareholders would be more satisfied.

DPR is used as dependent variable in regressions (La Porta et al. 2000, Fidrmuc and Jacob 2010, Jiang et al 2017). Different factors are considered as determinants of DPR, some of them – financial (e.g., size, return of assets, leverage, sales growth, in Fidrmuc and Jacob 2010, Jiang et al 2017, Ye et al. 2019), other – legal (legal system, mandatory dividends, tax advantages, etc., as in La Porta et al. 2000, Fidrmuc and Jacob 2010, Ye et al. 2019, etc.), cultural (individualism, power distance, uncertainty avoidance[5], in Fidrmuc and Jacob 2010), related to ownership structure (Jiang et al 2017, Ye et al. 2019), board gender diversity (Chen et al. 2017, Ye et al. 2019), etc. DPR is also used as independent variable in some studies (e.g., Lintner 1956, Lamont 1998, Lettau and Ludvigson 2001, Arnott and Asness 2003, Cincotti et al 2010, Baker et al. 2012, He et al. 2017).

Based on empirical evidences, different papers found that the presence of non-paying dividends companies is significant (Fama and French 2001, von Eije and Megginson 2008, Fatemi and Bildik 2012, Kuo et al. 2013). Maybe for this reason, many papers prefer to analyse the propensity to pay dividends and its determinants, along with dividend payout ratio or not (e.g., Denis and Osobov 2008, von Eije and Megginson 2008, Fatemi and Bildik 2012, Kuo et al. 2013, Banyi and Kahle 2014, Jiang et al. 2017, Ye et al. 2019) (see also Table 1). Even PPD is a less sensitive indicator, it has the same purpose as DPR in reflecting the company's interest for paying dividends for shareholders.

One missing link between considering averages DPR and propensity to pay dividends in modelling dividend policy can be somehow intuited. On the one hand, the use of the average DPR can be misleading, as long as DPR is 0% in many cases. An average DPR should be interpreted cautiously; it is as if you would say that in average you feel all right if one part of you is kept in frozen water and the other one in boiling water. On the other hand, neglecting the distribution of DPR in the absence of DPR = 0 (considering 1% DPR to be as such important as a 100% DPR) can determine missing some information.

For all these reasons, finding if probability distribution of DPR can be modelled can provide a useful result for both academics and practitioners. Finding the probability distribution for one variable is studied in literature (e.g., Clauset et al. 2009). In general, in is accepted that the selection procedure is following some subsequent steps, respectively (Clauset et al. 2009): (1) choose a suitable theoretical model; (2) estimate the model parameters; (3) determine the significance level and use a goodness-of-fit test in order to determine the most appropriate theoretical distribution. As far as we know, finding the distribution for DPR is a new contribution for financial literature.

3 Methodology

[5] These indicators are proposed by Hofstede (2001), as proxies for the national culture.

Our methodology is focused on finding the most appropriate distribution for DPR. In order to fit the probability distribution for DPR, we follow the methodology recommended by Clauset et al. (2009), and we applied it for the analysed variable. Thus, the fitting problem can be split in three main tasks (Clauset et al. 2009).

First, we have chosen a suitable theoretical model. Descriptive statistics like histogram and skewness are useful in this step. Based on the shape of the empirical distribution, we have decided to estimate a range of theoretical distribution that may fit the data: Tweedie, Scaled Tweedie, Lognormal, Burr, Weibull, Inverse Gaussian, Exponential, Generalized Pareto Distribution, Pareto and Gamma distribution. The Tweedie distribution, as a model for zero-inflated data (see Gilchrist and Drinkwater, 1999), has been previously used in other areas, such as healthcare data (Kurz 2017), modelling insurance claims (Rehshaw 1994; Jorgensen et al. 1994), etc.

Secondly, we have estimated the model parameters. In order to estimate the parameters of the theoretical distributions, the Maximum Likelihood method was used.

Finally, we have determined the significance level and we have used a goodness-of-fit test in order to determine the most appropriate theoretical distribution. For finding the most appropriate distribution for the data, we have used the Anderson-Darling test (Anderson and Darling 1954). This is one alternative used to test and to find the distribution of experimental data that follows a theoretical distribution. The conclusion of the Anderson–Darling test is usually drawn by comparing the obtained statistics with the available critical value. This test is one of the most frequent tests used to find the best distribution for the data, generally called „goodness-of-fit tests" (Pearson 1895, Anderson and Darling 1954, Stephens 1974, Jäntschi and Bolboacă 2018). This methodology has the advantage of allowing a more sensitive test (Scholz and Stephens 1987). By minimizing the statistics obtained from the Anderson Darling test, we have chosen the most appropriate distribution for our data.

4 Data

All companies' financials were collected from the Thomson Research Worldscope database[6]. We have included in our database only those countries with minimum 10 companies available for the entire period (for this reason, we have excluded from the initial database some countries). In addition, we have not considered the financial institutions because of the difference in the accounting standards for financial reporting, as La Porta et al.

[6] The access to the Thomson Research Worldscope Database was granted by Deloitte Romania.

(2000), Fidrmuc and Jacob (2010), Jiang et al. (2017), etc.[7], [8]. Furthermore, we have imported from the original database only companies with data available for the entire analysed period. Also, we have excluded from our database those companies which recorded negative net income (as in La Porta et al. 2000, Fidrmuc and Jacob 2010). The inclusion of this kind of data is incoherent with the financial logic of the indicator – dividend payout ratio is defined as a *share of profit* paid to shareholders. Another criterion for the imported data from Thomson Research Worldscope was that dividend DPR ≥ 0 (to eliminate possible negative dividend payout ratio) (Jiang et al. 2017). We considered dividends, but not other forms of shareholders' remuneration (such as shares repurchases) (as Floyd et al. 2015, among others) (due to data availability, but also because share repurchases determine the end of the quality of company's shareholder for their receiver). Also, have considered only cash dividends, and no other "cosmetically" (non-cash) operations (e.g., dividends in stocks).

The final database consists of 12,085 companies operating in 73 countries in the period 2008-2014. As such, our database covers a crisis, but also a post-crisis period. The data are winsorized to 2% and DPR is limited to 100%.[9] We have considered each company as being a different and sole company, in the case of a group of companies, which activates in more than one country[10].

Appendix 2 presents the descriptive statistics for DPR for the analysed countries. The number of companies per country is constant for the entire period analysed and the average number of companies per country is 168. Table 2 provides much more details about the process of building the final sample.

Table 2: Final sample construction

Description	**Companies**

[7] Different studies, after the exclusion of companies with missing values, eliminate from their databases: (i) utility companies (Fidrmuc and Jacob, 2010); (ii) companies from Luxembourg (La Porta et al. 2000, Fidrmuc and Jacob 2010); (iii) companies completely or partially owned by the governments (La Porta et al. 2000); (iv) companies from socialist or former socialist countries (La Porta et al. 2000). We included these categories for assuring a larger perspective on DPR. As observation, in our database, inclusion of Luxembourg does not have an important impact, as long it counts only with 56 records. In addition, even some particularities persist for the economies of socialist or former socialist countries, we do not consider them significant for the purpose of our study.

[8] Zheng and Ashraf (2014) analyze the banks' dividend policy in an international context.

[9] In some cases, the rough data is questionable per se. In this category can be mentioned companies with negative dividends (reported also in Fidrmuc and Jacob 2010), or with dividends exceeding sales (reported in La Porta et al. 2000, Fidrmuc and Jacob 2010). The quality of the databases used can be a problem. For instance, Fidrmuc and Jacob (2010) use as main source of data "Standard & Poor's Capital IQ database, which provides data covering company information for 58,670 public companies". From this total number of companies, the authors exclude 37,109 companies (that means approximately 63.25%!!!), because they have missing dividend data, negative dividends or dividends exceeding sales. DPR can be greater than 100% if dividends are paid from reserves. We did not consider this case for the reasons explained in Section 2.

[10] Relatively the same database was used in Yaseen and Dragotă (2019) and Yaseen (2019).

Total number of companies imported from the database	14,071
Banks and investment trust	1,540
Companies without a specific industry (not mentioned in the database)	30
National Banks	2
Negative Assets, Negative Sales, Negative Income or other aberrant financial data	336
Companies from countries with less than 10 companies	78
Final Sample	**12,085**

Appendix 1 presents DPR distributions for the countries included in our sample, for the period 2008-2014. In almost all of the cases (53 countries from 73, respectively 72.6% from the total population), DPR distribution is zero inflated (the modal value of the distribution equals 0)[11].

One issue that can complicate the picture is the existence in some countries of the mandatory dividend, respectively a legal requirement that a fraction of earnings to be paid as dividend[12]. The results (somehow surprising) confirm the same distribution even for the cases of the countries with regulated dividend payment. The mode for DPR for Brazil, Greece, Peru, Philippines and Venezuela is zero, and the percent of companies that do not pay dividends in Chile is important (44%).[13]

Table 3 provides the descriptive statistics for DPR. As observation, a look only to the mean (and to the median) of the population can be misleading. The mode is 0% and a closer look to the distribution of the variable confirms that, for the entire population, but also for the majority of the countries, the distribution of DPR is a zero-inflated distribution - the mode being 0, with the corresponding probability significantly higher than the other probabilities. This phenomenon is documented also by many other studies (Fama and French 2001, Denis and Osobov 2008, von Eije and Megginson 2008, Fatemi and Bildik 2012, Kuo et al. 2013).

