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## AN ANALYSIS OF THE IMPACT OF DIGITAL BANKING ON THE FUTURE USE OF OPEN BANKING: A TODA-YAMAMOTO CAUSALITY ANALYSIS IN THE CONTEXT OF AZERBAIJAN

**ABBASOV ALIAKBAR ABBAS<sup>1</sup>**

<sup>1</sup>Azerbaijan State University of Economics,  
Baku, Azerbaijan

ARTICLE INFO	ABSTRACT
<p><i>Article history:</i> Received: 2024.12.03 Received in revised for: 2025-01-07 Accepted: 2025-01-09 Available online</p> <hr style="border: 0.5px solid black;"/> <p><i>Keywords:</i> Open banking development; open banking; fintech; digital banking; Toda-Yamamoto.</p> <p>JEL CODES: E58, G21, G28, G29, O36.</p>	<p><i>This study provides detailed statistical results on the use of digital banking and digital payments in Azerbaijan, highlighting a high level of usability. However, consumer adoption of open banking remains very low despite the implementation of relevant legislation and security standards. This study aims to assess the impact of digital banking on the use of open banking in Azerbaijan. Using the Toda-Yamamoto causality method and data covering the years 2022-2024, the variables "Bank accounts", "Bank customers", "Digital banking Number", and "Instant Payment System Number", where open banking operations will be carried out, were used in the econometric model. Based on the Toda-Yamamoto causality between "Digital Banking Number" (lnDBN) and "Instant Payment System Number" (lnIPSN), carried out for the main purpose of the research, digital banking will have a positive effect on the future use of open banking, and there is a bidirectional relationship. Additionally, while there is a causal relationship between "Bank Accounts" (lnBA) and "Instant Payment System Number" (lnIPSN), no causal relationship was found between "Bank Customers" (lnBC) and "Instant Payment System Number" (lnIPSN). Factors such as ease of use, usefulness, reliability, and a sense of psychological ownership will play crucial roles in the rapid adoption of open banking.</i></p>

### 1. INTRODUCTION

Digital banking refers to the ability for users to access innovative services that expand upon traditional banking operations. This is made possible through the digitization of processes using the internet and modern electronic devices, allowing transactions to be conducted anytime and anywhere. In another form, digital banking is defined as a financial service that includes transactions, trading, advisory services, transaction history visualization, and cross-selling of products through mobile and digital means (Baptista & Oliveira, 2015). "Digital banking is a contemporary financial economic concept that is based on digitizing all bank activities and operations" (Tiong, 2020). Digital banking, as a part of digital finance (Məmmədov, 2022), has become a part of our daily lives, and the process of carrying out financial transactions has become much simpler.

Open banking, as opposed to digital banking, involves the sharing of customer financial information with TPPs through secure channels. Open banking involves the acquisition and exchange of services and products offered by other banks and TPPs as a result of the secure sharing of financial information of individual and legal customers with TPPs (Gozman &

Hedman, 2018). The Bank of International Settlements and Organization for Economic Co-operation and Development defines the concept of open banking as follows “Open banking is defined as the sharing and leveraging of customer-permissioned data by banks with third party developers and firms to build applications and services, including for example those that provide real-time payments, greater financial transparency options for account holders, marketing and cross-selling opportunities.” (Bank for International Settlements [BIS], 2019, p.4). “Open banking is a driving force of innovation in the banking industry, enabling customers to securely share their financial data with other financial institutions” (Sharmin, et al., 2024).

Open banking is like digital banking in terms of access to services and products, except for the payment system associated with financial services. Also, there is the concept of open banking, the approach of acceptance as "Digital banking + Open API = Open Banking" (Principe, 2021). Open banking provides account information and payment initiation services by encompassing the features included in digital banking. However, explicit consent, sharing of financial data with TPPs, and access to financial services and products using various applications require a richer user experience, awareness, and responsibility. In addition, digital banking has a positive effect on the formation of new habits and skills for customers to conduct transactions digitally. It also enhances (Mbama & Ezepue, 2018) and enriches the customer experience by providing ease of use (PwC, 2018). Open banking has the potential to fundamentally change customer-bank relationships (Frei, 2023). The adoption of open banking is likely to lead to an increase in customer reliance on fintech companies, while potentially reducing the usage of traditional digital banking apps provided by banks. With open banking in place, customers will use fintech to access banking services, but the actual operations and transaction processes will still be handled by the banks.

The importance of Third-Party Providers (TPPs) is anticipated to grow as the adoption of open banking continues. As financial institutions integrate open banking practices, TPPs will play a crucial role in enabling greater access to banking services and promoting innovative solutions that can enhance customer experiences. This evolving landscape offers a unique opportunity for collaboration between banks and TPPs, fostering a competitive atmosphere that prioritizes the needs and preferences of consumers. Engaging TPPs in this journey will be instrumental in realizing the full potential of open banking, benefiting both financial institutions and their customers alike.

Research on the direct impact of digital banking on open banking is limited. The similarity of the features of using digital banking and open banking and the statistical high of digital banking and digital payments in Azerbaijan have led to the idea that digital banking will impact the use of open banking. This study primarily examines the similarities between digital banking and open banking, as well as the characteristics that influence their usage. By analyzing the similarities and user-related characteristics, the study investigates in detail how factors such as ease of use, usefulness, trust, and psychological factors affect users' adoption of open banking and their intention to use it. To evaluate how digital banking influences the adoption of open banking, a thorough analysis was conducted on the statistical results related to Instant Payment System transactions, digital banking, and digital payments in Azerbaijan over the past few years. Finally, Short-term Toda-Yamamoto causality between the variables was investigated to test whether users of digital banking will also use open banking.

### **1.1. The Influence of Digital Banking on the Adoption of Open Banking and Its Similarities**

Digital banking and open banking are banking models that offer customers access to financial products and services through digital channels. Key factors such as accessibility, usefulness, ease of use, trust, security, and service quality are crucial for both digital banking and open banking. The reasons that drive the use of digital banking also affect the adoption of open banking, reflecting similar usage trends in both models.

Features that will influence digital banking users to use open banking:

- **User Perceptions:** Factors such as perceived ease of use, perceived usefulness, perceived security, and trustworthiness play a critical role in user adoption of these systems (Almuraqab & Cruz, 2024).
- **Convenience:** The convenience of managing finances and making payments anytime and anywhere is a strong motivator for users to adopt digital banking and open banking.
- **Consumer Behavior:** Shifts in consumer behavior, particularly the increasing preference for online and mobile transactions, contribute to the widespread adoption of digital banking and open banking.
- **Cost Efficiency:** The cost savings associated with digital transactions, compared to traditional banking methods, encourage financial institutions and consumers to adopt these systems (Ananda, Devesh, & Al Lawati, 2020).
- **Regulatory Environment:** The legal and regulatory framework surrounding digital banking and open banking can either facilitate or impede their adoption. Supportive regulations promote innovation and ensure consumer protection (Beals, 2024).

Increasing the use of open banking via digital banking applications and platforms can be accomplished through the following steps:

- Enhancing user adaptation to open banking by regularly educating them through digital banking, utilizing engaging marketing tools within the app and platform.
- Integration of APIs and interoperability with digital banking applications allows users to access open banking services provided by third-party providers (TPPs).
- The presence of a user-friendly interface for providing open banking services within a digital banking platform can enhance the adoption and satisfaction of open banking.
- Banks acting as data custodians for open banking services (van Zeeland & Pierson, 2021; Abbasov, 2024) can increase trust in using open banking.

