





“A cross-impact analysis of the bank payment card market parameters and non-financial sectors’ indicators in the Ukrainian economy”

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A CROSS-IMPACT ANALYSIS OF THE BANK PAYMENT CARD MARKET PARAMETERS AND NON-FINANCIAL SECTORS' INDICATORS IN THE UKRAINIAN ECONOMY

Abstract

In Ukraine, card payment systems develop at a rate similar to that of modern digital payment instruments in most European countries.

The purpose of the paper is to establish interdependence and explain the nature of changing situations in the market of bank payment cards (BPC) taking into account the dynamics of economic development parameters in non-financial sectors of the Ukrainian economy.

The methodology of the study includes graphic methods analyzing the dynamics of economic development indicators and a method for analyzing the cause-and-effect relationship between the studied parameters considered with different lags.

Results showed that the most significant parameters for the development of the payment card infrastructure were the level of provision with POS terminals and the share of non-cash transactions. Their correlation with the economic development indicators reached 0.97. Up to the stage when the volume of non-cash payments by cards reached 5% of GDP, the impact of the BPC market on the change in the level of economic development had been insignificant according to the general idea. The development of the economy up to that point stimulated the development of the BPC market. Subsequently, the BPC market that was already sufficiently developed became one of the drivers aimed at the development of non-financial sectors of the Ukrainian economy after overcoming the 5% GDP level.

Keywords

card payment systems, payment infrastructure
parameters, economic development indicators,
macroeconomic indicators

JEL Classification

C12, E42, O33

INTRODUCTION

The process of rapid development of financial technologies, which is currently taking place, is characterized primarily by expanding the range of financial instruments of the digital economy. In recognition of the continuous growth of the share and role of digital goods, along with the corresponding instruments and methods of payment for them, modern civilization may be reasonably called digital. Its new features include those that, in addition to traditional means of payment, cash and non-cash payments, confirm the increased spread of digital instruments and cryptocurrencies. The volumes and number of payments made through non-banking financial institutions are growing. The periods needed to develop new instruments are minimized by up to 5-10 years. Against this background, an increase in turnover may be observed. In respect thereof, some researchers conclude that it is the development of non-cash payment instruments and their availa-

bility that forms the reason for accelerating economic development and specifically in the real economy and the service sector (Ridho & Razzaq, 2020; Oleshko et al., 2018, Hasan et al., 2013).

Herewith, the extreme complexity of the task to find and prove cause-and-effect relationships in the economy should be noted; furthermore, this problem manifests itself as difficult to formalize due to a large number of cross-impacts, transit dependencies, and other factors that affect the interaction of the studied economic objects or processes.

Meanwhile, determining the presence or absence of a cause-and-effect relationship between the level of development of the payment infrastructure and relevant institutions, on the one hand, and the indicators of non-financial sectors of the economy, on the other hand, is crucial for the formation of a state development strategy. This is especially true for countries that, like Ukraine, have made accelerated digitalization of the economy their policy.

It is worth pointing out that, in comparison with most countries of the world, Ukraine already has a unique experience in the accelerated implementation of new payment systems and instruments. In 1996 alone, international card payment systems Visa and Europay International (MasterCard's partner) began their operations in Ukraine. And already in 2003 Ukraine ranked third in Eastern Europe with respect to the number of issued plastic cards. Ukraine needed only 6-7 years of accelerated development to create a fairly developed infrastructure for servicing payment cards, while, naturally, the United States and Western European countries spent more than 30 years to cover the same distance.

This fact, therefore, confirms that the dynamics of card payment systems in Ukraine is similar to the global pace of development of modern digital payment instruments.

This allows us to predict the dynamics of digitalization processes and its impact on indicators of non-financial sectors of the economy of Ukraine and also the European Union.

1. LITERATURE REVIEW

Various studies have repeatedly raised the issues of establishing links and the impact exerted by the developing payment instrument market on the country's level of economic advancement. Thus, the analytical report of The Institute for Economic Research and Policy Consulting (IER, 2010) presented the results of a study focused on the role of electronic payments in the economy. Analyzing the data provided by 26 EU member countries, as well as by the USA, Canada, Switzerland, and Singapore, builds a conclusion about their positive impact expressed in the following aspects: stimulating household consumption; contributing to the attraction of the population's and companies' funds to the banking system and reducing a cash-flow cycle; reducing transaction costs of the banking system and the state as a whole; contributing to the reduction of the shadow economy that mainly uses cash payments due to their anonymity; contributing to the development of tourism and e-commerce.

Quite a number of other researchers share a similar opinion and extend it not only to payment cards but also to all non-cash payment instruments in general. For instance, at the very beginning of the development of mobile payment systems, Donner and Tellez (2008) predicted their significant positive impact on the economy resulting from the acceleration and simplification of payments. Mieseigha and Ogbodo (2013) conducted a study on the example of the Nigerian economy and proved a positive impact exerted by an increase in the share of cashless payments on the level of economic development. It should be noted that both studies mentioned above did not operate with real data, but only with expert estimates.

Ridho and Razzaq (2020) showed a high level of correlation between the indicators signaling the development of payment card service infrastructure and tourism development indicators when analyzing factual information for 2003–2015 on the tourism and hospitality industry in Indonesia.

The results of the study, however, can be interpreted in two ways, namely, it is quite possible that it was the increase in the tourist flow that led to the development of the infrastructure for servicing plastic cards, or both of these processes intensify each other.

Azevedo et al. (2019) explored the phenomenon of credit cards issued to non-financial entities. The study results count in favor of the fact that, regardless of the issuer, the possibility of paying by card has a positive effect on the indicators characterizing the development dynamics of the analyzed economy sectors.

