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# EFFICENCY OF THE MACEDONIAN BANKING SECTOR: A NON-PARAMETRIC APPROACH

**Katerina Fotova Čiković, PhD**
katerina.fotova@gmail.com

**Violeta Cvetkoska, PhD**,
Assistant Professor, Ss. Cyril and Methodius University in Skopje, Faculty of Economics-Skopje
vcvetkoska@eccf.ukim.edu.mk

***Abstract***

*The aim of this paper is to measure the relative efficiency of the commercial banks in Macedonia by using the non-parametric methodology Data Envelopment Analysis (DEA). The key role when applying DEA for measuring the efficiency of entities is given to the selection of inputs and outputs. In our study 3 inputs and 3 outputs are selected according to the intermediation approach. The sample consists of 14 banks and the observed period is eight years (2008-2015). According to the obtained results, the average efficiency of the Macedonian banking sector in the observed period is 88.77%. There is no bank that is relatively efficient in every year in every window. The results indicate that 28.57% of the banks have an overall efficiency by years that is higher than 95%. The group of large banks has the highest efficiency in the Macedonian banking sector. Furthermore, Macedonian banks have noted lower efficiency in the post-crisis period. Findings from our paper are valuable for further use by regulators, policy makers and bank management in order for the efficiency of the relatively inefficient Macedonian banks and the banking sector as a whole to improve.*

***Key words:*** *non-parametric approach, DEA, relative efficiency, banking sector, commercial banks*

***JEL:*** *C02, C44, C61, G21*

## 1. Introduction

Financial institutions in every country are a very important part of the financial system. The quality of the financial institutions determines the level of the development of a country's economy. A healthy financial institution relies on its asset quality, capacity, asset flow, capital adequate ratio, etc. (Kumar et al., 2015).

The banking sector plays a significant role in the economic development of any country and is considered a backbone of the country's economy. The financial system of Macedonia is relatively simple and financial markets are still underdeveloped. It is considered to be a bank-based financial system where banks play a cru-

cial role in financing the economic activities and maintaining the financial stability of the system as well as the stability of the other institutional segments. Banks are the main strings that connect the institutions and participants in the financial system, and they have the highest influence on the total movements in the system. It is safe to assume that the banking sector is the key segment, which can transfer the risks onto the other segments in the financial system. Therefore, it is crucial to maintain its stability in order to maintain the total financial stability in the economy (NBRM, 2016).

According to Khan and Khattak (2016), the banking sector is considered to be a nervous system of the country's economy. If the nervous system fails to function, the whole body becomes useless. Similarly, failure of the banking system will lead to a catastrophe of the whole economic system. Therefore, for the stability and growth of economy, the banking sector has to function at its optimum level. This can be achieved only if the banking sector is able to allocate the resources efficiently or with minimum waste. In the last few decades, substantial changes have been witnessed in the banking sector, like financial deregulation, globalization, competition, innovation and advances in technology. These changes have drastically altered the financial scenario and led the banks to operate at a high level of efficiency in order to survive.

Data Envelopment Analysis (DEA) is the leading non-parametric methodology for measuring the relative efficiency of Decision-Making Units (DMUs). Thanassoulis (2001) points out that the DMUs should be homogeneous, i.e. they shoud use the same inputs and produce the same outputs. This methodology is introduced in the literature of the discipline Operations Research (OR) by Charnes, Cooper and Rhodes in 1978. Based on the empirical data for the inputs that are used and the outputs that are produced, i.e. achieved by the decision-making units under consideration, an empirical efficiency frontier is constructed. The DMU that is efficient lies at the extreme frontier, while the inefficient one lies below this frontier (Charnes et al.,1994: 5-6). DEA assigns a score of 1 (100%) to highly efficient DMUs and a score of less than 1 to relatively inefficient units. DEA enables the amounts and sources of inefficiency to be determined, which is very valuable information in order to improve the efficiency of inefficient DMUs. Emrouznejad et al. (2008) published a bibliography on DEA that consists of over 4000 research articles, and in the following areas most of the applications are noted: banking, education, healthcare and hospital effficiency (Cvetkoska and Savic, 2017).

