SUBSTITUTION OF PAYMENTS ON THE PAYMENT CARDS MARKET IN POLAND

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Abstract: In the initial period of payment card usage by bank customers, they were primarily used to take out cash at ATMs. It reduced the banking system costs as well as facilitated and accelerated the money holders' access to their cash. Along with a development of the infrastructure dedicated to handling non-cash transactions using payment cards, a rapid increase in the number of the value of non-cash payments took place.

The aim of this work is to analyze the process of the changes in non-cash payments using payment cards against the background of their use to withdraw cash at ATMs.

A suitable econometric model constitutes the tool used for the analysis of the potential process of substitution of cash transactions with payments using payment cards. For this purpose, statistical data obtained from the National Bank of Poland, in the form of quarterly time series from the years 2008-2017, have been used. As a result, it is expected to clarify whether the Polish payment system is moving towards the dominance of non-cash transactions or not. A relation was studied, in the form of the changes in the values of non-cash transactions using payment cards in Poland, under the influence of the development of the infrastructure for their servicing. The impact of the values of ATM withdrawals using payment cards on the volume of non-cash transaction with the use of those cards.

A measure of substitution of cash payments with non-cash payments, as a quotient of the values of non-cash transactions and the values of ATM withdrawals with the use of those cards, has been constructed. The value of this substitution measure has been growing dynamically in Poland. Short-term quarterly forecasts of payment-card payments for the year 2018 have also been constructed.

Key words: payment cards, econometric model, substitution of payments

JEL codes: C1, C5, G17, G21

1. Introduction

The dynamic increase in non-cash transactions has been a global trend. In wealthy countries, non-cash turnover has been supplanting cash. One of the instruments used in non-cash payments is payment cards. Studies on the payment-card market had appeared in literature as early as the end of the 20th century. Examples include: Humphrey et al. (1996), Hancock, et al. (1999) and many others. More advanced research results were published at the beginning of the 21st century. For example, such studies include: Hauswald and Marquez (2003), Amromin and Chakravorti (2007), Rysman (2007), Sokołowska (2015a), Sokołowska and Wiśniewski (2015), Wiśniewski et al. (2017), which contain various results of empirical studies on the payment-card market. Payment cards belong to innovative financial instruments, which has been dealt with in such works as: Tufano (2003) and Sokołowska (2015b). The need and the consequences of substituting cash payments with electronic money has been dealt with, for instance, in an article by a team of authors: Evans et al. (2013).

The aim of this work is to analyze the process of the changes in non-cash payments using payment cards against the use of those cards for cash withdrawal at ATMs. It is necessary to answer the question whether non-cash transactions using payment cards have been supplanting the traditional money obtained by the payment card holders at ATMs.

The tool used for analysis of the potential process of substitution of cash transaction with payments using payment cards incorporates a suitable econometric model. As a result, clarification is expected as to whether the Polish payment system has been moving towards the dominance of non-cash transactions or not.

2. Methodology and Data

In the initial period of payment card usage by bank customers, cards were primarily used to withdraw cash at ATMs. It reduced the cost of the banking system as well as facilitated and accelerated the money holders' access to their own cash. Along with a development of the infrastructure dedicated to servicing non-cash transactions using payment cards, a dynamic increase in the number and in the values of non-cash transactions occurred.

In modern countries, cash transactions have been dispersing. Cash has been supplanted by electronic money. The subject of this study is analysis of the payment card usage for realization of non-cash transactions against payment card use for cash withdrawal at ATMs in Poland. An attempt will be made to answer the question whether development of the electronic payment system and supplement of cash transactions by electronic money has been occurring in Poland.

In the empirical econometric equations presented in this work, the following variables, characterizing the payment-card market in Poland, occur:

$vtrc$ – quarterly value of non-cash transactions using payment cards (bln PLN),
$vatm$ – quarterly value of cash withdrawals at ATMs (bln PLN),
pos – the number of the facilities realizing payment-card payments (in thousands),
atm – the number of ATMs in Poland (in thousands).

An econometric linear model will be used in the study, in the form of:

$$y_t = \sum_{j=0}^{k} \alpha_j x_{tj} + \sum_{i=1}^{4} \beta_i y_{t-i} + \sum_{l=1}^{4} \sum_{j=1}^{k} \lambda_{lj} x_{t-l,j} + \gamma_1 dq1 + \gamma_2 dq2 + \gamma_3 dq3 + \gamma_4 t + \eta_t, \tag{1}$$

where:

y_t – observations on the dependent variable ($t = 1, …, n$),
x_{tj} – observations on the exogenous variables,
t – time variable,
$dq1$, $dq2$, $dq3$ – dummy variables, taking the value of 1 in the highlighted quarter and the value of 0 in the remaining quarters,
η_t – the random component of the equation,
$\alpha_j, \beta_i, \lambda_{lj}, \gamma_p$ ($j = 0,1, …, k, i = 1, …,4, l = 1, …, 4, p = 1, 2, 3, 4$) – structural parameters of the equation.