The vast majority of researchers are not sure, however, that all these factors remain sufficiently significant in Ukrainian settings (Ponomarenko et al., 2017). Despite 30 years of Ukraine's development, in many respects, the payment card market differs from the structure traditional for other developed countries greatly (Kolodiziev et al., 2022). Notably, only two card payment systems operate in Ukraine as a matter of fact, in particular, Visa and MasterCard. Other players made attempts to enter the market and those failed, even during the period of the greatest economic recovery in 2006–2007 (Gorokhovskiy, 2020).

A small amount of research on the Ukrainian payment card market and its role in economic development should also be considered. Recent studies (Bublyk, 2016; Sobolieva-Tereshchenko, 2018; Oleshko et al., 2018) suggest mainly a qualitative analysis of the development indicators characterizing the payment card market, its comparison with the indicators provided by other countries, and the conclusions based on logical designs. The analyzed literature fails to reflect in full the issues concerning the existence of a connection between the development parameters of the payment card market in Ukraine and the indicators of its economic development, as well as the trend dynamics of the same connection (Kolodiziev et al., 2020; Kapralov, 2013).

What is also important to notice is that conducting statistical research in the study area requires the availability of a sufficient amount of data (Bujang & Baharum, 2016). In this regard, requirements are put forward not only to the size of the sample

but also to the statistical characteristics of the data in it. Over the past couple of years only, statistical data on the Ukrainian payment card market have met these conditions (NBU, 2021a).

The purpose of this work accordingly lies in establishing the nature of the relationship between the development of the Ukrainian payment card market and the non-financial sectors of the country's economy. To accomplish this, it is necessary to define hypotheses, select parameters, collect statistical data, study them, and process the results.

The following hypotheses are tested in the paper:

- H1: Changes in the BPC market are at the bottom of the alterations in the non-financial sectors of the Ukrainian economy.*
- H2: Changes in the BPC market are among the consequences of the alterations in the non-financial sectors of the Ukrainian economy.*

2. METHODOLOGY

2.1. Methods

The methodological background of the study consists of the methods for analyzing the dynamics of economic development indicators and methods for studying the relationships between time datasets, including cause-and-effect relationships.

Analyzing the dynamics of economic development indicators is accomplished through a graphical method used in the work. Graphical methods are applied at the stages of primary data analysis; they provide means for presenting statistical data in a visual form. By utilizing charts, data are compared and their dynamics, structure, and relationships are analyzed depending on the tasks of statistical analysis. This study relies upon line charts that are primarily focused on the analysis of the data alteration pattern. At the same time, they make it possible to evaluate their structure and compare indicators.

To identify the relationship between the studied indicators, the paper applies a correlation analysis. Among the most closely related studies using this

method, the article by Baranovskyi et al. (2021) should be noted, since its authors incorporate correlation analysis to identify the relationship between cryptocurrency market indicators and fundamental economic indicators.

In an effort to identify a cause-and-effect relationship, let us bring into action the method proposed by Kuliichev (2006) and tested by Yakunin (2012). This method is based on comparing the correlation coefficients between the studied parameters taken with different lags.

2.2. Data collection

The data used in the study can be logically divided into three groups:

- development parameters of the bank payment card (BPC) market;
- development indicators of the non-financial sectors of Ukrainian economy;
- auxiliary indicators.

As already mentioned, at the initial stages of development, payment cards were used almost exclusively for paying salaries; they cannot be considered a full-fledged means of payment due to the lack of a sufficiently developed infrastructure. It was not until the early 2000s that the number of ATMs and POS terminals in Ukraine became sufficient to refer to the use of payment cards as full. Moreover, not sooner than in April 2001, the Law on payment systems and money transfers was adopted to regulate legal and economic relations in this area. It is, therefore, advisable to start collecting indicators of the BPC market development from 2002. The study is mainly based on such a source of information as official statistics published by the National Bank of Ukraine (NBU), namely NBU payments (NBU, 2021a) and NBU cards (NBU, 2019). Including these two sources is due to the fact that since 2019, the NBU has significantly expanded the number of annually published payment card market indicators as well as completely changed the structure of access to them through the website. The data collection period comprised 19 years, from 2002 to 2020.

The results obtained upon analyzing the studied parameters and related statistical information provided means for forming a system of indicators: the number of banks participating in card payment systems (*bm*); the number of operating ATMs (*atm*); the number of operating POS terminals (*pos*); the number of active cardholders (*ch*); the number of active cards (*ac*); the number of non-cash transactions with cards (in million UAH (*sumu*) and units (*sumc*); the number of cash withdrawal transactions (in million UAH (*sumu*) and units (*sumc*).

Some of the listed indicators should be considered not according to their absolute determination presented in the data source, but in the form of their relative values. Let us consider these indicators.

The number of banks participating in card payment systems (*bm*). This indicator should be considered as related to the total number of banks in Ukraine.

The number of active cardholders (*ch*). To consider it, it is necessary to take into account an auxiliary indicator, namely the total population of Ukraine.

The number of active cards (*ac*). It should be considered in relation to the total population of Ukraine.

The specific indicators of the number of ATMs and POS terminals per 1000 people are calculated in a similar way (*atm*). Based on the example of ATMs, the formula for calculations is as follows:

$$atm = \frac{ATM\ count}{population} \cdot 1000. \quad (1)$$

For another thing, it is advisable to calculate the indicator of cash turnover per card (*trn*) and express it in US dollars (the hryvnia exchange rate was pegged to this currency for a long time):

$$trn = \frac{total\ cards\ turnover}{active\ cards \cdot exchange\ rate}. \quad (2)$$

Calculating the listed indicators relies on additional sources of information, specifically, the

NBU data on the development level of the banking system, data provided by the Institute for Demography, and data obtained from the State Statistics Service of Ukraine.

