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THE DEVELOPMENT OF CASHLESS TRANSACTIONS IN POLAND: EMPIRICAL APPROACH AND FORECASTS

The aim of the article is to analyze the current state and prospects for the development of cashless payments in Poland. The study uses empirical data, in particular statistics from the National Bank of Poland, to identify trends and estimate forecasts for selected indicators illustrating the dynamics of non-cash transactions. As part of the analysis, trends and forecasts for 2020-2022 were estimated for the following variables: the number of debit and credit cards in circulation on a quarterly basis (1999-2019), divided into two sub-periods: up to 2009 and from 2010 onward, the value of transactions carried out with payment cards (1999-2019), including a forecast up to 2022, the value of ATM withdrawals in Poland (2004-2019) and abroad (2004-2019), including forecasts for 2020-2022. The application of econometric tools in the analysis makes it possible to highlight a research gap in the field of quantitative modeling of processes related to the development of cashless payments — an area still insufficiently explored in the literature. The results confirm the dynamic and systematic growth of cashless payments in Poland, accompanied by a simultaneous decline in the dynamics of cash transactions. The analysis is based on the estimation of trends and forecasts for selected indicators for 2020-2022, which enables a comparison of model predictions with currently available empirical data. This, in turn, allows for the verification of forecasting assumptions and the assessment of the pace of development of cashless payments in Poland. The article serves as a starting point for further research on the development of non-cash payments in Poland, especially in the context of applying quantitative methods that support trend identification and forecast formulation. Thanks to the availability of actual statistical data for the years 2020-2022, it is now possible to empirically verify the validity of assumptions and the accuracy of forecasting models, which significantly enhances the cognitive value of the conducted analyses. The article analyzes the current state and prospects of cashless payments in Poland using empirical data, particularly statistics from the National Bank of Poland. The study identifies trends and produces forecasts for 2020-2022 across several indicators: the number of debit and credit cards in circulation (1999-2019), the value of card transactions (1999-2019, with projections to 2022), and ATM withdrawals in Poland and abroad (2004-2019, with forecasts to 2022). By applying econometric methods, the research highlights a gap in quantitative modeling of processes related to cashless payments, a field still underexplored in the literature. The findings confirm dynamic growth in non-cash transactions alongside a decline in cash-based operations. Comparing model predictions with observed data for 2020–2022 allows for the verification of assumptions and the assessment of Poland's payment trends. The study serves as a foundation for further research, particularly in advancing quantitative approaches to forecasting cashless payment development.

Keywords: *non-cash transactions, electronic payments, forecasting, Poland, payment system.*

Єж О. РОЗВИТОК БЕЗГОТІВКОВИХ ОПЕРАЦІЙ У ПОЛЬЩІ: ЕМПІРИЧНИЙ ПІДХІД ТА ПРОГНОЗИ

Здійснено комплексний аналіз сучасного стану та перспектив розвитку безготівкових розрахунків у Польщі. Дослідження базується на емпіричних даних, насамперед статистиці Національного банку Польщі, що дало змогу виявити ключові тенденції та сформувати прогнози динаміки розвитку безготівкових операцій. Розглянуто показники, які найбільш повно характеризують ринок безготівкових розрахунків: досліджено кількість дебетових і кредитних карток в обігу за кварталами впродовж 1999-2019 рр. із поділом на два часові відрізки (до 2009 р. та після 2010 р.), що дало змогу простежити вплив інституційних і технологічних змін; проаналізовано обсяг операцій із використанням платіжних карток за період 1999-2019 рр. і здійснено прогноз до 2022 р.; вивчено динаміку обсягів зняття готівки в банкоматах як у Польщі (2004-2019 рр.), так і за кордоном (2004-2019 рр.). Особливу увагу приділено застосуванню економетричних інструментів, які дали змогу не лише описати наявні тенденції, але й здійснити кількісне прогнозування. Використання таких методів виявило прогалину в науковій літературі, де кількісне моделювання процесів, пов'язаних із розвитком безготівкових платежів, досі представлено недостатньо. Отримані результати підтверджують динамічне та систематичне зростання обсягу безготівкових операцій у Польщі, що відбувається на тлі поступового зниження значення готівкових трансакцій. Це свідчить про структурні зміни у фінансовій поведінці населення та про зростання довіри до сучасних платіжних технологій. Важливим є також те, що розвиток цифрової інфраструктури та поширення інноваційних фінансових сервісів у Польщі створюють передумови для ще більш активного зростання безготівкових платежів надалі. Аналіз тенденцій і прогнозів на 2020-2022 рр. уможливлює порівняння модельних оцінок з фактичними статистичними даними, що суттєво підвищує достовірність дослідження. Такий підхід надає можливість перевірити правильність прогнозних припущень, оцінити точність застосованих моделей та окреслити реальні темпи розвитку безготівкових розрахунків.