Table 3: Descriptive Statistics for Dividend Payout Ratio

Number of records	71,824	Interquartile Range	47.06%
Mean	27.734%	Variance	0.081
Standard Deviation	28.383%	Excess Kurtosis	-0.462
Skewness	0.767	Standard Error Mean	0.001
Coefficient of Variation	102.338	Median	21.840%
		Mode	0.00%

[11] The case of Oman is somehow between DPR zero-inflated distribution and the other case (see Appendix 1), but the same pattern as in the general case can be suspected, too.

[12] La Porta et al. (2000) mention as countries with a mandatory dividend Brazil, Chile, Colombia, Greece, Venezuela and, in some extent, Germany. La Porta et al. (2000) exclude these countries from their analysis from the beginning. However, they mention that "they nevertheless appear, in the data, to have lower payouts than required by the law. A possible reason for this is that the accounting earnings reported to the authorities for the purpose of compliance with mandatory dividend rules are lower than the earnings reported to the shareholders which we use in our analysis". La Porta et al. (2000) use the March 1996 edition of the WorldScope Database, "which presents information on the (typically) largest firms in 46 countries". According to Fidrmuc and Jacob (2010), such requirements are present in Brazil, Chile, Greece, Peru, and the Philippines. Huang et al. (2015) mention in this category Brazil, Chile, Colombia, Greece, and Venezuela. The differences can be related not only to the countries included in the database, but also to the moment of analysis.

[13] Colombia is not included in our database.

5 Results

Analysing visually the histogram of distribution, it can be easily observed that it is a zero-inflated distribution (see also Appendix 3). Statistical literature documents the existence of different zero-inflated distributions (e.g., Poisson, Gamma, Tweedie) (El-Shaarawi, Zhu and Joe 2011, Jørgensen and Kokonendji 2016, Bonat and Kokonendji 2017).

By minimizing the statistics obtained from the Anderson Darling test, we have chosen the Tweedie Distribution as being the most appropriate distribution for our data (see Table 4). Figure 2 explains graphically this choice. Figure 2 depicts the empirical distribution function of DPR versus the estimated Tweedie Cumulative Distribution Function. It can be observed that the estimated Tweedie distribution fits the best the empirical distribution of DPR, out the selected probability density functions. Figure 3 fits the empirical distribution with the Tweedie distribution. Figure 4 shows the conditional probability density function estimates for Tweedie distribution against the empirical distribution: Tweedie distribution is a good choice in approximating the real distribution.

Table 4: Model Selection based on the Anderson-Darling test

Distribution	**Converged**	**Anderson-Darling Statistic**	**Selected**
Tweedie	Yes	-52014	Yes
Scaled Tweedie	Yes	-52011	No
Lognormal	Yes	-48101	No
Burr	No	-47679	No
Weibull	Yes	-47519	No
Inverse Gaussian	Yes	-45203	No
Exponential	Yes	-41865	No
Generalized Pareto Distribution	Yes	-41856	No
Pareto	Yes	-41710	No
Gamma	Yes	-35549	No

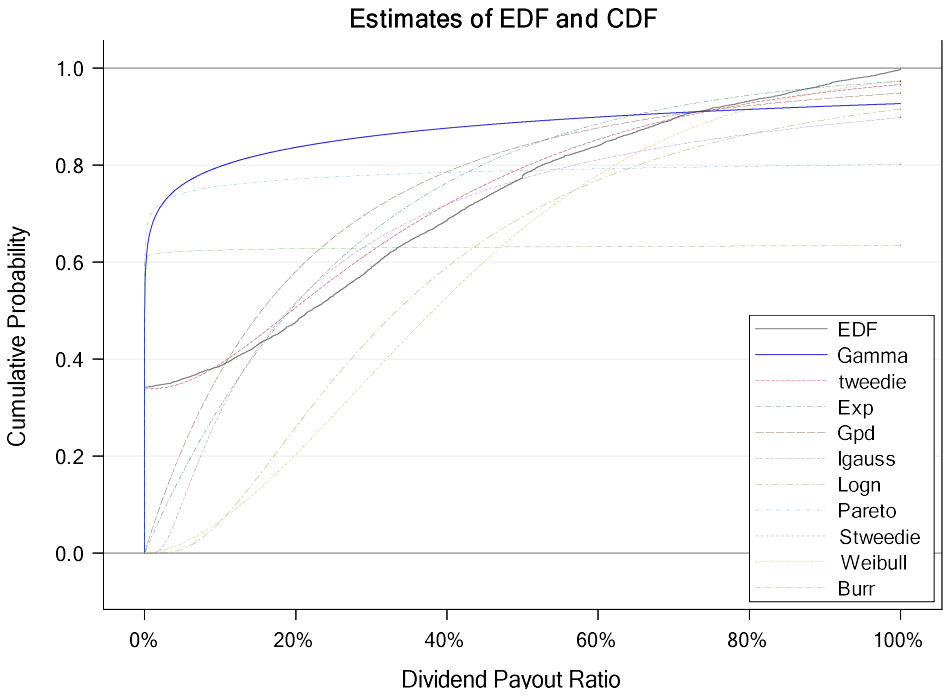


Figure 2: Estimates of Empirical Distribution Function of Dividend Payout Ratio (EDF) and other distributions

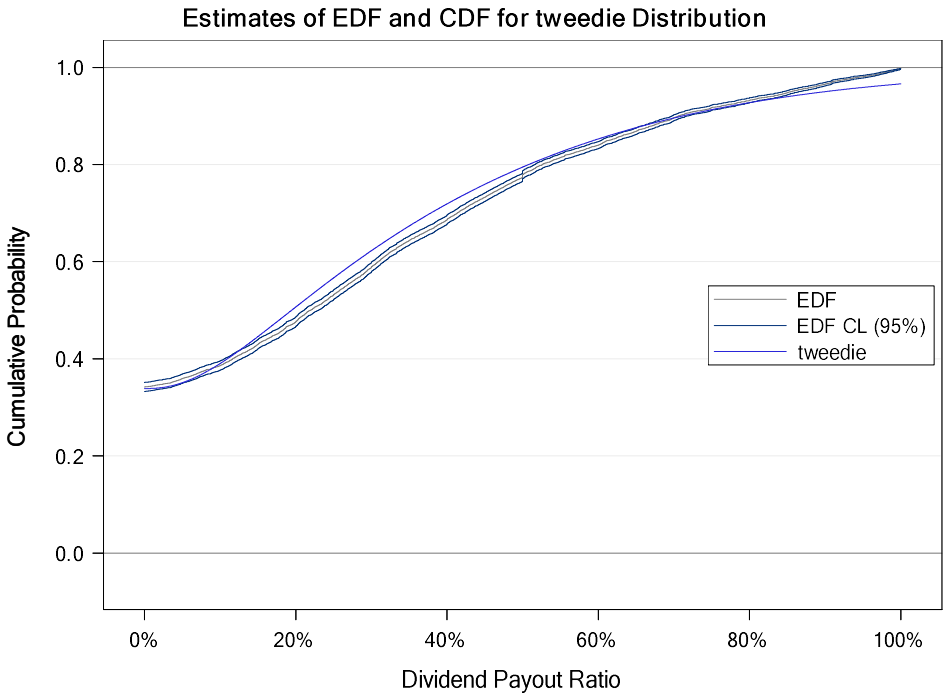


Figure 3: Empirical Distribution Function of Dividend Payout Ratio (EDF) versus the estimated Tweedie Cumulative Distribution Function

Note: In this figure, CL means confidence limit.

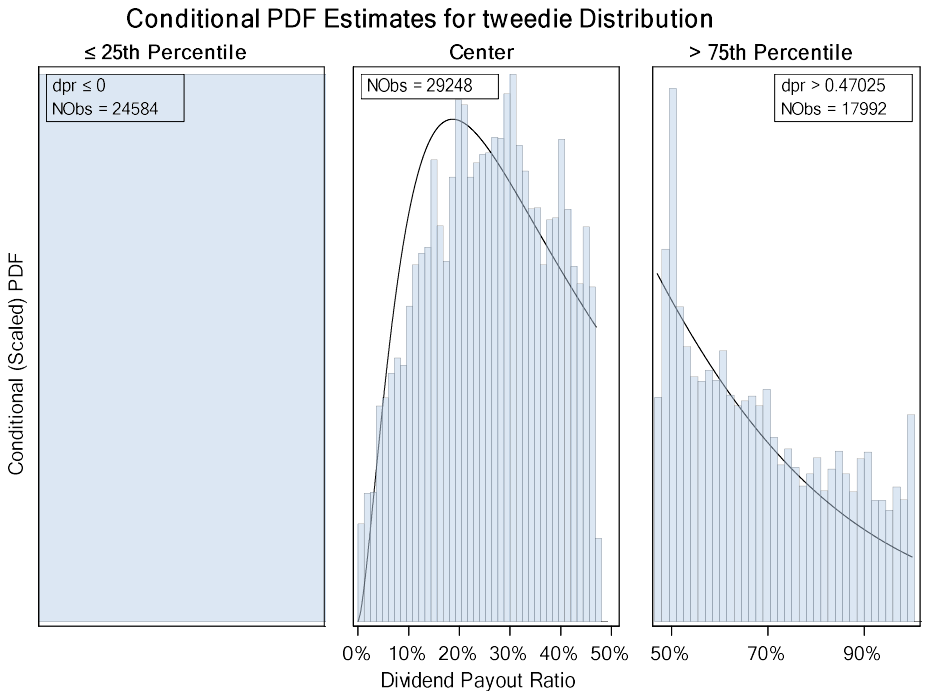


Figure 4: The conditional probability density function estimates for Tweedie distribution against the empirical distribution: Tweedie distribution is a good choice in approximating the real distribution.