Using suitable econometric models, impact of the development of the infrastructure servicing payment cards on the volume of non-cash transactions will be studied. Impact of the changes in the usage of these cards for cash withdrawals at ATMs on the values of non-cash payments with the use of those cards will be considered as well.

A measure of substitution of cash payments with non-cash transactions has been constructed:

$$substyt = \frac{1000 \cdot vtrc}{vatm}. \tag{2}$$

The study used statistical information of the National Bank of Poland (www1). The data is in the form of quarterly time series from the years 2008-2017, beginning at the first quarter of 2008, finishing at the 3rd quarter of 2017. The number of statistical observations in time series is $n = 39$.

The result of the construction of an econometric model describing the substitution of the usage of payment cards for cash withdrawal at ATMs with the use of those cards for non-cash transactions will constitute short-term forecasts of the variable $substyt$.

3. Results and Discussion

The first empirical econometric model describing the substitution of the ATM withdrawal function with non-cash payments using cards is provided in table 1. This model is characterized by a high description accuracy of the values of non-cash transactions ($vtrc$), because $R^2 = 0.98$ signifies the degree of explanation of the variability of the variable $vtrc$, at the level exceeding 98%. The equation is also devoid of residue autocorrelation. Figure 1 presents empirical and theoretical values of the non-cash transactions realized using payment cards in Poland, obtained with the use of the model provided in table 1.

Tab. 1 The empirical model describing quarterly values of the transactions using payment cards in Poland (*vtrc*) in the years 2008-2017

Variable	Coefficient	Std. Error	t-statistic	Prob. p	
const	−2061.18	6186.95	−0.3331	0.7413	
atm_1	−2.28707	0.716655	−3.1913	0.0032	***
vatm_4	0.29473	0.0780995	3.7738	0.0007	***
pos	223.69	22.583	9.9052	<0.0001	***

Mean dependent var.	34706.63	S.D. dependent var.	13849.07
Sum squared resid.	98649832	S.E. of regression	1783.887
R-squared	0.984872	Adjusted R-squared	0.983408
F (3, 31)	672.7354	Prob(F-statistic)	2.76e-28
Log likelihood	−309.5683	Akaike info criterion	627.1366
Schwarz criterion	633.3580	Hannan-Quinn criterion	629.2842
Autocorrel. coeff. (rho1)	0.056671	Durbin-Watson statistic	1.874069

Source: Own calculations using the GRETL package.

The value of ATM withdrawals, delayed by 4 quarters (*vatm_*4) increases the current value of non-cash transactions. The strongest impact on the increase in the values of non-cash transactions using payment cards has been caused by the number the facilities at which such transactions can be realized (*pos*). No seasonal fluctuations of the variable *vtrc* have been observed.

Tab. 2 The empirical model describing quarterly volumes of substitution of ATM cash withdrawals with non-cash transactions using payment cards in Poland (*substyt*) in the years 2008-2017

Variable	Coefficient	Std. Error	t-statistic	Prob. p	
const	30.5096	8.51817	3.5817	0.0012	***
pos	2.83461	0.635207	4.4625	<0.0001	***
pos_1	−2.34228	0.63486	−3.6894	0.0009	***
dq1	−53.7318	7.55249	−7.1144	<0.0001	***
dq2	−31.2726	6.59098	−4.7448	<0.0001	***
dq3	−30.8576	6.77337	−4.5557	<0.0001	***
substyt_1	0.701515	0.104251	6.7291	<0.0001	***

Mean dependent var.	460.0388	S.D. dependent var.	150.7654
Sum squared resid.	6261.792	S.E. of regression	14.21243
R-squared	0.992555	Adjusted R-squared	0.991113
F(3, 31)	688.7656	Prob(F-statistic)	1.47e-31
Log likelihood	−150.9077	Akaike info criterion	315.8155
Schwarz criterion	327.2786	Hannan-Quinn criterion	319.8940
Autocorrel. coeff. (rho1)	−0.021463	Durbin h-statistic	−0.172685

Source: Own calculations using the GRETL package.