Результати проведеного дослідження становлять вагомий внесок у вивчення безготівкових платежів у Польщі. У статті не лише описано сучасний стан ринку, отримані результати створюють підґрунтя для подальших досліджень, особливо у сфері застосування кількісних методів аналізу та прогнозування, що сприяє формуванню ефективних стратегій розвитку платіжних систем. Крім того, результати дослідження можуть бути корисними для банківських установ, регуляторів та урядових органів, які зацікавлені в прискоренні процесів цифровізації та мінімізації витрат, пов'язаних з обслуговуванням готівкового обігу.

Ключові слова: *безготівкові операції, електронні платежі, прогнозування, Польща, платіжна система.*

Problem statement. The development of cashless transactions is an integral part of the digitization of the economy. With technological progress and the growing popularity of innovative financial services, there has been increasing interest in payment instruments that serve as alternatives to cash, such as payment cards, online transfers, mobile banking applications, and BLIK solutions. Cashless transactions are not only convenient and time-saving but also contribute to enhancing the transparency of economic activity by leaving a digital transaction footprint (digital trail) [1], limiting the shadow economy, and reducing the costs of operating the payment system [2; 3].

In Poland, cashless transactions have been growing dynamically, supported by both regulatory and institutional initiatives as well as the rising economic awareness of society. In recent years, there has been a marked increase in the number and value of transactions carried out through systems such as ELIXIR, Express Elixir, BLIK, and Blue Cash. This development has also been driven by the activities of the National Bank of Poland, including the Cashless Transactions Development Programme for 2014-2020, which outlined strategic directions for the evolution of the payment system in Poland.

Analysis of recent research. In the literature on the subject, payment systems are analyzed from the perspective of their function in the economy, the security of transactions, their impact on the efficiency of resource allocation, and their role in reducing the shadow economy. Particular attention is also paid to issues related to financial inclusion and the digitalization of banking services. Domestic publications emphasize the role of the National Bank of Poland as both an initiator and regulator of changes in the area of non-cash transactions. Programs such as the Cashless Transactions Development Programme are identified as turning points in the popularization of electronic forms of payment in Poland [3].

The study by Grzelczak and Pastusiak showed that the development of cashless payments positively correlates with the level of GDP per capita [4], with transfers and card payments having the greatest impact. In Western European countries, e-money plays a significant role, while in Central and Eastern Europe, the development of payment infrastructure is still ongoing. At the international level, the European Central Bank and the Bank for International Settlements (BIS) highlight substantial differences in the development of payment instruments among Member States.

Scandinavian countries such as Sweden and Denmark are seen as leaders in the transition to a cashless economy. Research indicates that the rapid decline in cash use in Sweden can be attributed to high levels of public trust, low levels of corruption, robust digital infrastructure, and widespread access to banking services. However, the authors emphasize that the Swedish model of digitization may not be directly applicable to other countries [5].

Econometric models have confirmed that debit card transactions significantly stimulate GDP growth, while the impact of credit cards, e-money, and cheques was statistically insignificant [6]. In the international literature, researchers such as Arvidsson [7] and Fung and Halaburda [8] analyze the impact of digital technologies on the structure of the financial services market and on consumer behavior.

Authors such as Zetzsche et al. [9] address issues of security and the ethical aspects of payment digitization, highlighting the need to strike a balance between efficiency and privacy protection. Despite the rise of cashless payments, cash remains the dominant means of payment (accounting for 89% of retail transactions) due to its anonymity, ease of spending control, widespread acceptance, and the absence of fees for consumers [10].

Many publications also emphasize the importance of payment infrastructure, the level of financial inclusion, access to technology, and digital competencies as key conditions for the development of cashless transactions.

An analysis of annual data from the G7 countries (2012-2020), using the Panel ARDL model, revealed a strong positive long-term relationship between non-cash transactions (cards, e-money, transfers, cheques) and real GDP. In the short term, card payments, e-money, and cheques also had a significant impact on GDP, while the effect of transfers was negligible [11].

Previous research has also focused on the analysis of the costs of cash and non-cash payments [12], the efficiency of interbank settlements [13], and the role of both public and private initiatives in the transformation of the payment market.

The September 2024 report on Ukraine indicates that the number of cards with contactless payment functionality increased from 23.9 million in 2020 to an estimated 75.3 million in 2024, with a compound annual growth rate (CAGR) of approximately 33.2% [14]. In 2024, 90% of US and European consumers used payment apps. Particularly dynamic growth was observed in in-app mobile payments, reaching 60% in the US and 28% in Europe [15], confirming that consumer expectations are now the most important factor institutionalizing cashless payments in SMEs – especially as contactless cards and devices are increasingly associated with modernity, fairness, and high service standards [16].

Quantitative research on the acceptance of non-cash payment instruments by businesses was conducted, among others, by Jonker [17], and includes measurement of payment processing times across a wide range of methods used at points of sale [18].

Recently, smart rings offering cashless payment options have emerged. Banks in Poland have introduced a contactless payment ring (PeoPay Ring) as part of their product offerings [19; 20].