Tweedie distribution (Tweedie 1984) is included in the class of exponential dispersion models. Some familiar distributions are special cases of the Tweedie distribution (e.g., normal, Poisson, compound Poisson gamma distribution, etc.) (Kurz 2017). They have positive mass at zero, but are otherwise continuous. Tweedie distribution is a special case of exponential dispersion models, a class of models used to describe error distributions for the generalized linear model.

If Y is a Tweedie random variable, then the mean and the variance are $E(Y)=\mu$ and $Var(Y)=\phi\mu^p$, where ϕ is the dispersion parameter and p is an extra parameter that controls the variance of the distribution. The Tweedie distribution is not defined when p is between 0 and 1. In practice, the most interesting range is from 1 to 2, in which the Tweedie distribution gradually loses its mass at 0 as it shifts from a Poisson distribution to a gamma distribution. For $p>1$, the Tweedie probability density function (pdf) has the following form:

$$f(x;\mu,\phi,p)=a(x,\phi)\exp\left[\frac{1}{\phi}\left(\frac{x\mu^{1-p}}{1-p}-k(\mu,p)\right)\right] \quad (1)$$

Where $k(\mu,p)=\begin{cases}\dfrac{\mu^{2-p}}{2-p}, for\ p\neq 2,\\ log(\mu), for\ p=2\end{cases}$, while the function $a(x,\phi)$ has no closed analytical expression.

For $1<p<2$, the Tweedie distribution (denoted here Tweedie (μ, ϕ, p)) is a compound Poisson-gamma mixture distribution, which is the distribution of S defined as $S = \sum_{i=1}^{N} X_i$, where $N \sim Poisson\ (\lambda)$ and $X_i \sim$ gamma (α, θ) are i.i.d. gamma random variables with shape parameter α and scale parameter θ. The correspondence between these parameters and the parameters of the Tweedie distribution is the following:

$$\begin{cases} \lambda = \dfrac{\mu^{2-p}}{\phi(2-p)} \\ \alpha = \dfrac{2-p}{p-1} \\ \theta = \phi(p-1)\mu^{p-1} \end{cases} . \qquad (2)$$

The Scaled Tweedie distribution (denoted here STweedie (θ, λ, p)) is a version of the Tweedie distribution, corresponding to a compound Poisson-gamma distribution with gamma scale parameter θ, Poisson parameter λ, and the index parameter p such as $\alpha = \dfrac{2-p}{p-1}$ (Dunn and Smyth 2005).

The correspondence between the parameters of the STweedie (θ, λ, p) distribution and the Tweedie (μ, ϕ, p) distribution is the following:

$$\begin{cases} \mu = \lambda\theta\alpha \\ \phi = \dfrac{(\lambda\theta\alpha)^{2-p}}{\lambda(2-p)} = \dfrac{\theta}{(p-1)(\lambda\theta\alpha)^{p-1}} \end{cases} . \qquad (3)$$

The Tweedie distribution has nonnegative support and can have a discrete mass at zero, making it useful to model responses that are a mixture of zeros and positive values, just like the empirical distribution of DPR (see Figures 1-4). Hence, we will describe the behaviour of DPR using the Tweedie distribution.

We have estimated the parameters of the Tweedie distribution for the complete database, using numerical method for the maximum likelihood estimator of extra parameter of variance, mean and dispersion parameter. A detailed description of the method is given in Gilchrist and Drinkwater (1999). This method has been implemented in SAS 9.3 and we have used the *proc severity procedure* for this. The results of the estimation are presented in Table 5.

Table 5: Parameter Estimates for Tweedie Distribution (entire period 2008-2014)

Parameter	DF	Estimate	Standard Error	t Value	Approx. Pr > |t|
p (extra parameter of variance)	1	1.279	0.002	719.830	<.0001
μ (mean)	1	0.277	0.001	235.680	<.0001
ϕ*(dispersion parameter)*	1	0.509	0.003	158.590	<.0001

Source: Own calculation using SAS 9.3

By analysing the parameters of the estimated Tweedie distribution, several conclusions can be drawn. Firstly, the value of extra parameter controlling for variance is significantly different from zero, as it would be the case if DPR follows a Gaussian distribution. Moreover, $1<p<2$, so the distribution of dividend payout ratio is in fact a compound Poisson–gamma distribution[14]. A compound Poisson random variable Y is the sum of N independent gamma random variables where N follows a Poisson distribution and N and the gamma random variates are independent. The distribution of DPR is stable in time, the parameters of the yearly Tweedie distribution being significant and in line with the values estimated for the entire time-period (see Table 6).

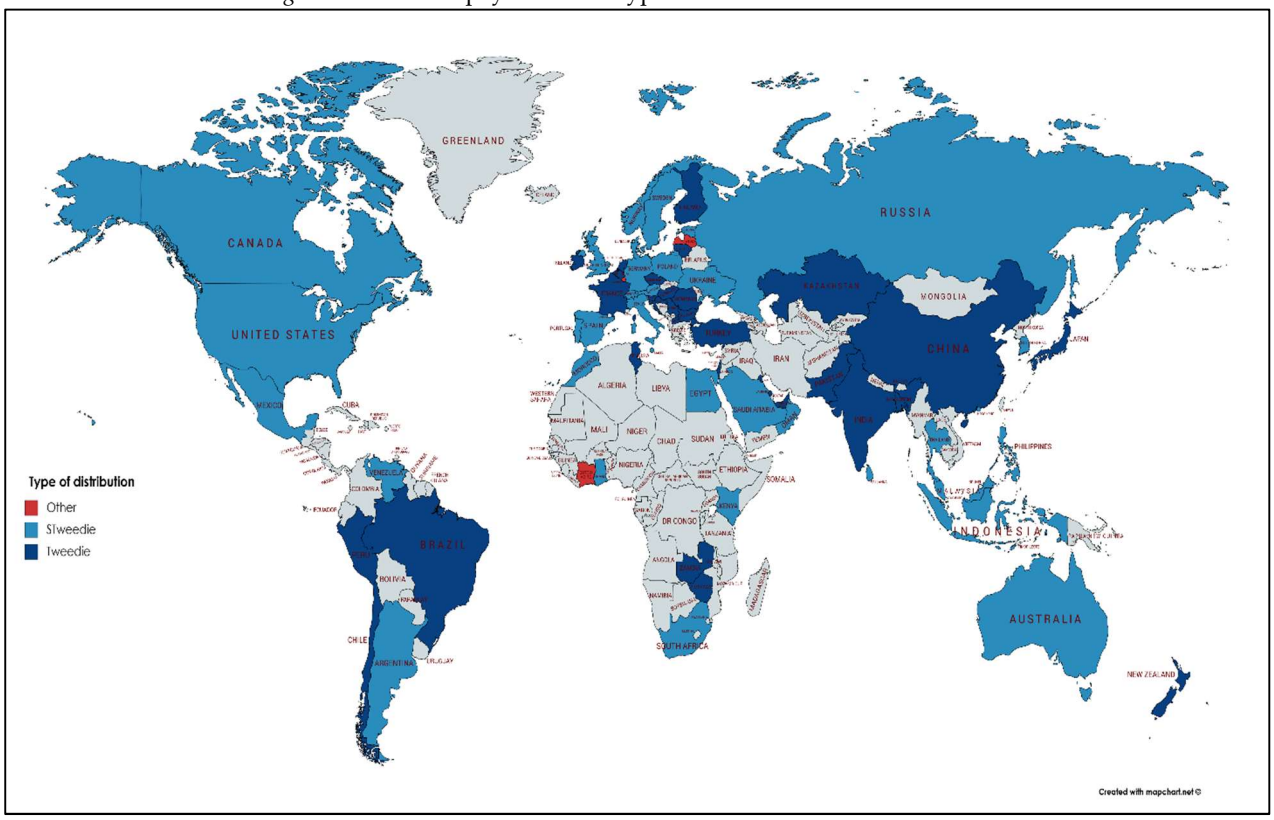
Table 6: Parameter Estimates for Tweedie Distribution by year

Parameter	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
p (extra parameter of variance)	1.252	1.277	1.287	1.292	1.283	1.274	1.271
μ (mean)	0.283	0.274	0.275	0.274	0.277	0.276	0.280
ϕ*(dispersion parameter)*	0.466	0.513	0.514	0.538	0.528	0.508	0.465

For the majority of countries in our sample, DPR follows either a Tweedie distribution or a Scaled Tweedie (STweedie) distribution. This may be a sign of systematic behaviour, regardless of country. The exceptions are Côte d'Ivoire, Luxembourg and Latvia. In the map below, the distribution for each country is presented (see Figure 5). In Appendix 4, the estimated parameters of the Tweedie and Scaled Tweedie distribution by country are shown.

