

# **Current Trends and Effects of Changing Ratios of Cash and Non-cash Transactions in Europe**

## **Bachelor Thesis**

**Thesis supervisor:**

**doc. Ing. Petr Rozmahel, Ph.D.**

**Ondřej Kolařík**

**Brno 2017**







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## **Abstract**

The aim of the thesis is to examine and compare current trends in non-cash transactions to GDP in European countries and to identify converging or diverging tendencies. The effects of policies aimed at reducing cash transactions and their efficiency is compared across countries. Also the effect of share of cash transactions in total payment volume on share of shadow economic activities is estimated in the thesis.

## **Keywords**

Cash, transaction, shadow economy, GDP, competitiveness index, e-money, barter, euro.

## **Abstrakt**

Cílem práce je prozkoumat a porovnat současné trendy v bezhotovostních transakcích s HDP v evropských zemích a identifikovat konvergentní a divergentní tendence. Účinky politiky zaměřené na snížení peněžních transakcí a její efektivita jsou porovnány mezi jednotlivými zeměmi. V práci je také testován možný efekt počtu hotovostních transakcí na podíl stínové ekonomiky.

## **Klíčová slova**

Hotovost, transakce, stínová ekonomika, index konkurenceschopnosti, e-money, výměnný obchod, euro.





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## Introduction

21<sup>st</sup> century is with no doubt a century of progress and innovation. According to Moore's law, there is an exponential grow in technological industry, which basically means that technological progress doubles every two years. Besides that, there is a trend of massive digitization of all the data, which we can be observed across all sectors.

We can see the trend on a daily basis. Shopping online is growing rapidly, communication is massively abandoning written form and social networks are penetrating more and more into the lives of each and every one of us. World is changing faster than ever before, but there are still things from the past, which seem to be changing very slowly. Use of cash is currently one of them.

Even though the usage of cash might seem outdated, it is still the most used payment instrument in Europe. Factors of the trends diverging vary from country to country. Only 8 out of 28 member states of European Union have succeeded in reducing the share of cash in the total payment volume under 50%. And only Luxembourg<sup>1</sup> found a stronger payment instrument than cash. The most representative exemplar is Nordic countries, which aim to become “*cashless society*” in the near future.

At the same time, there is increasing number of other possibilities to cash, which are modern, safer and easier to use. Credit cards are nothing new on the market and in the form, as we know it, have been already used for more than 50 years. The first e-payment was introduced by Stanford Federal Credit Union in 1994 to all of its customers. However, beside those conventional types of non-cash payments, which are generally contributing to a better control of the governments over the financial markets, there are also growing tendencies to use more anonymous and unregulated ways. For example, bitcoin<sup>2</sup>

As a number of possibilities and a volume of non-cash transaction are rapidly growing, cash is still holding its position on the imaginary peak. Despite that, the volumes are slowly shifting in favor of non-cash transaction, the total number of cash transactions seems to stay untouched.

In order to increase efficiency of tax systems, in terms of decreasing civil frauds and reduce the share of shadow economy, the European governments pursue policies leading to increase portion of non-cash transactions (electronic payments) to GDP over cash transactions. However, development of cashless transactions shares in Europe differs significantly. These include economic, social, cultural, institutional and other country-specific factors.

Hence, the thesis deals with examination of current trends in using non-cash over cash transactions in European Union. In particular, it focuses on identifica-

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<sup>1</sup> in Luxembourg is located company PayPal Europe, which holds all of the transaction made by PayPal in Europe. This increases share of e-money transaction on more than 60%. When adjusted for this, cash would be also the largest payment instrument in the country.

<sup>2</sup> Basic principles of bitcoin are explained in following chapter.

tion, convergence and divergence of trends among EU countries in this area. Also, the policy strategies and other factors influencing share of electronic transactions are examined in the thesis.

# 1 Literature review

## 1.1 Definition of used terminology

### 1.1.1 Barter

It is a compensation for goods or services without the use of finances. Nowadays, it can occur especially in the trade with developing countries that do not have enough financial resources to pay off services or goods to developer countries.

In the past, barter served as a payment method that was used before the invention of money. (VLČEK, 1992)

### 1.1.2 Money

It is a unit of a purchasing power, which generally has two main functions.

- Money as a medium of exchange: money is considered a medium of exchange for goods and services. Exchange for money simplifies and facilitates the exchange.
- Money as a store of value: money has an ability to store a value in time. To achieve this, money is temporarily decommissioned from the circulation in a form of savings. By this process, money becomes an asset. The volume of value is changing over the time. (JÍLEK, 2013)

### 1.1.3 Banknote

Invention of banknotes was originally inspired by deposit papers in England, which was originally used to confirm that moneychangers had gold or silver deposited in their vaults. Bankers were by emitting banknotes bound to return the gold or silver on request.

Banknotes were accepted by wider and wider range of users, so gradually they became accepted as a fully-fledged payment method.

The coverage of banknotes was extended to dual, metallic and credit. This means that they were issued for an exchange for gold or as a loan. (VLČEK, 1992)

Banknotes are against counterfeiting protected by many ways:

- Special paper with watermark.
- By adding metallic stripe with micro text.
- By using special printing techniques.
- By adding special fibers visible under ultra violet light.

### 1.1.4 Shadow Economy

Measuring of Gross Domestic Product (GDP) clearly does not reflect the reality of the economic production in a country, if the unofficial production is not taken into account (LICHARD, 2013).

Shadow economy can be understood as a set of activities regulated only by the participants themselves. It is also possible, that the activity can be considered a violation of the law.

Measuring of shadow economy is well known as difficult, because it is deliberately hidden from official authorities (SCHNEIDER, 2002).

Dataset used in this thesis was calculated by the MIMIC (Multiple Indicators and Multiple Courses) estimation procedure (SCHNEIDER, 2013).

### 1.1.5 Global Competitiveness Index

It was introduced in The Global Competitiveness Report, which interprets data of World Economic Forum. In the report a comparison of 138 countries can be found.