This article contributes to the body of research on local determinants of cashless transactions by incorporating methods for analyzing the current state and prospects for the development of cashless payments in Poland.

The paper purpose is to analyze the current state and prospects for the development of cashless payments in Poland. The study uses empirical data, including statistical information provided by the National Bank of Poland. This article contributes to the ongoing discourse on the future of the payment system and the role of the state and financial sector in shaping modern and secure forms of monetary settlements.

Major research findings. *Purpose and research hypotheses*. The main objective of this article is to identify and assess the degree of development of cashless transactions in Poland during the years 2014-2020. The study is based on empirical data, primarily statistics from the National Bank of Poland, to identify trends and estimate forecasts for selected indicators illustrating the dynamics of non-cash transactions. As part of the analysis, trends and forecasts for the period 2020-2022 were estimated for the following variables:

– the number of debit and credit cards in circulation on a quarterly basis (1999-2019), divided into two sub-periods: up to 2009 and from 2010 onward;

– the value of transactions carried out using payment cards (1999-2019), with a forecast through 2022;

– ATM withdrawals in Poland (2004-2019) and abroad (2004-2019), including forecasts for 2020-2022.

The use of econometric tools in the analysis helps to identify a research gap in the field of quantitative modeling of processes related to the development of cashless payments, which remains insufficiently explored in the literature.

The article puts forward the following main hypotheses: 1) In Poland, there was a noticeable increase in the use of non-cash payments during the analyzed period. 2) The main determinants of the development of cashless transactions are: improved technological accessibility, an increase in the number of bank accounts and payment cards, a reduction in interchange fees, and promotional activities by financial institutions.

In the study of the potential for the development of cashless payments in Poland, the following four specific research hypotheses were formulated: H1: The number of credit cards is increasing. H2: The demand for credit cards is decreasing. H3: The value of transactions using payment cards is increasing. H4: The growth rate of ATM withdrawals is declining.

Test materials and methods. The study is based on the analysis of secondary data. The quantitative part uses statistical data of the National Bank of Poland on the functioning of payment systems in Poland in 2011-2019, including, m.in others, the number and value of transactions carried out. In order to forecast the development of selected indicators for 2020-2022, the linear trend method and regression analysis were used.

In the first step, the parameters of the linear function (trend function) were estimated using the classical least squares method (KMNK). Trends of various analytical forms were used, which were most suited to the course of the data [21].

In order to eliminate seasonal fluctuations, theoretical values were first determined:

$$\widehat{y_t} = b + a \cdot t. \quad (1)$$

Periodic fluctuations were measured by calculating the seasonality index. Individual seasonality indices were determined [22]:

$$W_t = \frac{y_t}{\widehat{y_t}} \quad (2)$$

for $t = 1, 2, \ldots, n$.

The crude seasonal index was determined, which is the arithmetic mean of individual indices:

$$O_i^{'} = \frac{\sum_{j=0}^{s} w_{i+jd}}{s} = \frac{w_i + w_{i+d} + w_{i+2d} + \cdots + w_{i+(s-1)d}}{s}, \quad (3)$$

$i = 1, 2, 3, \ldots, d$; s – number of identical periods (repetitions for a given season); d – number of seasons [21].

We calculate the correction index:

$$W_k = \frac{d}{\sum_{i=1}^{d} O_i^{'}}. \quad (4)$$

The adjusted seasonality index was also estimated:

$$O_i = W_k \cdot O_i^{'} \quad (5)$$

for t = 1, 2, …, n.

Forecasts for phenomena with multiplicative seasonal fluctuations were calculated:

$$y_T^P = (aT + b) \cdot O_i. \quad (6)$$

For each forecast, the average forecast error is determined:

$$S_{PT} = S(e_t)\sqrt{\frac{(T-t)^2}{\sum_{t=1}^{n}(t-\bar{t})^2} + \frac{1}{n} + 1}, \quad (7)$$

where:

T – forecast period [21].

In the interpretation of the average error, the forecasts are given as a percentage, thanks to which seasonal deviations (plus and minus) from the average values resulting from the trend are known. The calculations have been done by means of Program Firmy Microsoft Excel [23].

Test results. In order to verify the hypotheses, trends[1] and values of the development forecast until 2022 were calculated for selected indicators (the number of various types of cards in circulation, the number and volume of transactions concluded with these instruments and the value of withdrawals from ATMs). It began with an estimation of the trend and a forecast of the number of debit cards issued in Poland (Fig. 1).

[1] For a linear function, R2=0.98.