[14] This is the most used case in practice, when the Tweedie random variable can be generated from a Poisson gamma distribution (see Smyth 1996).

Figure 5: Dividend payout ratio's type of distribution across countries



The finding that the Dividend Payout Ratio follows a Tweedie distribution can be have practical applications; for example, one can use the fitted distribution in order to have better estimates of the probability that a certain event will occur (e.g., DPR to be lower or higher than a benchmark).

6 Conclusions

Dividend policy is still a largely discussed issue in corporate finance literature. For its analysis, dividend payout ratio has certain advantages and is extensively used. Using a database consisting of 12,085 companies operating in 73 countries, for the period 2008-2014, we found that this indicator does not follow a normal distribution, but a zero-inflated one. The most appropriate distribution for modelling dividend payout ratio is the Tweedie distribution (Tweedie 1984) and its version Scaled Tweedie Distribution (Dunn and Smyth 2005). Thus, a better estimation of the probability that dividend payout ratio is lower or higher than a benchmark can be provided. Also, an analysis of dividend policy, distinctly considering payer versus non-payer companies, can offer additional important information for practitioners and, also, for academics. The use of the average levels of dividend payout ratio can determine misleading results. As far as we know, finding the distribution for DPR is a new contribution for financial literature.

Another contribution, comparative to previous research, is the large number of countries considered (73) and covering a crisis and a post-crisis period (2008-2014). Our sample included countries from Africa, North and South Americas, Asia, Australia, and

Europe. From here, conclusions are validated for countries with a large diversity regarding the cultural values, but also legal systems (our sample includes common law, but also civil law countries).

This outcome could be useful in the future research where a more appropriate distribution could be used for modelling the influencing factors of the DPR. Based on our knowledge, there was not literature in the past that tried to investigate which would be the most appropriate distribution function for DPR. Our result can be useful in the context of international portfolio management, especially when we discuss about investments made in a large number of companies (with minority participations), and when forecasting of the future collected dividends is of interest.

As a limitation of the study, our analysis and results are made on only one financial indicator that describe dividend policy - dividend payout ratio. One interesting extension can be made analyzing other indicators reflecting the dividend policy, too. Also, accounting rules are different from country to country (Chui 2002; Dragotă et al. 2018) and from sector to sector (Short et al 2002). Fiscal systems are also different and they can have an impact on financial decisions (Chui 2002, Dragotă et al. 2018), including dividend policy (Short et al 2002, Fidrmuc and Jacob 2010). These issues can have an impact on earnings (La Porta et al. 2000), and, from here, on dividend payout ratio.

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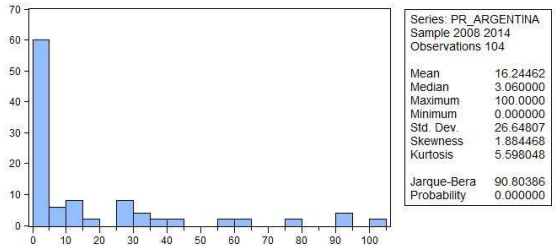
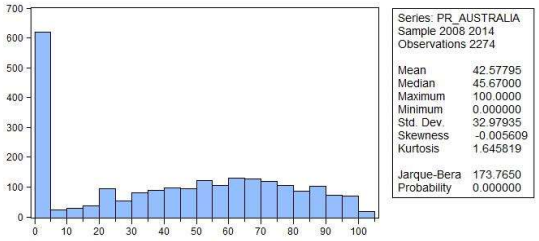
Appendixes

