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# The Croatian banking system total assets concentration dynamics: performing a variety of inequality measures

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## Abstract
The paper provides an overview of the trend in the concentration of the total assets of banks in Croatia for the period from 2007 to 2016 with the aim of analysing and presenting the changes that occurred in the system. Also, the paper shows the theoretical framework of the indicators used in the research as well as the comparison of their obtained values. The data used to calculate the total assets concentration are taken from the Croatian National Bank. The concentration indices used in the study include the entropy measure, the Theil entropy, the Gini coefficient, the Pietra index, the Atkinson index and the coefficient of variation. The results indicate a very slight decrease in concentration over the past several years, while the coefficient of variation points to the heterogeneity of the system, as well as to inequalities among the banks, which are most evident in the size of banks assets.

**Keywords:** Atkinson index, entropy, measures of concentration, Pietra index, total assets of banks.

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## Introduction
A decreasing trend in the number of banks, as well as the trend of a slight decrease in the total assets and profitability of the system characterize the Croatian banking

system over the last few years. What accounts for this trend is a significant decline in the number of banks as well as a series of mutual mergers and mergers of banks. According to the annual report of the Croatian National Bank (2017) on the reduction of the total assets of the banks, the trend has also been affected by the conversion of loans in Swiss francs into euro-denominated loans, as well as by the weakest credit activity of the system over the last few years.

The paper provides an overview of the trends in the assets concentration of the Croatian banking system in the last ten years and presents and analyses the changes that occurred in the system itself.

Since the banking system is subject to many structural changes, it is necessary to continuously monitor how it adapts to new conditions, which includes supervising the concentration of its assets. It is by means of different concentration measures that indicate the level of assets concentration in the system, i.e. the level of inequality and competition present in the market, may be revealed.

# Literature overview

Jakovčević (2001) gives a historical overview of the ownership structure of the Croatian banking system and describes the entry of foreign banks in Croatia while Galac and Kraft (2001) research the effects of their entry. Low profitability of the banking system, i.e. mostly of small banks, is explored by Stojaović, Leko and Krišto (2016) while Šverko, Pavlović and Vukas (2012) present the problems of small banks which, due to a less profitable and "old-fashioned" manner of doing business, are prone to mergers and acquisitions.

The concentration as well as inequality and diversification indicators are presented by Foldvary (2006), while Kraft (2007), also interested in this subject, links concentration and competition and concludes that the Croatian banking system is competitive and efficient. The subject of competitiveness and competition as well as the role of the Croatian National Bank in the monitoring of the concentration of the system is explored by Ružić (2006). In their paper, Stojanović and Krišto (2011) emphasise the importance of the supervision of the entire financial sector over the supervision of individual institutions. By introducing different macroprudential indicators and measures, early signals announcing possible changes and threats in the system may be recognised. Mandac and Krišto (2016) evidence the lower credit activity of the banks, mostly towards non-financial enterprises and citizens, after the financial crisis. In their paper, they elaborate on the process of decreasing liabilities towards majority shareholders, which has a negative impact on the profitability itself.

Ljubaj (2005) also provides an overview of concentration indicators and underlines the concentration increase after two large mergers which took place in 2003. Tipurić, Kolaković and Dumičić (2002, 2003), Dumičić, Pavković and Akalović Antić (2012) as well as Palić, Dumičić and Čurković (2016) also provide an insight into this subject.

In Tipurić, Kolaković and Dumičić (2003) basic evidence on the banking industry concentration in Croatia in the 1993-2002 period is shown. Industrial concentration is measured by typical (4-bank, 8-bank and 20-bank) concentration ratios, the Hirschman-Herfindahl index, entropy, the Lorenz curve, and the Gini coefficient. The research shows that the Croatian banking industry is relatively concentrated, showing an unbalanced oligopolic structure with two big market players, several medium-sized banks, and many small banks. The study has shown that merging and acquisition trends have been prevalent over the few last years.

Dumičić, Čeh Časni and Čibarić (2008) compare the concentration in the banking industry in Bosnia and Herzegovina, Croatia, Serbia and Montenegro using eight measures, showing that the concentration of banking assets is the highest in

Croatia, followed by Bosnia and Hercegovina, while in Serbia and Montenegro concentration is moderate.