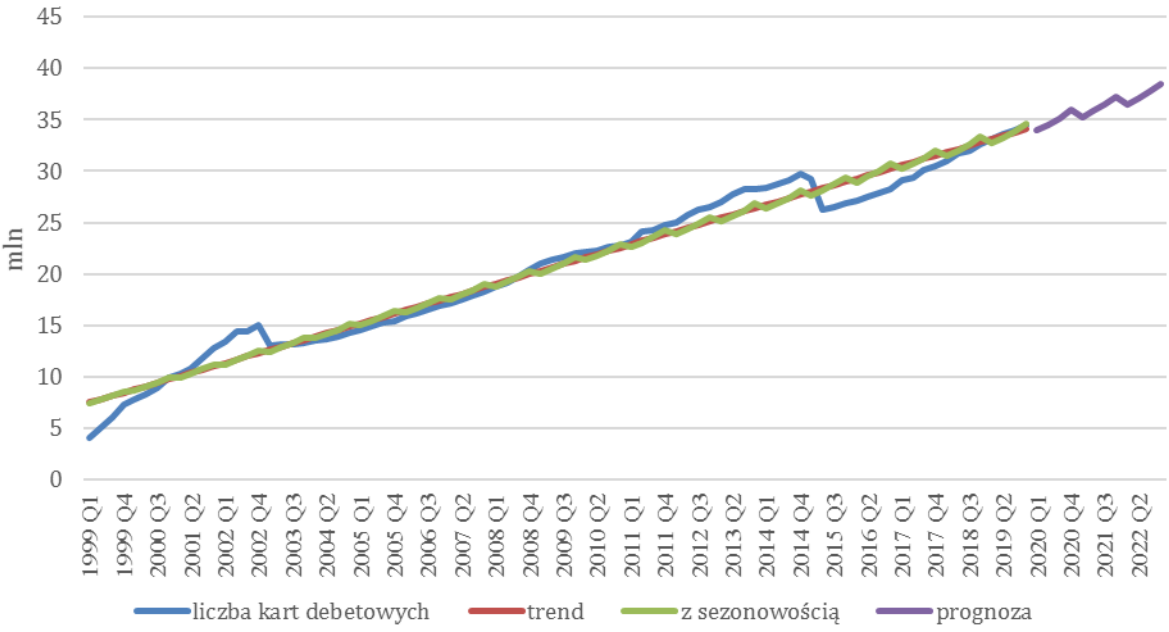

Fig. 1. Number of debit cards on a quarterly basis in 1999-2019 and forecast for 2020-2022

Source: own work based on [5].

There is a clear growing trend in the number of debit cards issued in Poland:

$$\widehat{LKD}_i = (7207264{,}2 + 320115{,}6t_i) * (0{,}988Q_1 + 0{,}994Q_2 + 1{,}003Q_3 + 1{,}016Q_4),$$

Where:

LKDi – empirical level of the number of debit cards period i;

Qs – a zero-one variable taking 1 in quarter s.

Excluding the adjustments in 2003 and 2015 (resulting from the withdrawal of certain types of cards, we are dealing with a dynamic permanent increase of 320,000 cards per quarter. This is a high number corresponding to the demand, especially from individual (non-commercial) customers. It is the result of both the emergence of new potential users, m.in. young people reaching the age of majority, and the persuasion of older people to this type of service. The growth process is also in many cases forced by the actions of institutions that accumulate savings, pay benefits and accept payments. Table 1 shows the projected number of debit cards.

Table 1

Values of the forecasts of the number of debit cards for individual quarters of 2020-2022

Period	Forecast, mln	Average Percentage Error of the Forecast
Q1 2020	33,987	0,7%
Q2 2020	34,539	0,7%
Q3 2020	35,144	0,6%
Q4 2020	35,924	0,6%
Q1 2021	35,251	0,6%
Q2 2021	35,812	0,6%
Q3 2021	36,428	0,6%
Q4 2021	37,225	0,6%
Q1 2022	36,516	0,6%
Q2 2022	37,085	0,6%
Q3 2022	37,712	0,6%
Q4 2022	38,525	0,6%

Source: own work based on [5].

Forecasts indicate slow growth – about 320,000 cards per quarter with clear seasonality. In the fourth quarter of 2022, approximately 38.525 million debit cards should be available to customers (Table 1). These forecasts are burdened with a relatively low error of 0.6%

The number of credit cards on a quarterly basis in the years 1999-2019 and the trend until 2009 and since 2010 are shown in Fig. 2.