Competitiveness is a level of productivity of an economy. It consists of institutions, policies, and factors influencing the level of prosperity that country can achieve.

Index itself is calculated by combination of 114 factors, which indicates a long-term prosperity and productivity of the country. (SCHWAB, 2016)

### 1.1.6 Bitcoin

Bitcoin is a so-called crypto currency, which is not linked to the real-world entities, but only to the bitcoin addresses. And even though all of the transactions are public, the identity of the owner of the account remains hidden. After only eight years on the market, bitcoin is enjoying a lot of attention and trust, mainly from the IT community. Despite the fact that the main idea behind bitcoin is very attractive and lures a lot of users hankering for alternative types of payments, it can very easily be misused by drug traffickers and terrorist groups to anonymously fund their activities. (STROUKAL, 2015)

## 1.2 Review of literature

### 1.2.1 History

From the beginning of existence of human race, people traded things which they needed for day-to-day life. Firstly, they exchanged those things, which they had abundance for those, which they could not manage to gain otherwise. Initially, it had many benefits, but later people figured out that barter trade brings many disadvantages as well, such as low portability or bad divisibility.

Later on, people started use metals as a means of payments, for their characteristic properties. First, pieces of metals were used. The quality and weight of the metal were the basic parameters, which determined the value of the piece.



What accelerated monetary developments significantly was the beginning of coinage. Coins were made out of pure metals - gold, silver, etc. For equality of its inner and nominal value, those are identified as vaults.

As long as coin purity was respected, the coin was a holder of a value of treasure. If there was a need to increase money in circulation, treasure was simply transferred to minted coins and *vice versa*. This is how market stability was maintained.

Firstly, there was no regulation on who can coin money. Later, the privilege of coinage was held by the ruler. Every ruler was making claims on either raw materials or coins. The possession right of the ruler was usually emphasized by illustration of the ruler's own portrait on the coins, which served as a sign of superiority and power. This coinage monopoly right was later transferred to the banks, which since then held the rights as money regulators.

In times, when supply of the precious metals was no longer sufficient, coins were replaced by paper money. Paper money was divided into two groups. The ones issued by the state to cover its debts were called representative money. After that the traditional banknotes started to form, which was basically a commitment of a banker to convert the notes for a monetary metal at given any time.

The reason for introduction of new cover trade bills was, that it was difficult for the banks to hold sufficient amount of precious metal corresponding to the nominal value of issued banknotes.

By the time, the process of gradual removal of the option to trade banknotes for gold, called the demonetization, was completed and the option disappeared altogether.

Nowadays, no amount of metal has influence on emission of money, so the banks hold the prerogative decisions over monetary situation. (ŠLAJEROVÁ, 2010)

### 1.2.2 Current overview

Davies (2002) points out that invention of electronic money transfer belongs to one of the two changes in human history that leads to major changes in the system of using money itself. The first was when printed money started to replace minted coins. The second when electronic money transfer has become global tool and accelerated the development rapidly. Both of these inventions brought a significant reduction of monopoly of the government over money and gave the power into the hands of banks as a new competitive source of money.

It was World War II which led to the establishment of Schuman's Coal and Steel Community, which eventually became European Union as we know it. Finally, the two thousand years old dream of Roman Empire's single currency could be fulfilled. At the beginning of 2002, 12 European countries successfully replaced their national currencies with euro. This was the biggest successful transformation in monetary history, which brought over 300 million people under a single currency.

Davies also talks about cashless society, which was predicted many decades ago, but was not reached yet.

Susan Bevan (1994) in the article 'Cash is still king', written on the topic of continuity on still increasing amount of cash in circulation, comments on that the British society seems to have a different opinion on usage of cash than banks, and that banks are the main supporters of cashless society.

Different opinion was expressed in *The Economist* (2007), where the total end of cash payments was predicted. But *The Economist* was not the first with such notion. For example, Mervin King (1999), the former governor of Bank of England, that the most important will be the technological progression because currently we do not disposal of sufficient computing capacity. But in his opinion it is only the matter of time. The end of cash was also predicted in *The New York Times* (1996) which labeled cash as an old, filthy and technologically outdated which will be soon replaced with modern technologies.

Nevertheless, number of cash in circulation is still growing and according to Jan Cimburek (2008) it was increased in the United States between years 1993 and 2005 for more than 100 %. He also points out the fact that only 40 % of USD is circulating in the United States, the rest is used mainly as an alternative currency in developing countries and unstable economies. There is also examined a phenomenon of „cashless society“, which is with no doubts a current topic that moves the world. Electronic and mobile transactions are on the rise, used by higher percentage of population each year.

Amount of euro in circulation doubled between years 2002 and 2007. This significantly exceeded ECB predictions. According to Cimburek there are two unpredictable qualitative factors which enabled such a significant shift: popularity of euro in transactions and trust in euro as a currency.

He also expresses a possibility that euro could replace USD as a reserve currency in the future. This depends on the future development of both Euro zone and the USA.

Qualitative factors of usage of cash can be easily accessibility, general acceptability and acceptance, user friendliness, efficiency, anonymity, control and monitoring and low costs connected with usage and preservation of value.

Quantitative factors are, for example, safety and crisis management.

Smith (2012) believes that in the near future, payments will be done mostly by swiping on a smart-device. He reacts to the recent trends in the USA regarding the use of smart phones. Nevertheless, he believes that cash and credit card usage will persist as a tool for customers who want to remain anonymous.

According to Humphrey (2000), there is an interest of governments to keep cash in circulation. Printing of a 100 euro note costs about 0.04 euro, meaning that the value of currency outstanding is a loan, free of interest, from the people to the government.