In their paper Dumičić, Pavković and Akalović Antić (2012) deal with the measurement of concentration in banking by applying variables of the total assets as well as other variables that measure the total bank performance such as received deposits, time deposits, loans granted, interest and non-interest income, income after tax and equity in Croatia in the 2004 -2011 period. For the purpose of the study, the following indicators were used, such as various concentration ratios, the Lorenz curve, the Gini coefficient, the entropy indicator, and the Herfindahl-Hirschman's index. All calculated measures point to the trend of an increased concentration in banking in Croatia in the observed period. In addition to the most commonly analysed variables, such as the total assets, received deposits and loans, taking both interest and non-interest income and profit and capital into account results in an even higher degree of banking concentration in Croatia.

In Palić, Dumičić and Čurković (2016) the concentration of the total assets of the banks in Croatia for the 2003-2014 period was analysed. A significant number of concentration indicators, the entropy index, the exponential index, the Herfindahl-Hirschman index, the Gini coefficient, the Lorenz curve, different concentration ratios, the Hall-Tideman index, as well as the Rosenbluth index, show a slight increase in concentration of the banking system in Croatia from 2003 to 2014.

In the analysis of the relationship between concentration and competition in the banking system of Bosnia and Herzegovina, Jović (2006) utilizes different indices for concentration measurement: concentration ratios K1, K3 and K5, Gini coefficients, entropy measure and Herfindahl – Hirschman's index. In the period 1999 – 2004, all concentration measures, except Gini coefficient indicate an increase of deposits and loans concentration in the banking sector of Bosnia and Herzegovina, and all concentration measures, except Gini coefficient, were highly correlated. Despite the expectation of traditional theory of industrial organizations, the growth in concentration of Bosnia and Herzegovina banking sector had no impact on the competition reduction.

# Data and methods

During the analysed period from 2007 to 2016, the number of banks in Croatia significantly decreased. The data provided by the Croatian National Bank suggest that the number of banks decreased from 33, operating in 2007, to 25, operating at the end of 2016. A decreasing trend in the number of banks is a result of the fact that smaller banks ceased to operate mostly due to their profitability problems (Stojanović, Leko and Krišto, 2016) and many mergers and acquisitions of banks took place. In addition, one of the reasons for the decrease in the number of banks is the opening of the first branch of a foreign bank in Croatia. In October 2016, BKS bank ceases to operate as a joint-stock company in the Republic of Croatia and starts operating as a branch of the parent bank having its registered seat in Austria. Pursuant to the Council Directive(1989) 89/117/EEC, the first branch office of a foreign bank in Croatia, with a full name BKS Bank AG, Main branch office in Croatia, does not have the obligation to submit annual financial reports on independent business activity to the Croatian National Bank and the Croatian National Bank is not competent for its supervision.

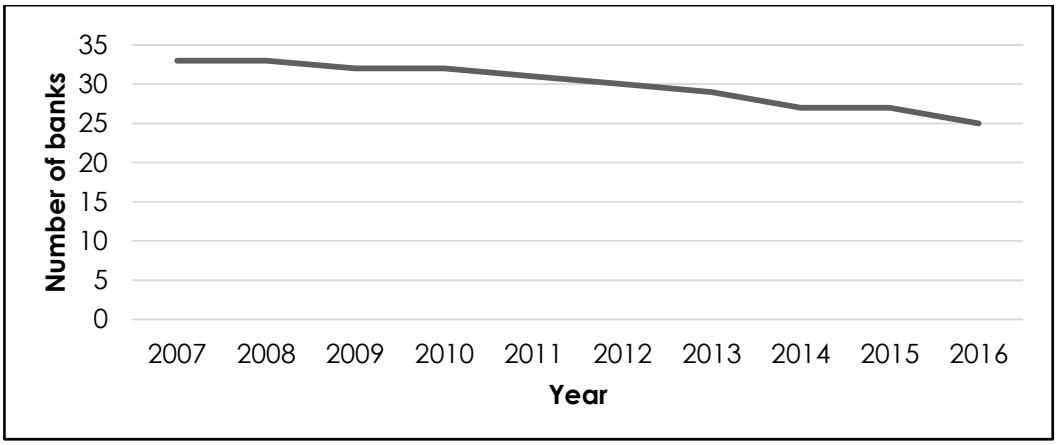


Figure 1 Number of banks in Croatia
Source: Authors' creation, Croatian National Bank data.

