DOI: https://doi.org/10.32782/2524-0072/2025-77-1

UDC 336.7

APPLICATION OF POWER INDICES BY NATIONAL ECONOMIC ENTITIES FOR ULTIMATE BENEFICIAL OWNER IDENTIFICATION

ВИКОРИСТАННЯ НАЦІОНАЛЬНИМИ СУБ'ЄКТАМИ ГОСПОДАРЮВАННЯ ІНДЕКСІВ ВПЛИВУ ДЛЯ ІДЕНТИФІКАЦІЇ ФАКТИЧНИХ БЕНЕФІЦІАРНИХ ВЛАСНИКІВ

Varenyk Volodymyr
Postgraduate Student,
Private Higher Education Establishment"European University"
ORCID: https://orcid.org/0009-0002-9777-4899

Вареник Володимир Вікторович
Приватний вищий навчальний заклад «Європейський університет»

The research explores the possibility of using power indices by primary financial monitoring entities to identify the ultimate beneficial owners of their clients. It outlines the algorithm for calculating the Shapley-Shubik index, the Banzhaf index, and the Deegan-Packel index. It was determined that the Shapley-Shubik index and the Deegan-Packel index are advisable for use when applying enhanced due diligence measures to a client and when a reporting entity calculates its own risk profile. If clients are assigned a low or medium risk level, it is recommended to apply the Banzhaf index, which identifies the degree of a shareholder's power regardless of the order in which the company owner joins a winning coalition. Another advantage of using the Banzhaf index is its indifference to the number of shareholders capable of making a management decision.

Keyword: financial monitoring, power indices, primary financial monitoring entities, ultimate beneficial owner, national economic entities.

У статті розглянуто можливість використання індексів впливу при визначенні суб'єктами первинного фінансового моніторингу кінцевих бенефіціарних власників своїх клієнтів. Предмет дослідження обрано у зв'язку з вимогами міжнародного та національного законодавства щодо виявлення справжніх власників клієнтів та труднощами звітних установ в сфері фінансового моніторингу виконувати дані вимоги без наукового підґрунтя. Використання індексів впливу дозволить звітним установам знизити ризики у сфері протидії відмиванню коштів та фінансуванню тероризму та довести суб'єктам державного фінансового моніторингу факт виявлення кінцевого бенефіціарного власника клієнта, спираючись на результати комплексного та належного аналізу. Практичним значенням статті є створення рекомендацій стосовно застосування національними суб'єктами господарювання індексів впливу для виявлення серед своїх клієнтів фактичних бенефіціарних власників. У статті розкрито алгоритм розрахунку індексу Шеплі-Шубіка, індексу Банзафа та індексу Діґана-Пеккела. Встановлено, що індекс Шеплі-Шубіка та індекс Діґана-Пеккела доцільно використовувати при застосуванні до клієнта посилених заходів належної перевірки та при розрахунку звітною установою власного ризик-профілю. Даний висновок ґрунтується на факті, що лише при посилених заходах належної перевірки в звітної установи з'являється можливість запиту додаткових документів у клієнта, які дають змогу отримати інформацію про результати голосування акціонерів. Крім того, суб'єкт первинного фінансового моніторингу має можливість обробляти статистику голосування власних акціонерів через аналіз протоколів загальних зборів акціонерів та протоколів наглядової ради. В разі встановлення клієнтам низького або середнього рівня ризику, який дозволяє звітній установі здійснювати аналіз лише структури власності клієнта, рекомендовано застосовувати індекс Банзафа, що ідентифікує ступінь влади акціонера незалежно від черговості потрапляння власника компанії до виграшної коаліції. Іншою перевагою застосування індексу Банзафа є його індиферентність до кількості акціонерів, які мають здатність ухвалити управлінське рішення.

Ключові слова: фінансовий моніторинг, індекси впливу, суб'єкти первинного фінансового моніторингу, кінцевий бенефіціарний власник, національні суб'єкти господарювання.