The process of making payments in open banking is carried out through the Instant (or Faster) Payment System of each country. "Fast payments are defined as payments in which the transmission of the payment message and the availability of final funds to the payee occur in real time or near real time and on as near to a 24-hour and 7-day (24/7) basis as possible." (BIS, 2016). All payments related to open banking in Azerbaijan will be made through the Instant Payment System (IPS) created on September 26, 2018. Examples of faster payment systems in various countries include the Faster Payment System in the United Kingdom, Pix in Brazil, FAST in Turkey, and SPB in Russia. The integration of the Fast Payment System (FPS) into digital

banking will positively impact the adoption of open banking payments and transfers. Benefits to be gained by promoting the use of open banking services by integrating Fast Payment Systems into Mobile banking applications:

- Fast Payment Systems integrated into mobile banking applications include real-time direct payments and transfers to users. The Instant Payment System has been integrated into the mobile application of 15 banks across Azerbaijan, and the service of making transfers is currently provided (Ali Kerim, 2024).
- The integration of FPS with mobile banking enhances the user experience by providing a convenient and efficient way to manage finances on-the-go. Users can perform transactions anytime and anywhere, using features like mobile wallets and in-app payment options.
- Regulatory frameworks often support the integration of FPS with mobile banking to promote financial inclusion and improve payment efficiency (World Bank, 2021a).
- The interoperability of FPS with mobile banking apps allows for seamless transactions across different banks and financial institutions (World Bank, 2021b).

## 2. ADOPTION OF OPEN BANKING

Adopting open banking depends on various factors and directly influences usage formation. The adoption process involves the customers' existing skills, awareness, and intention regarding the innovative approach. The open banking model includes the same features as digital banking in the requirement of common usability. However, compared to digital banking, open banking features financial data sharing, data control and management, explicit consent giving, and third-party communication features increase customer responsibility. In the face of this responsibility, the following factors significantly affect the expansion of the use of open banking and the adoption of open banking within society.

**Ease of use and usefulness** - The usefulness of using electronic payment systems is considered one of the most important factors (Ozkan, Bindusara, and Hackney, 2010). Ease of use has a positive effect on adaptation to electronic payment systems (Riskinanto, Kelana, and Hilmawan, 2018). Ease of use is perceived as a driver of the adoption of an innovative service or product (Agyapong et al., 2017; Davis et al., 1989; Masoud & AbuTaqa, 2017). The concept of perceived ease of use is considered as the degree of ease of understanding and using any innovation (Zeithaml et al. (2000). Perceived usefulness, ease of use, and trust influence the intention to use digital payments (Giri & Ghimire, 2020). Perceived ease of use and usefulness continuously influence the use and adaptation of technology (Okocha & Awele Adibi, 2020).

According to research, the perceived usefulness factor significantly influences a user's intention to use a new e-payment system (Kelly & Palaniappan, 2023). Perceived ease of use has been noted as one of the main factors influencing Saudi Arabian users' use of electronic payment systems (Alyabes & Alsalloum, 2018). According to a study conducted in Turkey, ease of use significantly influences the adoption of digital banking (Celik, 2008). Ease of use, compatibility, familiarity, and habit strongly influence the adoption of digital banking, according to a study in Nepal (Nepal, S., & Nepal, B., 2023). According to another study, perceived usefulness is more important than perceived ease of use and has a greater influence on the intention to adapt to digital banking (Wamai and Kandiri, 2015; Ifoenu and Rupert, 2015). Perceived ease of use has a

significant impact on the adoption of mobile banking (Hosseini et al., 2015) and mobile payment services (Mun et al., 2017). Also, perceived usefulness significantly influences trust in mobile wallet payment services (Chang et al., 2018; Bashir and Madhavaiah, 2015). A survey conducted among 562 participants in Azerbaijan revealed that digital banking significantly enhances the quality of life, with the ease of use emerging as the most influential factor contributing to this phenomenon (Rəhimli, 2024).

These are factors that have a positive effect on the implementation of digital payments, as well as open banking payments. Using the TRAM model, a survey-based study was conducted across India to study the intention to use open banking, and based on the results, perceived usefulness, and perceived ease of use have a positive effect on using open banking, and discomfort and insecurity have a negative effect on the use of open banking (Sivathanu, 2019). Also, a survey-based open banking adoption study conducted among young university students in Brazil found that perceived ease of use did not affect open banking adoption, while lack of trust had a negative effect on adoption. It was emphasized that the problem of trust should be solved by the central bank in the formation of customers' use of open banking (Valarini & Nakano, 2022). Perceived usefulness (PU) plays a critical role in the adoption of fintech and open banking, according to a study conducted with the TAM model, including Social Influence (SI) and Initial Trust (INT), two key elements of the UTAUT model. Perceived ease of use (PEOU), on the other hand, indirectly influences the adoption of fintech and open banking. Perceived ease of use in the initial adoption of technology does not play a significant role in behavioral adoption, and the reason for this is related to the lack of use or the lack of opportunity to use the introduced innovation (Venkatesh, 2000). SI influences Behavioral Intention more than perceived usefulness in the adoption of open banking services, and INT is one of the important factors. (Briones & Cassinello, 2023). According to another study, ease of use plays a minor role in the adoption of open banking (Briones, et al., 2022).

**Trust** - As the open banking approach is new, it is important to gain customer trust. The initial trust model is important in innovation adoption (Gao & Waechter, 2017) and High level of trust is also important in the formation of adaptation to electronic payment systems (Indrawati & Putri, 2018). However, open banking has certain challenges related to privacy, data leakage and authentication process (Mansfield-Devine, 2016). Overall, based on the conducted survey, 7 out of 10 participants have concerns about using the collected information for other purposes (Coiera & Clarke, 2004).

Trust is the most crucial and key factor that motivates customers to engage with digital banking (Letamendia & Poher, 2020; Keskar and Pandey (2018). Trust is considered as a variable that directly and indirectly affects intention to use digital banking, but also affects perceived ease of use, perceived usefulness, perceived risk and security (Esendemirli, et al., 2024). Həmçinin, güvən yeni elektron ödəniş sistemlərindən istifadənin formalaşmasına təsir edir Also, trust influences the use of new e-payment systems (Drakpa, et al., 2024)

This is one of the factors that negatively affect the use of open banking. UTAUT model Perceived risk negatively affects the use of open banking account information services. There is no direct relationship between effort expectations and account information service in open banking. Also, security is considered a more critical factor in open banking account information services than in traditional Internet banking operations (Rosati, et al. 2022). However, the legislation and security standards adopted by Open Banking countries for payment transactions

are the main factors affecting the formation of customer trust. In addition, the users' full understanding of the risks involved in the innovation has an important influence on the adoption decisions of the innovation. (Claudy, Garcia & O'Driscoll, 2015). Gaining customer trust and respect for customer data by service providers are the main factors in achieving the results related to adaptation to open banking (Polasik & Kotkowski, 2022). According to a study carried out using the TAM model on 410 Spanish citizens, performance expectations and social influence play a crucial role in the adoption of new technologies, but trust plays a very important role in determining behavioral intention to adopt open banking (Briones, & Cassinello). Intuitively, gaining users' trust affects the willingness to share data on open banking (Babina, et al., 2024).

**Psychological** - Based on open banking, customers act as the owner of their financial data. "The psychological ownership of data is being considered as important in the context of open banking" (Scassa, 2019) and "psychological ownership, can develop a great feeling of attachment to the object" (Pierce et al., 2003). The concept of psychological ownership has the potential to increase positive attitudes about open banking services and products, also, having customers feel ownership over their financial data can make it easier to use open banking services and products (Marzouk, 2021). Customers who use open banking services will further reduce their use of traditional banking services once they gain psychological comfort. Open banking is not only about psychological ownership; it also offers customers a wide range of banking services and products to choose from freely. This will influence the competition within the current sector.