In order to calculate concentration indicators of the total assets of the banks in Croatia the published data on the total assets of the individual banks operating in Croatia in the analysed period were used. The data were taken from the official web pages of the Croatian National Bank.

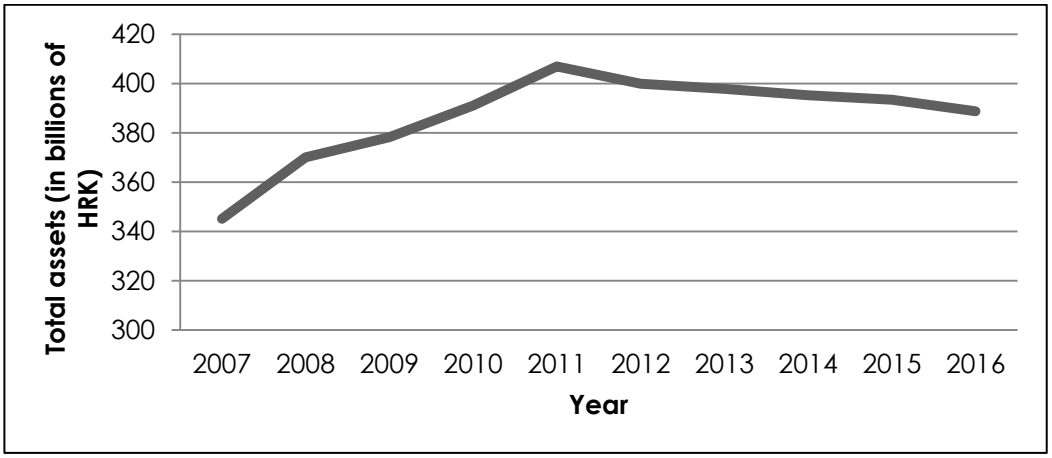


Figure 2 Total assets of banks in Croatia from 2007 to 2016, in billions of HRK
Source: Authors' creation, Croatian National Bank data

The Figure 2 shows the increase of the total assets of the banks in Croatia until 2011 when the total assets of the Croatian banking system amounted to HRK 407 billion. In the period from 2011 until the end of 2016 there is a slight decrease of the total assets to approximately HRK 389 billion. Based on the Annual Report of the Croatian National Bank for 2016, the decrease in the total assets of the banks was mostly due to the conversion of Swiss franc loans into the euro-denominated loans but also to the exchange rate fluctuation, exit of two banks from the system as well as the sale of irrecoverable claims and a weaker lending activity of the system. A weaker lending activity of the system has been noticed since 2011 due to a postponed impact of the global financial crisis and mostly due to a decrease in lending to non-financial enterprises and citizens (Mandac and Krišto, 2016).

The measures of concentration are applied to reveal how a certain aggregate value is distributed per modalities of statistical variables, and two types of measures exist: absolute concentration measures and relative concentration measures also known as inequality measures (Šošić, 2006). In this paper, the following measures are used to assess the concentration of the Croatian banking system: the entropy index,

the Theil entropy measure, the Gini coefficient, the Pietra index, the Atkinson index of inequality and the coefficient of variation.

## Entropy and Theil entropy measures

Entropy is defined as a measure for the quantity of unused energy in a closed thermodynamic system (Tipurić, Kolaković, Dumičić, 2003). In information theory, entropy represents the measure of uncertainty. If applied in concentration measurement, entropy has the meaning of deviation from the lowest concentration or the total equality. The entropy measure that is often used for calculating the concentration in certain industries, and therefore it can be used for determining the assets concentration of the banking system, takes the following form:

$$E = -\sum_{i=1}^{N} p_i \ln p_i \,, \tag{1}$$

where N is the total number of units and $p_i$ is the proportion of variable value corresponded to i-th unit in the sum of all variable values (Tipurić, Kolaković, Dumičić, 2003). The entropy is negatively correlated to the concentration level, i.e. the smaller the concentration, the greater the measure of entropy. The values of the entropy measure are within the range from 0 to lnN. Concentration is the lowest when the entropy measure is lnN and the greatest when the entropy equals zero, i.e. the monopoly takes place (Valdevit, Čibarić, Žmuk, 2008).