Statement of the problem. The identification of the ultimate beneficial owner (UBO) is part of the customer due diligence (CDD) measures that must be conducted in accordance with the recommendations of the Financial Action Task Force on Money Laundering (FATF) and Ukrainian legislation. In particular, primary financial monitoring entities are obligated to determine the nature and share of beneficial ownership of their clients through an analysis of the ownership structure of legal entities. The extent of the reporting institution's actions to collect the necessary information and the depth of analysis of the obtained data should be proportionate to the identified risks, taking into account, among other things, the complexity of the ownership structure. The result of such analysis should be a well-founded conclusion by the institution regarding the presence or absence of a factual owner of the client. To increase objectivity, power indices based on a game-theoretical approach may be used in the process of identifying company beneficiaries.

Analysis of recent research and publications. N. Stepanenko and V. Hurenko [1] investigated the peculiarities of identifying ultimate beneficial owners in Ukrainian non-profit organizations. In their work, T. Yamnenko and V. Savenkova [2] analyze the definition of a beneficial owner according to the terminology of the Financial Action Task Force on Money Laundering. I. Mitić [3] researched the legality of personal data transparency of ultimate beneficial owners, relying on standards established by European Union legislation. S. Jafarnejad, F. Robinet and R. Frank [4] proposed identifying politically exposed persons by using information on the participation of minor shareholders in companies and the number of registered companies at a single address. H. Von Haenisch and T. Egner [5] provided proposals for creating a unified approach to client due diligence processes across Europe.

Highlighting previously unresolved parts of the overall problem. Thus, the issues of finding and using methods that would allow primary financial monitoring entities to identify ultimate beneficial owners, based on a scientifically sound approach, remain insufficiently explored.

Formation of the objectives of the article (task statement). The aim of the article is to define power indices that can be applied by Ukrainian financial monitoring entities when identifying ultimate beneficial owners.

Summary of the main research material. Power indices are mathematical tools used to assess the actual impact of coalition game participants on the outcome of a particular decision. Their application is logical in cases where the reporting institution in the field of anti-money laundering and counter-terrorist financing (AML/CFT) identifies a high concentration of power in the corporate ownership structure, which indirectly indicates a high probability of the client having ultimate beneficial owners. The use of power indices enables a more accurate assessment of each shareholder's impact on decision-making, thereby identifying the shareholders who exercise actual control over the company.

One of the most widely used power indices, employed by scholars for the analysis of both political and economic spheres, is the Shapley–Shubik index, developed by Lloyd Shapley and Martin Shubik in 1954. The main idea of the index is to determine the probability that a given player – in our case, a shareholder – will be considered a 'pivotal' member of a coalition. A 'pivotal' player is one whose vote or shareholding turns a losing coalition into a winning one. The inclusion of such a shareholder in the coalition is the final step needed to reach the required quota for decision-making. Unlike simple vote-counting, the Shapley–Shubik index takes into account all possible sequences of coalition formation. This is important because the order in which players join a coalition can power their ability to be the 'pivotal' player [6, p. 3530]. The index is calculated by listing all possible permutations of players. For each permutation, the player who is pivotal is identified. The number of times each player turns out to be pivotal is then divided by the total number of permutations.

To analyze the ownership structure of a company, the index for shareholder i in game v can be represented by the following formula [6, p. 3526] (1):

$$\varphi_i = \sum_{S \subseteq N} \frac{(n-s)!(S-1)}{v^n!} \left[v(S) - v\left(S \setminus \{i\}\right) \right] \quad (1)$$

where n – the number of players in the set N;

S – coalition consisting of N players;

s – players in coalition S.