Some may argue that without cash there will be no crime and thefts. Barter trade would take place, or crypto currencies would be used. But this phenomenon is already happening with bitcoin and identity theft blackmailing, where bitcoin is exchanged for stolen data from a user's computer. The risk of system would present a bigger threat as all the money would be stored in digital form. Overall the

most threatening fact is loss of privacy as every transaction would be detectable. Cammarosano (2015) also examined term „cashless society“, but from a different perspective. He is definitely an objector of the idea. In an article *The Dark Side of a Cashless Society* he provides pros and cons of this idealistic concept. For many people, cash represents freedom to make a choice without a surveillance of a third party. Cammarosano urges the society not to give up cash, because there is no turning back. There are not many other options on how to make a government-free transaction other than cash. The crypto currency bitcoin can be considered as a modern successor of it in many ways.

In Sweden a trend is emerging of abolishing cash and adopting electronic payments, mainly by card. Critics are pointing out the possible danger of identity theft according to Alderman (2015) when for example losing a phone could potentially mean someone else taking a loan on the phone holder's identity. With less than five percent representation in the country's economy means it uses less bills and coins than the USA and the Euro zone. Habits of people spending more are starting to appear as there is not a physical transaction done by paying with bills and coin by hand.

Another author who compares advantages and disadvantages of payments method is Knaap (2016). Detailed comparison of all thinkable aspects is shown in Fig. 1.

The study provided me with many impulses and suggestions for my own work. The most significant part is a detailed comparison of economic situation across European Union. Future recommendations are also included. There is opinion in the study that despite the positive criteria of cash usage, its end is inevitable. The recommendations for cash stakeholders are divided in four presumed steps.

The first step is current situation and status quo. In this step, ECB or NCB are considered to have the same responsibilities, Commercial banks are focused on costs and cash represents expensive product. It is expected that the banks will try to find ways to lower cost-benefit ratio by promoting different payment instrument. For the consumers, the cash integration is an ongoing process with 19 countries already using euro. For retailers is acceptance of cash not a problem. For regulators, several regulations have already taken place across EU28 and there is no direct need for more at this point.

In the second step, which is called Single European Cash Area, there will be desire for higher integration. ECB's and NCB's role will increase with higher cash centralization. Increase of supra-national cooperation in further cost saving strategies can be reached by higher integration. For consumers this would mean a single currency in Europe with no foreign currency left. Euro and higher standardization would make things for retailers much easier. For regulators this would mean deeper regulation and control to maintain the new standards.

The third step would mean high digital integration and no cash usage. Both European and National Banks would have new challenges to maintain such a huge amount of electronic payment, but there would be no concern to manage cash anymore. Commercial banks finally eliminated expensive cost of cash and can also

fully focus on more profitable electronic payments. All of the consumers would have to have access to the infrastructure, which is not the case by far yet. Retailers would need to be able to accept only electronic payment instruments, which could mean an additional cost. For regulators, there is not a need to regulate cash in an ideal scenario.

The hypothetical last step would mean digital fragmentation, but there is already no need for integration and no cash usage. ECB and NCB role will increase significantly, yet there will be no need to manage cash. Commercial Banks became very profitable. Now the cost can be increased to implement and maintain new products to the market. Customers will finally experience a cashless society. Retailers will not only be forced to accept the electronic payments, but to accept increasingly more of it, which would mean additional costs to keep up with the amount of data transferred. Regulations of cashless transactions will be operated on national levels.

This future might seem a little bit utopian, but not really unbelievable.

	Anonymous	Legal tender	Secure	Safe haven/Fall back	Direct	Tangible/Budgeting	Remote payment	Higher value payment (>€5000)	Availability	Reliability	Efficient	Safe	Convenience
Cash	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	+	+	✓
Cards	✗	✗	+	✗	✗	✗	✓	✓	+	+	✓	✓	✓
Debit card	✗	✗	+	✗	✗	✗	+	+	+	+	✓	+	✓
Credit card	✗	✗	+	✗	✗	✗	✓	✓	+	+	+	+	✓
Pre paid card	✓	✗	+	✗	✗	✗	+	✗	+	+	+	+	✓
Credit transfer	✗	✗	+	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓
Direct debit	✗	✗	+	✗	✗	✗	✓	✓	+	+	✓	+	+
Cheques	+	✗	✗	✗	✗	✗	✗	✗	+	+	✗	✗	✗
Mobile	✗	✗	+	✗	✗	✗	✓	✗	✗	+	+	+	✓
Internet	✗	✗	+	✗	✗	✗	✓	✓	✗	✓	+	✓	✓
Virtual currency	✗	✗	✗	+	+	✗	✓	✗	✗	+	+	✗	+
Instant payments	✗	✗	+	✗	✓	✗	✓	✓	+	+	+	✓	✓

Fig. 1 Advantages and disadvantages of payments method<sup>3</sup>

<sup>3</sup> Source: <http://www.g4scashreport.com/>

## 2 Objectives and Methods

### 2.1 Objectives

Firstly, this thesis focuses on description of the current situation in EU28. Comparative statistics between countries are included. The policies aimed at reducing cash transactions and their efficiency is compared across countries.

The second aim of the thesis is to examine and compare current trends in non-cash transactions to GDP in European Union and to identify converging or diverging tendencies.

Lastly, also possible effect of cash transaction volume on share of shadow economic activities is estimated in the thesis.

### 2.2 Methodology

There are numerous researching methods which were used in the thesis. Firstly, a document analysis was used for better understanding of the issue, and served as a support for the following parts.

Secondly, descriptive and comparative statistics were implemented, to show the background of researched countries. The statistics are shown graphically, and compared to EU28 average. The variables compared are Internet penetration, GDP per capita, competitiveness index, population with at least one bank account, share of cash usage and time-series of shadow economy. To compare payment mixes and regulations of banks and governments across the countries, these issues are presented in a table for better understanding of the issue.

To discover convergent and divergent tendencies on share of cash usage, single-regression analysis was used. OLS model enables selection of statistically significant variables. After elimination of insignificant values, multiple-regression model was constructed to provide proportional distribution of each effect.

To verify an effect of share of cash usage on shadow economy, there was another single regression analysis used.