The negative impact on the values of non-cash transactions using payment cards in Poland was caused by an increase in the number of ATMs, delayed by 4 quarters (*atm_1*). Access to ATMs encouraged card holders to use cash in payments. By the first quarter of 2017, the number of ATMs in Poland was increasing, reaching the number of 23,751. Starting from the second quarter of 2017, the number of ATMs has been decreasing. It mainly results from the downward trend in the number of ATM withdrawals, the most of which were realized in the third quarter of 2013 (198.185 million). Beginning at the fourth quarter of 2013, the number of ATM withdrawals has been decreasing, reaching the lowest level in the first quarter of 2017, equal to 160.881 million withdrawals. The values of cash withdrawals at ATMs are still increasing, with higher amounts of the average withdrawal. The decrease in the number of ATM withdrawals in the last four years results in a decrease in the demand for ATMs. The decay in the number of ATMs will cause a quantitative and a evaluative increase in payment-card payments.

Table 2 presents an econometric model describing the mechanism of substituting ATM cash withdrawals with non-cash transactions realized in Poland using payment cards. The model describes the variability of the variable *substyt* with high accuracy, since R^2 exceeds the level of 0.99. This is illustrated by figure 2. The value of the non-cash transactions using payment cards, per 1000 PLN of the ATM cash withdrawal value, has been increasing systematically. In the first quarter of 2008, it was equal to 291.92 PLN, systematically increasing to the level of 760.48 PLN in the third quarter of 2017.

**Fig. 1** Actual and fitted values of variable: *vtrc*
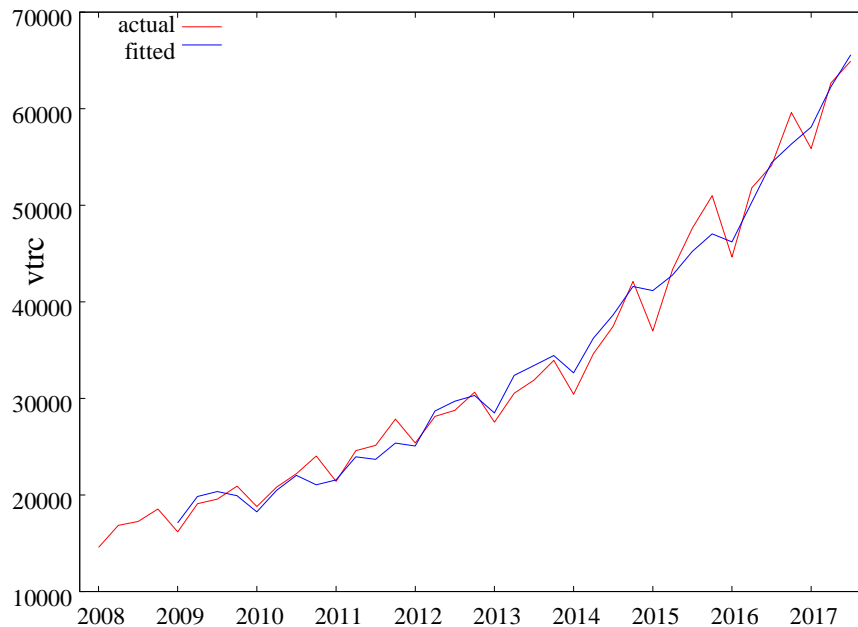
Source: Own calculations using the GRETL package and table 1.

In the model being discussed, autoregression of the first order is significant (*substyt_1*), signifying the inertia of payment card holders' habits for non-cash transactions. Strong impact on the increase in the values of non-cash payments using these cards is caused by a simultaneous increase in the number of facilities (*pos*) has. An interesting fact is the occurrence of seasonal fluctuations described using the dummy variables *dq1*, *dq2* and *dq3*. At the same time, the variable *dq1* took the value of 1 in each first quarter of the year and zero in the remaining quarters, *dq2* reached the value of 1 in each second quarter of the year and zero in the remaining quarters, while *dq3* took the value of 1 in the third quarter of the year and zero in the remaining quarters. Using the results contained in table 2, the values of seasonal deviations in subsequent quarters can be calculated. They amount to: -24.76 PLN in the first quarter, -2.30 PLN in the second quarter, -1.89 PLN in the third quarter and +28.97 PLN in the fourth quarter. Significant positive deviation from the so-called systematic component occurs in the fourth quarter of the year. In contrast, in the remaining quarters of the year, negative deviations occur, while the highest negative deviation from the systematic component occurs in the first quarter of each year.