The group of Ukraine's development non-financial indicators is formed on the grounds of macroeconomic indicators published annually by the NBU and the State Statistics Service of Ukraine. The data collection period comprised 19 years, from 2002 to 2020. Among the information collected, the following indicators were selected: the gross domestic product (GDP) (*gdp*); the unemployment rate (*unemp*); the inflation rate (*infl*); the industrial production index (*ipp*); the retail turnover (*ort*); and the real wage index (*izp*).

GDP will be considered as the main indicator of economic development. This corresponds to the studies by Ridho and Razzaq (2020). GDP alone, taken in its absolute determination, however, is inappropriate to be used in statistical studies, since, in addition to the state of the economy, this indicator is affected by the country scale (for instance, during the study period, Ukraine lost Crimea and the eastern regions of Donbas), inflation, exchange rate, as well as other parameters. In addition to GDP, therefore, this study also used the indicators derived from it: GDP growth (*gdpp*); GDP per capita (in UAH) (*gdppcu*); GDP per capita (in USD) (*gdppcd*).

The list of indicators presented and their symbols at the stage of analysis of the mutual influence of the studied factors are presented in Table A1, Appendix A.

Since, in macroeconomic statistics, the economic development indicators (*gdpp*, *infl*, *ipp*, *ort*, *izp*) are represented by incremental characteristics, these indicators have been transformed to ensure their comparability with other indicators based on absolute indicators. As exemplified by the industrial production index, the conversion formula assumes the following shape:

$$\begin{aligned} ipp'_i &= \frac{ipp_{i-1} \cdot ipp_i}{100}; \\ ipp_1 &= 100; \quad i = 2..n, \end{aligned} \quad (3)$$

where n is the number of indicators in the sample.

2.3. Measurements

The paper analyzed a sample of 24 indicators characterizing the development of the Ukrainian BPC market and non-financial sectors of its economy over 19 years. Accordingly, the data sample provides 456 values in total. Since it was not clear in advance which indicators would be sensitive to changes in the parameters of the payment card market and which indicators could characterize its state most comprehensively, the set of indicators taken was somewhat redundant. Therefore, the first stage of the study included a preliminary analysis of the data to determine the general patterns of development and the current state of the objects under study.

During the second stage, the study results were supplemented by the data obtained with reference to pairwise correlation calculations between all the studied indicators. A total of 300 different correlation coefficients were calculated. Interpreting the strength of the correlation relied upon the Chaddock scale, this scale is used for this purpose in statistical studies (Dzwigol et al., 2019). Further generalization of the results obtained during the first two stages allows identifying the key indicators for this study.

The third stage tested the hypotheses with regard to a cause-and-effect relationship between the development indicators of the payment card market and the state of the Ukrainian economy. To accomplish this, the set of selected key indicators is supplemented with columns containing the same indicators taken with a 1-year shift forward and a 1-year shift back. Afterwards, the correlation between the indicators is calculated again. If there is a steady increase in the correlation between a certain indicator i_t and indicators j_{t-1} , j_t , and j_{t+1} , this may testify to the fact that changes in indicator i are among the reasons for changes in indicator j .

3. RESULTS

The development dynamics of the payment card market in Ukraine was analyzed using the following indicators: the number of ATMs and POS terminals per 1000 people (*pos*); the share of non-cash payment and cash withdrawal transactions in the total volume (*clc*).

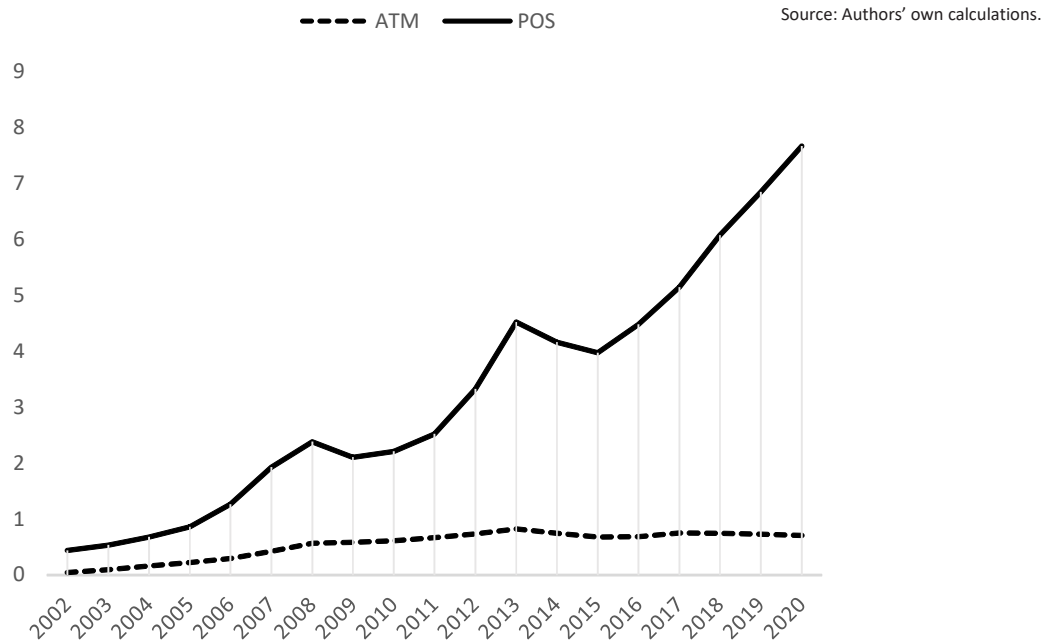


Figure 1. Number of ATMs and POS terminals per 1,000 people

Figure 1 graphically represents the dynamics of changes in the card service infrastructure.

As demonstrated by the analysis of the data presented in Figure 1, the growth of the ATM network infrastructure in Ukraine was intensive until 2008. Then the growth slowed down significantly, and since 2013 there has been a steady downward trend in the specific number of ATMs. Moreover, this trend continues even against the background of a decrease in the total population of Ukraine from 49 million people in 2000 to 42 million people in 2020.