The Shapley–Shubik index is appropriate to use in cases where the order in which shareholders join a coalition matters and when it is necessary to assess the shareholder's contribution at the moment of the 'decisive vote.' Such a situation may arise in corporate cultures where coalition-building is a common practice in decision-making processes. Depending on the specific issue being voted on, the group

of shareholders willing to support it often changes. Therefore, a shareholder's power is best demonstrated by their ability to be the final member of a coalition that ultimately enables a decision to be made. Among the disadvantages of the index is its computational complexity when there is a large number of shareholders, since calculating it requires evaluating N! permutations. Additionally, the index may yield counterintuitive results if a particular shareholder turns out to be pivotal in many, but highly improbable, combinations.

Unlike the Shapley–Shubik index, which focuses on all possible sequences of coalition formation, the Banzhaf index centers around the concept of the 'critical vote.' The index was developed by American mathematician and attorney John F. Banzhaf III in 1965. In calculating this index, only winning coalitions are considered, and within those, the 'critical' players are identified. A player is deemed 'critical' in a winning coalition if their departure from the coalition would turn it into a losing one. In other words, a 'critical' player is one whose presence is absolutely necessary for a particular coalition to succeed. For each player, the total number of times they are critical is then counted and normalized [7, p. 373]. The key difference between the Shapley–Shubik index and the Banzhaf index lies in their approach to determining a player's 'power.' The Shapley–Shubik index bases a player’s power on the idea of marginal contribution in an ordered sequence, while the Banzhaf index is grounded in the concept of a player’s criticality within a winning coalition, regardless of the order in which the coalition is formed.

Mathematically, the Banzhaf index for shareholder i can be represented as follows [8, p. 2137] (2):

$$\beta_{(i)} = \frac{b_i}{\sum_{j=1}^{\eta} b_j} \qquad (2)$$

where $\beta_{(i)}$ – normalized Banzhaf index for shareholder i;

b_i – total number of coalitions in which shareholder i has the status of a key player;

$\sum_{j=1}^{n} b_j$ – sum of the deciding votes of all players.

The use of the Banzhaf index for the purpose of identifying the ultimate beneficial owner is appropriate in cases where the primary consideration is a shareholder's ability to power the outcome of a vote, regardless of the order in which they joined the coalition. Its calculation is less labor-intensive, as it involves analyzing only winning coalitions. One of the drawbacks of the index is that it may underestimate the power of very large shareholders if they always appear in winning coalitions.

Another tool for measuring the distribution of power in cooperative games, particularly in weighted voting systems, is the Deegan–Packel index, developed by John Deegan and Edward Packel in 1978. Unlike the Shapley–Shubik index, which considers all possible orders of coalition formation, and the Banzhaf index, which focuses on 'critical' votes in all winning coalitions, the Deegan–Packel index concentrates exclusively on minimal winning coalitions – those from which no player can be removed without the coalition losing its winning status. In such coalitions, every member is 'critical.' The idea behind the Deegan–Packel index is based on a player's ability to be a member of a minimal winning coalition, where power is distributed equally among all coalition members [9]. This reflects the concept of 'solidarity' within minimal winning coalitions.

Normalized Deegan–Packel index for shareholder i can be determined, using the following formula [9, p. 114] (3):

$$DP_i = \frac{1}{|MWC|} \sum_{s \in MWC_i} \frac{1}{|s|} \qquad (3)$$

where s_{wa} – weighted average expert score;

MWC – the set of all minimal winning coalitions;

MWC_i – the set of all minimal winning coalitions with shareholder i;

s – separate minimum winning coalition;

$|s|$ – number of players in the coalition s.

This index is useful in cases where the key assumption is that only the smallest winning coalitions are relevant for assessing a shareholder’s power. Accordingly, the Deegan–Packel index is effective when it is important to understand which shareholders are truly indispensable for forming minimal winning groups. However, it does not account for the power of shareholders in larger, yet still winning, coalitions.

