SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2024
ORGANIZATION AND MANAGEMENT SERIES NO. 207

THE IMPACT OF ADVANCED TECHNOLOGIES ON THE DEVELOPMENT OF THE CASHLESS PAYMENTS MARKET IN POLAND

Viktoriia STOIKA

Casimir Pulaski Radom University; v.stoika@urad.edu.pl, ORCID: 0000-0002-6356-890X

Purpose: the purpose of the article is to analyze the impact of modern technologies on the development of cashless payments and to assess the trend of changes in the Polish payment instruments market.
Design/methodology/approach: general scientific and empirical methods and tools of economic science, methods of analysis and synthesis, comparison, summary and grouping were used in the study. GRETL programming was used to find out the impact of the cashless payment market on the economic development of the country. The method of summarizing the results was used to draw conclusions regarding the trends of the cashless payment market in Poland.
Findings: the article analyzes the quantitative and qualitative changes in the market of payment instruments in Poland, the main place of which belongs to bank payment cards in conditions where the digitalization of the economy determines the main development trends not only of the financial sector but of all aspects of human life. The dynamics of the main quantitative parameters of the functioning of the payment card market in Poland over the past eight years have been analyzed, which indicates its active qualitative development and the presence of stable growth trends.
Research limitations/implications: modeling the relationship between GDP and the development of cashless payments is limited to selected indicators characterizing the development of the contactless payment market in Poland. Quarterly data for the period of 2012-2022 were used for this purpose.
Practical implications: the study confirms the need for the banking sector to implement a set of measures to develop the cashless payment market in Poland. Expanding the use of payment cards will not only contribute to the technological development of banks and strengthen their competitive position, but will also have a positive impact on the digital transformation of the economy in general.
Social implications: the development of cashless payments contributes to the accessibility, convenience, and speed of their implementation for users. The further use of innovative payment instruments by customers requires, first and foremost, improving the quality of their service and ensuring the security of cashless payments.
Originality/value: the study confirms a direct link between the number of payment card transactions and online payments and the country's economic development.
Keywords: cashless payments, payment cards, advanced technologies.
Category of the paper: Research paper.

1. Introduction

The rapid development of digital technologies has promoted the emergence of new tools for providing services in the financial market, the growing popularity of mobile applications, innovative IT technologies, neobanking, cryptocurrencies, etc. Innovations in the banking sector are changing the approaches and attitudes of customers to the use of financial services. First and foremost, they seek convenience, speed and security in managing their own funds and performing the required transactions. Automation of business processes, introduction of online banking, installation of self-service banking terminals, and use of artificial intelligence to analyze and monitor financial transactions benefit both financial services consumers and financial institutions.

Technological changes in the organization of banking institutions also affect the approaches to the implementation of their functions. Some researchers (Dziubliuk et al., 2022) point out that the organization of payment turnover as a key function of the banking system can no longer be considered separately from the emergence in recent decades of the latest digital products and technologies related to electronic transactions, bank cards, modern cash flow instruments, and virtualization of bank-customer interaction in general, which in fact fundamentally changes the entire banking activity, adding to it the dynamism that meets the needs of the new, digital economic order, especially in terms of payments. The spread of Internet banking, virtual wallets, contactless payment technologies and other innovations in banking is essentially an adequate response of the digital economy to the demands of the times to reduce the turnover costs associated with the movement of funds between market participants. The payment card market is the key link in this process, and it actually meets these needs in practice. Payment cards are becoming a key tool for implementing the complex task of reducing the share of cash payments in the overall structure of cash turnover as an important means of reducing overall turnover costs and increasing the efficiency of economic development in general.

A significant number of research papers have been devoted to the issues of cashless payments and their impact on economic development. The following research papers are particularly remarkable in this regard Galbraith & Tkacz (2007; 2009; 2015), Ching & Hayashi (2010), Hasan et al. (2012), Mieseigha & Ogbodo (2013), Guptha & Rao (2018), Przenajkowska & Polasik (2018), Aladangady et al., (2019), Sahi et al. (2021), Karjaluoto et al. (2021), Świecka et al. (2021), Kotkowski & Polasik (2021), Zandi & Singh (2021), Di Iorio & Rocco (2022), Carbo-Valverde et al. (2023), Niankara & Traoret (2023), Tut (2023), Stoika (2024).

However, despite a large number of thorough researches, it should be noted that a significant number of issues related to the impact of innovations on the development of the cashless payment market remain understudied.

The purpose of this publication is to analyze the impact of modern technologies on the development of cashless payments and to assess the trend of changes in the Polish payment instrument market.

2. Methods

General scientific and empirical methods and tools of economic science, methods of analysis and synthesis, comparison, summary and grouping were used in the study. GRETL programming was used to find out the impact of the cashless payment market on the economic development of the country. The method of summarizing the results was used to draw conclusions regarding the trends of the cashless payment market in Poland. Statistical data of the National Bank of Poland (NBP), the European Central Bank and the Polish Bank Association were used to analyse the development of the payment instrument market in Poland.

3. Literature review

In recent years, researchers have been increasingly focused on the impact of cashless payments on various processes in the economy. In particular, the article by Das et al., 2023, is devoted to the study of the impact of the Indian demonetization policy on tax compliance. The authors conclude that the use of e-payments has likely strengthened the ability of tax authorities to monitor tax liabilities and ensure compliance.

Rahman et al., 2022 note that the introduction of cashless payment systems by businesses in Malaysia can reduce the costs associated with handling huge amounts of cash in the market and increase the speed of transactions. At the same time, the key factors affecting the introduction of cashless payments by businesses are not their size, but the support of management, pressure by competitors, and the intensity of information.

The other researchers (Luan et al., 2023) note that the use of cashless payments increases the income of public tourist companies in Vietnam.