At the same time, there is a steady increase in the number of POS terminals and, in general, it is still exponential despite the two periods of a reverse trend caused by the reasons described above.

The two trends compared in Figure 1 suggest a gradual increase in the share of non-cash payment transactions. This is confirmed by the analysis results presented in Figure 2.

As follows from the data presented in Figure 2, until 2011 the share of non-cash payments in the card turnover indicator grew at an insignificant pace. After that, however, a sharp acceleration in the transition to cashless payments can be observed.

In 2020, for the first time, their amount exceeded the amount of money withdrawn from ATMs (whereas this happened much earlier in terms of the number of transactions). One might assume that by 2011 a certain “critical value” of infrastructure indicators had been reached, whereupon payment by payment cards became an objectively convenient alternative to cash.

Figure 3 presents the graphical results of comparing the dynamics of changes in the payment infrastructure parameters and the share of transactions with non-cash payments.

The data analysis results shown in Figure 3 suggest that until about 2010–2012, the growth in the number of POS terminals led to an increase in the share of cashless transactions. And after that period, cause and effect shifted their places and the growing interest in non-cash payments was already the reason for the improvement of the payment infrastructure.

Let us consider the significance of the indicator reflecting the level of non-cash payments, i.e., how significant the role card transactions play in the economy of Ukraine is. This requires analyzing the ratio between the amounts of non-cash card transactions using payment cards and the devel-

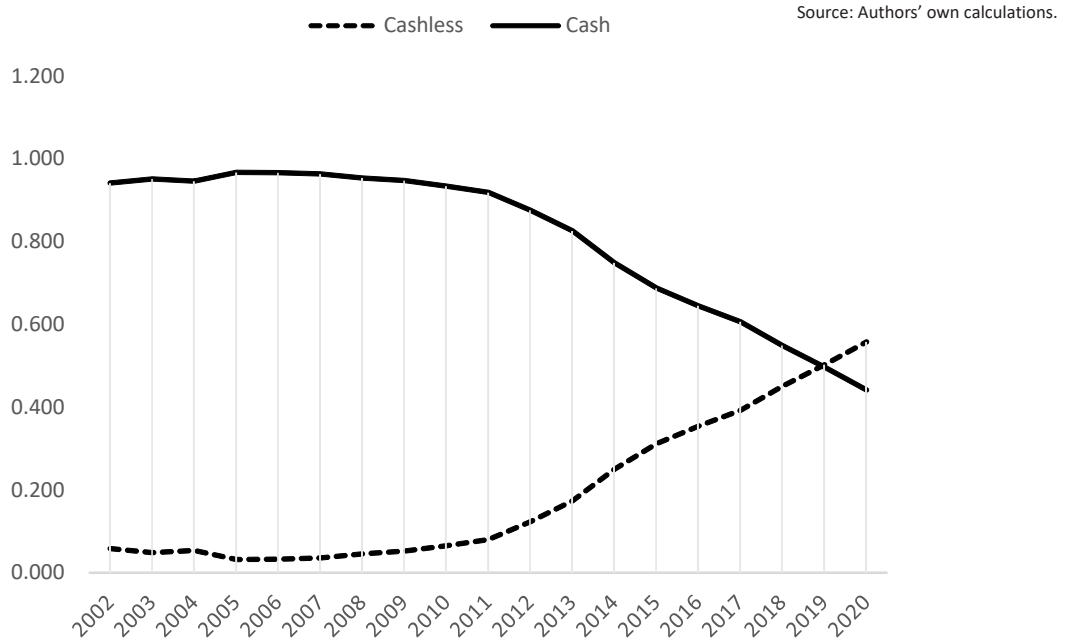


Figure 2. Share of non-cash payment and cash withdrawal transactions in the total volume

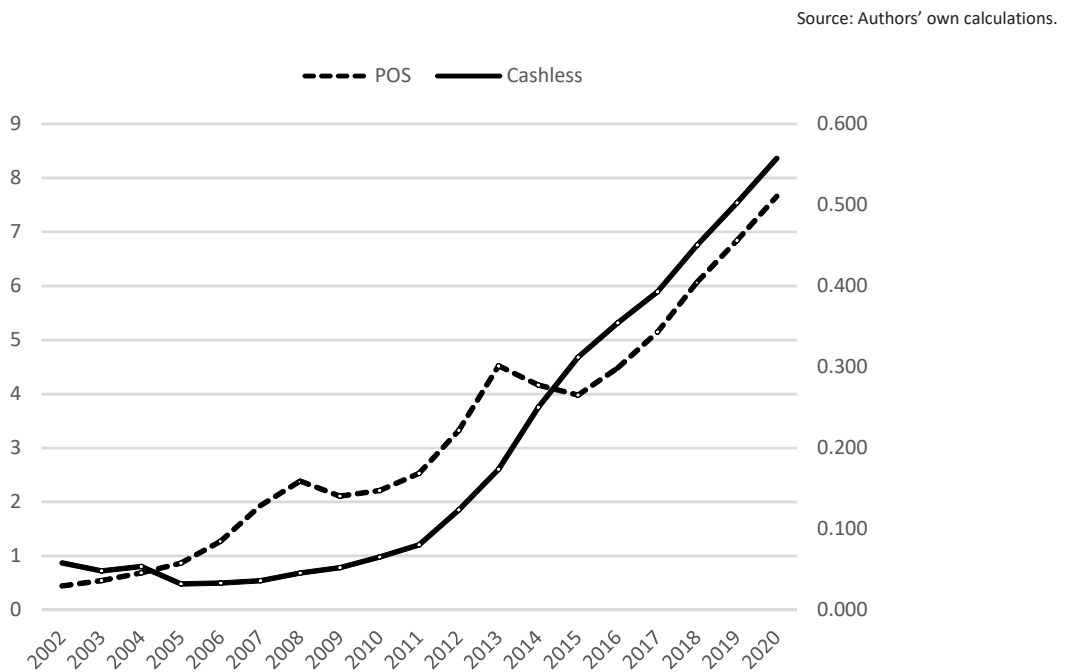


Figure 3. Comparison of the dynamics of changes in the payment infrastructure parameters and the share of cashless payment transactions

opment level of the Ukrainian non-financial sector that is characterized by the GDP value (Figure 4) for the period under study.