The family of generalized entropy measures, given by:

$$\begin{cases} GE(\alpha) = \dfrac{1}{N}\dfrac{1}{\alpha(\alpha-1)}\displaystyle\sum_{i=1}^{N}\left[\left(\frac{y_i}{\bar{y}}\right)^{\alpha} - 1\right], \ \alpha \neq 0,1 \\ GE(1) = \dfrac{1}{N}\displaystyle\sum_{i=1}^{N}\frac{y_i}{\bar{y}}\log\left(\frac{y_i}{\bar{y}}\right) \\ GE(0) = \displaystyle\sum_{i=1}^{N}\frac{1}{N}\log\left(\frac{y_i}{\bar{y}}\right) \end{cases} \tag{2}$$

has a specific parameter $\alpha$ that places sensitivity focus on the different parts of the variable distribution. In practice, the positive values of the parameter $\alpha$ are more commonly used. The lower the value of the parameter, the more sensitive the measure is to the changes in lower tail of the distribution, while the higher the value of the parameter, the more sensitive the measure is to the changes that affect the higher tail of the distribution of the chosen variable (Atkinson and Bourguignon, 2015), in this case the total assets of the banks. For the purpose of this paper, Theil entropy measure is used. It is obtained from the family of generalized entropy measures for $\alpha = 1$:

$$T = GE(1) = \frac{1}{N}\sum_{i=1}^{N}\frac{y_i}{\bar{y}}\ln\left(\frac{y_i}{\bar{y}}\right), \tag{3}$$

where N is the the total number of units, $y_i$ represents individual values of the variable for which the concentration is being calculated and $\bar{y}$ is the variable mean.

## Gini coefficient and Pietra index

The Gini coefficient is one of the most frequently used measures of concentration. It is a numerical representation of the inequality level connected to the Lorenz curve (Gogala, 2001). The Gini coefficient actually equals double concentration area – the

area between the Lorenz concentration curve and the uniform distribution line, and it is defined as follows (Šošić, 2006):

$$G = \frac{2\sum_{i=1}^{N} i \cdot y_i - (N+1)\sum_{i=1}^{N} y_i}{N\sum_{i=1}^{N} y_i}, \quad (4)$$

where N is the total number of units and $y_i$ are individual values of the variable for which the concentration is being calculated. The values of the Gini coefficient range from zero (the values are equally distributed and there is no concentration) to 1, being a sign of the highest concentration level.

It can be said that the Lorenz curve is a graphical representation of the Gini coefficient whose points are situated below the uniform distribution line, and the concentration is manifested as the distance of the curve from the line. The higher the concentration, the Gini coefficient is closer to 1, the curve is more distant from the line, and vice-versa, the closer the curve is to the line, the concentration is lower and the Gini coefficient is closer to zero.

The normalized Gini coefficient (Valdevit, Čibarić and Žmuk, 2008) is calculated based on the following formula:

$$G^* = G\frac{N}{N-1}, \quad (5)$$

where G is the value of the Gini coefficient and N the total number of units. The values of the normalized Gini coefficient are influenced by the number of banks, so the higher the number of the banks in the market, the closer the values of the Gini coefficient and the normalized Gini coefficient.

The Pietra inequality index (Inequality Measurement, 2015), also known as the Hoover index, the Ricci-Schutz or the Robin Hood index, shows how the variable values should be distributed in order for them to create a perfect equality or minimal concentration. The index value actually approximates a proportion of the total variable value which should be transferred from the value area above the arithmetic mean to the value area below the arithmetic mean so the uniform distribution can be achieved. One form of the Pietra (Hoover) index is defined by (Frosini, 2012):

$$H = \frac{\sum_{i=1}^{N} |y_i - \bar{y}|}{2\sum_{i=1}^{N} y_i}, \quad (6)$$

where $y_i$ are individual values of the variable for which the concentration is being calculated, $\bar{y}$ is the variable mean and N is the total number of units.

The value of this index can also be presented graphically on the Lorenz curve, and it represents the greatest vertical distance between the Lorenz curve and the uniform distribution line. Higher values of the index represent a higher inequality level since a greater redistribution of values is required in order to achieve equality and vice-versa, lower values of the index represent a lower inequality level.