Conclusions. The choice of the most suitable index for determining a shareholder’s actual power on a company’s operations depends on which definition of 'power' is most relevant for each legal entity being analyzed by the reporting institution in the field of financial monitoring. International recommendations and national legislation emphasize that national economic entities in the field of financial monitoring entities

should analyze the ownership structures of their clients and cross-check shareholder data against public registers of ultimate beneficial owners. However, this information alone is insufficient to draw conclusions about a legal entity's corporate governance and the role of specific shareholders in decision-making. A more in-depth analysis is required, based, for example, on resolutions recorded in shareholders' meeting minutes or the minutes of a company's supervisory board. Since obtaining such documents is possible only through enhanced due diligence measures, reporting entities in the AML/CFT sphere cannot incorporate their collection into the standard procedure for assessing a client's UBO.

Accordingly, the Shapley–Shubik index and the Deegan–Packel index, which are based on the variability of shareholder voting patterns, are appropriate for identifying ultimate beneficial owners only in relation to a specific group of clients for whom the primary financial monitoring entity has determined a high level of risk and, therefore, has the capacity to apply enhanced due diligence measures. In addition, a reporting institution in the AML/CFT sphere may use these indices in calculating its own internal risk profile.

For standard customer due diligence cases, where the national economic entity is only able to analyze the client's ownership structure, it is more appropriate to use the Banzhaf index, which emphasizes a shareholder's ability to exercise power regardless of the order in which they join a winning coalition or the number of participants in such a coalition.

REFERENCES:

1. Stepanenko, N. V., Hurenko V. A. (2023) Osoblyvosti vyznachennya kintsevoho benefitsiarnoho vlasnyka u neprybutkovykh orhanizatsiyakh Ukrayiny [Features of determining the ultimate beneficial owner in non-profit organizations in Ukraine]. *Yurydychnyy byuleten' – Legal Bulletin*, vol. 198(10), pp. 138–145. DOI: https://doi.org/10.31732/2708-339x-2023-10-138-145 (accessed July 28, 2025)

2. Yamnenko T. M., Savenkova V. G. (2023) Benefitsiarnyy vlasnyk u konteksti diyal'nosti FATF [Beneficial owner in the context of FATF activities]. *Naukovyy visnyk Uzhhorods'koho natsional'noho universytetu. Seriya: Pravo – Uzhhorod National University Herald. Series: Law*, vol. 1 (80), pp. 630–633. DOI: https://doi.org/10.24144/2307-3322.2023.80.1.97 (accessed July 28, 2025)

3. Mitić, I. (2023) UBO Information Transparency in the Corporate Registers and Its Effect on Privacy Protection from AML-CFT Perspective. *FACTA UNIVERSITATIS-Law and Politics*, vol. 21 (1), pp. 11–25. DOI: https://doi.org/10.22190/fulp230422002m (accessed July 28, 2025)

4. Jafarnejad S., Robinet F., Frank R. (2024) A Risk-Based AML Framework: Finding Associates Through Ultimate Beneficial Owners. *2024 IEEE Symposium on Computational Intelligence for Financial Engineering and Economics (CIFEr), Hoboken, NJ, USA, 22–23 October 2024*, pp. 1–7. DOI: https://doi.org/10.1109/cifer62890.2024.10772816 (accessed July 28, 2025)

5. Von Haenisch H. J., Egner T. (2024) Know your customer: Unravelling the challenges. *Journal of Payments Strategy & Systems*, vol. 18 (1), pp. 30–38. DOI: https://doi.org/10.69554/klro4841 (accessed July 28, 2025)

6. Kaczmarek J., Rothe J. (2024) Control by Adding Players to Change or Maintain the Shapley–Shubik or the Penrose–Banzhaf Power Index in Weighted Voting Games Is Complete for NPPP. *Frontiers in Artificial Intelligence and Applications*, vol. 392, pp. 3525-3532. DOI: https://doi.org/10.3233/faia240906 (accessed July 28, 2025)

7. Alon N., Edelman P. H. (2010) The inverse Banzhaf problem. *Social Choice and Welfare*, vol. 34 (3), pp. 371–377. DOI: https://doi.org/10.1007/s00355-009-0402-8 (accessed July 28, 2025)