Appendix 1: Dividend payout ratio on the world: some descriptive statistics

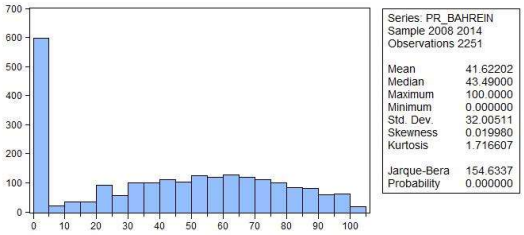
Country 1 – Argentina



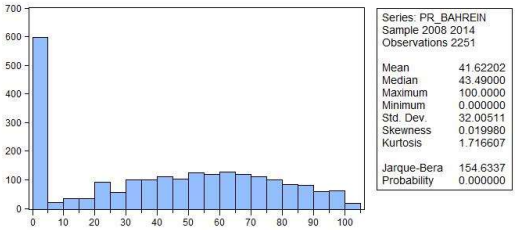
Country 2 – Australia



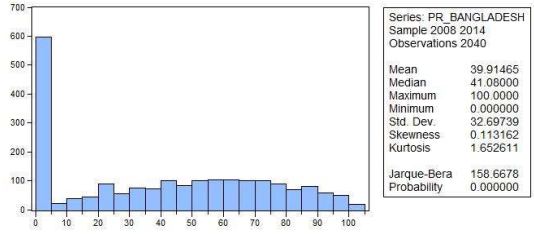
Country 3 – Austria



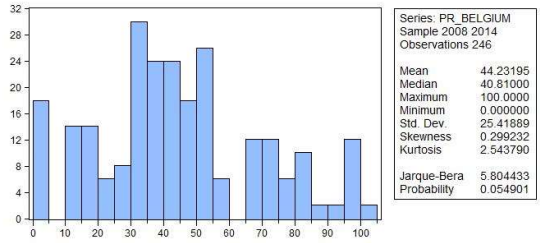
Country 4 – Bahrein



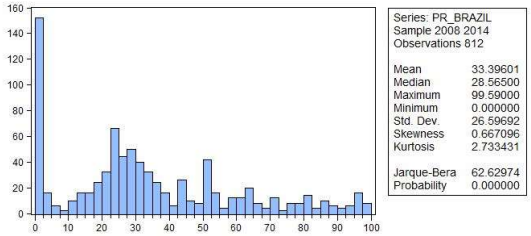
Country 5 – Bangladesh



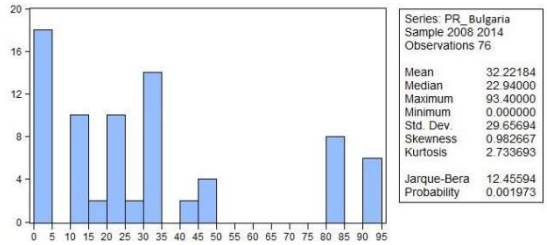
Country 6 – Belgium



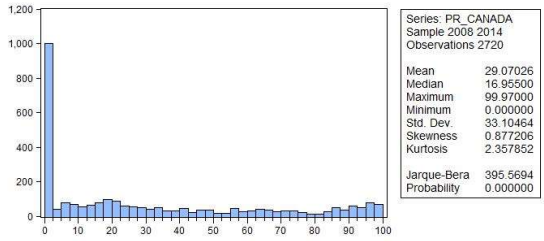
Country 7 – Brazil



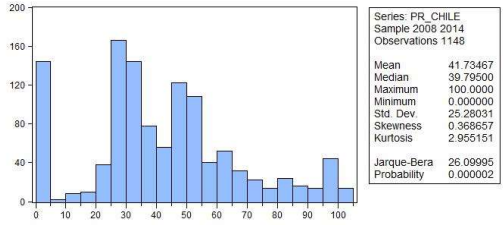
Country 8 – Bulgaria



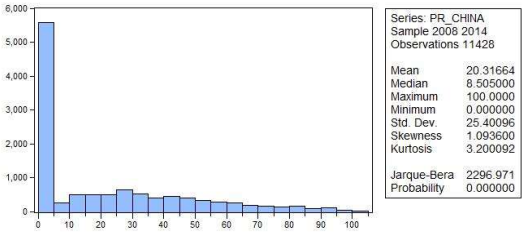
Country 9 – Canada



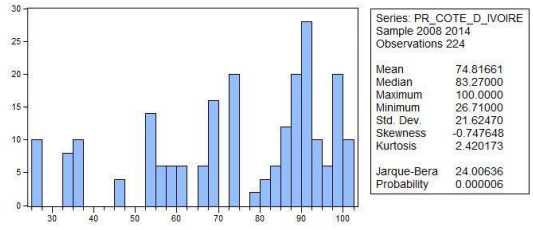
Country 10 – Chile



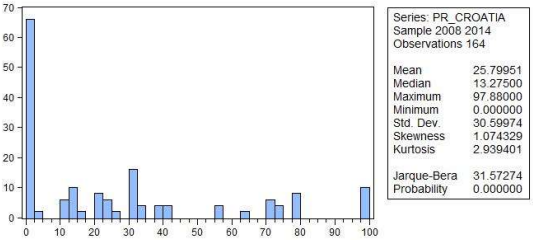
Country 11 – China



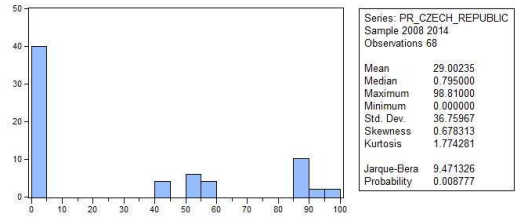
Country 12 - Cote d'Ivoire



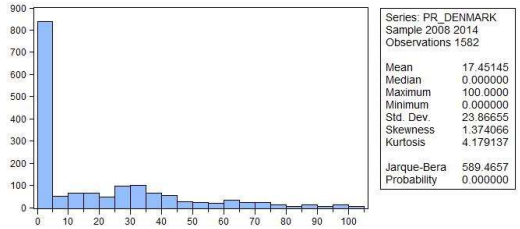
Country 13 – Croatia



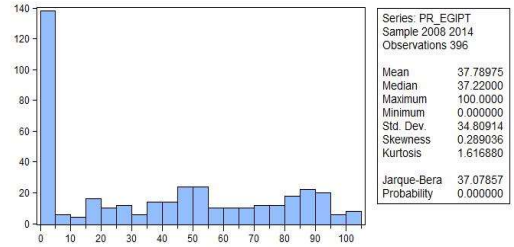
Country 14 – Czech Republic



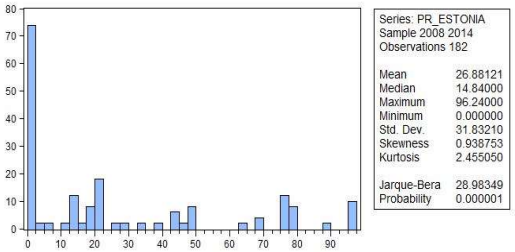
Country 15 – Denmark



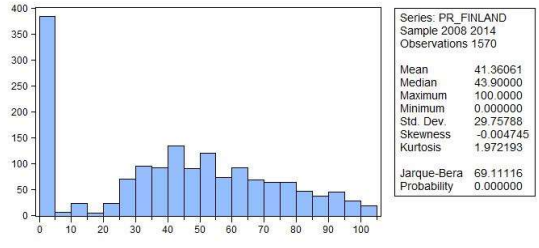
Country 16 – Egypt



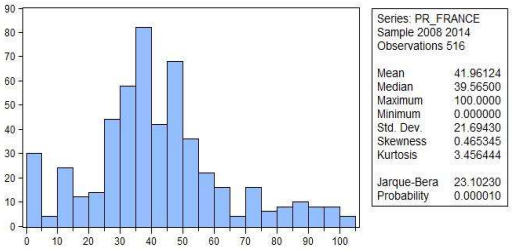
Country 17 – Estonia



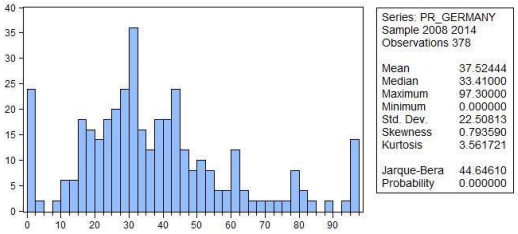
Country 18 – Finland