In this paper the DEA technique Window Analysis is employed in order to measure the efficiency of commercial banks in Macedonia in the period from 2008 to 2015. This technique allows for the number of DMUs to be increased and a time dimension to be included in the analysis. In the existing literature we have not found a study like ours, which means that it will contribute to the existing literature on banking efficiency in the developing countries, particularly in the Balkans.

The paper is structured as follows: besides the introduction that is given in Section 1, in Section 2 there is given a brief literature review. Methodology is explained in Section 3, and the data is presented in Section 4. The obtained empirical results are shown and analyzed in Section 5, while the conclusion is given is Section 6.

## 2. Literature review

Naumovska and Cvetkoska (2014) give an overview of literature of the application of DEA methodology in measuring the relative efficiency of banks in: Bosnia and Herzegovina (Memic and Memic, 2013), Bulgaria (Nenovsky et al., 2008; Toci, 2009), Greece (Varias and Sofianopoulou, 2012), Kosovo (Toci, 2009), Letonia and Lithuania (Titko and Jureviciene, 2014), Macedonia (Micajkova and Poposka, 2013), Poland (Chudy et al., 2012; Kisielewska et al., 2005), Slovakia (Repkova, 2014), Serbia (Mihailovic et al., 2009; Savic et al., 2012), Croatia (Jemric and Vujcic, 2002; Toci, 2009), Montenegro (Toci, 2009) and the Czech Republic (Repkova, 2013). Information regarding the author/s of the study, the observed country, the time period, the sample and the used methodology can be obtained from their review.

In this paper we have employed the DEA technique Window analysis for measuring the relative efficiency of the commercial banks in Macedonia. Based on the existing literature, it has been found that: Kisielewska et al. (2005) have used Window analysis and Malmquist indexes in order to analyze the performances of 10 large commercial banks in Poland in the period from 1995 to 2003; Asmild et al. (2004) have combined the

Window analysis with the Malmquist indexes in a study regarding the Canadian banking industry; Hartman and Storbeck (1996) have used the Window analysis for investigating the development of loan efficiency in 12 Swedish banks in the period of 9 years, while Savić et al. (2012) have used the Window analysis for measuring the efficiency of 28 commercial banks in Serbia in the period from 2005 to 2011.

There are a few studies regarding the measurement of the relative efficiency of the commercial banks in Macedonia: Micajkova and Poposka (2013), Naumovska and Cvetkoska (2014), and Naumovska and Cvetkoska (2016).

Micajkova and Poposka (2013) have estimated the efficiency of the Macedonian banking sector during the period 2008-2011 using the DEA approach. They have measured the technical, pure technical efficiency and scale efficiency of 15 banks in the Republic of Macedonia using two DEA models: the CCR model and the BCC model, which are input-oriented. The intermediation approach is applied and two inputs and two outputs are chosen. As inputs the following are chosen: total deposits received and labor costs, and as outputs: loans to banks and customers, and investments. According to the obtained results, the average efficiency of the Macedonian banking sector increased in the period from 2008 to 2010, while it decreased in the last year of the observed period, i.e. in 2011. In this banking sector the highest pure efficiency scores and the greatest scale inefficiency were noted in the group of large banks.

Naumovska and Cvetkoska (2014) measure the efficiency of the banking sector in the Republic of Macedonia from two perspectives. Firstly, they have compared the indicators of efficiency of the Macedonian banking sector with those of the countries of Central and Southeastern Europe in the period from 2003 to 2012. Secondly, they estimated the relative efficiency of 14 Macedonian commercial banks in the period from 2007 to 2013 by using the DEA methodology, i.e. the output-oriented CCR DEA model. Deposits and operating costs have been selected as inputs, whereas loans and net interest income as outputs. Based on the obtained results from the used DEA model, they have concluded that no bank has been efficient in all of the observed years. Komercijalna banka AD Skopje and ProCredit Banka AD Skopje have been relatively efficient in 6 out of 7 years, whereas 5 banks are not relatively efficient in any of the observed years. The highest number of efficient banks (i.e. 6 banks) has been identified in 2008, whereas the lowest number of efficient banks (i.e. 3 banks) has been identified in 2011 and 2012. The average efficiency of the Macedonian banking sector has been the highest in 2008 (90.35%) and the lowest in 2012 (79.83%).