As can be seen from Figure 4, until 2011, the volume of non-cash payments by cards was less than 5% of GDP (and less than 1% before 2007). It would be just too optimistic, therefore, to assert

any influence exerted on the change in the level of economic development of Ukraine by the BPC market before this period.

On the contrary, in 2011, a sharp increase in the volume of non-cash transactions began; by 2020, it reached the level of 52% of GDP. During that period, the influence of the BPC market on the level

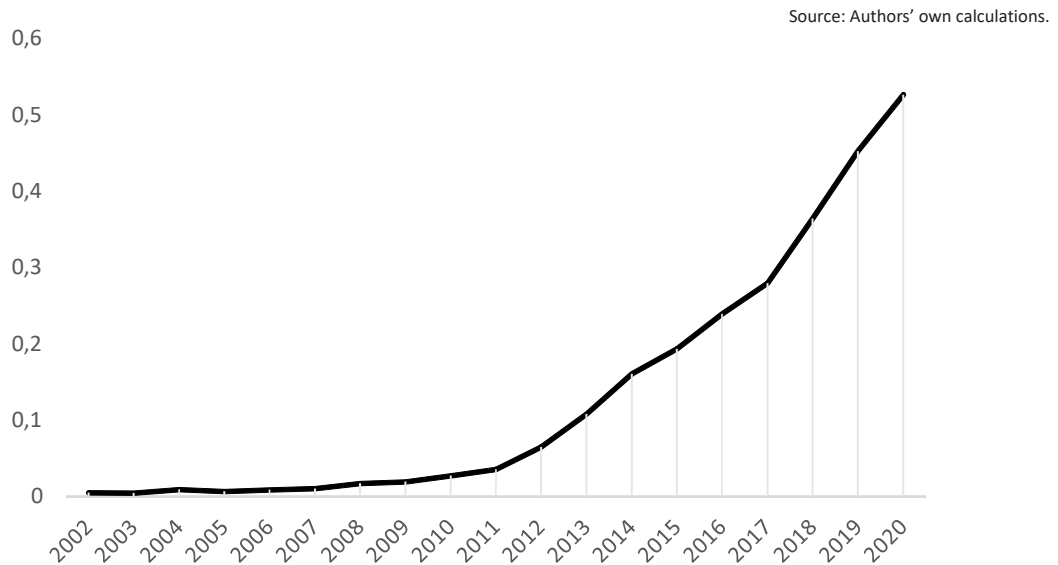


Figure 4. Ratio between the development levels of the payment card market and the development level of the non-financial sector of the Ukrainian economy

of economic development of Ukraine seemed to be quite possible.

purpose, let us apply the correlation analysis (Figure 5).

Next, the available data provide means for determining the values of the BPC market indicators and the indicators of economic development being most strongly related to each other. For this

As can be seen from the correlation analysis, non-financial indicators such as GDP (*gdp*) and GDP per capita in national currency (*gdppcu*) have the strongest relationship (at the “very strong”

Source: Authors' own calculations in STATA.

```
. corr bm atm pos ac clu sumu trn gdp gdpp gdppcu gdppcd unemp infl ipp ort izp
(obs=19)
```

	bm	atm	pos	ac	clu	sumu	trn	gdp	gdpp	gdppcu	gdppcd	unemp	infl	ipp	ort	izp
bm	1.0000															
atm	0.9183	1.0000														
pos	0.8978	0.8082	1.0000													
ac	0.8569	0.8369	0.7549	1.0000												
clu	0.7911	0.6181	0.9418	0.5627	1.0000											
sumu	0.7997	0.6108	0.9501	0.6176	0.9674	1.0000										
trn	0.8361	0.8437	0.9236	0.7173	0.7814	0.8393	1.0000									
gdp	0.8757	0.7036	0.9705	0.6846	0.9701	0.9877	0.8575	1.0000								
gdpp	0.3516	0.4888	0.1750	0.7091	-0.1173	0.0079	0.3264	0.0649	1.0000							
gdppcu	0.8662	0.6888	0.9673	0.6731	0.9738	0.9899	0.8485	0.9997	0.0476	1.0000						
gdppcd	0.7122	0.8039	0.6572	0.8369	0.3814	0.5082	0.8231	0.5508	0.7740	0.5338	1.0000					
unemp	0.1075	-0.0094	0.2139	-0.3328	0.4236	0.3046	0.0729	0.2866	-0.8072	0.2984	-0.4076	1.0000				
infl	0.8853	0.7011	0.9495	0.6580	0.9767	0.9623	0.7993	0.9877	-0.0066	0.9881	0.4647	0.3558	1.0000			
ipp	-0.2206	-0.0715	-0.3877	0.2194	-0.6025	-0.4865	-0.2143	-0.4618	0.8077	-0.4741	0.3398	-0.8999	-0.5278	1.0000		
ort	0.8884	0.9562	0.8682	0.8888	0.6633	0.6982	0.9153	0.7576	0.5602	0.7446	0.8930	-0.1020	0.7183	0.0006	1.0000	
izp	0.9170	0.8955	0.9558	0.8406	0.8154	0.8600	0.9686	0.8949	0.3928	0.8864	0.8285	0.0507	0.8533	-0.1755	0.9555	1.0000

Figure 5. Cross-correlation matrix of the studied parameters (financial and non-financial)

Table 1. Correlation between non-financial indicators and the BPC market indicators

Source: Authors' own calculations in STATA.