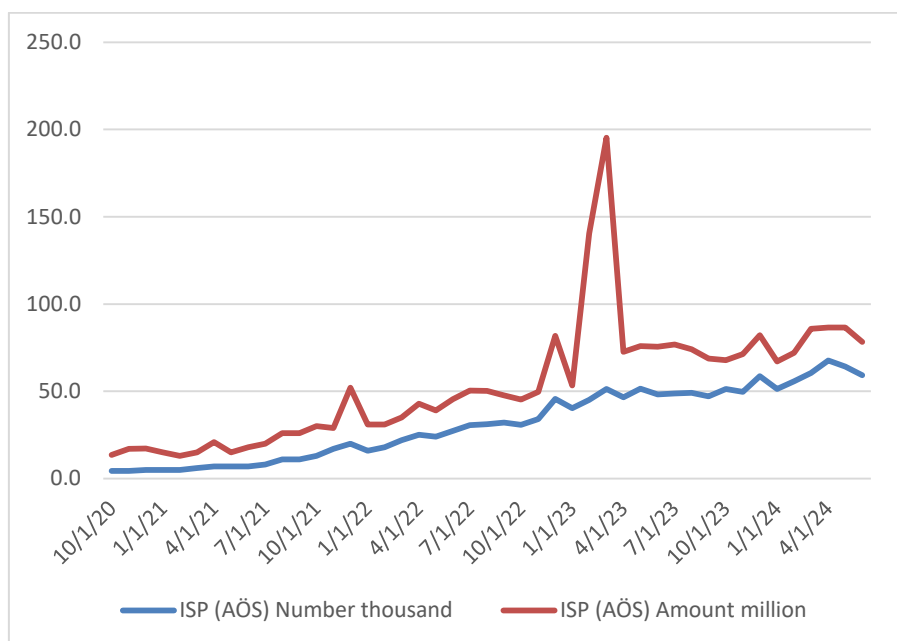
There are certain similarities and differences in the adoption of digital banking and open banking. It is possible to note that in the adoption of open banking, the experience of using digital banking will significantly reduce the difficulty of a customer using open banking for the first time. Digital banking applications and platforms also have the potential to facilitate and promote the use of Fast Payment Systems (BIS, 2024), which will lead to an increase in the use of open banking.

### **3. DIGITAL BANKING AND DIGITAL PAYMENTS IN AZERBAIJAN**

Since 2020, the growth rate of the number of transactions carried out under the Instant Payment System has been observed in Graph 1. In general, during the 45 months, the number of operations increased by 13.5 times, and the volume of operations increased by 5.8 times. CMGR<sup>1</sup> transaction number was 6%, and transaction volume was 4%.

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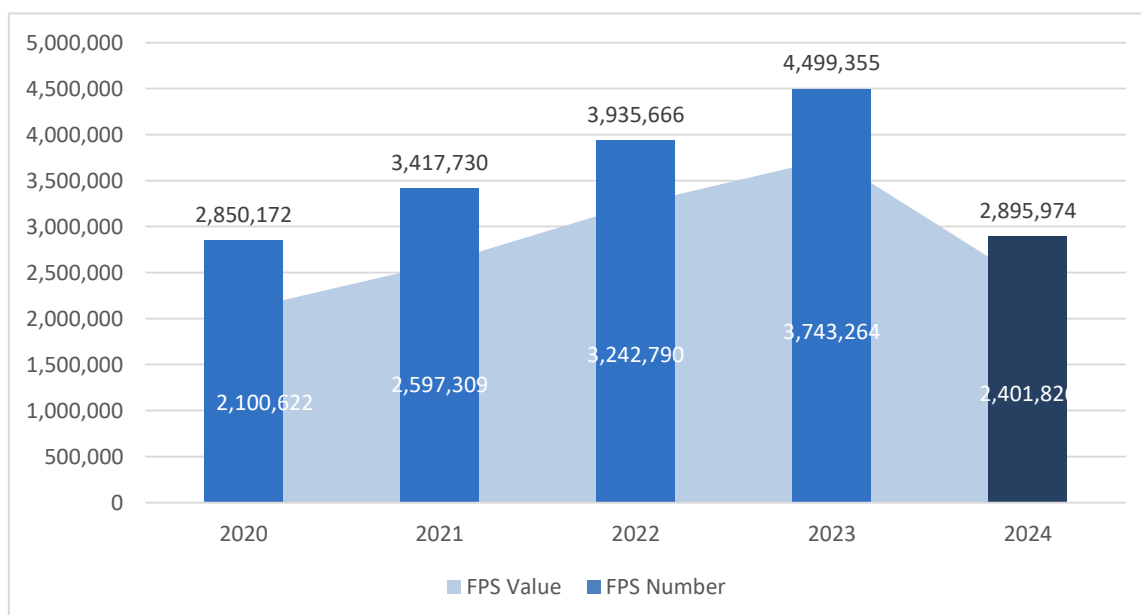
<sup>1</sup> CMGR - Compound Monthly Growth Rate



**Chart 1.** The Number and Volume of Transactions Carried out in 2020-2024 Under The Instant Payment System

*Source:* Central Bank of the Republic of Azerbaijan - Central Bank of the Republic of Azerbaijan - Payment system indicators (cbar.az)

In addition to taking several steps to open banking in Azerbaijan starting in 2021, there are opportunities for open banking on the Instant Payment System (Məmmədov, 2023). As payment transactions related to open banking will be carried out through the Instant Payment System, it will directly affect the statistical indicators related to the use of open banking.



**Chart 2.** Number and Value of Payments Made Under The Faster Payment System in The United Kingdom 2020-2024.

*Source:* Pay.UK - <https://www.wearepay.uk/what-we-do/payment-systems/payment-statistics-overview/>

**Note:** 7-month results for the 2024 Faster Payment System are reflected.

- Payment number result – billion
- Payment value result – trillion

When comparing Azerbaijan's Instant Payment System with the United Kingdom's Faster Payment System, there is a significant difference in both the number of transactions and the volume of transactions. In Azerbaijan, the number of payments made with IPS was 359 thousand in the last 6 months, while in the United Kingdom, this result was 2 billion 895 million in 7 months. In terms of transaction volume, these results were 477 million manats for Azerbaijan, and 2 trillion 401 billion pounds for the United Kingdom. The number of open banking users in the United Kingdom reached 10 million by 23 July 2024 and continues to grow. The number of customers using open banking in the United Kingdom<sup>2</sup> is already equal to the population of Azerbaijan.

Service fee rates applied to participants for use of the IPS system:

- No service fee is required for customer transfers between individuals.
- A service fee of 0.01% of the amount, with a minimum of 0.01 Azn and a maximum of 4 Azn, is required for sales points, e-commerce, cashing, and account deposit operations.