## Atkinson inequality index

According to its definition (Bellu and Liberati, 2006), the Atkinson indices show the percentage of total value that units are ready to waive in favour of others, i.e. in order to achieve less concentration level. These measures depend on parameter *e*, which represents aversion to inequality if indices are used in inequality measurement. Level of aversion is set by the researcher himself during his research or it is estimated

earlier, for given society. Higher values of the parameter mean that individuals are more ready to accept lower income in exchange for a more equal distribution. Indices are defined as follows:

$$A = 1 - \left[ \frac{1}{N} \sum_{i=1}^{N} \left( \frac{y_i}{\bar{y}} \right)^{1-e} \right]^{1/(1-e)}, \quad (7)$$

where N is the total number of units, $y_i$ are individual values of the variable for which the concentration is being calculated, $\bar{y}$ is the variable mean and *e* is the parameter representing the level of inequality aversion. The values of the indices vary between 0 and 1 where the lower values imply a less concentrated distribution of the variable. The higher positive values of inequality aversion parameter will give higher importance to the lower tail of the distribution. Therefore, the higher the inequality aversion level, the higher the value of the index as well.

## Coefficient of variation

The coefficient of variation (Šošić, 2006) is a relative dispersion measure, i.e. the measure of dispersion around the mean, expressed in percentage. It is calculated based on the following formula:

$$V = \frac{s}{\bar{y}} \cdot 100, \quad (8)$$

where s is a standard deviation and $\bar{y}$ the arithmetic mean of the variable. The higher coefficient of variation indicates a higher dispersion around the mean, i.e. a lower representativeness of the arithmetic mean. In some cases, the coefficient may even exceed 100%, meaning that the data set is very heterogeneous. Smaller values of coefficient of variation represents the lower level of concentration.

# Results

The research results, i.e. the values of selected concentration indices have been calculated by means of a web tool wessa.net (Wessa, 2017)and are shown in Table 1. The obtained results testify of a slight increase in the concentration up to 2011 and afterwards some indices show a slight decrease in concentration until the end of 2016. All results will be explained in detail in the following paragraphs.

Table 1 Concentration measures of total assets of Croatian banks from 2007 to 2016*

| Measure | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Entropy | 2.415 | 2.401 | 2.335 | 2.352 | 2.323 | 2.308 | 2.309 | 2.302 | 2.291 | 2.275 |
| Theil Entropy Index | 1.081 | 1.096 | 1.131 | 1.113 | 1.111 | 1.093 | 1.058 | 0.994 | 1.005 | 0.944 |
| Gini coefficient | 0.742 | 0.746 | 0.752 | 0.747 | 0.748 | 0.745 | 0.736 | 0.720 | 0.722 | 0.705 |
| Normalised Gini | 0.765 | 0.769 | 0.776 | 0.771 | 0.773 | 0.770 | 0.762 | 0.747 | 0.749 | 0.734 |
| Pietra | 0.625 | 0.626 | 0.648 | 0.642 | 0.640 | 0.631 | 0.617 | 0.598 | 0.599 | 0.576 |
| Atkinson e=0,5 | 0.481 | 0.485 | 0.499 | 0.489 | 0.490 | 0.485 | 0.471 | 0.450 | 0.450 | 0.427 |
| Atkinson e=1 | 0.757 | 0.761 | 0.772 | 0.759 | 0.763 | 0.759 | 0.746 | 0.726 | 0.720 | 0.693 |
| Atkinson e=2 | 0.913 | 0.915 | 0.916 | 0.909 | 0.912 | 0.910 | 0.903 | 0.889 | 0.880 | 0.862 |
| Coeff. of Variation | 179% | 182% | 184% | 183% | 183% | 181% | 178% | 169% | 172% | 164% |

*Note: www.wessa.net software was used.

### Entropy and Theil entropy measures

As it has already been mentioned, the entropy measure is negatively correlated to the concentration level. In other words, the closer the entropy value to zero, the

higher the concentration, and the closer the entropy to lnN value, the lower the concentration. For 2016, lnN equals ln(25)=3.22 so it can be concluded that the assets in Croatian banking system is slightly concentrated. The same conclusion can be drawn based on the Theil entropy measure. In addition, the graphic representations of the trends of these indices show that they are mutually consistent.