Indicators	bm	atm	pos	ac	clu	sumu	trn
unemp	0.1075	-0.0094	0.2139	-0.3328	0.4236	0.3046	0.0729
infl	0.8853	0.7011	0.9495	0.658	0.9767	0.9623	0.7993
ipp	-0.2206	-0.0715	-0.3877	0.2194	-0.6025	-0.4865	-0.2143
ort	0.8884	0.9562	0.8682	0.8888	0.6633	0.6982	0.9153
izp	0.917	0.8955	0.9558	0.8406	0.8154	0.86	0.9686
Sum(ABS)	3.0188	2.6337	3.3751	2.9396	3.4815	3.3116	2.9704

level on the Chaddock scale) with the indicators of the BPC market development such as the number of provided POS terminals per 1,000 people (*pos*: 0.9705), the share of non-cash transactions in the total amount of transactions (*clu*: 0.9701), and the number of transactions with BPC (*sumu*: 0.9877).

The share of banks that are members of payment systems (*bm*: 0.8757) and the annual turnover per card (*trn*: 0.8575) represent the indicators with a relationship that is close to “very strong”.

Table 1 distinguishes correlation coefficients between the individual non-financial indicators of economic development and the indicators of the BPC market development.

Among the considered indicators of the country's economic development in the non-financial sectors, the retail turnover (*ort*), the real wage index (*izp*), and the inflation index (*infl*) have the strongest relations with the indicators of the payment card market development. The relationship between the development indicators of the payment card market and indicators such as the unemployment rate and the industrial development index turned out to be negligible.

It can also be noted that the number of POS terminals per capita in Ukraine has the highest correlation with economic indicators.

The last line of Table 1 provides the calculation data for the total absolute values of the correlation coefficients. Based on these calculations, the further study uses the indicators of the level of provision with POS terminals (*pos*) and the share of non-cash transactions (*clu*) as the main indicators of the BPC market development.

Among the indicators of economic development, let us single out *gdppcu*, *gdppcd*, and *ort* for the following reasons:

- *gdppcu* has a high level of correlation with the indicators of the BPC market development;
- *gdppcd* is an analog of *gdppcu*, but it is exempted from the influence of currency inflation in Ukraine;
- *ort* refers to the development indicators with the highest degree of connection. In addition, retail turnover should logically be strongly related to the BPC development indicators.

The separate results of the correlation analysis aimed at these indicators only are shown in Figure 6.

As is evident from the calculated analysis data, a “very strong” (according to the Chaddock scale) positive relationship can be observed between the development indicators of the BPC market and the level of GDP per capita expressed in hryvnia.

```
. corr pos clu gdppcu gdppcd ort
(obs=19)
```

	pos	clu	gdppcu	gdppcd	ort
pos	1.0000				
clu	0.9418	1.0000			
gdppcu	0.9673	0.9738	1.0000		
gdppcd	0.6572	0.3814	0.5338	1.0000	
ort	0.8682	0.6633	0.7446	0.8930	1.0000

Figure 6. Cross-correlation matrix of parameters *pos*, *clu*, *gdppcu*, *gdppcd*, and *ort*

The relationship between these same indicators and the level of GDP per capita expressed in US dollars is at the “noticeable” and “moderate” levels but also remains positive.

The relationship between the BPC market development indicators and the retail turnover indicator is positive and remains at the “high” and “noticeable” levels where the former is aimed at the level of provision with POS terminals and the latter determines the indicator of the share of non-cash transactions.

As a separate matter, a high degree of the positive relationship between the *pos* and *clu* parameters should be noted. Although this study assigns both of them to the development parameters of the BPC market, the *clu* parameter (the share of non-cash transactions in the total amount) can also be considered as an indicator of the country’s economic development in the non-financial sectors.

3.1. Analysis of cause-and-effect relationships

As far as economic processes are inertial, the corresponding indicators change only after a time upon applying external influences. For such processes, the correlation between datasets taken with a 1-2-year shift is higher than the correlation between datasets considered without a shift. In the case of a similar phenomenon observed in the studied data, this can be regarded as confirmation of the presence of a cause-and-effect relationship (Kuliichev, 2006).

A sample containing the parameters *pos*, *clu*, *gdppcu*, *gdppcd*, and *ort* with a 1-period shift in both directions was formed from the initial data to carry out the analysis. The resulting parameters were named *pos1m*; *pos*; *pos1p*; *clu1m*; *clu*; *clu1p*; *gdppcu1m*; *gdppcu*; *gdppcu1p*; *gdppcd1m*; *gdppcd*; *gdppcd1p*; *ort1m*; *ort*; *ort1p*. At the same time, the number of observations decreased by 2 due to the inability to determine the previous data for 2002 and the next data for 2020.

Figure 7 presents the results of the correlation analysis applied to the sample.

The data obtained and shown in Figure 7 lead to the following conclusions:

Increasing in the share of non-cash transactions in the total volume of calculations in the economy is preceded by an increase in the number of POS terminals since the correlation coefficients between *pos* and *clu1m*, *clu*, and *clu1p* successively assume the values of 0.8989, 0.9306, and 0.9546.

As for the level of correlation between the number of terminals and GDP, it alternatively decreases with an increasing time shift. Thus, the correlation coefficients between *pos* and *gdppcu1m*, *gdppcu*, and *gdppcu1p* successively take the values of 0.9616, 0.9544, and 0.9499. A similar trend can be observed in the changing correlation parameters with GDP per capita in US dollars: 0.559, 0.5587, and 0.4423.