Naumovska and Cvetkoska (2016) have used the same sample of banks, variables and time frame as in the study by Naumovska and Cvetkoska (2014), but here the output-oriented BCC DEA model is applied. Based on the obtained results, it has been determined that in the observed period, 4 banks have been relatively efficient. The average efficiency of the Macedonian banking sector has been the highest in 2008 (93.66%) and the lowest in 2009 (86.96%). In 2013, 5 of the banks were identified as relatively inefficient and there has been a projection of how to improve their efficiency.

Based on the above, it can be concluded that there is no reference for the Window analysis application in the analysis of the relative efficiency of commercial banks in Macedonia. Therefore, this is an original study.

## 3. Methodology

For measuring the relative efficiency of commercial banks in Macedonia, in this paper we have used the output-oriented DEA Window analysis model with the variable returns to scale (VRS) assumption. A model is output-oriented when its purpose is to maximize the outputs by using the given level of inputs (Cooper et al., 2007). According to Popovic (2006), variable returns to scale (VRS) means that the increase in inputs does not lead to a proportional change in the outputs.

In this paper, the DEA technique Window analysis is used under variable a returns to scale assumption, based on the Banker-Charnes-Cooper (BCC) model. Further details about the BCC model, which is one of basic DEA models, can be found in Banker et al. (1984). What follows is the envelopment form of the output-oriented BCC model (Cooper et al., 2007: 93; Cvetkoska and Barisic, 2014: 79):

$$(BCC\text{-}O_o) \qquad \max_{\eta_B,\lambda} \eta_B \tag{1}$$

subject to

$$X\lambda \leq x_o \tag{2}$$

$$\eta_B y_o - Y\lambda \leq 0 \tag{3}$$

$$e\lambda = 1 \tag{4}$$

$$\lambda \geq 0 \tag{5}$$

where $\eta_B$ is a scalar; ($x_{1j}, x_{2j},\ldots.x_{mj}$) - the input data for DMUj (j=1,…,n), ($y_{1j}, y_{2j},\ldots.y_{sj}$) - the output data; by two matrices $X$ and $Y$ the data set is given, the input data matrix is $X$, and the output data matrix is $Y$, a column vector with all elements non-negative is $\lambda$, and the row vector with all elements equal to 1 is $e$.

If the number of DMUs is not at least three times larger than the total number of inputs and outputs (Cooper et al., 2007: 116), more DMUs will form the efficiency frontier, and in order to overcome this problem, the DEA technique Window analysis can be used. It enables the number of DMUs to be increased and the changes in efficiency of the DMUs to be observed over time.

In our case, three inputs and three outputs are selected, and the number of DMUs, i.e. banks is 14 (explained in the next section), so to achieve appropriate results, the number of DMUs should be at least 18. Because of this, we have decided to use the DEA technique Window analysis.

The name of this DEA technique and its basic concept are associated with Klopp (1985). The idea of Window analysis is that the same DMU in the period i, i.e. in the period j (for i ≠ j) is observed like two different DMUs; p is the length of the window (a number of periods to be observed), then, first to be observed is the data for the first p period, then the data for the period 1 are omitted and the data for the period p + 1 are added, and this allows for the next window to be obtained, then the data for the first two periods are omitted and the data for periods p +1 and p + 2 are added, so the next window is obtained, and this is repeated as soon as all of the time periods in the analysis have passed (Neralic, 1995: 207).

In Window analysis the following symbols and formulas are used (Cooper et al., 2007: 326-327, Cvetkoska and Savic, 2017: 322): n – the number of decision-making units, k - the number of periods, p - length of the window (p ≤ k), p=k+1/2, w – the number of windows (w = k – p + 1), the number of decision making units in each window is calculated according to this formula: np, while the number of "different" decision making units is calculated through the formula: npw.

The obtained results with the Window analysis are presented in a table, and through the rows the trend can be observed, while through the column what can be noted is how the result changes or not with the change from one to another window. A disadvantage of this technique is that the DMUs in the first and the last period are not tested as frequently as others (Cooper at al., 2007).