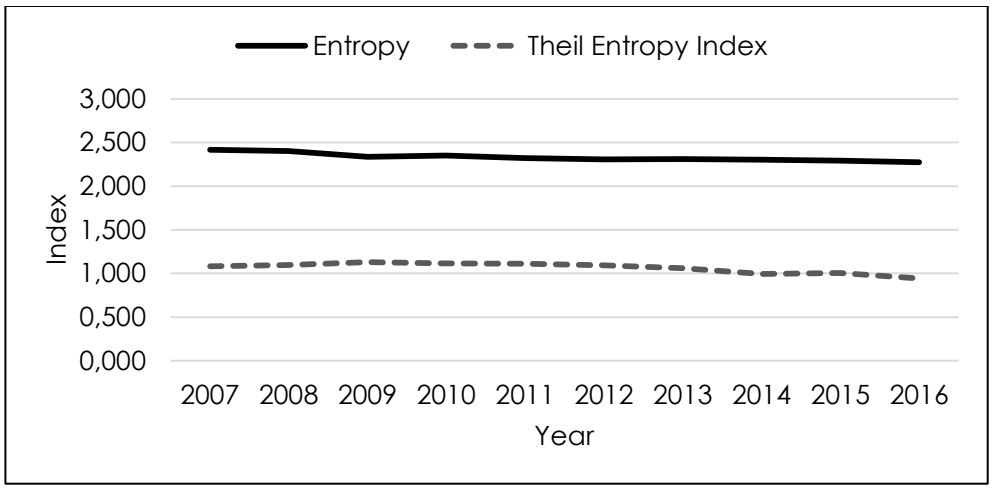


Figure 3 Entropy and the Theil entropy index of bank assets in Croatia from 2007 to 2016

Source: Authors' creation, Croatian National Bank (2017).

In the first year of the analysed period, the entropy measure was equal to 2.415 while in 2016 its value was 2.275, which indicates a slight increase of concentration. In addition, in 2007 the Theil index was equal to 1.081 and in 2016 it fell slightly to 0.944. The Theil index was at the highest level in 2009 when its value was 1.131, but all these data imply a slight decrease in concentration which can be concluded on the basis of a decreasing trend regarding the number of the banks in the market.

**Gini concentration coefficient and Pietra index**

Since the Gini concentration coefficient and the Pietra inequality index are in theory related to the Lorenz curve, they should be observed together as they are supposed to represent similar movements. The values of the Gini coefficient range from 0 to 1 and higher values of coefficients indicate a higher concentration as well as a larger distance between the Lorenz curve and the uniform distribution line. The values of the normalised Gini coefficient should always be higher that the values of the Gini coefficient and the values of both indices should come closer as the number of banks rises. As it has already been defined for the Pietra index, the more distant the Lorenz curve from the uniform distribution line, the higher the value of the Pietra index, which means a greater concentration.

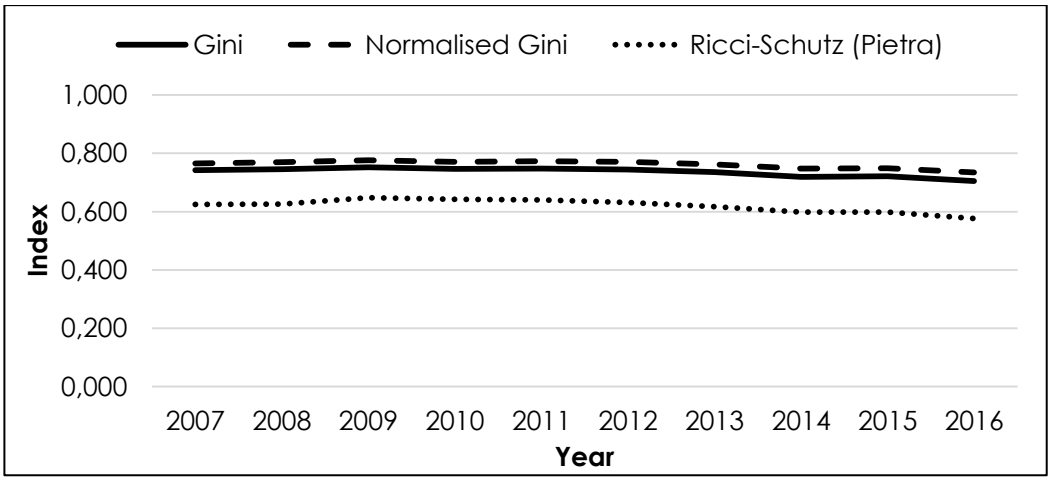


Figure 4 The Gini coefficient and the Pietra index of bank assets in Croatia from 2007 to 2016

Source: Authors' creation, Croatian National Bank (2017).