Using the model provided in table 2, forecasts of the variable *substyt* can be determined. First, however, it is necessary to determine a forecast of the number of facilities for the subsequent quarters of the years 2017-2018. For this, a suitable autoregressive-trend model with seasonal fluctuations of the variable *pos* has been used. The results are presented in figure 3 and table 3.
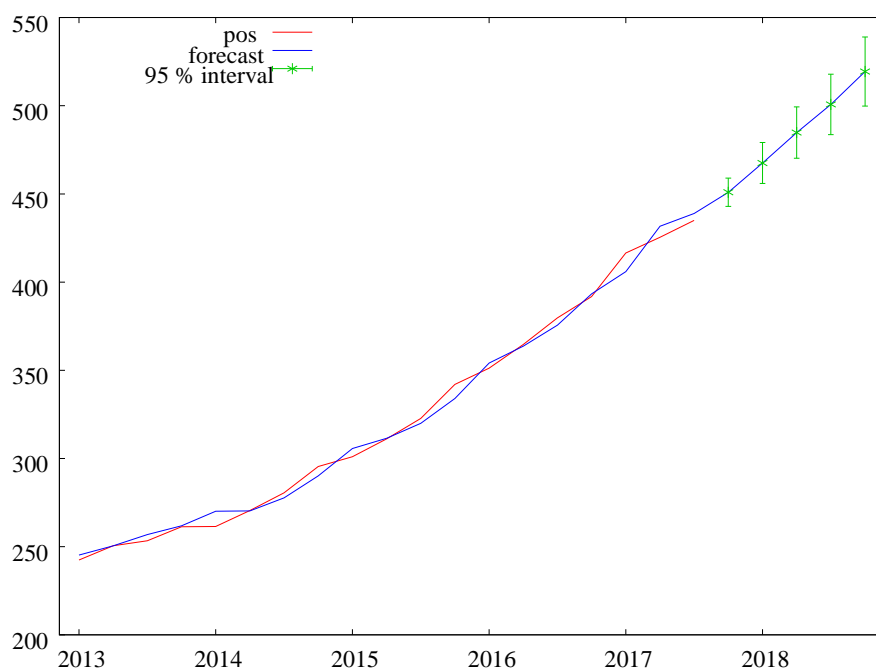
Table 3 presents forecasts of the substitution of cash in ATMs with non-cash payments with the use of payment cards, calculated using the model provided in table 2. An increase in the number of facilities *(pos)* can be expected, from the level of 450.9 thousand in the fourth quarter of 2017 to the number of 519.4 thousand in the fourth quarter of 2018. With this assumption, the values of non-cash payments using payment cards will increase to the amount of 823.2 PLN per 1000 PLN of ATM cash withdrawals in the fourth quarter of 2017, to the level of 950.1 PLN in the fourth quarter of 2018. While the upward trend of the variable *substyt* persists, it can be expected, that in 2019 the values of non-cash transactions using payment cards in Poland will be higher than the amounts of ATM cash withdrawals. Electronic money will slowly, but systematically, supplant the traditional money. Forecasts of the variable *substyt* are illustrated in figure 4.

Fig. 2 Actual and theoretical values of the variable *substyt*, calculated on the basis of the model provided in table 2
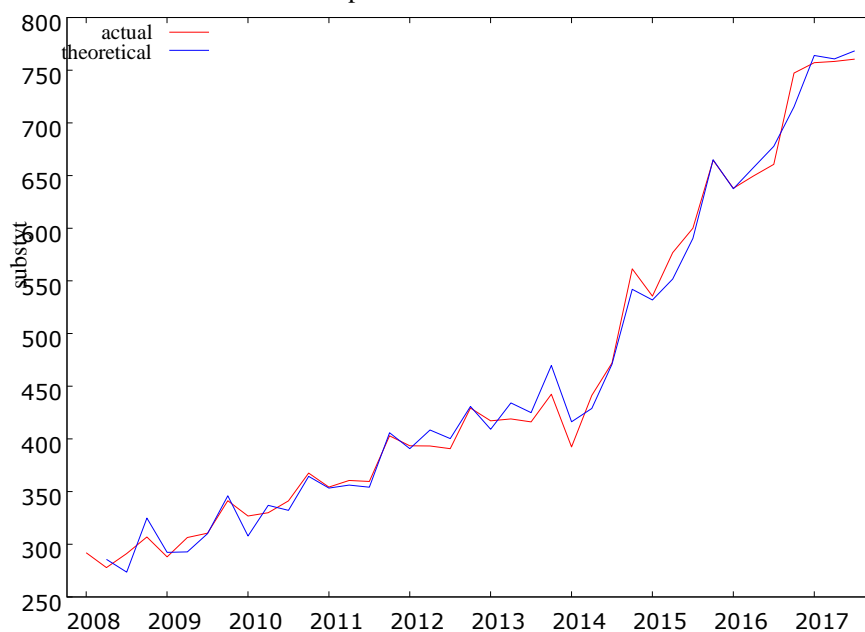
Source: Own calculations using the GRETL package.