Source: Authors’ own calculations in STATA.

```
. corr pos1m pos pos1p clu1m clu clu1p gdppcu1m gdppcu gdppcu1p gdppcd1m gdppcd gdppcd1p
ort1m ort ort1p (obs=17)
```

	pos1m	pos	pos1p	clu1m	clu	clu1p
pos1m	1.0000					
pos	0.9750	1.0000				
pos1p	0.9456	0.9790	1.0000			
clu1m	0.8972	0.8989	0.9116	1.0000		
clu	0.9343	0.9306	0.9337	0.9923	1.0000	
clu1p	0.9542	0.9546	0.9528	0.9777	0.9942	1.0000
gdppcu1m	0.9439	0.9616	0.9718	0.9540	0.9583	0.9598
gdppcu	0.9371	0.9544	0.9696	0.9668	0.9681	0.9660
gdppcu1p	0.9399	0.9499	0.9648	0.9769	0.9796	0.9769
gdppcd1m	0.5684	0.5590	0.4813	0.1656	0.2582	0.3358
gdppcd	0.4545	0.5587	0.5467	0.1888	0.2380	0.3063
gdppcd1p	0.3495	0.4423	0.5440	0.2584	0.2580	0.2846
ort1m	0.8558	0.8195	0.7588	0.5538	0.6344	0.6931
ort	0.8051	0.8438	0.8045	0.5341	0.6042	0.6687
ort1p	0.7478	0.8143	0.8495	0.5721	0.6138	0.6648

Figure 7. Cross-correlation matrix of parameters *pos*, *clu*, *gdppcu*, *gdppcd*, and *ort* with a 1-year shift for the entire study period

Source: Authors' own calculations in STATA.

```

export(-2011).txt
. corr poslm pos poslp clulm clu clulp gdppculm gdppcu gdppculp gdppcdlm gdppcd gdppcdlp
ortlm ort ortlp (obs=9)

```

	poslm	pos	poslp	clulm	clu	clulp
poslm	1.0000					
pos	0.9405	1.0000				
poslp	0.8395	0.9252	1.0000			
clulm	0.0668	-0.0948	0.0015	1.0000		
clu	0.5814	0.4875	0.5113	0.6661	1.0000	
clulp	0.7115	0.6764	0.7545	0.5958	0.8813	1.0000
gdppculm	0.9821	0.9279	0.8936	0.1694	0.6600	0.8031
gdppcu	0.9474	0.9688	0.9413	0.1241	0.6486	0.8101
gdppculp	0.9166	0.9427	0.9688	0.0850	0.6097	0.7877
gdppcdlm	0.9538	0.9700	0.8586	-0.1712	0.3829	0.5769
gdppcd	0.8185	0.9554	0.9599	-0.1675	0.3725	0.6166
gdppcdlp	0.7411	0.8182	0.9547	-0.0529	0.4176	0.6428
ortlm	0.9895	0.9494	0.8483	-0.0490	0.4790	0.6385
ort	0.8957	0.9915	0.9303	-0.1510	0.4255	0.6336
ortlp	0.7983	0.8943	0.9901	-0.0577	0.4394	0.6870

Figure 8. Cross-correlation matrix of parameters *pos*, *clu*, *gdppcu*, *gdppcd*, and *ort* with a 1-year shift for the period up to 2011

When it comes to the nature of the relationship between the level of the BPC market development and the retail turnover indicator, the most obvious relationship can be traced between *ort* and *clulm*, *clu*, and *clulp*; it consistently takes values of 0.5341, 0.6042, and 0.6687. This suggests that during most of the analyzed period of growth in the trade turnover, it acted as a driver for the development of retail non-cash payments.

Next, let us review the above assumption regarding the diverse nature seen in the mutual influence of the development parameters of the BPC market and the development level of the Ukrainian economy in the study period.

Figure 8 provides the results obtained from the correlation analysis of the same indicators as those used in Figure 7, but this time they cover the period up to and including 2011. That year was chosen because it was from that point that a sharp increase in the specific volumes of non-cash transactions began according to the graph in Figure 4.

The changes in the dynamics of the correlation coefficients *gdppcu/clu*, *gdppcd/clu*, *gdppcd/pos*, and *ort/clu* can be noted and they grow significantly as the delay lag changes from -1 to +1. By this reasoning, one can conclude that during this period, the growth of the economy preceded the growth of the payment card market and suggest that the growth of the economy was definitely the reason for the

growth of the payment card market. From this perspective, therefore, Hypothesis 2 stating that changes in the BPC market are among the consequences of alterations in the non-financial sectors of the Ukrainian economy is confirmed at this stage.

Let us further consider the results of a correlation analysis of the same indicators; only at this point, they are taken for the period from 2011 inclusively (Figure 9).

The results obtained upon analyzing the data shown in Figure 9 seem rather ambiguous. Compared to the period up to 2011, the following changes can be distinguished:

- 1) The total amount of transactions exposes a strong relationship between the number of provided POS terminals (*pos*) and the share of non-cash transactions (*clu*). Moreover, due to the nature of the change in the correlation values depending on the time shift of the datasets, the *pos* indicator of all others can be assumed as the driver for the changes.
- 2) There is a strong relationship between the share of non-cash transactions (*clu*) and gross per-capita income in hryvnia (*gdppcu*). The nature of the change in the correlation values depending on the time shift of the datasets suggests that the *clu* indicator acts as a driver for the changes.

```

export(2011-).txt
. corr poslm pos poslp cluilm clu clulp gdppculm gdppcu gdppculp gdppcdlm gdppcd gdppcdlp
ortlm ort ortlp (obs=9)
-----+-----+-----+-----+-----+-----+-----
          | poslm      pos      poslp      cluilm      clu      clulp
-----+-----+-----+-----+-----+-----+-----
poslm | 1.0000
pos   | 0.9220    1.0000
poslp | 0.8341    0.9337    1.0000
cluilm| 0.9094    0.9028    0.9214    1.0000
clu   | 0.9409    0.9143    0.9078    0.9938    1.0000
clulp | 0.9535    0.9368    0.9105    0.9875    0.9970    1.0000
gdppculm| 0.8836    0.9468    0.9836    0.9467    0.9338    0.9354
gdppcu | 0.8785    0.9233    0.9747    0.9690    0.9530    0.9499
gdppculp| 0.8884    0.9078    0.9461    0.9907    0.9780    0.9730
gdppcdlm| -0.1614    -0.1664    -0.3489    -0.5252    -0.4618    -0.4114
gdppcd | -0.2330    0.0440    0.0441    -0.3037    -0.3276    -0.2885
gdppcdlp| -0.1296    0.1185    0.3734    0.0666    -0.0067    -0.0206
ortlm | 0.4186    0.2692    -0.0066    0.0382    0.1394    0.1851
ort   | 0.1985    0.3873    0.2374    -0.0324    -0.0008    0.0621
ortlp | 0.0883    0.3843    0.5398    0.2043    0.1509    0.1586
  