Based on the data presented in Table 1 and in the figures, it can be concluded that the concentration had been increasing slightly until 2009 when a slight decrease took place as indicated by the values of calculated indices. The highest level of the indices was recorded in 2009 (the Gini coefficient was equal to 0.752, the normalised Gini to 0.776 and the Pietra index to 0.648), and the lowest at the end of the analysed period, in 2016 when the Gini coefficient was equal to 0.705, the normalised Gini to 0.73 and the Pietra index to 0.576. In 2007, the number of banks operating in the market is the highest during the analysed period and then the difference in values of the Gini coefficient and the normalised Gini was the lowest while it was the highest in 2016 when the number of banks operating in the market was the lowest during the analysed period. The values of these indices imply that the system is concentrated and the concentration slightly decreased after 2009.

**Atkinson measure**

Based on the definition of the Atkinson index presented earlier, this index depends on the level of inequality aversion which is determined by the researcher himself or estimated for the population. In this research, three levels of inequality aversion were used: 0.5, 1 and 2, in order to confirm the theoretical statement that the higher the level of inequality aversion, the higher the index values, and vice versa. The Figure 5 confirms this assumption as the index attains the lowest values when the level of aversion is 0.5 and the highest when the level of aversion is 2.

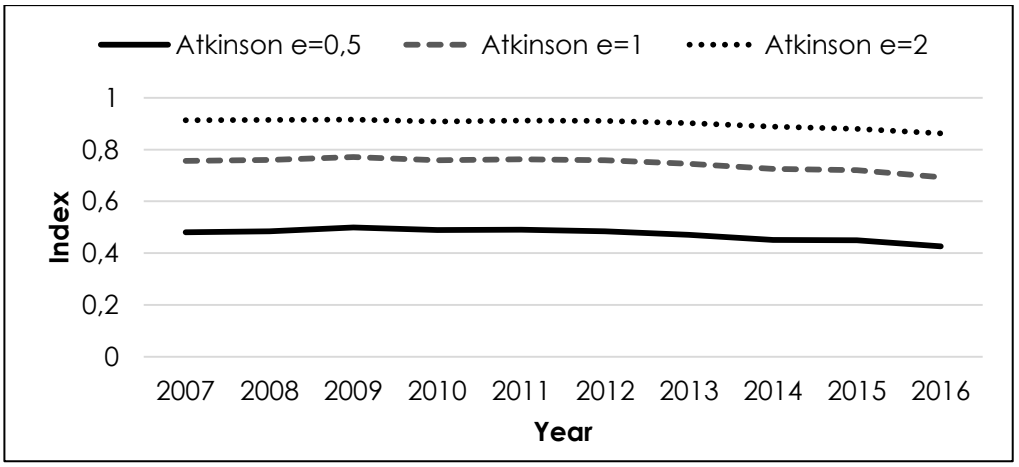


Figure 5 Atkinson's inequality measures of bank assets in Croatia from 2007 to 2016
Source: Authors' creation, Croatian National Bank (2017).

The Atkinson index may range between 0 and 1 where lower index values imply a more equal distribution of the value of the variable, i.e. a lower inequality which also means a lower concentration. As expected, the index with the lowest level of inequality aversion attained the lowest values but all three calculated indices show a relatively high level of assets concentration but also a trend of a slight decrease in the observed period.

**Coefficient of variation**

Based on the obtained results and the figure 6 it can be concluded that the coefficient of variation is the most volatile measure of all the measures used in the research for the analysed period. As it has been defined earlier, the higher coefficient of variation implies a greater dispersion around the mean and it should amount up to 100%. However, in some cases the coefficient may exceed the value of 100%, meaning that the data set is very heterogeneous.