**4. Data**

The sample for analysis consists of 14 commercial banks in Macedonia: Alfa Banka AD Skopje (rebranded in Silk Road Bank AD Skopje in May 2016), Centralna Kooperativna Banka AD Skopje, Eurostandard Banka AD Skopje, Halk Banka AD Skopje, Kapital Banka AD Skopje, Komercijalna Banka AD Skopje, NLB Tutunska Banka AD Skopje, Ohridska Banka AD Ohrid, ProKredit Banka AD Skopje, Sparkasse Banka AD Skopje, Stopanska Banka AD Bitola, Stopanska Banka AD Skopje, TTK Banka AD Skopje and Uni Banka AD Skopje. We have left out the Macedonian Bank for Development Promotion from our analysis because it is not comparable with other banks: it has a specific function in the sector and works on different principles than the commercial banks (it is a state-owned bank and is not involved in deposits collection).

The selection of inputs and outputs has been made according to the intermediation approach. The intermediation approach refers to the process in which from collected deposits loans are being given (Paradi et al., 2004: 355). As inputs the following 3 are selected: total deposits (deposits from banks and other clients),

interest costs and operating (non-interest) costs (costs for salaries, amortization, administrative costs and other operating costs), while as outputs the following 3 are selected: total loans (issued to banks and other clients) interest income and non-interest income (fee and commission income and other operating income). We have used data from the revised financial statements for the selected inputs and outputs for each commercial bank in the period from 2008 to 2015.

**5. Empirical results and analysis**

Our sample of analysis consists of 14 commercial banks (n=14), eight years are considered (k=8), the length of the window is 4 years (p=4), and the number of windows is 5 (w=k-p+1= 8-4+1=5). In each window there are 56 banks, and the number of "different" banks is 280. Every window covers 4 years (for example, window 1 covers 4 years: 2008, 2009, 2010 and 2011; in the next window (window 2) data for 2008 are omitted and the data for 2012 are added, and so on), as presented below:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| window 1 | 2008 | 2009 | 2010 | 2011 | | | | |
| window 2 | | 2009 | 2010 | 2011 | 2012 | | | |
| window 3 | | | 2010 | 2011 | 2012 | 2013 | | |
| window 4 | | | | 2011 | 2012 | 2013 | 2014 | |
| window 5 | | | | | 2012 | 2013 | 2014 | 2015 |

For solving the specified DEA model the software DEA-Solver-LV has been used, and details for this software can be found in (Cooper et al., 2007: 454-476). DEA efficiency scores will enable banks that are relatively efficient to be identified, as well as those that are relatively inefficient. Efficient banks will be those with a score of 1, i.e. 100%, while inefficient ones will have an efficiency score lower than 1.

Table 1 presents the average efficiency of commercial banks in Macedonia, by years, and the average efficiency for the whole banking sector in the observed period. According to the presented results in Table 1 it can be noted that in the post-crisis period (i.e. in the first few years shortly after the Global financial crisis) many of the banks note lower efficiency. The lowest average efficiency for the whole banking sector was achieved in 2011 (83.26%), while the highest was achieved in 2015 (96.35%). From 2012 to 2015 the average effieciency for the whole banking sector in Macedonia noted an increase. The increase in efficiency can be interpreted as a consequence of the processes of M&A in 2012 (when Halk Banka AD Skopje took over Ziraat Banka) and 2014 (when Postenska Banka AD Skopje was acquired by Eurostandard Banka AD Skopje). For example, in 2014, Eurostandard Banka AD Skopje acquired Postenska Banka AD Skopje. In 2015, its efficiency reached the peak and equaled 1 (100%), i.e. the bank was relatively efficient after the M&A. Halk Banka AD Skopje was taken over by the Turkish Halk Banka in 2011, and in 2013 the Macedonian Halk Banka acquired Ziraat Banka AD Skopje. Stopanska banka AD Bitola had AD Pelisterka as its largest shareholder in 2013 and that was the year that this bank began its modernization and expansion. According to the average efficiency scores, it increased its efficiency after this ownership change, i.e. after the year 2013.

As presented in Table 1, there is no one bank which has noted an efficiency score of 1 in each of the 8 years of the observed period. Furthermore, two banks (Ohridska Banka AD Ohrid and Uni Banka AD Skopje) have not achieved an efficiency score of 1 in any of the analyzed years.