```

Figure 9. Cross-correlation matrix of parameters *pos*, *clu*, *gdppcu*, *gdppcd*, and *ort* with a 1-year shift for the period starting from 2011

- 3) At a zero time shift, the strongest connection occurs between the BPC market infrastructure (*pos*) and retail turnover (*ort*). One can also assume that the corresponding processes develop synchronously or with a time delay that is significantly less than 1 year.

Taken as a whole, the selected parameters indicate a significant change in the nature of the BPC market development in Ukraine after 2011. They also demonstrate the dynamics supporting the idea that at this stage, Hypothesis 1 stating that similar transformations in the BPC market are at the bottom of the alterations in the non-financial sectors of the Ukrainian economy is more reasonable.

The results of any statistical study conducted with reference to annual observations should be considered critically from the standpoint of the representativeness of the data sample. In view of this, despite the rather long observation period (i.e., 19 years) in terms of statistics, the study uses a relatively small data set. Moreover, analyzing cause-and-effect relationships includes data samples that correspond to the lower acceptable limit for statistical studies (Bujang & Baharum, 2016).

Emphasis should also be placed on the fact that correlation analysis is intended for the analysis of stable processes. Meanwhile, during the period under study, Ukraine went through two major crises that changed the characteristics of its

economy and infrastructure significantly. This may raise certain doubts about the stability of the processes under study. The same was partially taken into account in the study conducted by dividing the study sample into two periods.

Considering the presented results of the study positions us to state that the method of identifying a cause-and-effect relationship using correlation analysis is not generally recognized, although it is described and utilized in a number of scientific publications. In addition, the use of this method is significantly limited by the fact that it provides means for proper identification with regard to only those relationships where the delay between cause and effect is measured by a period that is a multiple of 1 year. In cases where the duration of such a delay is significantly shorter than 1 year, the dependence cannot be found using the method introduced in the paper. Therefore, the results obtained in recognition of the hypotheses suggested should be considered not as a formal demonstration, but as a reasonable assumption.

Further studies will refine the results obtained as additional observations are accumulated and the sample size of the studied data increases. In turn, this ensures the creation of models for the development of the digital payment instrument market; these models will be suitable for practical use to predict the impact of digitalization on the real sector of the economy and the service sector.

CONCLUSION

Generalization and systematization of the results of the analysis allow establishing the relationship between the development indicators of the Ukrainian payment card market and the non-financial sectors of the country's economy. With regard to the above mentioned, two hypotheses were tested, namely that changes in the BPC market are among the reasons for the alterations in the non-financial sectors of the Ukrainian economy and that changes in the BPC market are also among the consequences of the alterations in the non-financial sectors of the Ukrainian economy.

The results obtained were instrumental in substantiating the assumptions that, until about 2011, the development of the economy stimulated the development of the BPC market. This is confirmed by the dynamics of changes in the correlation coefficients $gdppcu/clu$, $gdppcd/clu$, $gdppcd/pos$, and ort/clu that grow significantly as the delay lag changes from -1 to $+1$.

Since 2011, the nature of the analyzed dependencies has changed drastically. Despite the fact that a deep crisis in the Ukrainian economy falls within this period, the results obtained, taken as a whole, confirm the validity of Hypothesis 1. Put in other words, starting from about 2011, the BPC market that has developed sufficiently starts acting as one of the drivers for the development of the Ukrainian economy.

Thus, the results obtained provided no means to fully confirm or completely refute the validity of the formulated hypotheses during the entire period under study. The assumption that both hypotheses were valid for Ukraine at different times appears the most likely. Altogether, the results obtained lead us to a conclusion that the positive impact of the market of payment cards and other digital payment instruments on the development of non-financial sectors of the economy begins to manifest itself only after reaching a certain "critical mass" of transaction volumes; in this case, such a mass amounted to approximately 5% of GDP. Until this point is reached, the payment card market cannot act as a driver for economic development in practical terms.

AUTHOR CONTRIBUTIONS

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APPENDIX A

Table A1. Indicators and their symbols at the stage of analysis of the mutual influence of the studied factors

Symbolic representation	Description
y	Year of observations
bm	Share of banks in the banking system that are members of card payment systems
atm	Number of ATMs per 1,000 people
pos	Number of POS terminals per 1,000 people
ch	Specific number of BPC holders
ac	Specific number of active cards
clu	Share of non-cash transactions in the total amount
cu	Share of cash transactions in the total amount
sumu	Amount of transactions with BPC (mln hryvnias)
trn	Annual turnover per active card (USD)
clc	Share of non-cash transactions in the total number
cc	Share of cash transactions in the total number
sumc	Number of operations with BPC (million pieces)
pop	Population of Ukraine (thousand people)
exc	Hryvnia/dollar exchange rate
gdp	GDP (million UAH)
gdpp	GDP growth
gdppcu	GDP per capita (in UAH)
gdppcd	GDP per capita (in USD)
unemp	Unemployment rate
infl	Inflation rate
ipp	Industrial production index
ort	Retail turnover
izp	Real wage index