Lv, J. et al., 2024, investigate the impact of the digital economy on the informal economy in China. The researchers conclude that the development of digital finance has a negative impact on the informal economy. This is because digitalization provides many more benefits in terms of addressing the informality problem, such as transparency of payments, easing credit constraints, increasing overall income, and helping governments reach out to the population and businesses.

Some researchers (Aladangady et al., 2019; Baker, 2018; Galbraith, Tkacz, 2007) notes, that the use of electronic payments, including mobile banking and other FinTech platforms, is an important determinant of the cyclical position of the economy and is an indicator of economic growth Electronic payments represent a unique source of information for short-term economic forecasting (Aprigliano et al., 2019). Existent research denotes a link between the development of non-cash payment system and economic growth (Alvarez, Lippi, 2009; Mieseigha, Ogbodo, 2013; Aliha et al., 2020). The existing literature has determined that electronic card transactions are a real-time indicator of the economy's cyclical position (Galbraith, Tkacz, 2009, 2015).

Zandi & Singh (2021) have conducted a comprehensive analysis of the macroeconomic benefits of payment cards in terms of their distribution in individual countries and their impact on economic growth. Their findings show that the transition from physical cash to payment cards serves as an impetus for the development of the entire global economy and thus determines the need for public policy that encourages and accelerates such a transition.

Humphrey et al. (2006) found that the development in the use of electronic payment systems, mainly electronic retail payment instruments, is related to notable improvements in banking performance. In fact, as documented in Humphrey et al. (2006), between 1987 and 1999, European countries may have saved $32 billion by shifting from paper-based to electronic payment systems that is the 0.38% of the aggregate GDP in 1999. Furthermore, they document that if a country shifts from an all paper-based to a fully electronic-based payment system and substitutes branch offices with ATMs, the annual savings may be around 1% of GDP.

In 2019, the largest U.S. banks paid out $35 billion in rewards (Sumit et al., 2023). For cardholders, credit card rewards are an opportunity to earn money or perks with the use of their credit cards. For banks, credit card rewards are an incentive scheme to induce consumers to adopt and increase the usage of the banks' credit card products (Sumit et al., 2010; Ching, Hayashi, 2010).

Kotkowski R. & Polasik M. (2021) notes, however, the COVID-19 pandemic (henceforth "the pandemic"), and the measures imposed by governments to contain it, appear to have had a considerable impact on consumer payment behaviour. This is most evident in the rapid increase in the adoption of cashless payments.

Tut D. (2023) shows the effects of the coronavirus disease 2019 (COVID-19) pandemic on financial institutions and on consumers' adoption of Financial Technology (FinTech) for payments. Carbo-Valverde et al. (2023) examines the impact of the Covid-19 mobility restrictions on the payment choices at brick-and-mortar establishments. Niankara I. & Traoret R.I. (2023) shows, how the digital payment-financial inclusion nexus fostered demand-driven payment system innovation and diffusion within the global open economy during the COVID-19 crisis.

Driven by the worldwide increase in consumers' preferences for real time payments, especially since the onset of the global COVID-19 crisis (Vargo et al., 2021), the global demand

for digital payment transactions, has been reportedly fuelled by the increasing adoption of contactless payment solutions, including digital wallets (Singh et al., 2020), mobile payment, online banking (Karjaluoto et al., 2021) and point of sale (Sahi et al., 2021).

By drawing on the data from various national payment systems, Kraenzlin et al. (2020), Ardizzi et al. (2020) shows that the volume of cashless payments increased in Switzerland, Italy and France during the pandemic, despite an overall decline in consumption expenditure.

The innovation in the payment system and instruments have caused a change in the choice of payment method among the consumers. Consumers are expected to benefit from the convenient payment instruments, both in terms of timing and costs. Therefore, cashless payment is expected to facilitate consumption, thereby increasing economic growth. Payment cards as a key tool for remote access to bank accounts are the main driver of the development of cashless payment operations and the promotion of the institutional foundations of money circulation in the direction of the increasing growth of its cashless component.

4. Results and Discussion

Information technology is one of the main factors affecting the possibility of banking services access. During 2015-2021, the share of Internet users in the European Union (EU) and Poland increased from 76% to 87% and from 68% to 85%, respectively (Fig. 1). Increasing penetration of the Internet and mobile telephony in the EU and in Poland has contributed to the change of consumers' habits and preferences. They increasingly use social interaction via digital media to share information about themselves, interact with administrative authorities, make online purchases, or gain access to new services, including 24/7 financial services (Peterson, 2018).

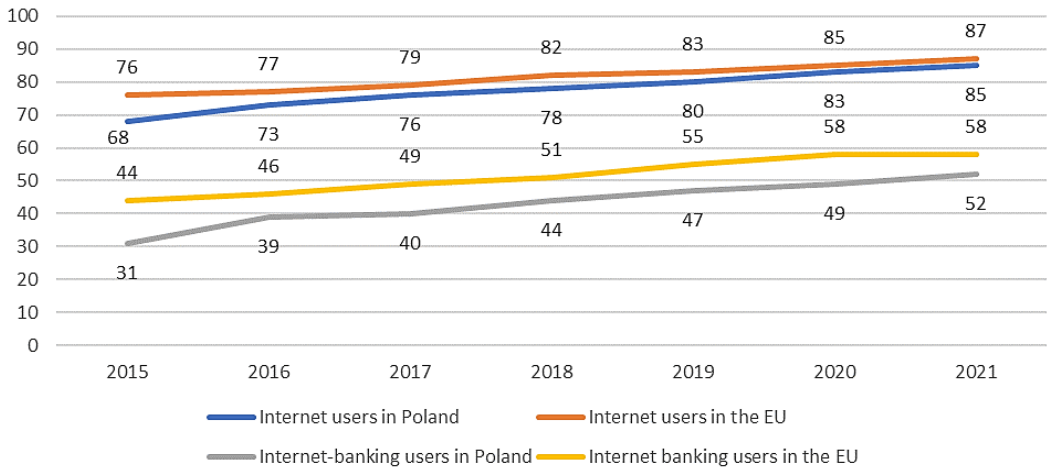

Figure 1. Internet and internet banking users in the EU and Poland in 2015-2021 (% of population).
Source: The author' own research on the basis of Eurostat.