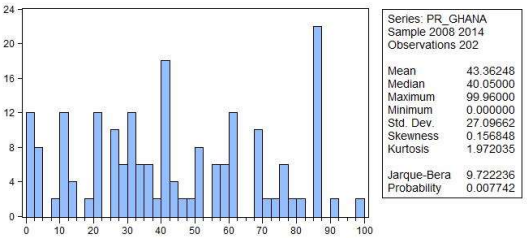
Country 19 – France



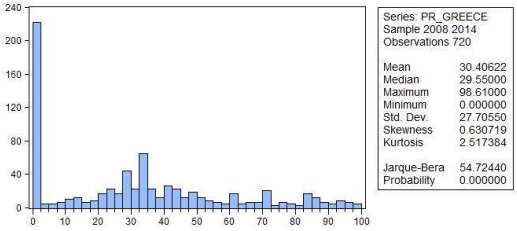
Country 20 – Germany



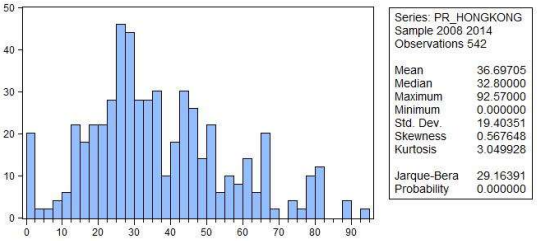
Country 21 – Ghana



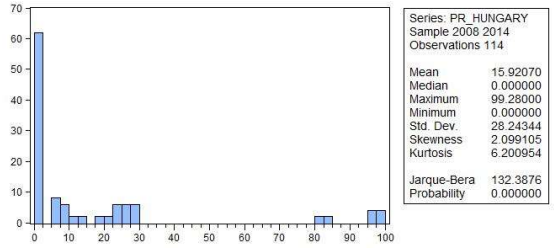
Country 22 – Greece



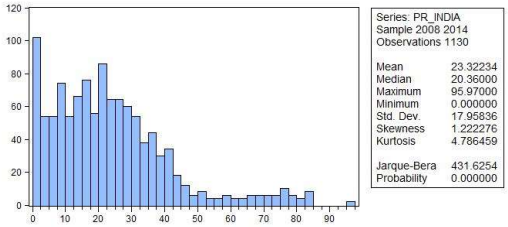
Country 23 – Hong Kong



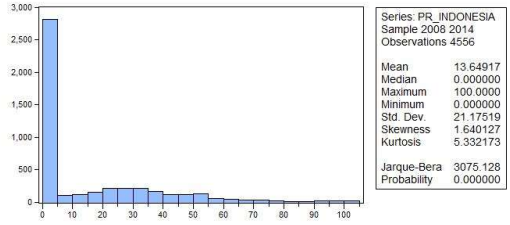
Country 24 – Hungary



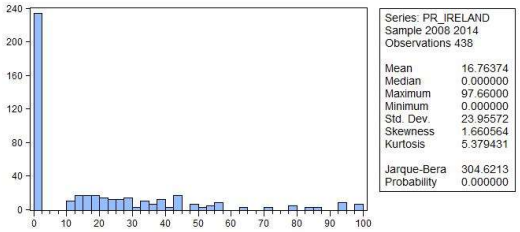
Country 25 – India



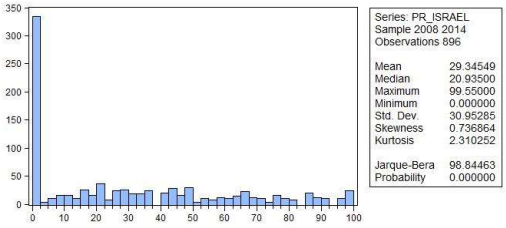
Country 26 – Indonesia



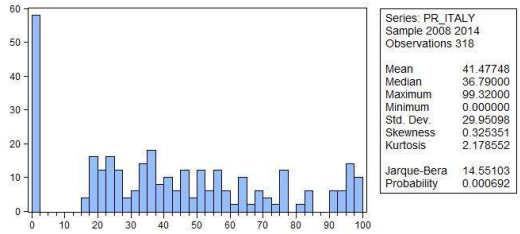
Country 27 – Ireland



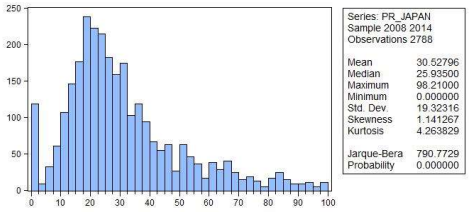
Country 28 – Israel



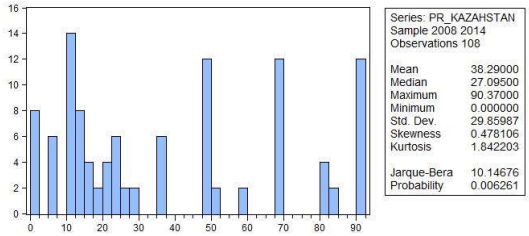
Country 29 – Italy



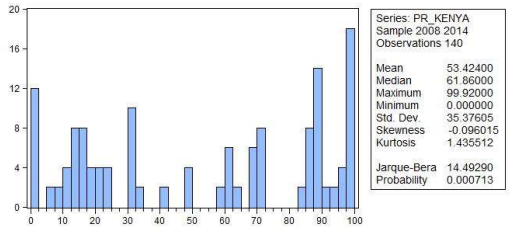
Country 30 – Japan



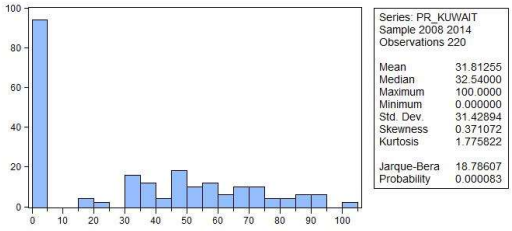
Country 31 – Kazakhstan



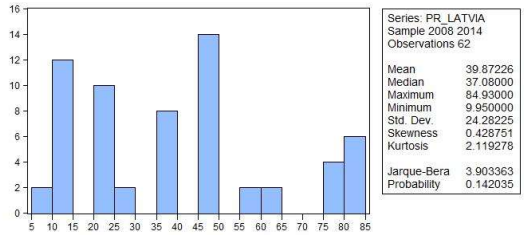
Country 32 – Kenya



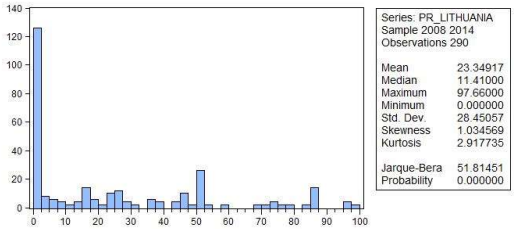
Country 33 – Kuwait



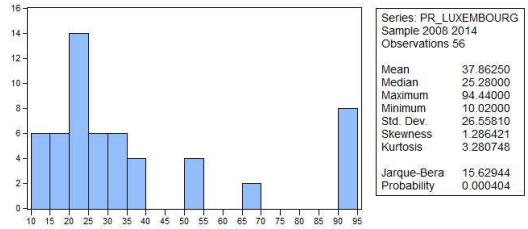
Country 34 – Latvia



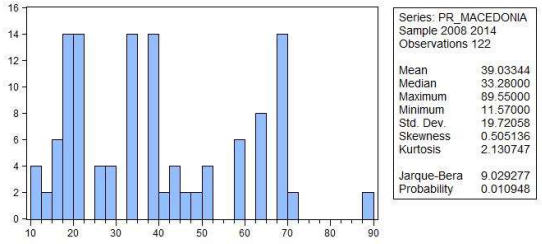
Country 35 – Lithuania



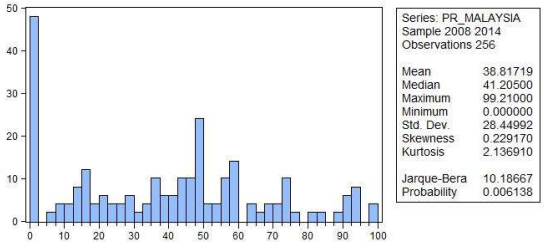
Country 36 - Luxembourg



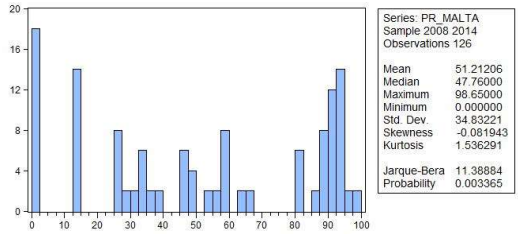
Country 37 – Former Yugoslav Republic of Macedonia