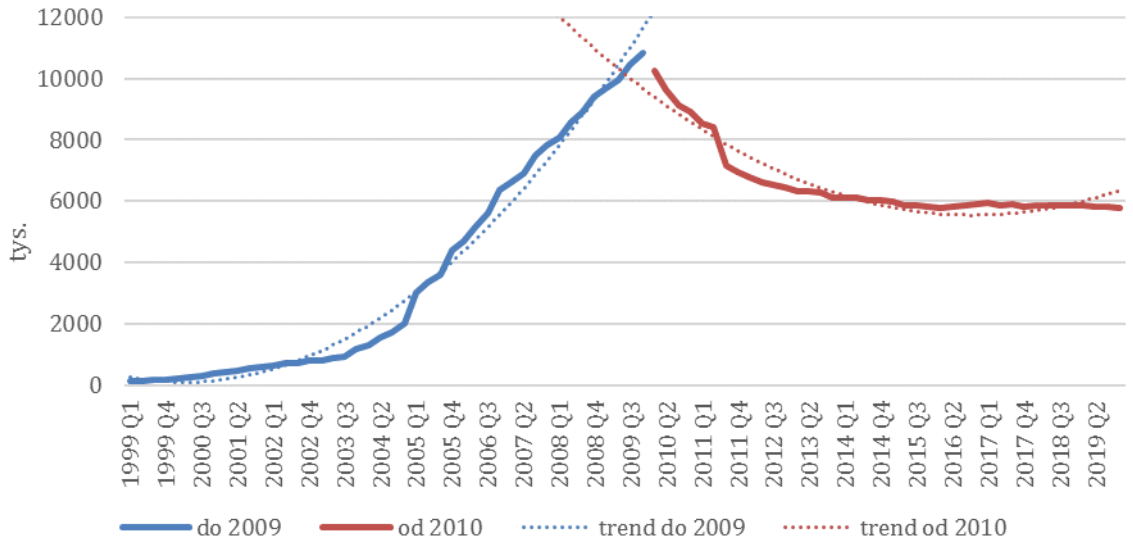

Fig. 2. Number of credit cards on a quarterly basis in 1999-2019 and trend to 2009 and since 2010

Source: own work based on [5].

Due to the specificity of credit cards and the decreasing differences in their usability compared to debit cards, the demand for the former is not so dynamic. Before the crisis, banks in Poland pursued a very expansive policy and offered credit cards to almost everyone. A change in this area (at the end of 2009) is clearly visible, resulting as it may seem from the collapse on the financial market – the crisis – and the repercussions in the economy. As a result of the crisis, both entrepreneurs and individual customers had to slightly revise their views on consumption and payment methods. The transition away from credit cards has been quite smooth and we can talk about a relatively constant demand for this means of payment, at the level of less than six million. The growth from 1999-2009 was almost exponential and was probably related to too much optimism in the economy and ease (too much) in terms of the availability of financial resources offered by banks. On the one hand, the crisis situation has reduced this optimism, and on the other hand, it has increased caution on the part of both customers and bidders.

In the next step, the trend and forecast of the value of transactions carried out with the use of payment cards were estimated (Fig. 3).

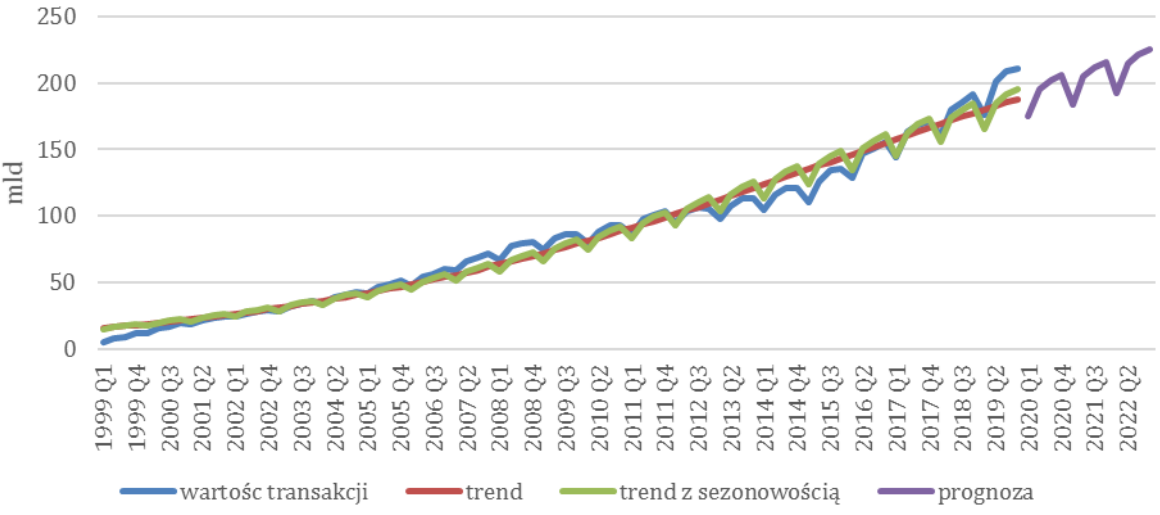

Fig. 3. Quarter-on-quarter value of transactions with the use of payment cards in 1999-2019 and forecast for 2020-2022

Source: own work based on [5].

The logistics trend function was estimated:

$$\widehat{WTKK}_t = \left[288938mln + \frac{(-4335{,}2mln + 288938\ mln)}{(1 + 0{,}0706675 * e^{0{,}039 * t})}\right]$$

$$* (0.918Q1 + 1.012Q2 + 1.032Q3 + 1.039Q4),$$

Where:

WTTKi – empirical level of the value of transactions carried out with the use of payment cards in period i;

Qs – a zero-one variable taking 1 in quarter s.