Against the background of increased access to Internet technologies, there is an increase in the share of people using Internet banking. During 2015-2021, it increased from 44% to 58% among the EU population, and from 31% to 52% in Poland. Among the EU Member States, internet banking is most common in Denmark (95% of users in 2021), Norway (96%), Iceland (95%), Finland (93%) and the Netherlands (91%). The fewest internet banking users in 2021 were in Bulgaria (15%) and Romania (15%) (Eurostat 2023). The high level of e-banking use is primarily due to the active development of digital innovations and information technology. In particular, this is confirmed by the data of the Digital Economy and Society Index (DESI). In 2021, the leaders according to the DESI index were Denmark, Finland and Sweden. Poland was in 24th place among EU countries, ahead of Greece, Bulgaria and Romania (DESI, 2021).

During 2015-2022, the number of individual accounts of customers with access permission agreements to online banking in Poland increase from 30 million to 42 million. Moreover, only half of customers are active users of Internet banking, of which about 10% are small and medium-sized enterprises (SME) (Fig. 2):

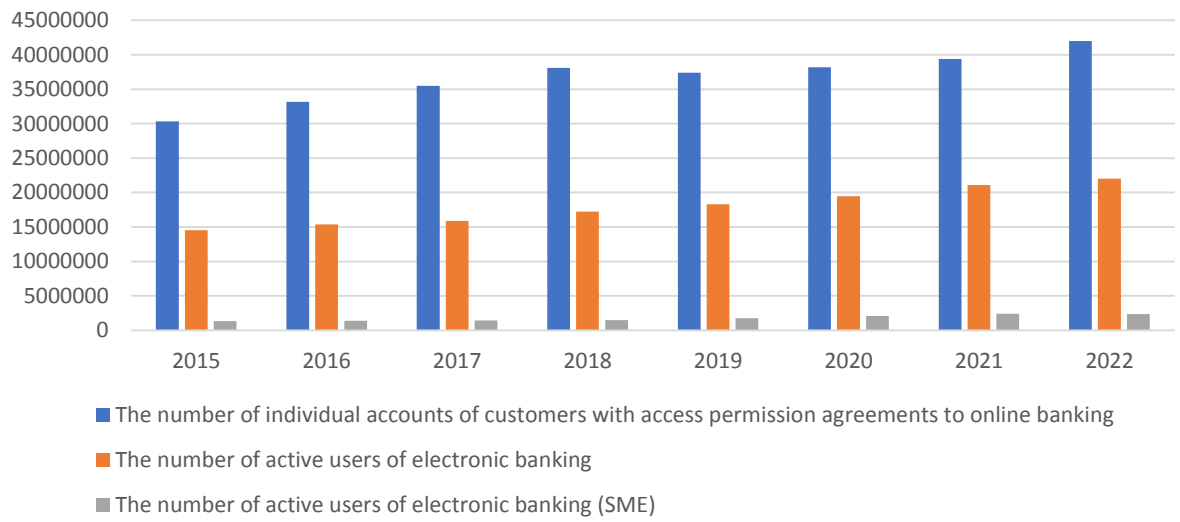

Figure 2. Number of e-banking users in Poland in 2015-2022, persons.

Source: The author's own research on the basis of Polish Bank Association.

The number of Poles who actively use their bank account via the Internet is increasing (from 46% in 2009 to 80% in 2021). At the same time, the relationship between the age of a bank client and the use of an Internet account is obvious. In younger age groups up to 44 years, up to 96% of customers use the Internet to access their accounts. In the group of 45-54-year-olds – 86%, among 55-64-year-olds 67% use the possibility of servicing accounts via the Internet, and among the oldest customers (over 64 years old) – 44%. Most often, Internet accounts are used to check transaction history and make payments. At the same time, there is an increase in the number of people who often pay bills or make money transfers using the Internet (by the end of 2021, their share was 99%). Instead, other transactions, in particular, opening a deposit, buying shares in an investment fund, are less popular. The percentage of Poles who say that they "definitely more often" use remote bank account management instead

of visiting a branch increased from 46% in 2009 to 73% in 2021. Moreover, only 5% of people who have access to an account via the Internet more often choose a personal visit to a bank branch (Maison, 2021).

In Poland, payment cards were first introduced to the market in the 1990s. This payment instrument is becoming more popular and, against the background of the other cashless instruments, its use is growing annually by about 30%, while in the EU market this growth is about 10% (Niedzwiedzka, 2018). Over the past eight years, the number of payment cards in Poland has increased by almost 10 million (Table 1):

Table 1.
Number of payment cards in Poland in 2015-2022 (pcs.)

Years	Cards, total	Cards for individual customers		Cards for business customers		Contactless cards	
		number	share, %	number	share, %	number	share, %
2015	35,209,043	32,217,141	91.50	2,991,902	8.50	27,018,902	76.74
2016	36,874,489	33,324,415	90.40	3,550,074	9.60	28,494,784	77.30
2017	39,095,880	35,059,278	89.68	4,036,602	10.32	31,138,220	79.65
2018	41,237,320	36,829,538	89.31	4,407,782	10.69	34,675,149	84.09
2019	42,989,876	38,277,841	89.04	4,712,035	10.96	37,281,629	86.72
2020	43,675,231	38,742,597	88.71	4,932,634	11.29	38,361,247	87.83
2021	43,261,902	38,303,241	88.54	4,958,661	11.46	40,174,309	92.86
2022	44,523,137	39,825,523	89.45	4,697,614	10.55	41,637,837	93.52

Source: The author' own research on the basis of NBP.