8. Przybyła-Kasperek M., Smyczek F. (2022) Comparison of Shapley-Shubik and Banzhaf-Coleman power indices applied to aggregation of predictions obtained based on dispersed data by k-nearest neighbors classifiers. *Procedia Computer Science*, vol. 207, pp. 2134–2143. DOI: https://doi.org/10.1016/j.procs.2022.09.273 (accessed July 28, 2025)

9. Deegan Jr, J., & Packel, E. W. (1978) A new index of power for simple n-person games. *International Journal of Game Theory*, vol. 7 (2), pp. 113–123. DOI: https://doi.org/10.1007/BF01753239 (accessed July 28, 2025)

СПИСОК ВИКОРИСТАНИХ ДЖЕРЕЛ:

1. Степаненко Н. В., Гуренко В. А. Особливості визначення кінцевого бенефіціарного власника у неприбуткових організаціях України. *Legal Bulletin*. 2023. № 198 (10). С. 138–145. DOI: https://doi.org/10.31732/2708-339x-2023-10-138-145 (дата звернення: 28.07.2025)

2. Ямненко, Т. М., Савенкова, В. Г. Бенефіціарний власник у контексті діяльності FATF. *Науковий вісник Ужгородського національного університету. Серія: Право*. 2023. № 1(80). С. 630–633. DOI: https://doi.org/10.24144/2307-3322.2023.80.1.97 (дата звернення: 28.07.2025)

3. Mitić, I. UBO Information Transparency in the Corporate Registers and Its Effect on Privacy Protection from AML-CFT Perspective. *FACTA UNIVERSITATIS-Law and Politics*. 2023. № 21 (1). С. 11–25. DOI: https://doi.org/10.22190/fulp230422002m (дата звернення: 28.07.2025)

4. Jafarnejad S., Robinet F., Frank R. A Risk-Based AML Framework: Finding Associates Through Ultimate Beneficial Owners. *2024 IEEE Symposium on Computational Intelligence for Financial Engineering and Economics (CIFEr), Hoboken, NJ, USA, 22–23 October 2024*. 2024. С. 1–7. DOI: https://doi.org/10.1109/cifer62890.2024.10772816 (дата звернення: 28.07.2025)

5. Von Haenisch H. J., Egner T. Know your customer: Unravelling the challenges. *Journal of Payments Strategy & Systems*. 2024. № 18 (1). С. 30–38. DOI: https://doi.org/10.69554/klro4841 (дата звернення: 28.07.2025)

6. Kaczmarek J., Rothe J. Control by Adding Players to Change or Maintain the Shapley–Shubik or the Penrose–Banzhaf Power Index in Weighted Voting Games Is Complete for NPPP. *Frontiers in Artificial Intelligence and Applications*. 2024. № 392. С. 3525–3532. DOI: https://doi.org/10.3233/faia240906 (дата звернення: 28.07.2025)

7. Alon N., Edelman P. H. The inverse Banzhaf problem. *Social Choice and Welfare*. 2010. № 34 (3). С. 371–377. DOI: https://doi.org/10.1007/s00355-009-0402-8 (дата звернення: 28.07.2025)

8. Przybyła-Kasperek M., Smyczek F. Comparison of Shapley-Shubik and Banzhaf-Coleman power indices applied to aggregation of predictions obtained based on dispersed data by k-nearest neighbors classifiers. *Procedia Computer Science*. 2022. № 207. С. 2134–2143. DOI: https://doi.org/10.1016/j.procs.2022.09.273 (дата звернення: 28.07.2025)

9. Deegan Jr, J., & Packel, E. W. A new index of power for simple n-person games. *International Journal of Game Theory*. 1978. № 7 (2). С. 113–123. DOI: https://doi.org/10.1007/BF01753239 (дата звернення: 28.07.2025)