All the data used in those models was continuously tested on multicollinearity, heteroskedasticity and normality in software gretl.

### 2.3 Data

There are several sources of the data. The data of GDP per capita and currency in circulation outside MFIs was obtained on [www.ecb.europa.eu/stats/](http://www.ecb.europa.eu/stats/), internet penetration on Cash Report Europe 2015<sup>4</sup>, percent population with at least one bank account on [www.statista.com](http://www.statista.com), level of shadow economy in Size and Development of the Shadow Economy of 31 European and 5 other OECD Countries from 2003 to 2015: Different Developments by Friedrich Schneider and share of cash in

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<sup>4</sup> Data available on <http://www.g4scashreport.com/>

total payment volume in The Social and Private Costs of Retail Payment Instruments by Heiko Schmiedel.

Data sample of each variable is  $n = 28$ . The selection of the variables was based on other research studies and analytic papers listed in literature review and on logical assumptions.

### Endogenous variable<sup>5</sup>

- Cash\_usage = share of cash in total payment volume (in %).

### Exogenous variables

- Internet\_penetration = Share of population participating in online commerce and online banking (in %).
- GDP\_per\_capita = Gross Domestic Product per capita (in euro).
- Currency\_in\_circ = Currency in circulation per capita outside monetary financial institutes (in euro).
- Population\_with = Population with at least one bank account (in %).
- Shadow\_economy = Level of shadow economy per country (in %).
- Post\_comunist\_co = Whether the country was occupied by The Soviet Union (1 - yes, 0 - no).
- Competitiveness\_i = States competitiveness index by The Global Competitiveness Report 2014 (index/number).

## 2.4 Research questions

The research questions are:

1. Does the volume of internet penetration have an effect on share of cash in the total payment volume in EU countries?
2. Does GDP per capita have effect on share of cash in the total payment volume in EU countries?
3. Does currency in circulation per capita have effect on share of cash in the total payment volume in EU countries?
4. Does a volume of population with at least one account have effect on share of cash in the total payment volume in EU countries?
5. Has the fact that some EU countries were under the occupation of Soviet Union, influenced share of cash in the total payment volume?

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<sup>5</sup> This can be applied in all of the test in the thesis, except chapter 5.7, where we test effect of cash usage on share of shadow economy.

6. Does The Global Competitiveness Index have any effect on share of cash in the total payment volume?
7. Does a share of cash in the total payment volume in EU countries have effect on percent level of shadow economy?

The following research question is:

8. What are the factors that affects share of cash in the total payment volume in EU countries?

## 2.5 Hypothesis

1. Countries with a higher percentage of internet penetration have lower share of cash in total payment volume.
2. GDP per capita has a negative effect on share of cash in the total payment volume in EU countries.
3. Currency in circulation per capita has a positive effect on share of cash in the total payment volume in EU countries.
4. Volume of population with at least one account has a negative effect on share of cash in the total payment volume in EU countries.
5. Countries which were occupied by Soviet Union have a higher share of cash in the total payment volume.
6. Countries with a better competitiveness according to The Global Competitiveness Report have lower share of cash in the total payment volume.
7. Share of cash in the total payment volume in EU countries has a positive effect on percent level of shadow economy.
8. GDP per capita, population with at least one bank account and competitiveness index all has a negative effect on share of cash in the total payment volume.

### 3 Situation in Europe

This part of the thesis mostly deals with descriptive statistics of selected countries, compared to the European average. Aim of this part is to give basic outline of situation across the EU28 countries, in the terms of financial situation as a background for further research.

All the data from this part are from the statistics for the year 2014. Following sources were used: ECB Statistics, Statista.com, World Bank, Europa.eu and Cash report 2014.

Only countries of V4 (Visegrád Group) are compared in this part. Complete statistics are enclosed in attachment. V4 countries are Slovakia, Poland, Hungary and Czech Republic.

#### 3.1 GDP per capita in V4 countries<sup>6</sup>

From the statistics is obvious that countries of V4 are far behind the European average. Czech Republic with its GDP per capita €14 709 euro per year per capita is leading the sample of the data.

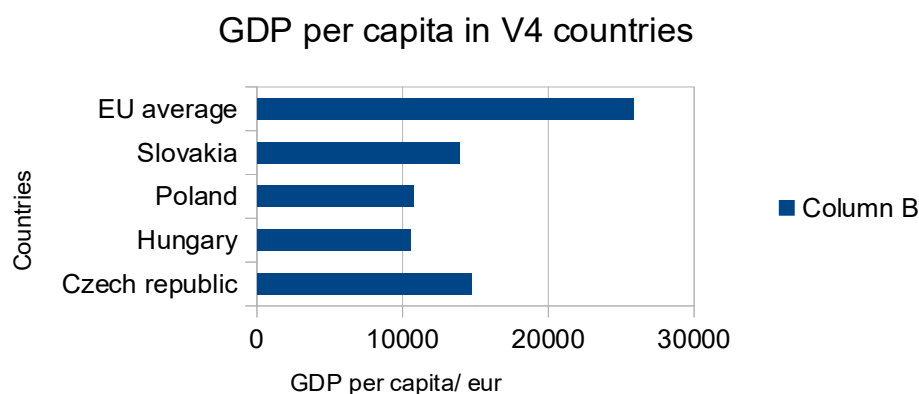


Fig. 2 GDP per capita in V4 countries

#### 3.2 Internet penetration in V4 countries<sup>7</sup>

This statistic shows what percentage of population of V4 participates in online commerce and internet banking. Slovakia is leading the table slightly above the average.

<sup>6</sup> Full statistic is available in attachments.

<sup>7</sup> Full statistic is available in attachments.