Cards for individual customers significantly prevail (89.45% in 2022), but the share of cards for business customers is also on the rise (10.55% in 2022). The number and share of contactless payment cards is also growing. Between 2015 and 2022, their volume increased by more than 14 million cards, and their share – from 76.74% to 93.52%. Besides contactless cards, there are also the other media on the Polish market that allow for contactless payments. These include cards installed in phones, watches, bracelets, and so-called stickers. According to the NBP, the number of all contactless payment instruments based on payment cards amounted to 49 million at the end of 2022. The gradual rise in popularity of contactless payment cards containing more advanced information security technologies is an indicator of the further digitalization of payment mechanisms and their coverage of an increasing number of economic agents in the payment environment.

Debit cards significantly prevail among the issued payment instruments in terms of the payment method. Between 2015 and 2022, their share increased from 76.43% to 84.20%, while the share of credit cards decreased from 16.49% to 11.00%. The feature of debit cards is that they allow paying for purchases or withdrawing cash within the amount of funds available on your bank account. Unlike bank deposits, payment cards show better liquidity and thus reliability for storing funds, and therefore enjoy a higher level of public trust.

The number of payment card transactions almost tripled between 2015 and 2022, from 3,307,005,565 to 9,097,719,555 (Fig. 3). At the same time, the number of cashless payment card transactions also increased significantly, from 2,556,223,180 to 8,566,775,212, and their share – from 77.3% to 94.2% during the period under review.

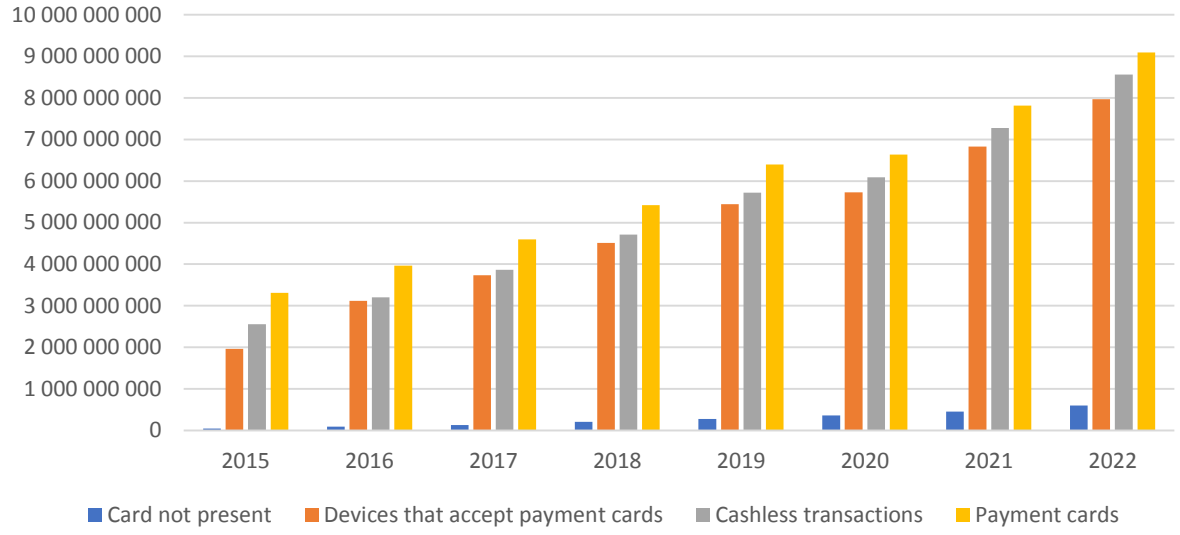

Figure 3. Number of transactions with payment cards and devices that accept payment card, as well as cashless transactions in Poland in 2015-2022**.**

Source: The author's own research on the basis of NBP.

It should be noted that during 2015-2022, the number of transactions using CNP cards grew significantly, from 44,577,242 to 596,718,881. Card not present (CNP) is a type of payment card transaction in which the cardholder is not physically present with their card at the time and place of payment. These trends indicate that Polish market participants are almost completely ready to use payment cards as a means of paying for goods and services in the course of cashless payments, rather than as a tool for withdrawing cash at a bank's cash desk or ATM.

The spread of cashless payments in Poland is facilitated not only by innovative card instruments, but also by payment systems. In particular, when making online purchases, 70% of customers usually choose a quick transfer through a payment service (e.g. PayU, DotPay, przelewy24), 48% - mobile payments (e.g. BLIK), and 42% - conventional transfers. At the same time, 76% of people make online purchases using a smartphone. In the youngest group of customers (15-24 years old), this figure was 92% (E-commerce w Polsce, 2021**)**.

Another factor influencing the increase in the number of e-banking users using mobile phones is the popularity of the BLIK mobile payment system. This system serves to carry out various transactions using the phone within the banking mobile application. BLIK is an entirely Polish "invention" and was developed in February 2015. By the end of 2015, less than a million transactions were carried out using BLIK, but since 2018, there has been an intensive increase in transaction data. By the end of 2022, the number of BLIK transactions was 1.235 billion (fig.4), and the number of active users of this system was about 13 million people.

What is more, 49% of users of banking mobile applications choose it most often as a form of payment. Such popularity of BLIK among Poles is explained by its convenience, safety and ease of use (Polski Standard Płatności, 2023).