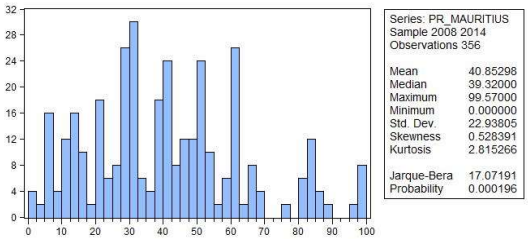
Country 38 – Malaysia



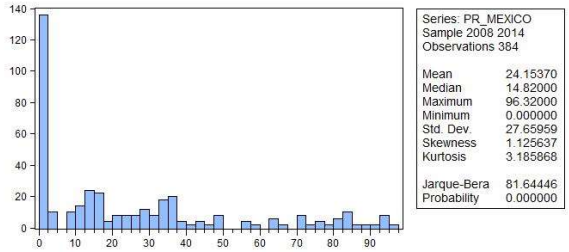
Country 39 – Malta



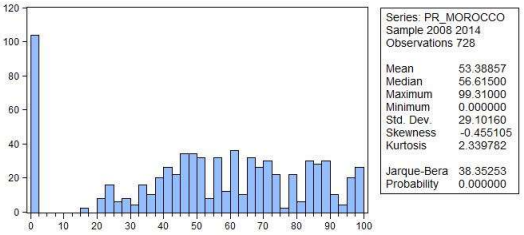
Country 40 – Mauritius



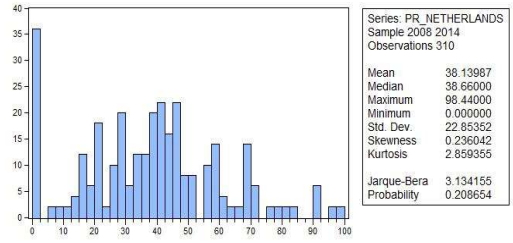
Country 41 – Mexico



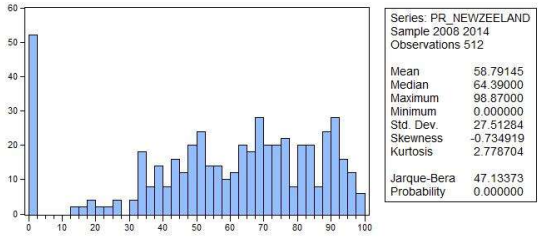
Country 42 – Morocco



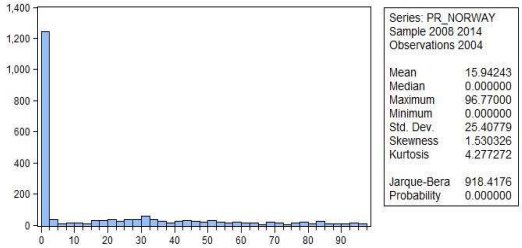
Country 43 – Netherlands



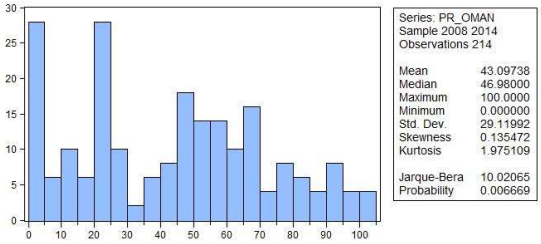
Country 44 - New Zealand



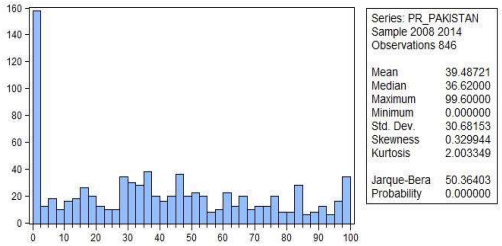
Country 45 – Norway



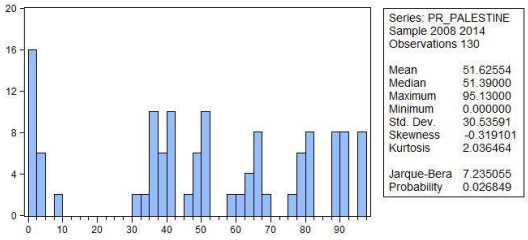
Country 46 – Oman



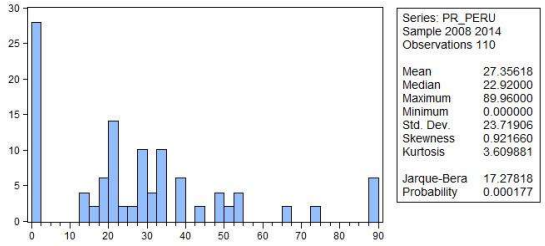
Country 47 – Pakistan



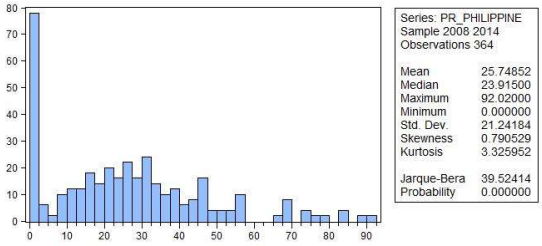
Country 48 – Palestine



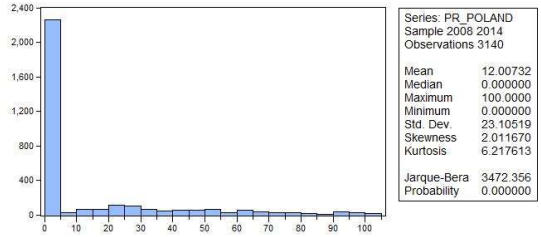
Country 49 – Peru



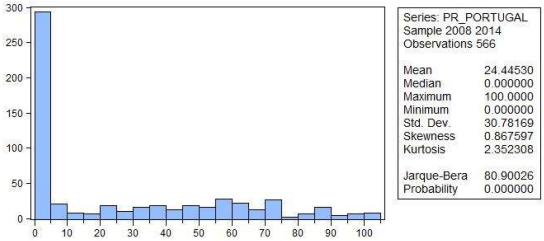
Country 50 – Philippines



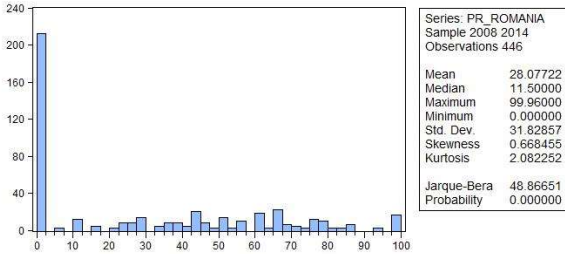
Country 51 – Poland



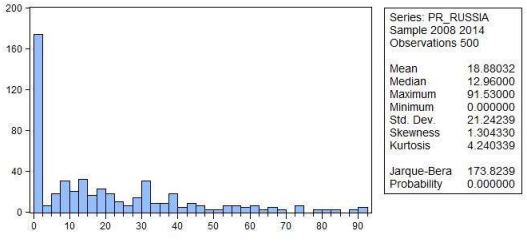
Country 52 - Portugal



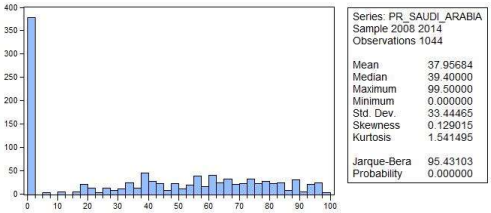
Country 53 - Romania



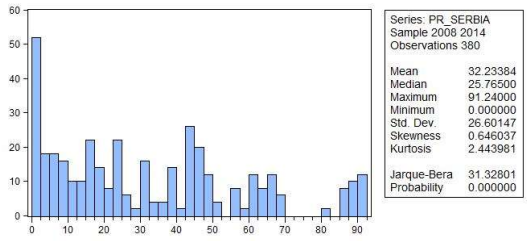
Country 54 – Russia



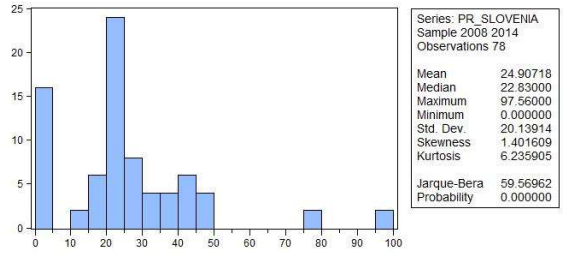
Country 55 – Saudi Arabia



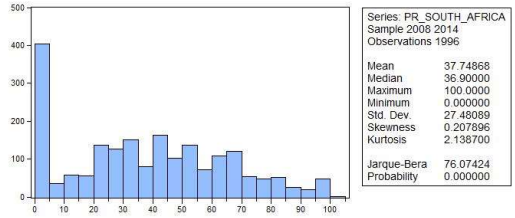
Country 56 – Serbia



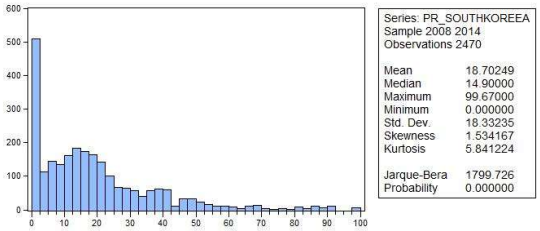
Country 57 – Slovenia



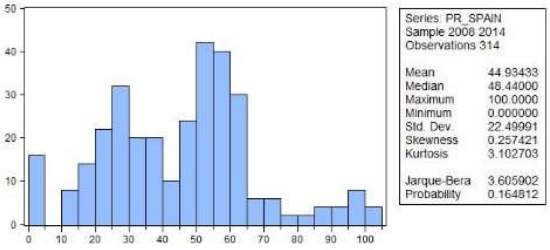
Country 58 - South Africa



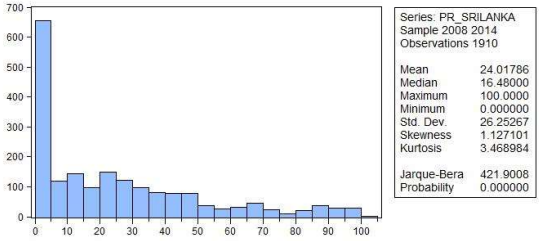
Country 59 - South Korea



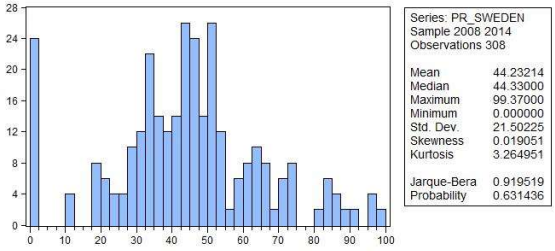
Country 60 – Spain



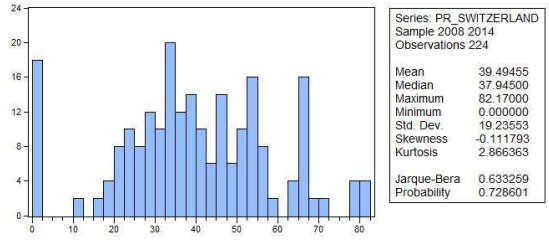
Country 61 - Sri Lanka



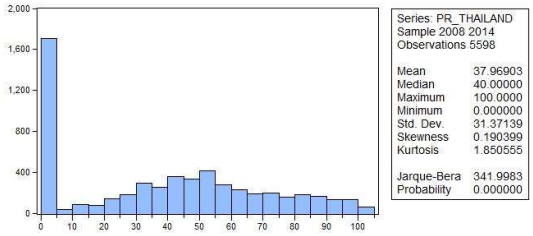
Country 62 – Sweden



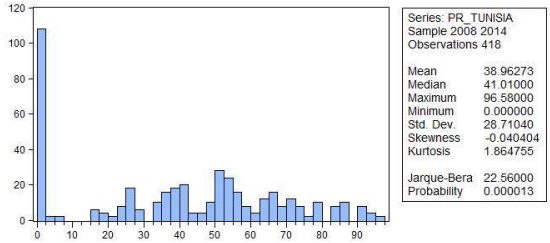
Country 63 - Switzerland



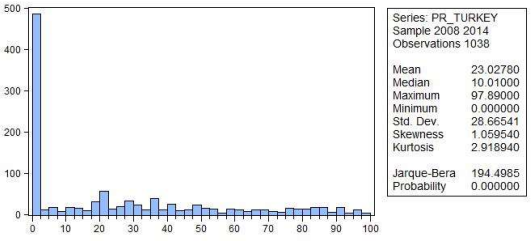
Country 64 – Thailand



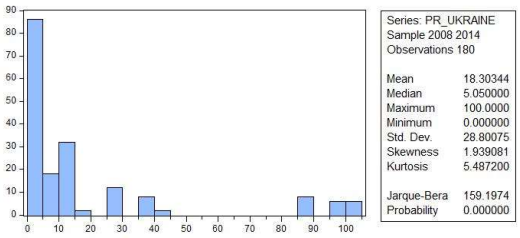
Country 65 – Tunisia



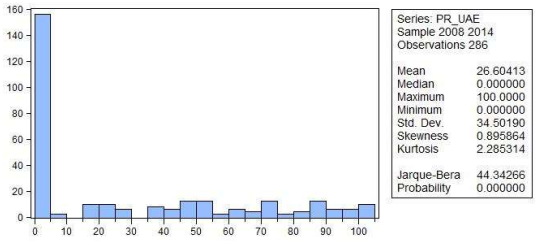
Country 66 – Turkey



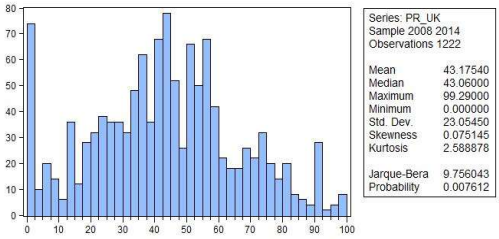
Country 67 – Ukraine



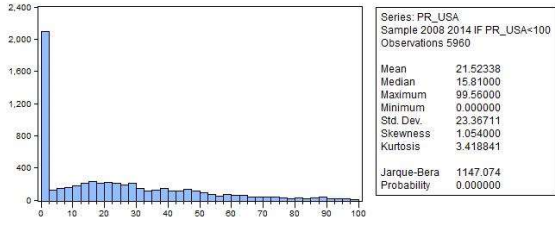
Country 68 - United Arab Emirates



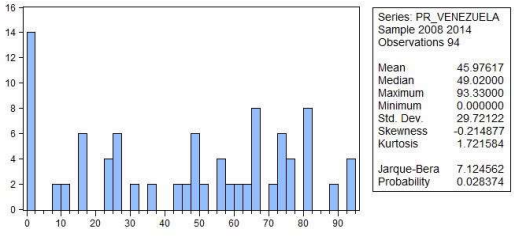
Country 69 - United Kingdom



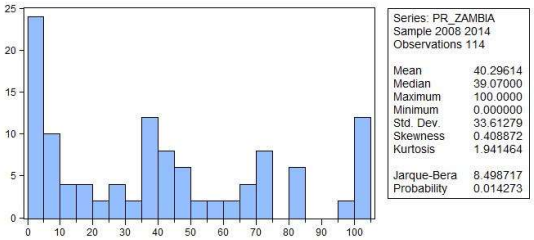
Country 70 - United States of America



Country 71 – Venezuela



Country 72 – Zambia



Country 73 – Zimbabwe

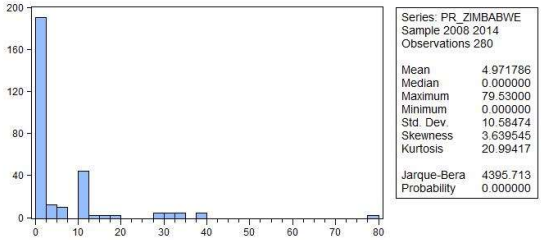


Figure A.1.1: Dividend payout ratio for the companies included in the sample (per country), in the period 2008-2014. All companies' financials were collected from the Thomson Research Worldscope database. DPR is computed as: $DPR = \frac{Dividends}{Net\ income}$.