**Table 1.** Comparison of Payment Service Charge Interest Rates Across POS/MPOS, IPS, and Payment Institutions

Type	POS and MPOS (Banks)	IPS (AÖS)	Payment Institutions
Markets	1.5-3%	0.3%	2.5-3% Apple Pay/ Google Pay – 2.8%
Gas stations		0.1%	
Pharmacy		0.1%	
Transportation		0.05%	
Other		0.35%	
Gamble		1.2%	
Ecommerce		0.3%	

Source: Author

Depending on the M-POS and POS terminal turnover limit<sup>3</sup>:

- for markets and pharmacies 2.2-2.3%
- for gas stations 1.7-1.6%
- for restaurants and general 2.5-2.4%

Interest rates on payments made on electronic commerce:

- Depending on the circulation limit on Epoint<sup>4</sup>:
  - for direct payments 2.5-3%
  - Apple Pay/ Google Pay – 2.8%
- Odero M-POS/ QR and link payments 3%<sup>5</sup>
- Pasha Bank 2% on e-commerce<sup>6</sup>

<sup>2</sup> <https://www.openbanking.org.uk/news/open-banking-marks-major-milestone-of-10-million-users/>

<sup>3</sup> M-POS and POS terminal tariffs are listed based on the information provided by Rabita Bank - Rabit-bankASCninFizikiv-Hquqi-xsl-r-Gst-riI-nXidm-tl-r.pdf (rabitabank.com)

<sup>4</sup> <https://epoint.az/en/prices>

<sup>5</sup> <https://odero.az/>



Service fees related to Faster Payment Systems for other countries:

Russia<sup>7</sup>:

- No service fee is required up to 100000 rubles per month, but if this limit is exceeded, 0.5% per transaction or a maximum of 1500 rubles is charged.
- 0.7% for business entities (0.4% for certain business entities)
- 0.05-3.0 rubles are required for payments made by banks.

Türkiye<sup>8</sup>:

- As of April 4, 2024, FAST transactions were raised from 50,000 TL to 100,000 TL, and the FAST-TR QR code-based transaction limit was raised from 100,000 TL to 250,000 TL (Central Bank of the Republic of Türkiye [CBRT], 2024).
- In FAST transfers, the commission varies between 4.22-105.52 TL<sup>9</sup>.

United Kingdom<sup>10</sup>:

- Limit on payouts up to £1 million, but limit requirements are subject to change by participants<sup>11</sup>
- There is no fee for individuals.
- Business entities are charged £0.50 per payment<sup>12</sup>

The advantages of the Instant Payment System, the service fee interest rates required for payments, and the possibility of making payments in an instant will encourage the use of open banking services. In Türkiye, Russia, and the United Kingdom, customer transfers made through the Fast Payment System are more efficient for customers. In general, the Instant Payment System and similar systems of other countries play a key role in the implementation of open banking operations and lead to the reduction of additional costs for payments. In addition, "Fast payments and open banking services are natural complements, and their integration generates synergies that can enable the more rapid adoption of both" (World Bank Group [WBG], 2023).

The presence of lower service fees compared to POS terminals and debit/credit card payments will directly influence the increase in the use of open banking. In general, the commission on average payments for M-POS and POS terminal services for local cards offered by banks operating in Azerbaijan is in the range of 1.5-3%. As a negative, we can note that even though banks digitally share information about the acquisition, advantages, and use of M-POS and POS terminals, the level of accessibility of information about service fees or commissions is low. It leads to the restriction of the selection activity of the business entity, or the client based on independent research and the formation of a physical application to the banks, and as a result, additional time loss occurs.

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<sup>6</sup> Pasha Bank provides a 2% commission for local cards and e-commerce for payments made at the POS terminal - Tariflər | PASHA Bank

<sup>7</sup> <https://www.cbr.ru/eng/psystem/sfp/>

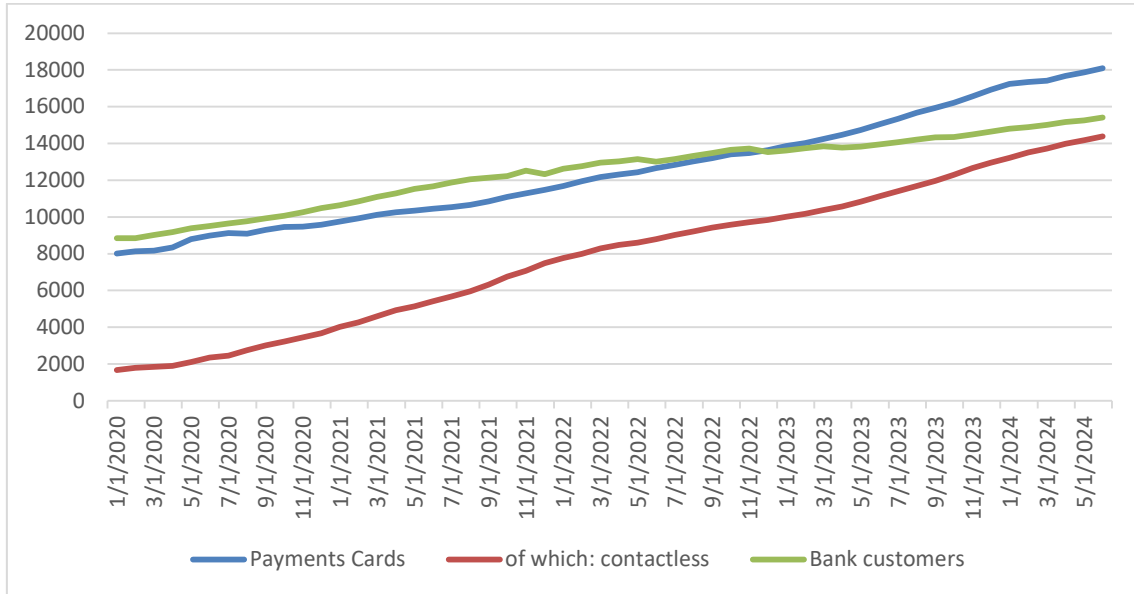
<sup>8</sup> <https://fast.tcmb.gov.tr/wps/wcm/connect/fast/anasayfa>

<sup>9</sup> <https://www.isbank.com.tr/urun-ve-hizmet-ucretleri#h1i2s4>

<sup>10</sup> <https://www.wearepay.uk/what-we-do/payment-systems/faster-payment-system/>

<sup>11</sup> <https://www.wearepay.uk/what-we-do/payment-systems/faster-payment-system/transaction-limits/>