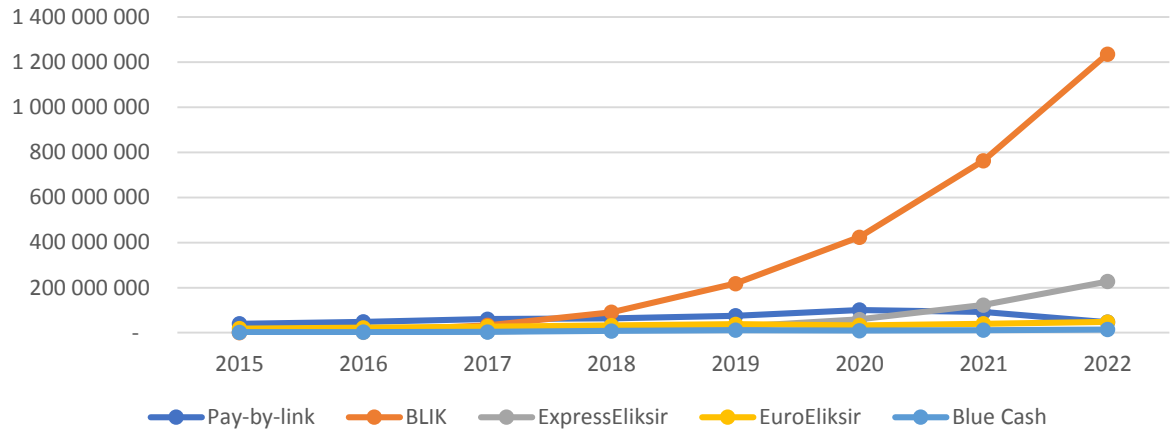

Figure 4. Number of transactions in terms of some payment systems in Poland in 2015-2022.
Source: The author's own research on the basis of NBP.

Given the customers' focus on cashless payments, there are changes in the payment card market infrastructure to ensure their implementation (Table 2):

Table 2.
Payment card market infrastructure in Poland in 2015-2022 (number, pcs.)

Parameters	2015	2016	2017	2018	2019	2020	2021	2022
Acceptors	196,758	225,196	276,288	367,959	417,861	492,755	553,518	618,531
Branches of retail and service networks	364,186	424,016	489,511	609,743	694,136	785,861	876,740	959,874
POS terminals	465,457	563,236	632,955	786,845	906,564	1,027,490	1,123,060	1,220,597
ATMs	22,143	23,443	23,230	22,879	22,704	21,829	21,396	21,310

Source: The author's own research on the basis of NBP.

During 2015-2022, the number of acceptors and branches of retail and service networks accepting payment cards, as well as POS terminals increased almost threefold. It should be noted that the growth in the number of POS terminals in Poland is largely due to the launch of the Poland Cashless program, which aims to eliminate the cost for entrepreneurs to install a payment terminal and the cost of using the same during the first twelve months after its installation. Instead, the number of ATMs decreased by about 1000 pcs. This trend is typical not only for Poland but also for the entire Europe. Banking institutions are interested in reducing the number of ATMs in order to cut their own costs and create conditions to encourage card users to further abandon cash and to maximize the use of cashless payments.

In 2015-2021, Poland ranked first among the 27 EU countries in terms of the number of payment service branches. Poland's high position in this ranking is mainly due to the fact that conventional l institutions offering payment services (banks, credit unions, Poczta Polska, etc.)

also include a new group of entities that have been eligible for the benefits of such services since the entry into force of the Payment Services Directive in 2009. In our country, these are mainly companies where customers deposit cash into bank accounts to make monthly payments (e.g., energy, gas, telephone, rent). According to NBP, excluding branches of payment service institutions and payment service points, this figure be 472 branches per million population in 2021, i.e. above the EU average (393), and Poland would have ranked 11th among the 27 EU countries.

In terms of the ratio between GDP per capita (in EUR) and the number of payment instrument transactions per capita in 2021, there is a clear difference between the so-called "old" EU member states and the "new" EU member states, i.e., countries that acceded to the EU on or after May 1, 2004. The "new" member states have both lower income levels and fewer cashless transactions per capita. In 2021, GDP per capita in Poland amounted to EUR 15.1 thousand. The number of transactions per capita in Poland in 2021 was 300.9 (2020: 253.3), while the average GDP per capita in the Union in 2021 was EUR 32.3 thousand and the average number of cashless transactions was 318.2.

In terms of the country's share in the total number of card payments in the EU, which amounted to 9.8% in 2021, Poland ranked fourth after France (21.5%), Germany (11.1%), and Spain (10.2%) (Fig. 5):

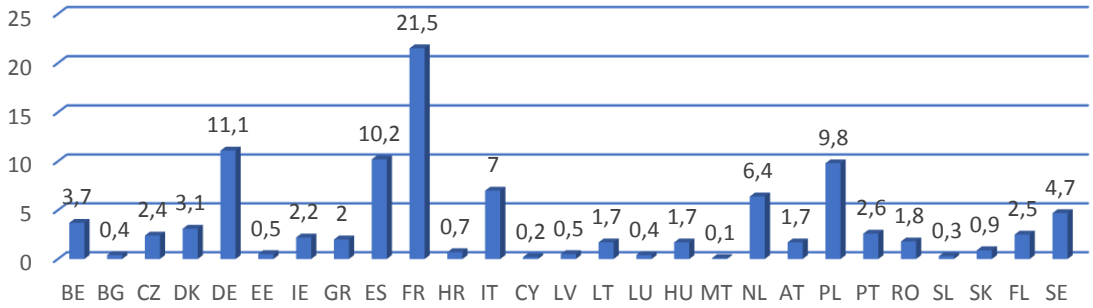

Figure 5. Country's share in the total EU number of card payments in 2021 (as a percentage; total for the period).

Source: The author's own research on the basis of European Central Bank.