We are observing a clear upward (logistical) trend in the area of cashless payments. This trend is also characterized by a clear seasonality. In the first quarters, the value of transactions is on average 8.2% lower than the quarterly average. In the second quarter, this value is 1.2% higher than the average, in the third quarter it is 3.2%, while in the last fourth quarter it is the highest and is higher than the average by 3.9%. The result for the third quarter is mainly related to expenses during the holiday period, when customers do not want to carry cash with them. In this case, a trend was determined using a four-parameter logistics function[2]. Its main advantage is the ability to indicate a certain asymptote – the level of saturation. In the case under study, it is 284.603 billion, which we should reach in the next 21 years. Table 2 presents forecasts of the value of transactions using payment cards for individual quarters of 2020-2022.

Table 2

Forecasts of the value of transactions carried out with the use of payment cards for individual quarters of 2020-2022

Period	Forecast, billion	Average Percentage Error of the Forecast
Q1 2020	174,993	2,85%
Q2 2020	195,474	2,55%
Q3 2020	201,999	2,47%
Q4 2020	205,931	2,43%
Q1 2021	184,148	2,72%
Q2 2021	205,419	2,44%
Q3 2021	211,990	2,36%
Q4 2021	215,831	2,32%
Q1 2022	192,749	2,60%
Q2 2022	214,738	2,34%
Q3 2022	221,329	2,27%
Q4 2022	225,061	2,24%

Source: own work based on [5].

Forecasts indicate an increasingly dynamic growth (in sections close to exponential) in the value of transactions carried out with the use of payment cards. In the fourth quarter of 2022, the value of transactions using payment cards should reach 225.061 billion. The forecasts are burdened with a relatively low error of no more than 3%. Moreover, the trend and forecasts of the value of ATM withdrawals were estimated (Fig. 4).

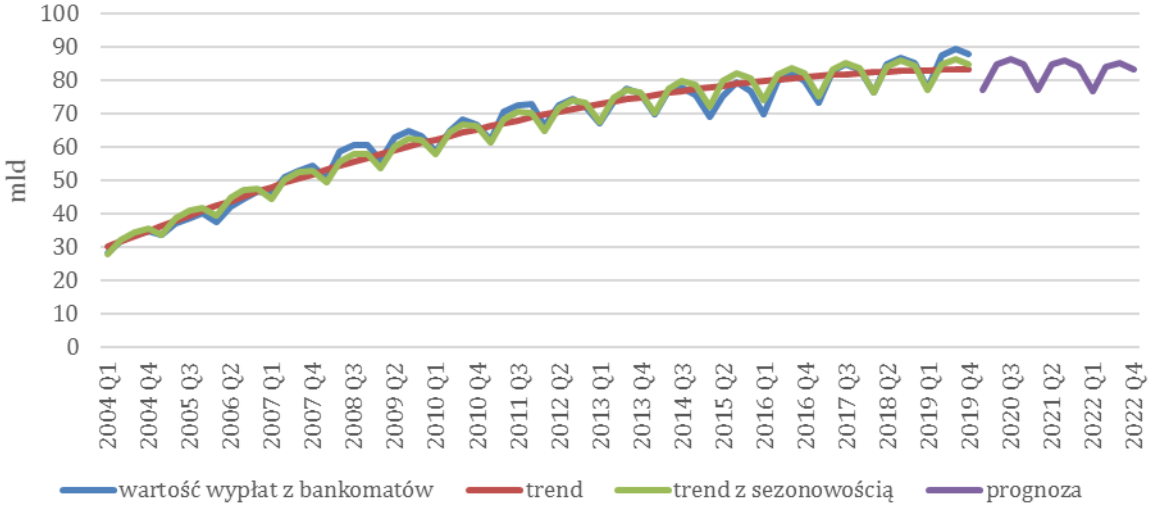

Fig. 4. Value of ATM withdrawals on a quarterly basis in 2004-2019 and forecast for 2020-2022

Source: own work based on [5].

ATM withdrawals are characterized by a trend similar to the logit or second-degree polynomial. The latter approach (used above) seems to be more adequate.

$$\widehat{WWB}\iota = (-12756515{,}9t^2 + 1674089250{,}1t + 28394583{,}3tys.)$$
$$* (0.9278Q1 + 1{,}018O2 + 1{,}038Q3 + 1{,}016Q4),$$

2

[2] For the linear function R2=0.961, for the logistic function R2=0.976. The logistic function is not much better suited to the data, but in terms of content it corresponds more to the course of the phenomenon under study. The assumption of growth "indefinitely" is difficult to justify, especially in relation to modern products.

Where:

WWBi – empirical level of ATM withdrawals in period *i*;

Qs – a zero-one variable taking 1 in quarter *s*.

The increasing liquidity of plastic money with the growing number of terminals supporting it and the decreasing importance of cash transactions naturally cause a decrease in the growth rate of ATM withdrawals. What is more, assuming such tendencies, in the coming years we may even be dealing with a decrease in the number and value of this type of operations. The level of ATM withdrawals is also characterized by a clear quarterly seasonality. As in the case of non-cash transactions, in the first quarter we observed withdrawals lower than the quarterly average by 7.3% and in the following quarters higher with an accumulation of 3.8% in the third quarter. Forecasts of the value of ATM withdrawals for individual quarters of 2020-2022 and the average percentage error of the forecast are presented in Table 3.