<sup>12</sup> <https://www.atlar.com/guides/bank-payments-in-the-uk>

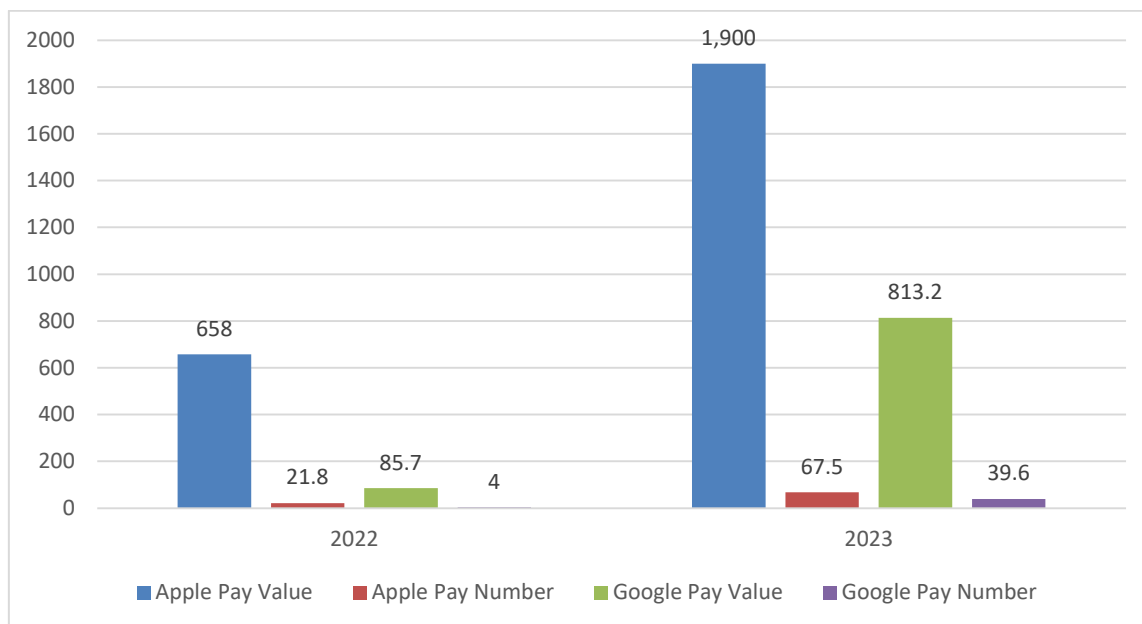


**Chart 3.** The Number of NFC-Enabled Payment Cards and Bank Customers in Azerbaijan, 2020-2024

*Source:* Central Bank of the Republic of Azerbaijan - Central Bank of the Republic of Azerbaijan - Payment system indicators (cbar.az)

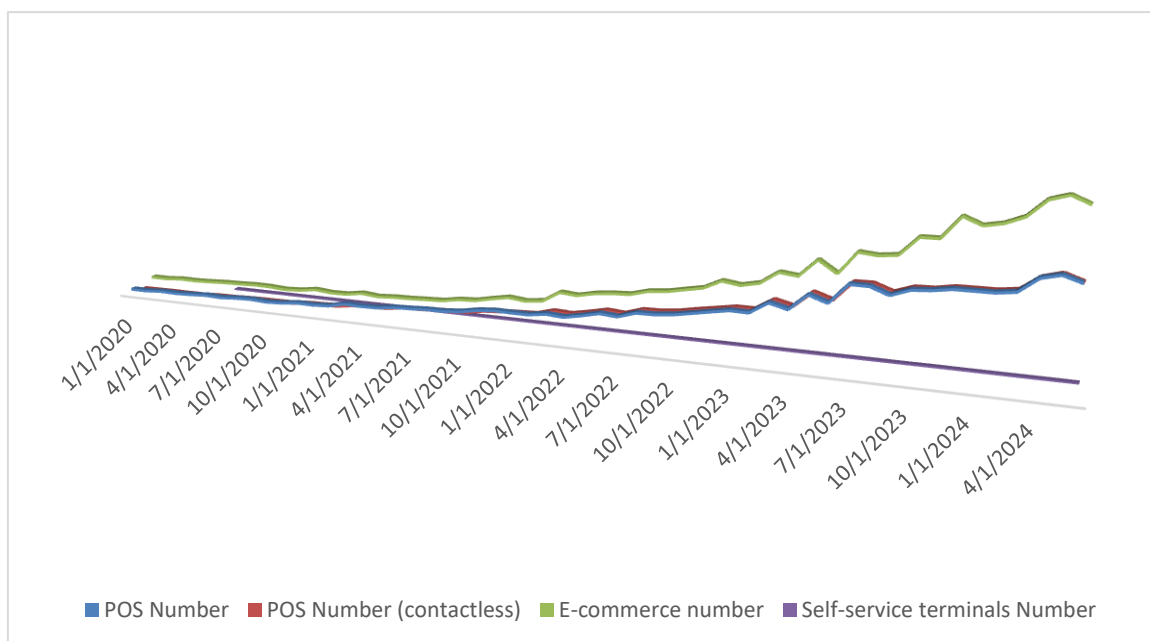
In addition to the number of payment cards owned by the population exceeding 18 million as of June 2024, the use of cards for contactless payments by society is increasing significantly, and the total number of bank customers has exceeded 15 million. In addition, the number of contactless cards has reached 14.4 million. According to the study, the growth in bank cards in Mexico, Costa Rica and Thailand has led to an increase in the use of the Fast Payment System (Suominen, 2024), which will also affect the adoption of open banking. Based on the number of bank customers, we can note the high potential customer base due to the use of open banking. In 2023, 67.5 million payments worth 1.9 billion manats were made through Apple Pay, 39.6 million payments worth 813.2 million manats were made through Google Pay, and 1 out of every 4 cashless payments made at POS terminals was made with this type of payment (CBAR, 2023).

Based on these statistical results, the adoption of digital payment behavior will lead to the easy implementation of payments on QR codes and M-POS/POS terminals in open banking. Making payments with the online payment option Apple Pay/Google Pay during e-commerce will play a role in increasing the use of the "pay by bank" payment type. However, at this time, the payment that will be made with the "pay by bank" payment option offered by open banking must provide a safer, faster, and better service quality than other payment methods, so that it is always chosen by clients.



**Chart 4.** Number and Volume of Apple Pay and Google Pay Payments in 2022 and 2023

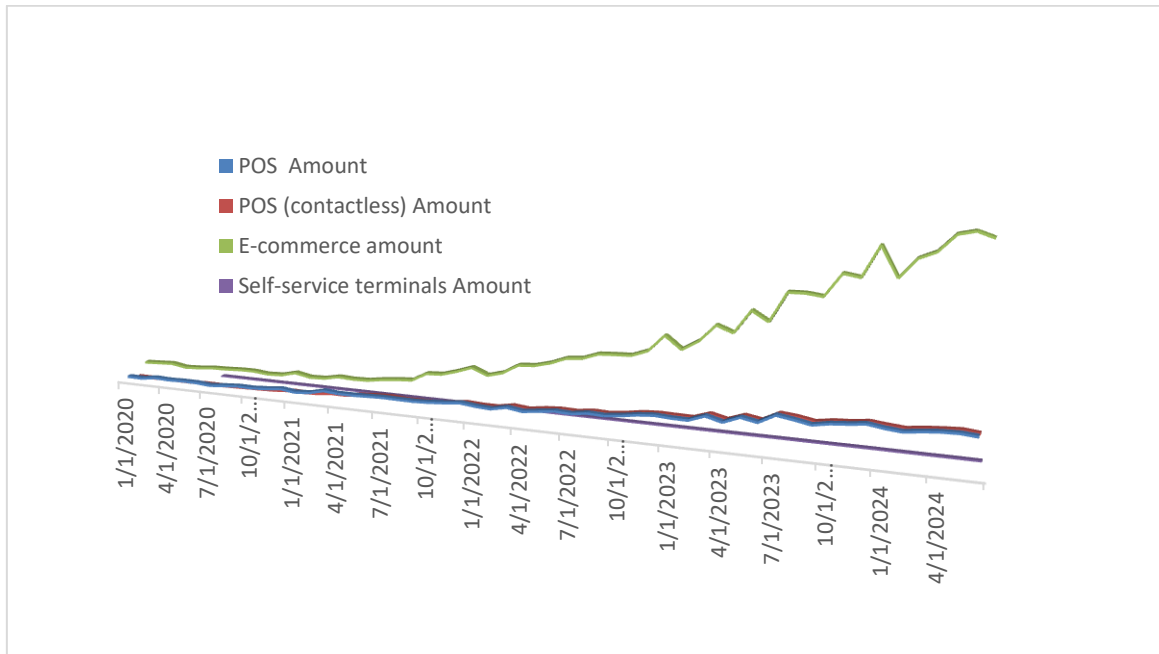
*Source:* Central Bank of the Republic of Azerbaijan - Azərbaycan Respublikasının Mərkəzi Bankı - Rəqəmsal ödənişlər icmalı (cbar.az)



**Chart 5.** Number of POS and Contactless, E-commerce Payment, Payment at Self-service Terminals in 2020-2024

*Source:* Central Bank of the Republic of Azerbaijan - Central Bank of the Republic of Azerbaijan - Payment system indicators (cbar.az)

A significant increase in the number of cashless payments made through e-commerce and POS terminals is observed and continues to rise. The number of POS terminals increased 16 times, and the number of contactless POS terminals increased 57 times in parallel. However, in terms of transaction volume, e-commerce contains more volume than POS terminals. Since 2020, after the COVID-19 pandemic, the volume of e-commerce has increased by 17.2 times, and this result has increased by 7.2 times for the POS terminal. Both the number and the volume of transactions performed through self-service terminals show steady slow growth.