**Table 1.** Avarege efficiency of the commercial banks in Macedonia, by years

| DMUs | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|
| Alfa Banka AD Skopje | 0.7041 | 0.7854 | 0.7549 | 0.7015 | 0.6044 | 0.8058 | 0.8030 | 1 |
| Centralna Kooperativna Banka AD Skopje | 0.8726 | 1 | 1 | 1 | 0.8687 | 0.7964 | 0.8139 | 0.8144 |
| Eurostandard Banka AD Skopje | 0.7030 | 0.7496 | 0.7050 | 0.6622 | 0.5739 | 0.5910 | 0.6373 | 1 |
| Halk Banka AD Skopje | 1 | 0.8328 | 0.7039 | 0.8415 | 0.8507 | 0.9477 | 0.9191 | 0.9499 |
| Kapital Banka AD Skopje | 1 | 0.9431 | 0.9715 | 0.5417 | 0.6419 | 0.8393 | 0.8931 | 1 |
| Komercijalna Banka AD Skopje | 1 | 1 | 1 | 1 | 1 | 0.9816 | 0.9943 | 1 |
| NLB Tutunska Banka AD Skopje | 1 | 0.9772 | 0.9341 | 0.9920 | 1 | 1 | 1 | 1 |
| Ohridska Banka AD Ohrid | 0.7342 | 0.8323 | 0.9157 | 0.8599 | 0.8271 | 0.8557 | 0.8094 | 0.8823 |
| ProKredit Banka AD Skopje | 1 | 0.9782 | 0.9970 | 0.9901 | 1 | 1 | 1 | 1 |
| Sparkasse Banka AD Skopje | 0.7467 | 0.8519 | 0.8039 | 0.7851 | 0.8761 | 0.9837 | 0.9833 | 1 |
| Stopanska Banka AD Bitola | 0.9907 | 1 | 0.8097 | 0.6935 | 0.7310 | 0.8435 | 1 | 0.9075 |
| Stopanska Banka AD Skopje | 1 | 1 | 1 | 1 | 1 | 0,9958 | 1 | 1 |
| TTK Banka AD Skopje | 0.7441 | 0.7285 | 0.8641 | 0.7641 | 0.8618 | 0.9682 | 0.9989 | 1 |
| Uni Banka AD Skopje | 0.8724 | 0.8425 | 0.8172 | 0.8255 | 0.8878 | 0.8765 | 0.9739 | 0.9345 |
| **Average** | **0.8834** | **0.8944** | **0.8769** | **0.8326** | **0.8374** | **0.8918** | **0.9162** | **0.9635** |

*Source: Authors' calculations.*

Table 2 gives the overall efficiency by windows and by years for the analyzed banks. For each bank what is used is the average of efficiency scores in 5 windows to estimate the overall efficiency by windows, while by using the average of annual efficiency the results of the overall efficiency by years for each bank are estimated. Based on the presented results (overall efficiency by years) in Table 2, it can be noted that the most relatively efficient banks are: Stopanska Banka AD Skopje (99.95%), Komercijalna Banka AD Skopje (99.70%), ProKredit Banka AD Skopje (99.57%) and NLB Tutunska Banka AD Skopje (98.79%), while the least efficient banks are identified as: Eurostandard Banka AD Skopje (70.27%) and Alfa Banka AD Skopje (76.99%).

**Table 2:** Overall efficiency (by windows and by years) of Macedonian commercial banks

| DMUs | Overall efficiency | |
|---|---|---|
| | by windows | by years |
| Alfa Banka AD Skopje | 0.7393 | 0.7699 |
| Centralna Kooperativna Banka AD Skopje | 0.9089 | 0.8957 |
| Eurostandard Banka AD Skopje | 0.6655 | 0.7027 |
| Halk Banka AD Skopje | 0.8589 | 0.8807 |
| Kapital Banka AD Skopje | 0.7920 | 0.8538 |
| Komercijalna Banka AD Skopje | 0.9967 | 0.9970 |
| NLB Tutunska Banka AD Skopje | 0.9862 | 0.9879 |
| Ohridska Banka AD Ohrid | 0.8481 | 0.8396 |
| ProKredit Banka AD Skopje | 0.9954 | 0.9957 |
| Sparkasse Banka AD Skopje | 0.8712 | 0.8788 |
| Stopanska Banka AD Bitola | 0.8278 | 0.8720 |
| Stopanska Banka AD Skopje | 0.9994 | 0.9995 |
| TTK Banka AD Skopje | 0.8599 | 0.8662 |
| Uni Banka AD Skopje | 0.8687 | 0.8788 |