Appendix 2: Descriptive statistics

Table A.2.1: Descriptive statistics

Indicator		**count**	**max**	**average**	**median**	**min**	**Standard deviation**
Dividend Payout Ratio	%	71,814	100.00	27.74	21.84	0.00	28.38

Source: own calculation based on database from Thomson Reuters Worldscope.

Appendix 3: Countries with zero-inflated distributions versus countries with other distributions of Dividend payout ratio

It can be noticed that zero-inflated distribution is not characteristic for all the countries included in our database (approximatively 26% from the total database are in this case) (see Table A.3.1). In some cases, this state is associated with a lower number of observations (e.g., Kazakhstan, Latvia, Luxembourg, Former Yugoslav Republic of Macedonia, Slovenia), but also the zero-inflated distribution appears in cases with a lower number of observations (e.g., Bulgaria, Czech Republic). In addition, it can be noticed that some developed countries, most of them from European Space (Belgium, Luxembourg, France, Germany, Spain, Sweden, Switzerland, UK), but, also, Japan are present in this category.

Table A.3.1: Countries with zero-inflated distributions versus countries with other distributions of Dividend payout ratio

Zero-inflated distribution	**Other distributions**
Austria	Belgium
Argentina	Bulgaria
Australia	Chile
Bahrein	Cote d'Ivoire
Bangladesh	Former Yugoslav Republic of Macedonia
Brazil	France
Bulgaria	Germany
Canada	Hong-Kong
China	Japan
Croatia	Kazakhstan
Czech Republic	Kenya
Denmark	Latvia
Egypt	Luxembourg
Estonia	Mauritius
Finland	Slovenia
Greece	Spain
Holland	Sweden
Hungary	Switzerland
India	United Kingdom
Indonesia	
Ireland	
Israel	
Italy	
Kuwait	
Lithuania	
Malaysia	
Malta	
Mexico	
Morocco	
New Zeeland	
Norway	
Pakistan	
Palestine	
Peru	
Philippines	
Poland	
Portugal	

Romania	
Russia	
Saudi Arabia	
Serbia	
South Africa	
South Korea	
Sri Lanka	
Thailand	
Tunisia	
Turkey	
Ukraine	
United Arad Emirates	
United States of America	
Venezuela	
Zambia	
Zimbabwe	

Note: the results for Oman are not conclusive.

It can be suspected that the situation from Table A.3.1 can be related to the capital market development (see market capitalization as proxy). However, from the first 10 countries ranked function of market capitalization[15], four present a zero-inflated distribution (US, China, Canada, India). Considering the value of stocks traded as percent in GDP[16], six present a zero-inflated distribution[17].

One interesting future direction for analysis is to consider some cultural determinants for explaining this zero-inflated distribution for DPR. These similarities can be explained by similar cultural dimensions or people behaviour. For example, similar harmony index (Yaseen and Dragotă, 2019) or similar life standards (Yaseen, 2019) in those countries may lead to similar decisions regarding paying dividends or not.

[15] Top 10 countries, as market capitalization, according to: https://www.indexmundi.com/facts/indicators/CM.MKT.LCAP.CD/rankings, is: 1. US. 2. China. 3. Japan. 4. Hong-Kong. 5. France. 6. Canada. 7. UK. 8. Germany. 9. India. 10. Switzerland.

[16] Top 10 countries, as value of stocks traded as percent in GDP, according to: https://www.indexmundi.com/facts/indicators/CM.MKT.TRAD.GD.ZS/rankings, is: 1. Hong-Kong. 2. US. 3. China. 4. South Africa. 5. Switzerland. 6. South Korea. 7. Japan. 8. Finland. 9. Italy. 10. Iceland.

[17] We did not include in our study Iceland because of lack of data.

Appendix 4: Parameters of the Tweedie and Scaled Tweedie distribution, by country

Table A.4.1: Estimated Parameters of the Tweedie and Scaled Tweedie distribution, by country

Country	Distribution of DPR (2008-2014)	Theta θ	P p	Mu μ	Phi ϕ	Lambda λ
Côte d'Ivoire	Burr					
Luxembourg	Burr					
Latvia	Exp					
South Africa	STweedie	0.029	1.139			2.150
Argentina	STweedie	0.204	1.478			0.727
Australia	STweedie	0.052	1.143			1.376
Austria	STweedie	0.022	1.063			1.009
Canada	STweedie	0.148	1.344			1.031
Denmark	STweedie	0.105	1.283			0.653
Egypt	STweedie	0.094	1.214			1.094
Switzerland	STweedie	0.004	1.038			3.542
Estonia	STweedie	0.101	1.258			0.928
Germany	STweedie	0.021	1.144			3.000
Ghana	STweedie	0.059	1.297			3.124
Greece	STweedie	0.083	1.248			1.213
Hong Kong	STweedie	0.010	1.099			3.954
Indonesia	STweedie	0.109	1.288			0.502
Italy	STweedie	0.018	1.070			1.699
Kenya	STweedie	0.034	1.140			2.586
Malaysia	STweedie	0.031	1.129			1.868
Malta	STweedie	0.041	1.149			2.219
Mauritius	STweedie	0.022	1.179			3.945
Mexico	STweedie	0.142	1.404			1.156
Morocco	STweedie	0.031	1.120			2.340
Norway	STweedie	0.140	1.295			0.476
Oman	STweedie	0.033	1.139			2.105
Palestine	STweedie	0.071	1.269			2.697
Philippines	STweedie	0.053	1.261			1.711
Poland	STweedie	0.125	1.259			0.335
Portugal	STweedie	0.145	1.282			0.660
Russian Federation	STweedie	0.112	1.432			1.285
Saudi Arabia	STweedie	0.080	1.172			0.984
Rep. of Korea	STweedie	0.057	1.336			1.662
Spain	STweedie	0.007	1.053			3.594
Sri Lanka	STweedie	0.109	1.356			1.212
Sweden	STweedie	0.003	1.027			4.111
Thailand	STweedie	0.061	1.157			1.161
Ukraine	STweedie	0.212	1.631			1.739
United Kingdom	STweedie	0.021	1.144			3.525
United States	STweedie	0.094	1.326			1.103
Venezuela	STweedie	0.190	1.537			2.805
Bahrain	Tweedie		1.050	0.430	0.210	
Bangladesh	Tweedie		1.375	0.286	0.600	
Belgium	Tweedie		1.054	0.442	0.181	
Brazil	Tweedie		1.267	0.334	0.351	

Country	Distribution of DPR (2008-2014)	Theta θ	P p	Mu μ	Phi ϕ	Lambda λ
Bulgaria	Tweedie		1.703	0.322	0.677	
Czech Republic	Tweedie		1.487	0.290	1.454	
Chile	Tweedie		1.181	0.417	0.238	
China	Tweedie		1.218	0.202	0.507	
Croatia	Tweedie		1.407	0.257	0.742	
Finland	Tweedie		1.144	0.413	0.394	
France	Tweedie		1.095	0.419	0.145	
Hungary	Tweedie		1.408	0.159	0.933	
India	Tweedie		1.268	0.233	0.191	
Ireland	Tweedie		1.160	0.168	0.411	
Israel	Tweedie		1.255	0.293	0.530	
Japan	Tweedie		1.124	0.305	0.133	
Kazakhstan	Tweedie		1.695	0.382	0.593	
Kuwait	Tweedie		1.083	0.318	0.492	
Lithuania	Tweedie		1.315	0.233	0.641	
FYR of Macedonia	Tweedie		2.639	0.390	0.534	
Netherlands	Tweedie		1.097	0.381	0.203	
New Zealand	Tweedie		1.030	0.587	0.183	
Pakistan	Tweedie		1.234	0.395	0.356	
Peru	Tweedie		1.073	0.274	0.271	
Romania	Tweedie		1.186	0.280	0.607	
Serbia	Tweedie		1.595	0.322	0.516	
Slovenia	Tweedie		1.583	0.249	0.478	
Tunisia	Tweedie		1.136	0.389	0.379	
Turkey	Tweedie		1.325	0.230	0.714	
United Arab Emirates	Tweedie		1.193	0.266	0.708	
Zambia	Tweedie		1.336	0.402	0.447	
Zimbabwe	Tweedie		1.620	0.049	1.828	