**Chart 6.** POS and Contactless, E-commerce payment, Self-service Terminals Payment Volume in 2020-2024

*Source:* Central Bank of the Republic of Azerbaijan - Central Bank of the Republic of Azerbaijan - Payment system indicators (cbar.az)

According to the mentioned graphs, it is possible to note the existence of possible conditions for the introduction of open banking and preparation for its use by society and the possibility of further increasing the current level of the growth rate of use of the Instant Payment System through open banking. In June 2024, the total number of transactions carried out with various payment service networks (payment service network) was 144.5 million, and the volume was 9.7 billion AZN. As digital payments made using open banking will be made through the Instant Payment System, the statistical results of the payment service networks will decrease.

Although the transaction volume of payments made on POS terminals in the country is small when compared to e-commerce, the use of open banking services during payment will lead to a decrease in additional costs, commissions, and interest rates paid for acquiring services on POS terminals. ABB has introduced a service where entrepreneurs can receive QR payments through AniPay with an ABB POS terminal (ABB-dən biznes sahibləri, 2024). As a result, the commission and service fees are lower than those of the traditional POS terminal, and this transaction is carried out through the Instant Payment System.

Although the Central Bank of Azerbaijan has not provided detailed information on the share of e-commerce payments by payment systems and payment service networks, with open banking, digital payments with the "pay by bank" option on the Instant Payment System will reduce additional costs and will provide the opportunity to make payments in a safe, easy and instantly.

The main issue is to make the numerical price difference of the payments made using open banking noticeable compared to other digital payments during the digital payments made by society for products and services. In addition to simply making the price difference in products and services open banking, providing customers with easy account management, sharing, and management of financial information will have a direct impact on increased usage.

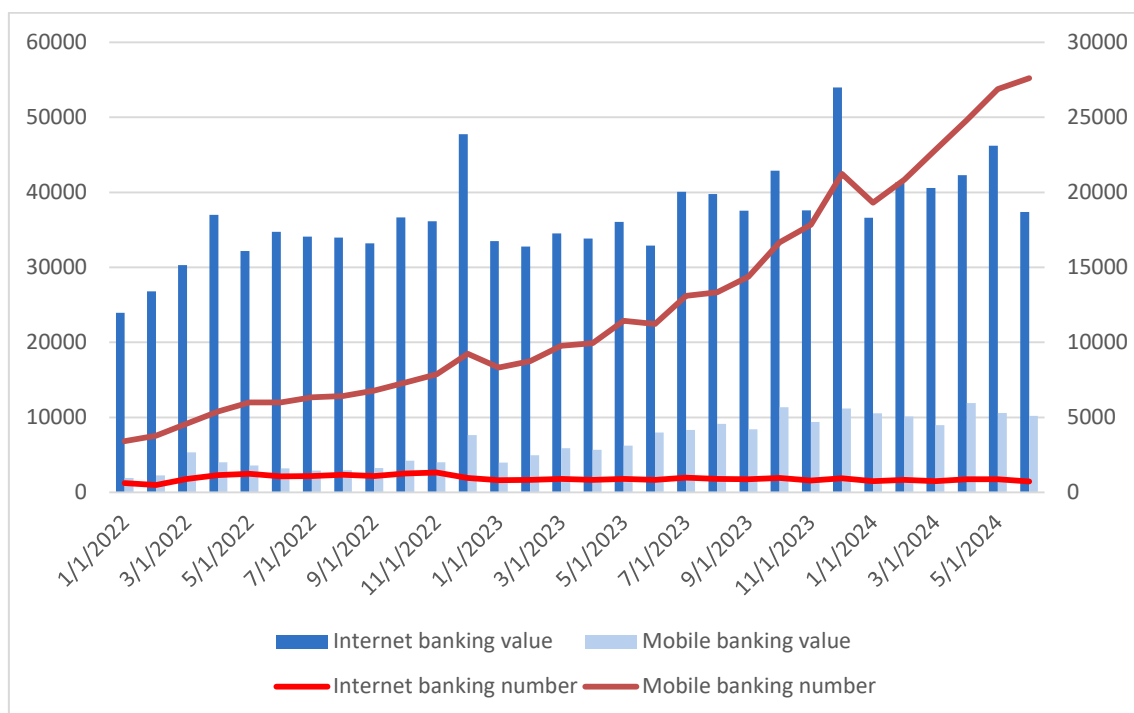


Chart 7. Number and Volume of Internet and Mobile Banking Transactions 2022-2024

Source: Central Bank of the Republic of Azerbaijan - Central Bank of the Republic of Azerbaijan - Payment system indicators (cbar.az)

In digital banking, the number of transactions conducted using mobile banking shows a sharp increase compared to internet banking, but the volume of transactions carried out by internet banking is many times higher than that of mobile banking. According to the statistical results of the last six months of 2024, 274.8 million transactions were conducted on mobile banking, and this result was 108.7 million in the first six months of 2023, which was a 153% increase when compared. The number of Internet banking transactions in the first 6 months of 2024 was 9.6 million. Compared to the first 6 months of 2023, there was a slight decrease.

A significant increase in the use of digital banking and the number of bank accounts in Azerbaijan in recent years will lead to a rise in the use of open banking soon. High accessibility, use, and adoption of innovations in digital banking by society are expected to achieve high results in open banking. The formation of the ability to use digital banking services within society will lead to a faster increase and adaptation of open banking.

#### 4. METHOD AND DATA

A significant increase in the volume of digital banking and digital payments in Azerbaijan during the period 2020-2024, taking steps related to the introduction of open banking by the Central Bank of the Republic of Azerbaijan, and obtaining a license for TPPs that include open banking services will lead to an increase in the use of open banking services. The similarity between the current use and adoption of digital banking and open banking led to this study. The main purpose of the research is to clarify the existence of the potential for future use of open banking by users who use digital banking. Due to the high potential of society to use digital banking and digital payments, it was decided to investigate the potential of digital banking on future open banking with Toda-Yamamoto causality and the relationship between the following variables will be investigated.

1. Analyze causality between digital banking transaction numbers and instant payment system transaction numbers in Azerbaijan;
2. Analyze causality between bank accounts and instant payment system transaction numbers in Azerbaijan;
3. Analyze causality between bank customers and instant payment system transaction numbers in Azerbaijan;

Statistical results of the Instant Payment System, where open banking operations will be carried out, were used to study the potential of using open banking. The data used in the econometric analysis were obtained from the Central Bank of the Republic of Azerbaijan. Within the analysis, bank customers were marked as "BC," bank accounts were marked as "BA," digital banking transaction numbers were marked as "DBN," and instant payment system transaction numbers were marked as "IPSN." In this analysis covering January 2022 and July 2024 (32 months of observation) - ADF (Augmented Dickey-Fuller Test) (Dickey and Fuller, 1979), PP (Phillips-Perron, 1988) unit root tests, VAR Residual Serial Correlation Lagrange Multiplier (LM) Tests and Inverse Roots of AR Characteristic Polynomial, and the Toda-Yamamoto causality test (Toda and Yamamoto, 1995) were calculated using EViews 12 lite software.