Fig. 3 Forecasts of the facilities servicing payment cards in Poland in the 4th quarter of 2017 and the four quarters of 2018
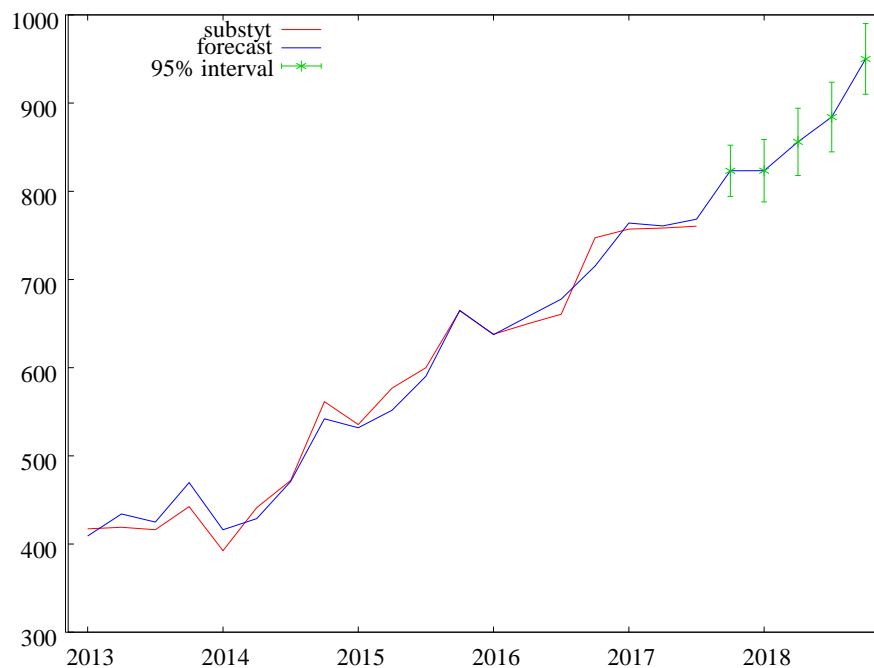

Source: Own calculations using the GRETL package.

Tab. 3 Quarterly forecasts of the volume of the substitution of ATM cash withdrawals with non-cash transactions using payment cards in Poland (*substyt*) for the years 2017-2018

Forecasted period	Payment substitution forecast	Relative forecast error ex ante	Forecast of the number of facilities
2017:4	823.2	1.73%	450.9
2018:1	823.3	2.11%	467.5
2018:2	856.0	2.19%	484.8
2018:3	884.2	2.19%	500.7
2018:4	950.1	2.07%	519.4

Source: Own calculations using the GRETL package.

Fig. 4 Quarterly forecasts of the volume of the substitution of ATM cash withdrawal with non-cash transactions using payment cards in Poland (*substyt*) for the years 2017-2018

Source: Own calculations using the GRETL package and tab. 3

4. Conclusions

The number of the payment cards held by Polish citizens has already exceeded the population. This means that the increase in the number as well as in the values of non-cash payments with the use of payment cards will occur dynamically.

In the last few years, a systematic decrease in the number of ATM cash withdrawals has been taking place, with a simultaneous increase in the amounts withdrawn. However, payment card usage in non-cash payments has been increasing both in terms of their number as well as evaluatively. The dynamics of the values of non-cash payments clearly exceeds the dynamics of the increase in the amounts of ATM cash withdrawals. This is evidenced by the increasing values of the variable *substyt*, indicating a substitution of the cash withdrawal function of the payment cards with their use for non-cash transactions.

Electronic money has been slowly, but systematically supplanting the traditional money in Poland. Substitution of cash transactions with non-cash ones is a global trend, which slowly has been realizing itself in Poland. ATM cash withdrawals still reach higher amounts than the amounts of non-cash transactions with the use of payment cards. The forecasts determined in this work indicate, that as soon as 2018, the value of the variable *substyt* will reach 950 PLN. This means that in 2019, it can be expected that the level of 1000 PLN will be exceeded, that is, the values of non-cash transactions using payment cards will be higher than ATM cash withdrawals. Supplement of cash payments by electronic money will progress in such manner, that within a dozen or so years, marginalization of the traditional money should take place in Poland.

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