Table 3

Forecasts of the value of ATM withdrawals for individual quarters of 2020-2022

Period	Forecast, billion	Average Percentage Error of the Forecast
Q1 2020	77,233	3,6%
Q2 2020	84,856	3,6%
Q3 2020	86,474	3,6%
Q4 2020	84,608	3,6%
Q1 2021	77,102	3,6%
Q2 2021	84,608	3,6%
Q3 2021	86,116	3,6%
Q4 2021	84,153	3,6%
Q1 2022	76,592	3,7%
Q2 2022	83,945	3,7%
Q3 2022	85,334	3,7%
Q4 2022	83,284	3,7%

Source: own work based on [5].

Forecasts indicate that a certain point of market saturation in terms of ATM withdrawals has been exceeded. Apart from quarterly increases, a slow decline in the value of payments is observed on a continuous basis. In the fourth quarter of 2022, the value of ATM withdrawals should reach 83.284 billion, i.e. it will be 1.6% lower than in the corresponding quarter of 2019, and year-on-year in 2020 withdrawals are forecast to be 1.1% lower. The forecasts are burdened with a low error of no more than 3.7%.

At the end of the deliberations, the value of withdrawals from ATMs outside the country was estimated (Fig. 5).

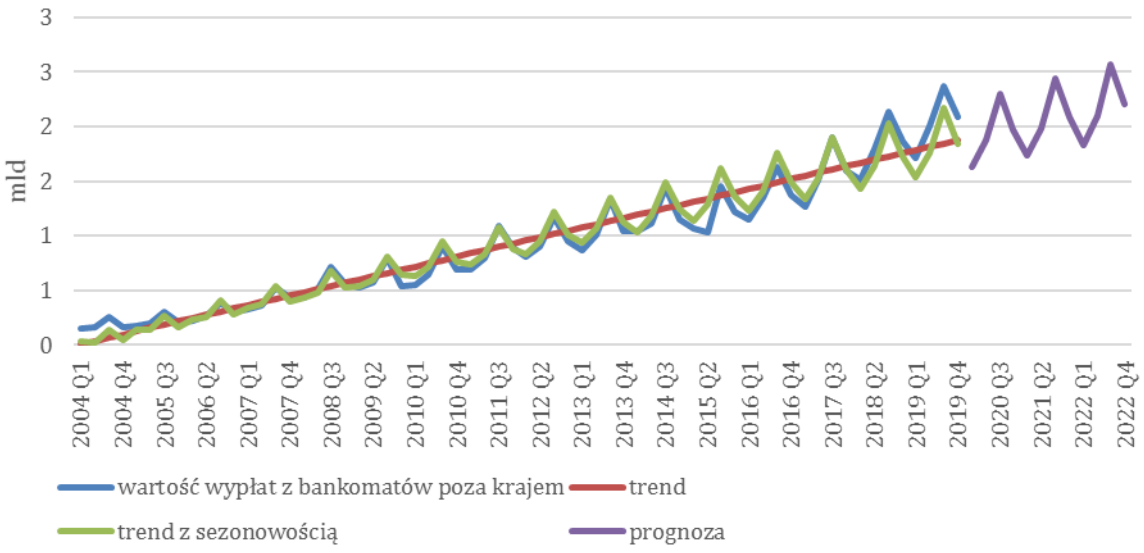

Fig. 5. Value of ATM withdrawals outside the country on a quarterly basis in 2004-2019 and forecast for 2020-2022

Source: own work based on [5].

While withdrawals from domestic ATMs are characterized by changes, seasonality and shape almost identical to the general approach, in the case of withdrawals from ATMs outside Poland, we observe much greater seasonality. What's more, the level of this seasonality is growing. Therefore, an equation containing zero-one variables corresponding to individual quarters was proposed, for which the equations were evaluated separately and combined into one model:

$$\widehat{WBPK_i} = 9356853+24952643ti)*Q1+ (-35185894+28917484ti)*Q2+$$

$$(35922383+33807592ti)*Q3+ (80265883+30128261ti)*Q4,$$

Where:

WBPKi – empirical level of ATM withdrawals in period *i*;

Qs – zero-one variable taking 1 in quarter *s*.

The analysis of the linear pace of change for individual quarters confirmed that the level of disbursements in the third quarter increased by 12.2% faster than in the fourth quarter, by 16.9% compared to the second quarter and by as much as 35.5% compared to the first quarter, in which we can still observe an increase of approximately PLN 99.8 million year on year. Calculated forecasts of the value of ATM withdrawals outside the country for individual quarters of 2020-2022 are presented in Table 4.