**Table 2.** Variable definitions and data sources

Variables	Symbol	Definition	Source
Instant Payment System Numbers (IPSN)	lnIPSN	The number of payment transactions made through the instant payment system.	Central Bank of the Republic of Azerbaijan
Digital Banking Numbers (DBN)	lnDBN	Digital Banking Number - the number of payment transactions made through Internet and mobile banking.	Central Bank of the Republic of Azerbaijan
Bank Customers (BC)	lnBC	Bank Customer - total number of banks customers.	Central Bank of the Republic of Azerbaijan
Bank Accounts (BA)	lnBA	Bank Account - the total number of bank accounts belonging to customers.	Central Bank of the Republic of Azerbaijan

**Note:** Instant Payment System Numbers, Digital Bank Numbers, Bank Customers and Bank Accounts variables were used in natural logarithmic form.

**Source:** Author

## 5. EMPIRIC RESULTS AND DISCUSSION

"Toda Yamamoto" causality was analyzed between the number of digital banking transactions, bank customers, bank accounts, and the number of Instant Payment System transactions where open banking transactions will be carried out, to clarify that the use of digital banking will affect the use of open banking in the future due to the rapid rise of digital banking in recent years. Before performing the "Toda Yamamoto" test, the Augmented Dickey-Fuller and Phillips-Perron unit root tests of the variables were first performed. Based on these test results, the following hypotheses are accepted and rejected:

- H0: The series has a unit root (is non-stationary)
- H1: The series has no unit root (is stationary)

**Table 3. ADF Unit Root Test - Intercept**

Variables	Augmented Dickey- Fuller (ADF) Unit Root Test Intercept			
	I(0)		I(1)	
	t-statistic	critical value / [p-value]	t-statistic	critical value / [p-value]
<i>lnBA</i>	0.769285	-3.689194 <b>[0.9916]</b>	-4.405173	-3.689194 <b>[0.0017]</b>
<i>lnBC</i>	0.002993	-3.670170 <b>[0.9516]</b>	-4.938540	-3.679322 <b>[0.0004]</b>
<i>lnDBN</i>	-1.163365	-3.679322 <b>[0.6762]</b>	-6.615097	-3.679322 <b>[0.0000]</b>
<i>lnIPSN</i>	-2.963833	-3.679322 <b>[0.0504]</b>	-6.902714	-3.679322 <b>[0.0000]</b>

**Note:** According to Mac Kinnon (1996) critical values, it indicates stationarity at 1% significance level.

**Table 4. ADF Unit Root Test – Trend and Intercept**

Variables	Augmented Dickey- Fuller (ADF) Unit Root Test Trend and Intercept			
	I(0)		I(1)	
	t-statistic	critical value / [p-value]	t-statistic	critical value / [p-value]
<i>lnBA</i>	-2.369846	-4.3098224 <b>[0.3863]</b>	-4.476680	-4.323979 <b>[0.0070]</b>
<i>lnBC</i>	-1.912855	-4.296729 <b>[0.6230]</b>	-4.889028	-4.309824 <b>[0.0025]</b>
<i>lnDBN</i>	-3.652188	-4.296729 <b>[0.0420]</b>	-6.632049	-4.309824 <b>[0.0000]</b>
<i>lnIPSN</i>	-2.990994	-4.296729 <b>[0.1511]</b>	-7.560170	-4.309824 <b>[0.0000]</b>

**Note:** According to Mac Kinnon (1996) critical values, it indicates stationarity at 1% significance level.

**Table 5. PP Unit Root Test – Intercept**

Variables	Phillips-Perron Unit Root Test Intercept			
	I(0)		I(1)	
	t-statistic	critical value / [p-value]	t-statistic	critical value / [p-value]
<i>lnBA</i>	0.504766	-3.670170 <b>[0.9840]</b>	-4.155625	-3.679322 <b>[0.0031]</b>
<i>lnBC</i>	0.514156	-3.670170 <b>[0.9844]</b>	-6.490247	-3.679322 <b>[0.0000]</b>
<i>lnDBN</i>	-1.327918	-3.670170 <b>[0.6033]</b>	-6.939344	-3.679322 <b>[0.0000]</b>
<i>lnIPSN</i>	-3.268566	-3.670170 <b>[0.0256]</b>	-6.980244	-3.679322 <b>[0.0000]</b>

**Note:** According to Mac Kinnon (1996) critical values, it indicates stationarity at 1% significance level.

**Table 6.** PP Unit Root Test – Trend and Intercept

Variables	Phillips-Perron Unit Root Test Trend and Intercept			
	I(0)		I(1)	
	t-statistic	critical value / [p-value]	t-statistic	critical value / [p-value]
<i>lnBA</i>	-1.687203	-4.296729 <b>[0.7320]</b>	-4.823928	-4.309824 <b>[0.0030]</b>
<i>lnBC</i>	-1.939319	-4.296729 <b>[0.6094]</b>	-7.632362	-4.309824 <b>[0.0000]</b>
<i>lnDBN</i>	-3.622695	-4.296729 <b>[0.0447]</b>	-6.852116	-4.309824 <b>[0.0000]</b>
<i>lnIPSN</i>	-2.973808	-4.296729 <b>[0.1557]</b>	-8.301674	-4.309824 <b>[0.0000]</b>

**Note:** According to Mac Kinnon (1996) critical values, it indicates stationarity at 1% significance level.

Based on the stationary results of the variables obtained in Augmented Dickey-Fuller and Phillips-Perron unit root test, the maximum integration degree  $d_{max} = 1$ , which is the initial stage of the Toda Yamamoto causality test, was obtained. The second step is to build the VAR model and find the optimal lag length  $k$  (optimal lag length). “While the Toda-Yamamoto method does not require the series to be integrated at the same degree, it also does not require the existence of a cointegration relationship between these series” (Çalışkan, Karabacak ve Meçik, 2017, s.50).

**Table 7.** Optimal lag length for the VAR model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	192.8172	NA	2.60e-11	-13.02187	-12.83328	-12.96281
1	326.3155	220.9628	7.97e-15	-21.12521	-20.18225*	-20.82989
2	349.5213	32.00793*	5.21e-15*	-21.62216*	-19.92483	-21.09057*

\* Optimal lag lengths selected by LR test statistic (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), Hannan-Quinn Information Criterion (HQ)

**Table 7.** shows the optimal length results based on LR test statistic, Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Information Criterion (HQ). Based on the results, the optimal lag length is 2 for LR, FPE, AIC, and HQ and 1 for SC. The most appropriate delay length is taken as  $k = 2$ . It is necessary to determine the stability and autocorrelation problem of the VAR model constructed with a suitable lag length.