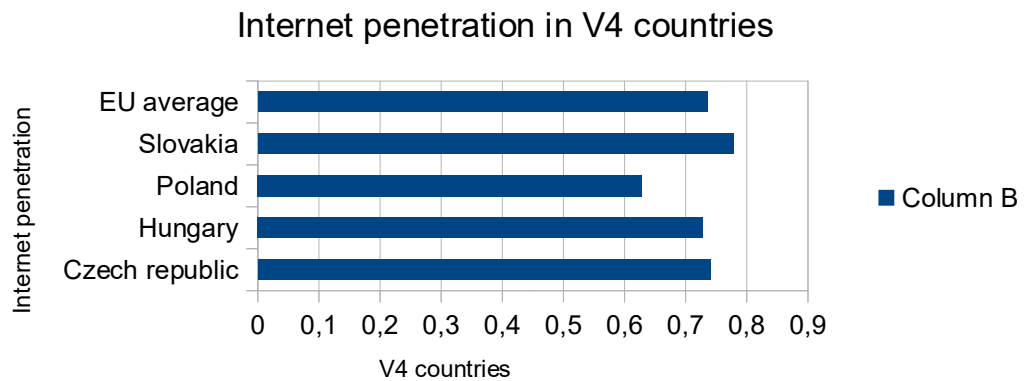


Fig. 3 Internet penetration in V4 countries

### 3.3 Competitiveness index<sup>8</sup>

In the following table is illustrated a statistic of competitiveness of V4 compared to the EU28 average. All of the countries are well below average.

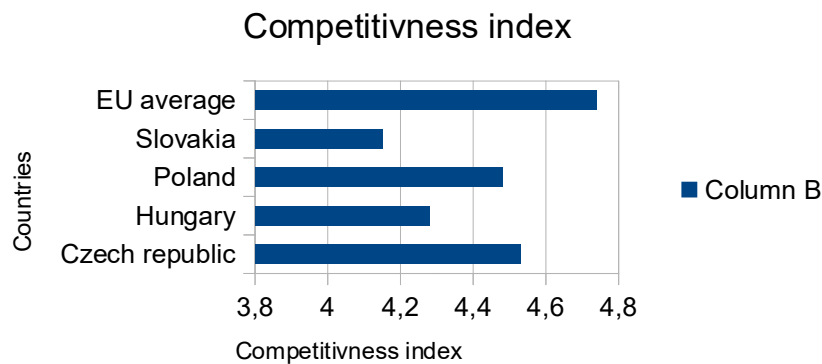


Fig. 4 Competitiveness index

### 3.4 Population with at least one bank account<sup>9</sup>

All of the V4 countries have a percentage of the population having at least one bank account below average. The lowest values has Poland with 62.8 %

<sup>8</sup> Full statistic is available in attachments.

<sup>9</sup> Full statistic is available in attachments.

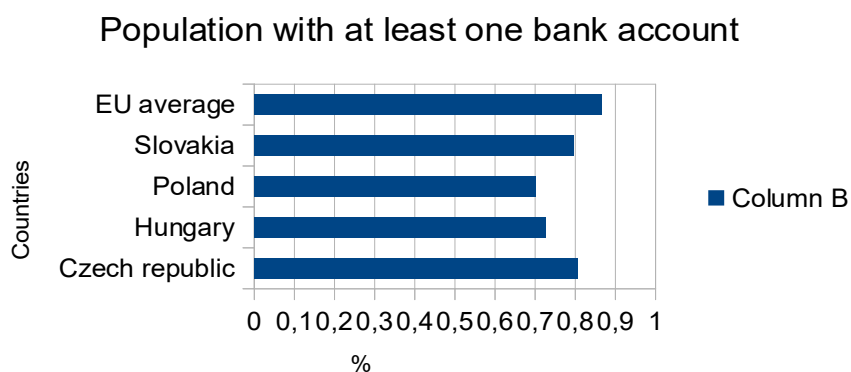


Fig. 5 the population with at least one bank account

### 3.5 Shadow economy<sup>10</sup>

In the following time-series table is shown involvement of shadow economy across V4 countries between years 2005 and 2017. Except for Slovakia, all of the countries are above average. However, a good indicator is that the trend has a descending tendency.

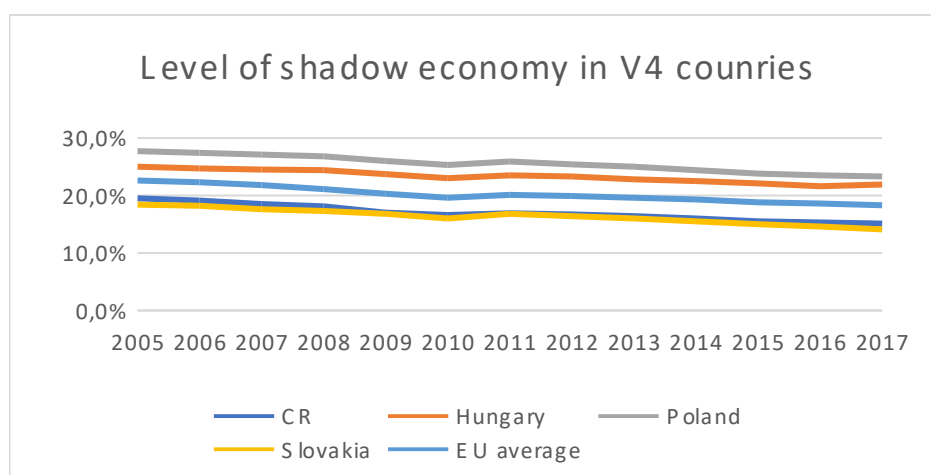


Fig. 6 Levels of shadow economy in V4 countries

### 3.6 The share of cash usage<sup>11</sup>

Cash is the most used payment instrument in terms of volume in V4 countries. Leading position has Poland with its 79.9 %.

Following statistic indicates that all of the V4 countries exceed the EU28 average.

<sup>10</sup> Full statistic is available in attachments.

<sup>11</sup> Full statistic is available in attachments.