*Source: Authors' calculations.*

As the previous research has shown (Naumovska and Cvetkoska, 2014, 2016), so has ours led to the conclusion that the group of large banks has the highest efficiency, and the group of small banks the lowest efficiency in the Macedonian banking sector. So, in order to improve their efficiency and the efficiency of the banking sector as a whole, small banks are best to consolidate. In that way, they could use the benefits of economies of scale and they could gain higher competitiveness through the ability to offer diversified products and invest in new and modern software and technological solutions, which will decrease their operating costs and thus increase their efficiency.

**Figure 1** shows the variation through Window (row-wise averages of results) for 4 banks from the sample. As can be noted, Stopanska Banka AD Skopje shows the most stable results, which is also the most efficient bank. Halk Banka AD Skopje shows an increase in its efficiency in window 3 and window 4, and a decrease in efficiency in the last window. Eurostandard Banka AD Skopje shows an increase in the efficiency score in the last window, while Alfa Banka AD Skopje shows an increase in the efficiency score in windows: 3, 4 and 5.

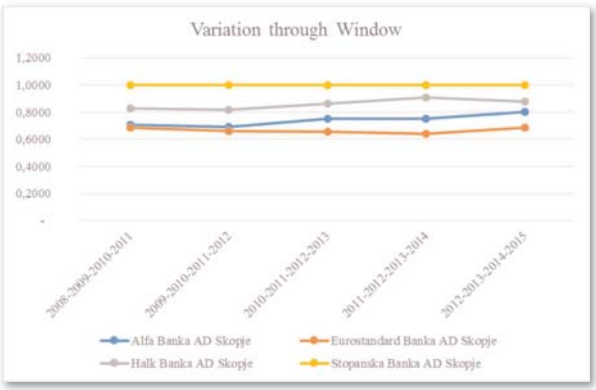


**Figure 1.**
Variation through Window

## 6. Conclusion

This paper attempts to measure the efficiency of the commercial banks in Macedonia in the period from 2008 to 2015 by employing the DEA technique Window analysis. According to the obtained results of average efficiency in separate years, a decrease of efficiency is noted in 2010 and 2011, and an increase in efficiency from 2012 to 2015.

The lowest score of average efficiency of the banking system as a whole was achieved in 2011 (83.26%), while the highest score of average efficiency was noted in 2015 (96.35%). The Global crisis has left its consequences on the Macedonian banking market with a time lag, but it appears that the market is rather quickly recovering, reaching 9 out of 14 banks in the sample being efficient in 2015. These results and the increase in efficiency can be interpreted as a consequence of the processes of M&A from 2012 (when Halk Banka AD Skopje took over Ziraat Banka) and 2014 (when Postenska Banka AD Skopje was acquired by Eurostandard Banka AD Skopje). Furthermore, we can name some more examples of benefits (in the form of growing efficiency) of the M&As in banking. Such benefits are identified in the cases of Halk Banka AD Skopje, Stopanska Banka AD Bitola and Eurostandard Bank AD Skopje.

Stopanska banka AD Skopje has been relatively the most efficient bank in Macedonia in this analyzed time frame, which has noted relative inefficiency only in 2013. The highest average efficiency scores were noted in the group of large banks.

The DEA technique Window analysis is applied to measure the efficiency of bank-branches of one of the leading banks in Macedonia – Komercijalna Banka AD Skopje, and the main contribution of our research is in the fact that this technique has not yet been applied to measure the relative efficiency of the Macedonian banking sector. The Macedonian financial markets are still underdeveloped and with the results of such a research not only can banking benefit but also the financial market and the whole economy, since it leads to conclusions and detection of inefficiencies among the commercial banks.

Considering the globalization and internalization of businesses and banks, the inception of new banking technologies as well as the continuous processes of M&A in banking, the commercial banks in the Republic of Macedonia would have to offer higher efficiency in the future, in order to survive these modern trends. The main contribution of the research is the fact that the whole banking sector as well as each individual bank have been screened in the study, enabling both generalization and specialization of the results and findings for their future use from the bank management and the interested public.

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