**Table 8.** VAR Residual Serial Correlation LM test

Lag	LRE*stat	df	Prob.	Rao F-stat	df	Prob
1	23.49464	16	0.1011	1.620175	(16, 40.4)	<b>0.1074</b>
2	11.21310	16	0.7961	0.673858	(16, 40.4)	<b>0.8015</b>
3	14.24895	16	0.5802	0.885463	(16, 40.4)	<b>0.5891</b>
Null Hypothes is: No serial correlation at lag h						
Lag	LRE*stat	df	Prob.	Rao F-stat	df	Prob
1	23.49464	16	0.1011	1.620175	(16, 40.4)	<b>0.1074</b>
2	35.59368	32	0.3029	1.134948	(32, 34.8)	<b>0.3565</b>
3	48.01319	48	0.4723	0.867945	(48, 21.3)	<b>0.6673</b>
Null Hypothes is: No serial correlation at lags 1 to h						

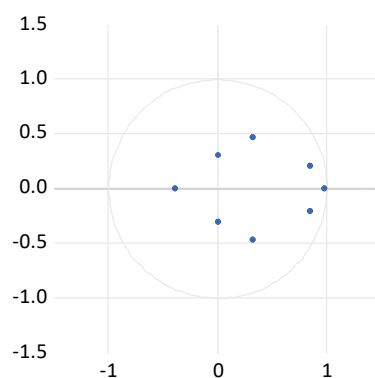


**Table 8.** Based on the most suitable delay length  $k = 2$ , the probability result is **0.8015**. By evaluating the results of the autocorrelation test, it is possible to note that we cannot reject hypothesis  $H_0$ , there is no autocorrelation problem in the variables.

**Scheme 1.** Dynamic stability of the model

Root	Modulus
0.980946	0.980946
$0.844295 - 0.210743i$	0.870199
$0.844295 + 0.210743i$	0.870199
$0.322329 - 0.464362i$	0.565268
$0.322329 + 0.464362i$	0.565268
-0.384515	0.384515
$0.008340 - 0.302020i$	0.302136
$0.008340 + 0.302020i$	0.302136

Inverse Roots of AR Characteristic Polynomial



According to the results of **Scheme 1**, all inverse root modulus values of the AR characteristic polynomials are less than 1, thus supporting our stationarity results. Finally, all the mentioned results confirm the model's suitability for investigating causality and  $k + d_{max} = 3$ .

The VAR model of Toda and Yamamoto causality will be as follows:

$$y_t = \mu_0 + \left( \sum_{i=1}^k a_{1t} y_{t-i} + \sum_{i=k+1}^{d_{max}} a_{2t} y_{t-i} \right) + \left( \sum_{i=1}^k \beta_{1t} x_{t-i} + \sum_{i=k+1}^{d_{max}} \beta_{2t} x_{t-i} \right) + \varepsilon_{1t} \quad (1)$$

$$x_t = \varphi_0 + \left( \sum_{i=1}^k \gamma_{1t} x_{t-i} + \sum_{i=k+1}^{d_{max}} \gamma_{2t} x_{t-i} \right) + \left( \sum_{i=1}^k \delta_{1t} y_{t-i} + \sum_{i=k+1}^{d_{max}} \delta_{2t} y_{t-i} \right) + \varepsilon_{2t} \quad (2)$$

**Table 9.** Toda Yamamoto Causality

Direction of Causality	$k+d_{max}$	Chi-square ( $X^2$ )	Prob.	Results (Causality)
lnDBN → lnIPSN	2+1	10.62827	0.0139	<b>H<sub>1</sub> - Yes</b>
lnBC → lnIPSN	2+1	0.819658	0.8448	H <sub>0</sub> - No
lnBA → lnIPSN	2+1	8.952471	0.0299	<b>H<sub>1</sub> - Yes</b>
lnIPSN → lnDBN	2+1	8.522623	0.0364	<b>H<sub>1</sub> - Yes</b>
lnBC → lnDBN	2+1	5.209828	0.1571	H <sub>0</sub> - No
lnBA → lnDBN	2+1	35.06416	0.0000	<b>H<sub>1</sub> - Yes</b>
lnIPSN → lnBC	2+1	5.255100	0.1540	H <sub>0</sub> - No
lnDBN → lnBC	2+1	7.814106	0.0500	H <sub>0</sub> - No
lnBA → lnBC	2+1	4.685516	0.1963	H <sub>0</sub> - No
lnIPSN → lnBA	2+1	5.478888	0.1399	H <sub>0</sub> - No
lnDBN → lnBA	2+1	5.056632	0.1677	H <sub>0</sub> - No
lnBC → lnBA	2+1	19.50555	0.0002	<b>H<sub>1</sub> - Yes</b>

If the probability of causality between the variables is lower than 5%, the hypothesis H<sub>0</sub> is rejected and H<sub>1</sub> is accepted, and the existence of a causal relationship is recorded. If it is above 5%, the H<sub>0</sub> hypothesis is not rejected and there is no causal relationship.

Based on the results obtained based on the analysis, a causal relationship between the dependent variable "Digital Banking Numbers" (lnDBN) and the independent variable "Instant Payment System Numbers" (lnIPSN) was obtained. As a result, the high and rising number of digital banking usage will affect the usage of open banking. Based on this short-term study, we can note the existence of a bidirectional relationship. According to a study by Polasik and Kotkowski (2022), card-based mobile and NFC payments have a positive correlation with the adoption of open banking services, although mobile banking has a more significant effect than NFC. Customers using mobile banking and NFC technology may adopt open banking.

For other variables, there exists a causal relationship between the dependent variable "Bank Accounts" (lnBA) and the independent variable "Instant Payment System Numbers" (lnIPSN). It is undeniable that there is a relationship, as transactions within both open banking and the instant payment system are conducted directly through bank accounts. Additionally, a causal relationship has been identified between "Bank Accounts" (lnBA) and "Digital Banking Numbers" (lnDBN). Utilizing digital banking services requires a bank account and the integration of these accounts into payment service networks. Additionally, there is a relationship between "Bank Customers" (lnBC) and "Bank Accounts" (lnBA), with each customer leading to the opening of a new bank account.

## 6. CONCLUSIONS AND RECOMMENDATIONS

Statistical data on the use of digital banking and digital payments in Azerbaijan has shown significant growth since 2020. From 2022 through the first six months of 2024, the total number of digital banking service transactions in Azerbaijan reached 743 million. Specifically, Apple Pay and Google Pay recorded 132.9 million transactions in 2022 and 2023. Additionally, there were 2.5 billion transactions conducted by customers across various platforms, including POS terminals, self-service terminals, and e-commerce, during the same period from 2020 to the first half of 2024. Based on the statistical results, it is possible to encourage users of digital banking to

adopt open banking through proper information and promotion. This study indicates that the similarities between digital banking and open banking such as ease of use, usefulness, trust, and efficiency will positively influence the rapid adoption of open banking among users.

In this study, the impact of digital banking on the use of open banking in Azerbaijan, and the short-term relationship between the number of transactions in digital banking and the number of transactions in the Instant Payment System was analyzed. A causality result was obtained in a study using the Toda-Yamamoto causality method. This analysis indicates that there is a potential link between customers using digital banking and their likelihood of adopting open banking. Additionally, the study found a causal relationship among bank accounts, bank customers, and the number of digital banking transactions.

Enhancing awareness of open banking in Azerbaijan will significantly elevate its adoption among consumers. As acceptance of the open banking concept increases, a corresponding decrease in the volume of digital banking transactions for domestic purposes can be anticipated. Furthermore, the implementation of open banking QR payments at point-of-sale (POS) terminals and "Pay by bank" payment type within the e-commerce sector is expected to witness substantial growth.

Further analysis using the main statistical results of transactions made through digital banking and payments via open banking services will effectively reveal the impact of digital banking on the adoption of open banking. Conducting a survey-based study on the intention to use open banking among digital banking users will provide valuable insights into the current situation. The limited adoption of open banking services by society, along with the challenges related to data accessibility, highlights the need for both short-term and long-term re-evaluation of the relationship between digital banking and open banking.

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