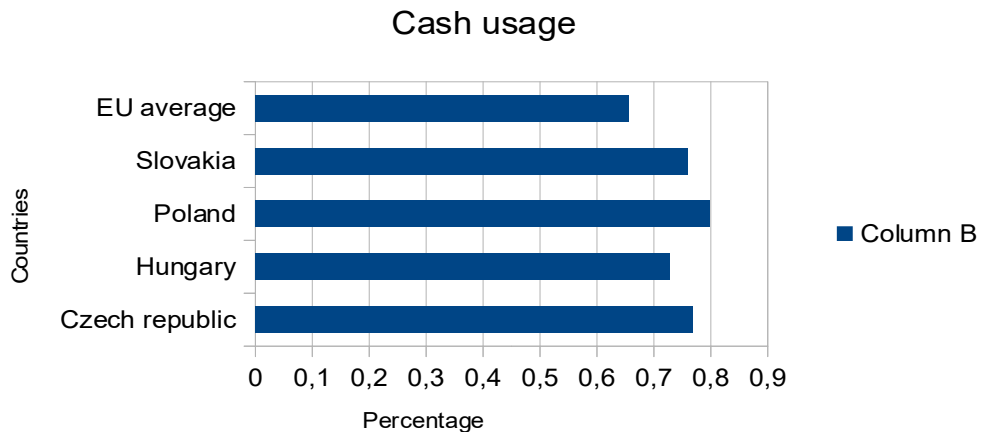


Fig. 7 The share of cash usage

### 3.7 V4 countries payment mix and regulation<sup>12</sup>

Each of the EU28 government has its own policy of regulations on cash usage. An objective of the regulations on usage of cash aims to prevent side effects which high volume of payments bring, or just aim to increase control over the transactions.

Country	Payment mix	Regulations
Czech Republic	77% Cash	Every bank has its own regulation in the terms of cash deposit. It also depends on credibility of a customer. Otherwise, there are no regulations on usage of cash.
Hungary	73% Cash 17% Credit transfer	Private customers are by law are allowed to make two first withdraws from ATM for free, if it not exceed an amount of 150.000 HUF (approximately 480 EUR). If the amount is higher, bank as the right to charge a fee.
Poland	80% Cash 12% Credit transfer 8% Card Direct debit is almost never used in Poland	There is a payment for withdrawing cash from other banks ATM, it ranges between 1.95 and 5 EUR.
Slovakia	76% Cash 12% Credit transfer 8% Cards	There is a 5.000 EUR regulation on cash payments.
EU average	65,5% Cash	

Tab. 1 Payment mix of V4 countries

<sup>12</sup> Full statistic is available in attachments.

## 4 Analyzing of the factors influencing share of cash transactions

The objective of this part is to identify converging or diverging trends in analyzed indices among countries. To achieve the results and its interpretation, linear regression and OLS model in software gretl were used.

This part is focused mainly on comparing cross-sectional data from year 2014 related to share of cash in the total payment volume. Share of cash transactions is an endogenous variable. Exogenous variables are listed and described in following sub chapters. The selection of the variables was based on other research studies and analytic papers listed in literature review and on logical assumptions.

After determination of the values which are statistically insignificant, and elimination of data, where hypothesis was rejected, there is multi-regression analysis with the lasting variables. The variables are tested on multi-collinearity, heteroskedasticity and normality.

The data of the countries are in the same order as in the chapter 3 and 4.

### Share of cash transaction in the total payment volume

This value refers to number of payments, where money is transferred physically as banknotes and coins. Cash transactions volume is a dependent variable in the thesis. It was chosen based on a percent part of a payment instrument mix, which tells us what percentage of transactions in the given country is made with cash.

Payment instrument mix consists of cash transaction volume, payments by card, credit transfer, direct debit, cheques, e-money and others.

This value is endogenous variable in all of the tested models, except 4.8, where we test its influence on shadow economy.

#### 4.1.1 The basic assumptions

All the required properties of the OLS estimator are derived from the so-called classical assumptions. These are the following:

1.  $E(\varepsilon_i) = 0$  the middle value of random components (errors) is zero.
2.  $\text{var}(\varepsilon_i) = \sigma^2$  error scaling is constant= homoskedasticity.
3.  $\text{cov}(\varepsilon_i, \varepsilon_j) = 0$  ;  $i \neq j$  every two different errors are uncorrelated.
4.  $\varepsilon_i$  is normally distributed.
5.  $X_i$  ( $i = 1, \dots, N$ ) is fixed. It is not a random variable.

### 4.1.2 Multi-collinearity test

All the data was tested on multi-collinearity to prevent repetition in model estimation. The highest value of collinearity was detected 0.88. This value is high, but not higher than 0.9. We can exclude the multi-collinearity issue and keep all of the variables.

## 4.2 Internet penetration and share of cash in the total payment volume

### 4.2.1 Internet penetration<sup>13</sup>

In this thesis is internet penetration understood as a tool used to get access to internet banking and other types of non-cash payments methods. It is an indicator which tells us which part of the population to participate in online commerce and online banking. Both of these indicators could influence the number of cash transactions in a country.

It is expected that internet penetration will have a negative effect on share of cash transactions. Internet penetration is entered in percent (%).

#### Endogenous variable

- Cash\_usage = share of cash in total payment volume (in %).

#### Exogenous variable

- Internet\_penetration = Share of population participating in online commerce and online banking (in %).

The research question is: Does volume of internet penetration have effect on share of cash in the total payment volume in EU countries?

$$\text{Cash\_usage} = \alpha + \beta_1 \text{Internet\_penetration} + \varepsilon,$$

where  $\alpha$ ,  $\beta_i$  ( $i = 1, \dots, 7$ ) = estimated variables,  $\varepsilon$  = random component (error).

### 4.2.2 Assumption

The reason why this variable was used was a presumption that if would be given internet access to higher percentage of population, more people could use internet banking. This means that it could increase the usage of credit transfer, direct debit and e-money and decrease usage of cash. Internet penetration also testifies about a level of internet literacy of population to a certain extent.