Table 4

Forecasts of the value of ATM withdrawals outside the country for individual quarters of 2020-2022

Period	Forecast, billion	Average Percentage Error of the Forecast
Q1 2020	1,631	6,1%
Q2 2020	1,873	5,3%
Q3 2020	2,301	4,3%
Q4 2020	1,968	5,1%
Q1 2021	1,731	5,8%
Q2 2021	1,989	5,0%
Q3 2021	2,436	4,1%
Q4 2021	2,089	4,8%
Q1 2022	1,831	5,5%
Q2 2022	2,105	4,8%
Q3 2022	2,571	3,9%
Q4 2022	2,209	4,6%

Source: own work based on [5].

Forecasts indicate a continuous increase and continuous differentiation of the level of ATM withdrawals outside the country on a quarterly basis. Apart from quarterly increases, a slow decline in the value of payments is observed on a continuous basis. In the fourth quarter of 2022, the value of ATM withdrawals outside the country should reach 2.209 billion, i.e. it should be 19.6% higher than in the corresponding quarter of 2019, and year-on-year in 2020 withdrawals are forecast to be 19.4% higher. The forecasts are burdened with low errors in the range of 3.9-6.1%.

To sum up, the following research hypotheses were not rejected:

– the number of credit cards is increasing;

– the dynamics of demand for credit cards is decreasing;

– the value of transactions using payment cards is increasing;

– the growth rate of ATM withdrawals is decreasing.

Discussion. The research confirms that Poland is on the path of dynamic development of cashless transactions, although the scale of this development is still inferior to the countries most advanced in terms of digitization of payments, such as Sweden, Denmark and the Netherlands. Compared to EU averages, Poland has made noticeable progress, especially thanks to the increase in the number of contactless transactions and the development of payment infrastructure, supported by banks and government and local government initiatives. The results correlate with the findings of previous studies conducted by the NBP, the European Commission and the BIS, which indicate the importance of the availability of technology and user awareness as factors determining the success of the payment transformation. The observed increase in the number of cashless transactions in domestic systems (e.g. BLIK) shows that local solutions can be an effective alternative to global payment systems, provided that they are available and secure. The article presents forecasts on the development of cashless payments in Poland for 2020-2022, prepared with the use of statistical methods in 2020 by the author of the article for his thesis, to a large extent confirmed in the light of actual data published by the National Bank of Poland.

The projected number of debit cards in the fourth quarter of 2022 was approximately 38.525 million, while NBP data indicate an actual figure of 37.465 million. This noticeable difference remains within the forecast margin of error and confirms the accuracy of the identified upward trend.

The paper adopted a hypothesis concerning a decrease in the dynamics of demand for credit cards. This was confirmed, as the actual number of credit cards in the fourth quarter of 2024 stood at 4.9 million, in line with the predicted slowdown in demand for this type of payment instrument.

In the case of the forecast for the value of transactions using payment cards, the author's study projected that this value would reach PLN 225 billion in the fourth quarter of 2022. However, NBP data indicate a significantly higher figure – PLN 265.67 billion for domestic transactions and PLN 22.29 billion for transactions conducted abroad. The underestimation in the forecast is attributable to the COVID-19 pandemic and the accelerated adoption of cashless payments.

The value of ATM withdrawals in Poland was forecast at PLN 83 billion but was slightly understated compared to the actual figure of PLN 88.62 billion. Nevertheless, the downward trend was correctly identified.

As for ATM withdrawals abroad, the projected value for the fourth quarter of 2022 was PLN 2.209 billion, while the actual figure was PLN 2.525 billion. Although the difference is noticeable, it remains within the forecast margin of error and confirms the accuracy of the identified trend.

To sum up, the directions of change were accurately predicted, the forecasts confirmed the validity of the research hypotheses, and the discrepancies in values can be attributed to post-pandemic effects that were unforeseeable at the time the estimations were made.

From a public policy perspective, further efforts are essential to promote electronic payments within public administration – for example, by mandating the acceptance of cashless payments in public institutions. There is also a need to align regulatory frameworks with emerging technological developments, such as central bank digital currencies (CBDCs), which could represent the next stage in the evolution of payment systems.

Conclusions. The analysis shows that cashless transactions in Poland are developing in a systematic and sustainable manner. The increase in the number and value of transactions using electronic payment instruments demonstrates the growing social and institutional acceptance of modern forms of settlement. The activities of the National Bank of Poland, including the Cashless Transactions Development Programme, have played a key role in creating favourable conditions for the expansion of non-cash payments.

However, several challenges have also been identified, such as the uneven distribution of payment infrastructure, technological and skill-related barriers, and limited trust in new solutions among certain social groups. This highlights the need for continued efforts to promote financial and digital education, as well as to support investment in payment infrastructure in economically less developed areas.

In the context of future research, it is worth considering the analysis of advanced user identification technologies – such as inertial sensors integrated into smart rings (so-called payment rings) – which can be used for user authentication in mobile payments. Another promising direction for future research could be the assessment of the impact of demographic and social trends – such as population ageing and increasing urbanisation – on the long-term evolution of payment preferences. These aspects were not examined in the present study, indicating a potential research gap.

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