In terms of the country's share in the total value of EU card payments in 2021, Poland ranked eighth after France (24.6%), Germany (14.6%), Italy (10.0%), Spain (9.5%), the Netherlands (5.0%), Belgium (4.4%), and Sweden (4%) (Fig. 6):

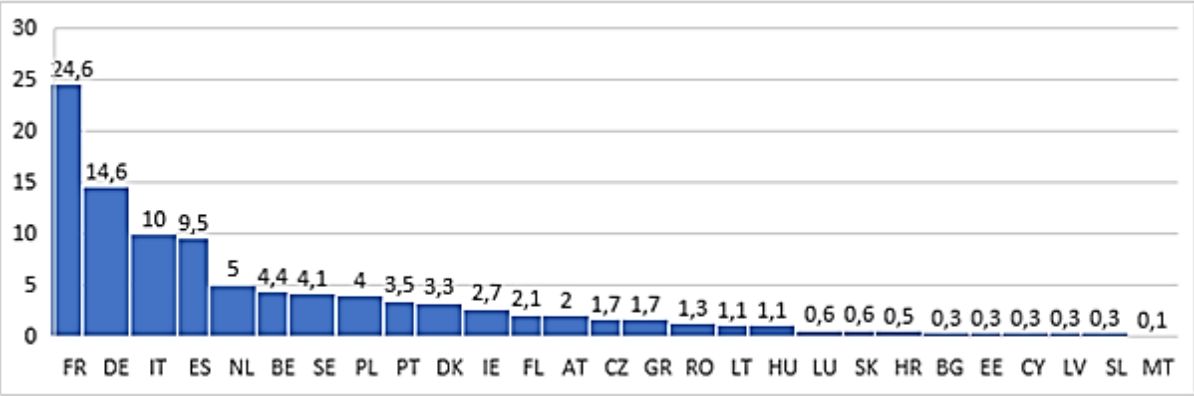

Figure 6. Country's share in the total EU value of card payments in the EU in 2021 (as a percentage; total for the period).

Source: The author's own research on the basis of European Central Bank.

To determine the relationship between a country's GDP and the cashless payment market, a linear model is built to explain its dependence on the following indicators that reflect the quantitative characteristics of the development of the payment card market and its infrastructure in the country:

- number of individual customers having access to e-banking, persons;
- number of ATMs, pcs.;
- number of POS terminals, pcs.;
- number of payment card acceptors, pcs.;
- number of online payment branches, pcs.;
- number of payment card transactions on the Internet, pcs.;
- cost of payment card transactions on the Internet, PLN;
- number of payment cards, pcs.;
- share of cashless payment card transactions, %;
- number of payment card transactions, pcs.

The calculations produced a model that reflects a linear relationship between a country's GDP and some indicators of the cashless payments development in the country.

To build the model, quarterly statistical data for the 2012-2022 period from the following databases were used: the Main Statistics Office, the National Bank of Poland and the Polish Bank Association. GRETL programming was used for the research and the classical least squares method was applied. As a result of calculations, a model was obtained that reflects the linear relationship between the country's GDP and some indicators of the payment card market:

$$GDP = a_0 + a_1POSt + a_2PCTinternet + a_3PCTnumber$$

where:

POSt - number of POS terminals, pcs.;

PCTinternet - number of payment card transactions on the Internet, pcs.;

PCTnumber - number of payment card transactions, pcs.

Table 3 shows the model evaluation results.

Table 3.
Model evaluation results: OLS estimation, using observations 2012:4-2022:4 (number of periods - 41). Dependent variable: GDP

Variables	***Coefficient***	***Std. Error***	***t-ratio***	***p-value***	***Notes***
const	465060	44792,7	10,38	<0,0001	***
POSt	−0,509913	0,151393	−3,368	0,0018	***
PCTinternet	0,00937317	0,00225546	4,156	0,0002	***
PCTnumber	0,000177345	5,39824e-05	3,285	0,0022	***
Basic statistics for variables					
Mean dependent var		535103,7	S.D. dependent var		115980,6
Sum squared resid		4,52e+10	S.E. of regression		34962,49
R-squared		0,915943	Adjusted R-squared		0,909127
F(3, 37)		134,3919	P-value (F)		6,04e-20
Log-likelihood		−485,0153	Akaike criterion		978,0307
Schwarz criterion		984,8850	Hannan-Quinn		980,5266
rho		−0,050343	Durbin-Watson		1,786693

Notes:
***The variable is statistically significant at a significance level of 0.01.
** The variable is statistically significant at a significance level of 0.05.
* The variable is statistically significant at a significance level of 0.1.

Source: The author's own calculations based on GRETL programming.

Additional model reliability testing confirmed the linear relationship between the dependent and independent variables, as well as the absence of heteroscedasticity and autocorrelation.

The model evaluation results show that it explains 91% of the variability of the dependent variable, and all variables of this model are statistically significant. The number of POS terminals in the country demonstrates the strongest relationship with the dependent variable (i.e. GDP), although it is inverse to GDP. A direct relationship between the country's GDP and the number of payment card transactions and payment card transactions on the Internet has also been confirmed. There is no relationship between the other indicators and the dependent variable. This situation may be due to the still weaker development of certain indicators of cashless payments in Poland (e.g., the number of individual customers having access to e-banking, the number of payment cards, the share of cashless transactions using payment cards) and, consequently, their insignificant impact on the country's GDP.

Conclusion

The development of modern technologies has determined the direction of changes in the payments sector. Digitalization is a recognised mechanism of economic growth due to the ability of technology to positively influence the efficiency, effectiveness, cost and quality of economic, public and personal activities. Modern banking can no longer be considered separately from the emergence of the latest digital products and technologies and the

virtualisation of interaction between banks and customers in general. Internet access, the use of smartphones, and the development of e-commerce have led to remote payment servicing. Modern customers choose convenience, ease, speed and security of payments. Banks are trying to adapt to the needs of the population and provide access to advanced payment instruments.

Poland is characterised by an increase in the number of individual customer accounts with access permission agreements to online banking, but in fact only about half of them are active users. The share of customers of small and medium-sized enterprises is also insignificant.

The main payment instrument in Poland is contactless payment cards, the number of which is growing rapidly. Further to that, CNP cards, which do not require the presence of their holder to make a payment, are gaining popularity. The emergence of the BLIK payment system in 2015, which allows for various transactions using a mobile banking application, also contributed to the spread of cashless payments in Poland.