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<sup>13</sup> The data are available on [www.ec.europa.eu/digital-agenda/en/news/digital-agenda-scoreboard-2015-most-targets-reached-time-has-come-lift-digital-borders](http://www.ec.europa.eu/digital-agenda/en/news/digital-agenda-scoreboard-2015-most-targets-reached-time-has-come-lift-digital-borders)

Hypothesis tested in this section is H1: Countries with a higher percentage of internet penetration has lower share of cash in total payment volume.

### 4.2.3 Linear regression

Tab. 2 shows that coefficient of internet penetration is  $-0.76$ . Which means that if internet penetration in a country would be increased by one percentage; cash transaction volume would drop by 0.76 %.

P-value is 0.0028 (lower than 0.05) which indicates that the data are statistically significant. There is no reason to reject hypothesis H1.

Model 1: OLS, using observations 1-28 (n = 27) Missing or incomplete observations dropped: 1 Dependent variable: Cash_transaction_volume Heteroskedasticity-robust standard errors, variant HC1				
	coefficient	std. error	t-ratio	p-value
Const	1.21988	0.177915	6.857	3.46e-07 ***
Internet penetr~	-0.763972	0.230570	-3.313	0.0028 ***
Mean dependent var	0.655715		S.D. dependent var	0.188037
Sum squared resid	0.417621		S.E. of regression	0.129247
R-squared	0.545721		Adjusted R-squared	0.527550
F(1, 25)	10.97869		P-value(F)	0.002810
Log-likelihood	17.97040		Akaike criterion	-31.94080
Schwarz criterion	-29.34913		Hannan-Quinn	-31.17016

Tab. 2

Linear regression proved the assumption that higher internet penetration of the population also improves their literacy. This leads to the first recommendation for governments aiming to decrease share of cash in the country. If the population will be more encouraged to get involved in e-commerce, or use of internet banking, it will have a verifiable effect on reducing cash usage. After estimation of the data it can be affirmed that internet penetration has a relevant effect<sup>14</sup> on changing the cash and non-cash transaction ratio in Europe.

Fig. 8 shows relation between internet penetration(X) and cash transaction volume(Y).

<sup>14</sup> Even though this value was proven to have an effect of the changing ratio of usage of cash, it was not included in final multi-regression model. Reason is that when compared with other variables, the significance in the final model is irrelevant.

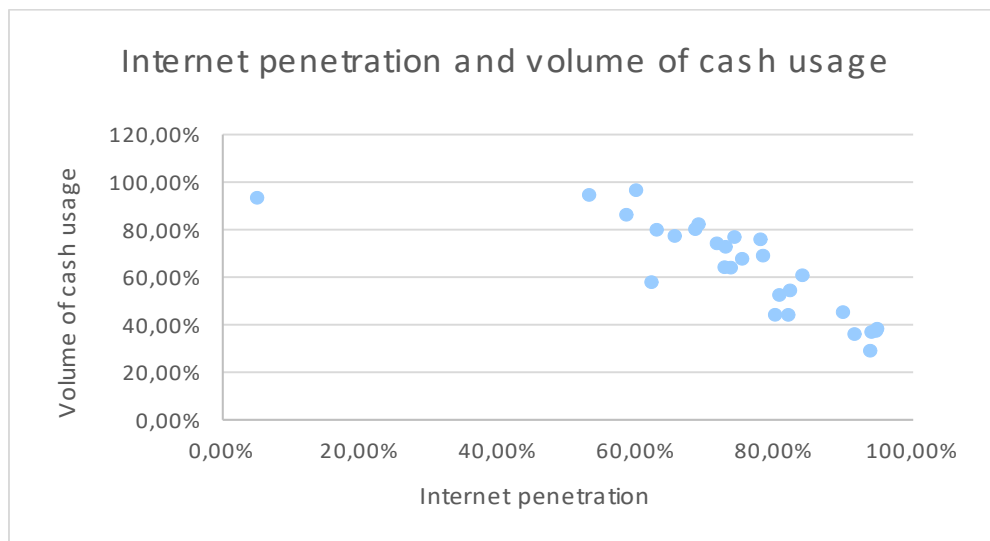


Fig. 8 Internet penetration and volume of cash usage

### 4.3 GDP per capita and share of cash in the total payment volume

#### 4.3.1 GDP per capita<sup>15</sup>

GDP per capita is one of the main indicators of prosperity of a country. It is defined as the amount of goods and services produced inside a country, divided by the number of its population. This value is entered in euros per capita, per year.

GDP per capita is basically an indicator of how many products and services in euros are produced by each citizen of a country. The main idea of this section is that more productive population could have access to more cashless types of payments.

#### Endogenous variable

- Cash\_usage = share of cash in total payment volume (in %).

#### Exogenous variable

- GDP\_per\_capita = Gross Domestic Product per capita (in euro).

The research question is: Does GDP per capita have effect on share of cash in the total payment volume in EU countries?

$$\text{Cash\_usage} = \alpha + \beta_1 \text{Internet\_penetration} + \beta_2 \text{GDP\_per\_capita} + \varepsilon,$$

where  $\alpha$ ,  $\beta_i$  ( $i=1,..,7$ ) = Estimated variables,  $\varepsilon$  = random component (error).

<sup>15</sup> The data source is ECB Statistics 2014.

### 4.3.2 Assumption

Objective of every government should be to increase GDP of their country, to provide better standard for its citizens. This regression analysis is clearly answering the question whether there is a relationship between GDP and cash usage. If so, governments should consider if they should follow the trend of reducing the cash usage in order to increase the countries productivity. This variable was considered because of assumption that countries with higher GDP have more resources to make more accessible possibilities of cashless transaction for its citizens.

Hypothesis tested in this section (H2) is: GDP per capita has a negative effect on share of cash in the total payment volume in EU countries.

### 4.3.3 Linear regression

Coefficient of GDP per capita has a negative effect on share of cash in total payment value. P-value is lower than 0.05 (0.0012), which indicates that the data are statistically significant, meaning we do not reject the hypothesis H2.