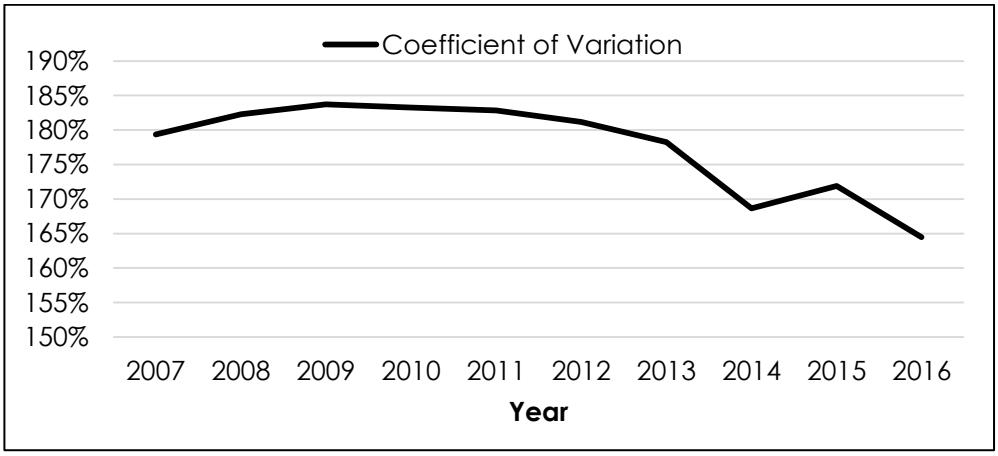


Figure 6 The coefficient of variation of bank assets in Croatia from 2007 to 2016 (authors' calculation)
Source: Authors' creation, Croatian National Bank (2017).

Based on the results presented in Table 1, it can be observed that the coefficient of variation throughout the entire analysed period is higher than 100%, which proves that the data set is heterogeneous. The individual data on the bank assets in the Croatian banking system, based on which all concentration indicators were

calculated, also suggest that the data set is heterogeneous. Namely, different banks have different values of the total assets so large banks have a significantly higher value of the total assets than smaller banks in the system, which indicates the inequality among the banks when the absolute value of their total assets is taken into account. In the accordance with the other calculated indicators, coefficient of variation also shows slight decrease in assets concentration of Croatian banking system in the observed period.

# Conclusions

The banks play an important role in the Croatian economy taking into account that the most significant portion of national monetary assets is concentrated in the banking system. Throughout the years they develop, their ownership structure changes, mergers and acquisitions take place and many banks are liquidated. The majority of the banks in Croatia have a foreign owner and since October 2016 the first branch office of a foreign bank has been operating over which the Croatian National Bank has no supervision authority. Over the years, the banks have increased their assets but since 2011 a slight decrease in the total assets of the banking system can be noticed, mostly due to lower credit activity towards enterprises and citizens as a postponed impact of the financial crisis but also the conversion of Swiss franc loans into the euro-denominated loans which occurred in 2016. A decreasing trend of the number of banks is still noticed in Croatia that indicates a further increase in concentration of the system.

The calculated indicators suggest a slight increase in concentration up to 2011 and then some indices show a slight decrease in concentration until the end of 2016. Inequality moves in the same direction as the concentration, which means that there is a slight decrease in inequality among the banks in the Croatian banking system. On the other hand, all indicators and obtained values are within certain limits suggesting a presence of concentration in the system. Furthermore, different banks have different values of their total assets so the large banks have a much higher value of the total assets than smaller banks in the system, which testifies of the inequality among the banks when the absolute value of their total assets is taken into account, which also suggests that the system is heterogeneous.

As Croatia is characterised by a decreasing trend of the number of banks, a further decrease in the number of banks is to be expected which in theory points to an increase in concentration. In the last several years, the system encounters profitability problems, which mostly impacts smaller banks which do not manage to withstand the competition and remain in the market. These reasons force small banks to involve in mergers and acquisitions, which directly influences concentration.

Extremely high concentration can have negative effects on the system due to reduced competition, and apart from the fact that banks can form higher prices, there is also a problem of risk dispersion which can be dangerous for the financial stability. On the other hand, a certain degree of concentration can be considered good for the system because larger and more competitive banks operate in the system, offering a greater range of products and services due to economy of scale, attracting more quality customers and thereby increasing their profitability. As larger banks are known as stable ("too big to fail"), it can be considered that it will have positive impacts on financial stability. For this reason, the constant analysis and monitoring of the concentration of the system is required together with constant monitoring of the financial system as a whole in order for early signals which can highlight potential threats to the system to be detected.

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