These changes in customers' approach to payment methods have promoted the development of the payment infrastructure. Between 2015 and 2022, the number of acceptors and branches of retail and service networks that accept payment cards, as well as POS terminals, almost tripled. In 2015-2021, Poland ranked first among the 27 EU countries in terms of the number of payment service outlets. These trends indicate that Polish market players are almost completely ready to use payment cards as a means of paying for goods and services in the course of making cashless payments, rather than as a tool for withdrawing cash at a bank's cash desk or ATM.

The model of GDP dependence on certain indicators of cashless payments development built by the author of this paper has confirmed the direct connection between the number of payment card transactions and Internet payments and the country's economic development.

The further development of the payment card and cashless payments market should become a strategic direction for the Polish financial system in the digital age. This requires expanding innovative services for payment cards, improving the quality of their service, further developing payment infrastructure tools, and ensuring security of cashless payments. Thus, it would be useful to learn from the foreign countries’ experience of arranging cashless payments in order to develop recommendations for their improvement in Poland.

References

1. Abdullah, Naved Khan, M. (2021). Determining mobile payment adoption: A systematic literature search and bibliometric analisys. *Cogent Business and Management, 8(1),* https://doi.org/10.1080/23311975.2021.1893245
2. Aladangady, A., Aron-Dine, S., Dunn, W., Feiveson, L., Lengermann, P., Claudia, S. (2019). From Transactions Data to Economic Statistics: Constructing Real-Time, High-Frequency, Geographic Measures of Consumer Spending. *NBER Working Paper, No. w26253.* Available at SSRN: https://ssrn.com/abstract=3454354.
3. Aliha, P.M., Sarmidi, T., Said, F.F. (2020). Investigating the impact of atm and pos terminals on money demand in nine european countries in the context of a random effect model as the appropriate panel data model. *Regional Science Inquiry, 12(2),* 31-41.
4. Alvarez, F., Lippi, F. (2009). Financial Innovation and the Transactions Demand for Cash. *Econometrica, Econometric Society, 77(2),* 363-402. https://doi.org/10.3982/ECTA7451
5. Aprigliano, A., Ardizzi, G., Monterforte, L. (2019).Using payment system data to forecast the Italian GDP. *International Journal of Central Banking, 15(4),* pp. 55-80.
6. Ardizzi, G., Nobili, A., Rocco, G. (2020). *A game changer in payment habits: evidence from daily data during a pandemic (No. 591).* Banca d'Italia Occasional Papers. https://www.bancaditalia.it/pubblicazioni/qef/2020-0591/QEF_591_20.pdf
7. Baker, S. (2018). Debt and the response to household income shocks: validation and application of linked financial account data. *Journal of Political Economy, 126(4),* 1504-1557. https://doi.org/10.1086/698106
8. Bounie, D., Camara, Y., Galbraith, J.W. (2020). *Consumers' mobility, expenditure and online- offline substitution response to Covid-19: evidence from French transaction data* (No. 2020S–28). CIRANO Working Papers.
9. Carbo-Valverde, S., Cuadros-Solas, P.J., Rodriguez-Fernandez, F., Sanchez-Bejar, J.J. (2023). Mobility restrictions and payment choices: The case of the Covid-19 pandemic. *Journal of Behavioral and Experimental Finance, 40,* https://doi.org/10.1016/j.jbef.2023.100850
10. Ching, A.T., Hayashi, F. (2010). Payment card rewards programs and consumer payment choice. *Journal of Banking & Finance, 34,* 1773-1787.
11. Das, S., Gadenne, L., Nandi, T., Warwick, R. (2023). Does going cashless make you tax-rich? Evidence from India's demonetization experiment. *Journal of Public Economics, 224,* https://doi.org/10.1016/j.jpubeco.2023.104907
12. Di Iorio, A., Rocco, G. (2022). Easier Said Than Done: Why Italians Pay in Cash While Preferring Cashles. *Bank of Italy Occasional Paper, No. 731,* http://dx.doi.org/10.2139/ssrn.4463072

13. Dziubliuk, O., Lutsiv, B., Chaikovskyi, Ya. (2022). Modern development of the payment card market in the digital economy. *Financial and credit activity: problems of the theory and practice, 6(47).* https://doi.org/10.55643/fcaptp.6.47.2022.3894
14. E-commerce w Polsce (2021). *Raport*. Gemius. Retrieved from: https://www.gemius.pl/wszystkie-artykuly-aktualnosci/raport-e-commerce-w-polsce-2021.html
15. Galbraith, J.W., Tkacz, G. (2015). Nowcasting GDP with electronic payments data. *Statistics Paper Series, 10*. European Central Bank.
16. Galbraith, J.W., Tkacz G. (2007). *Electronic Transactions as High-Frequency Indicators of Economic Activity. Technical report*. Bank of Canada. https://www.bankofcanada.ca/wp-content/uploads/2010/02/wp07-58.pdf
17. Galbraith, J.W., Tkacz, G. (2009). A Note on Monitoring Daily Economic Activity Via Electronic Transaction Data. *CIRANO Working Papers, s-23*, CIRANO.
18. Guptha, K.S., Rao, R.P. (2018). The causal relationship between financial development and economic growth: an experience with BRICS economies. *Journal of Social and Economic Development, 20(2),* 308-326. https://doi.org/10.1007/S40847-018-0071-5
19. Hasan, I., De Renzis, T., Schmiedel, H. (2012). Retail payments and economic growth. *Research Discussion Papers, 19*. Bank of Finland.
20. Humphrey, D.B., Willesson, M., Bergendahl, G., Lindblom T. (2006). Benefits from a changing payment technology in European Banking. *Journal of Banking and Finance, 30(6),* 1631-1652.
21. Jonker, N., Cruijsen, C., Bijlsma, M., Bolt, W. (2020). Pandemic payment patterns (No. 701). *DNB Working Papers*. Retrieved from: https://www.dnb.nl/media/xbrj1xuc/working-paper-no-701.pdf
22. Karjaluoto, H., Glavee-Geo, R., Ramdhony, D., Shaikh, A.A., Hurpaul, A. (2021). Consumption values and mobile banking services: understanding the urban–rural dichotomy in a developing economy. *International Journal of Bank Marketing, 39,* 272-293. https://doi.org/10.1108/IJBM-03-2020-0129
23. Kotkowski, R., Polasik, M. (2021). COVID-19 pandemic increases the divide between cash and cashless payment users in Europe. *Economic Letters, 209*. https://doi.org/10.1016/j.econlet.2021.110139
24. Kraenzlin, S., Meyer, C., Nellen, T. (2020). COVID-19 and regional shifts in swiss retail payments. *Swiss Journal of Economics and Statistics, 156,* http://dx.doi.org/10.1186/s41937-020-00061-x
25. Luan, D.X., Tran, N.V., Quyet, T.V., Kingsbury, A.J. (2023). Banking for tourism in the digital age: Access to credit and cashless payments for community-based tourism household-owned businesses in Vietnam. *Tourism Management Perspectives, 48,* https://doi.org/10.1016/j.tmp.2023.101144

26. Lv, J., Li, S., Zhu, M., Huang, W. (2024). Can the digital economy development limit the size of the informal economy? A nonlinear analysis based on China's provincial panel data. *Economic Analysis and Policy*, *83*, https://doi.org/10.1016/j.eap.2024.07.022
27. Maison, D. (2021). Postawy *Polaków wobec obrotu bezgotówkowego. Raport z badania 2021 i analiza porównawcza z danymi z 2009, 2013 i 2016 roku*. Narodowy Bank Polski.
28. Mieseigha, E.G., Ogbodo, U.K. (2013). An Empirical Analysis of the Benefits of Cashless Economy on Nigeria's Economic Development. *Research Journal of Finance and Accounting*, *4(17),* 11-16.
29. Niankara, I., Traoret, R.I. (2023). The digital payment-financial inclusion nexus and payment system innovation within the global open economy during the COVID-19 pandemic. *Journal of Open Innovation: Technology, Market, and Complexity*, *9(4),* https://doi.org/10.1016/j.joitmc.2023.100173
30. Niedzwiedzka, E. (2018). Tendencje zmian na rynku intrumentów płatniczych w Polsce na tle pozostalych krajów Unii Europejskiej w latach 2000-2018. *Problemy Zarządzania – Management Issue, 16(1),* https://doi.org/10.7172/1644-9584.72.6
31. Peterson, K.O. (2018). Impact of digital finance on financial inclusion and stability. *Borsa Istanbul Review*, *18(4),* 329-340. https://doi.org/10.1016/j.bir.2017.12.003
32. Przenajkowska, K., Polasik, M. (2018). Koszty gotówki i elektronicznych instrumentów płatniczych w Unii Europejskiej. *Ekonomiczne Problemy Usług*, *2(131/1),* 283-290. https://doi.org/10.18276/epu.2018.131/2Ğ28
33. Rahman, M., Ismail, I., Bahri, S., Rahman, M.K. (2022). An Empirical Analysis of Cashless Payment Systems for Business Transactions. *Journal of Open Innovation: Technology, Market and Complexity*, *8*, *213*, https://doi.org/10.3390/joitmc8040213
34. Sahi, A.A., Khalid, H., Abbas, A.F., Khatib, S.F.A. (2021). The Evolving Research of Customer Adoption of Digital Payment: Learning from Content and Statistical Analysis of the Literature. *Journal of Open Innovation: Technology, Market, and Complexity, 7(4),* https://doi.org/10.3390/joitmc7040230
35. Singh, N., Sinha, N., Liebanna-Cabanillas, F.J. (2020). Determining factors in the adoption and recommendation of mobile wallet services in India: Analysis of the effect of innovativeness, stress to use and social influence. *International Journal of Information Management*, *50*, 191-205**.** https://doi.org/10.1016/j.ijinfomgt.2019.05.022
36. Stoika, V. (2024). Digitalization processes as an integral component of modern banking in Poland. In: M. Baudry, S.I. Bukowski, M.B. Lament (eds.), *Financial Stability, Economic Growth and Sustainable Development* (pp. 168-182). New York: Routledge.
37. Sumit, A., Chakravorti, S., Lunn, A. (2010). Why do banks reward their customers to use their credit cards? *Federal Reserve Bank of Chicago Working Paper*, *19*.
38. Sumit, A., Presbitero, A.F., Silva, A., Wix C. (2023). Who Pays for Your Rewards? Redistribution of the Credit Card Market. *IMF Working Papers, Iss. 054*, *73,* https://doi.org/10.5089/9798400232428.001

39. Świecka, B., Terefenko, P., Paprotny, D. (2021). Transaction factors' influence on the choice of payment by Polish consumers. *Journal of Retailing and Consumer Services*, *58*, https://doi.org/10.1016/j.jretconser.2020.102264
40. Tut, D. (2023). FinTech and the COVID-19 pandemic: Evidence from electronic payment systems. *Emerging Markets Review*, *54*, https://doi.org/10.1016/j.ememar.2023.100999
41. Vargo, D., Zhu, L., Benwell, B., Yan, Zh. (2021). Digital technology use during COVID-19 pandemic: A rapid review. *Human Bechavior and Emerging Technologies, 3(1),* 13-24, https://doi.org/10.1002/hbe2.242
42. Zandi, M., Singh, A. (2021). *The Impact of Payment Cards on Economic Growth. Analysis.* Moody's Analytics. 22 November, 1-27. Retrieved from: http://www.moodysanalytics.com/