Fortunately, the assumption was proved to be correct and hypothesis accepted. This means countries which are trying to reduce a cash usage in order to create better conditions to increase their productivity, should share the pattern with other countries from EU28.

Fig. 9 shows us the relation between GDP per capita (X) and share of cash in the total payment volume(Y).

Model 2: OLS, using observations 1-28 (n = 27) Missing or incomplete observations dropped: 1 Dependent variable: Cash_transaction_volume Heteroskedasticity-robust standard errors, variant HC1				
	coefficient	std. error	t-ratio	p-value
<b>Const</b>	0.795622	0.0800519	9.939	3.63e-010 ***
<b>GDP_per_capita</b>	-5.289e-06	3.30128e-06	-1.602	0.00121
<b>Mean dependent var</b>	0.655715		<b>S.D. dependent var</b>	0.188037
<b>Sum squared resid</b>	0.700688		<b>S.E. of regression</b>	0.167414
<b>R-squared</b>	0.237807		<b>Adjusted R-squared</b>	0.207319
<b>F(1, 25)</b>	2.567169		<b>P-value(F)</b>	0.001217
<b>Log-likelihood</b>	10.98430		<b>Akaike criterion</b>	-17.96860
<b>Schwarz criterion</b>	-15.37693		<b>Hannan-Quinn</b>	-17.19796

Tab. 3



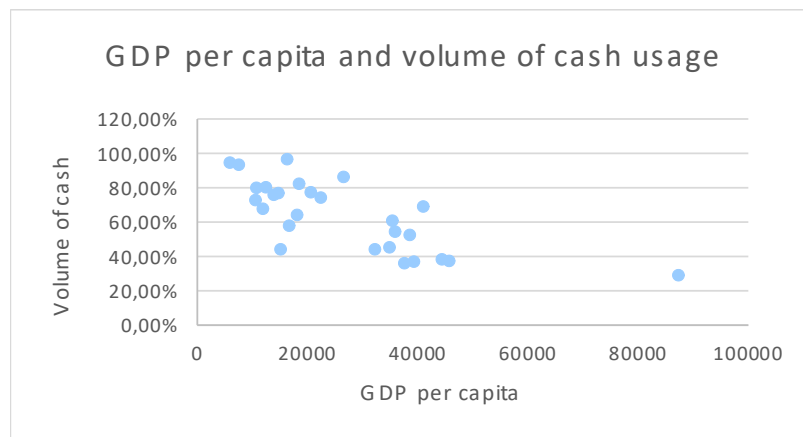


Fig. 9 GDP per capita and volume of cash usage

## 4.4 Currency in circulation per capita and cash transaction volume

### 4.4.1 Currency in circulation outside MFIs per capita<sup>16</sup>

Currency in circulation outside MFIs per capita is a variable that indicates what value of cash in bank notes and coins is in circulation, outside monetary financial institutions. Value is calculated per capita. It was decided to add this variable to the thesis after logical assumption that if there were more money in circulation, meaning more cash per capita, payments completed with cash would be more frequent.

It is expected that currency in circulation outside MFIs per capita will have a positive effect on share of cash in total payment volume. The data are shown in euro.

#### Endogenous variable

- Cash\_usage = share of cash in total payment volume (in %).

#### Exogenous variable

- Currency\_in\_circ = Currency in circulation per capita outside monetary financial institutes (in euro).

The research question is: Does Currency in circulation per capita have effect on share of cash in the total payment volume in EU countries?

$$\text{Cash\_usage} = \alpha + \beta_3 \text{Currency\_in\_circ} + \varepsilon,$$

where  $\alpha$ ,  $\beta_i$  ( $i=1, \dots, 7$ ) = Estimated variables,  $\varepsilon$  = random component (error).

<sup>16</sup> Data of currency in circulation outside MFIs are available on ECB Payment Statistics 2014. The value was divided by the population of each country. Population statistics are available on ECB Statistics 2014.

#### 4.4.2 Assumption

This variable was included based on a logical assumption that more printed or minted money in a country should encourage people to use it more as a payment method. In other words, increasing demand on cash could result in higher cash supply from banks. And the spoken increase of demand could be caused by the higher need or want of people to use money on daily bases. It is expected that higher number of currency in circulation outside MFIs per capita will increase share of cash in total payment volume.

Hypothesis tested in this section is H3: Currency in circulation per capita has a positive effect on share of cash in the total payment volume in EU countries.

#### 4.4.3 Linear regression

Even though coefficient of currency in circulation per outside MFIs per capita has positive effect on share of cash in total payment volume, from the p-value in table 2 is obvious that this data are statistically insignificant. Which means that amount of currency in circulation outside MFIs has no relevant impact on number of payments using cash, meaning we reject hypothesis H3.

Model 3: OLS, using observations 1-28 (n = 27) Missing or incomplete observations dropped: 1 Dependent variable: Cash_transaction_volume Heteroskedasticity-robust standard errors, variant HC1				
	coefficient	std. error	t-ratio	p-value
Const	63.5782	4.51950	14.07	2.22e-013 ***
Currency_in_circ~	0.0014	0.0015	0.96	0.34
Mean dependent var	65.57148		S.D. dependent var	18.80370
Sum squared resid	9016.748		S.E. of regression	18.99131
R-squared	0.019178		Adjusted R-squared	-0.020054
F(1, 25)	0.925322		P-value(F)	0.345294
Log-likelihood	-116.7599		Akaike criterion	237.5197
Schwarz criterion	240.1114		Hannan-Quinn	238.2904

Tab. 4

After the estimation of the data it was disproved that currency in circulation outside MFIs per capita has a relevant effect on changing the cash and non-cash transaction ratio in Europe. That means the higher supply of cash from banks has a different cause than demand of customers based on higher urgency to use cash as a payment method.

Fig. 10 shows the relation between currency in circulation(Y) and cash transaction volume(X).

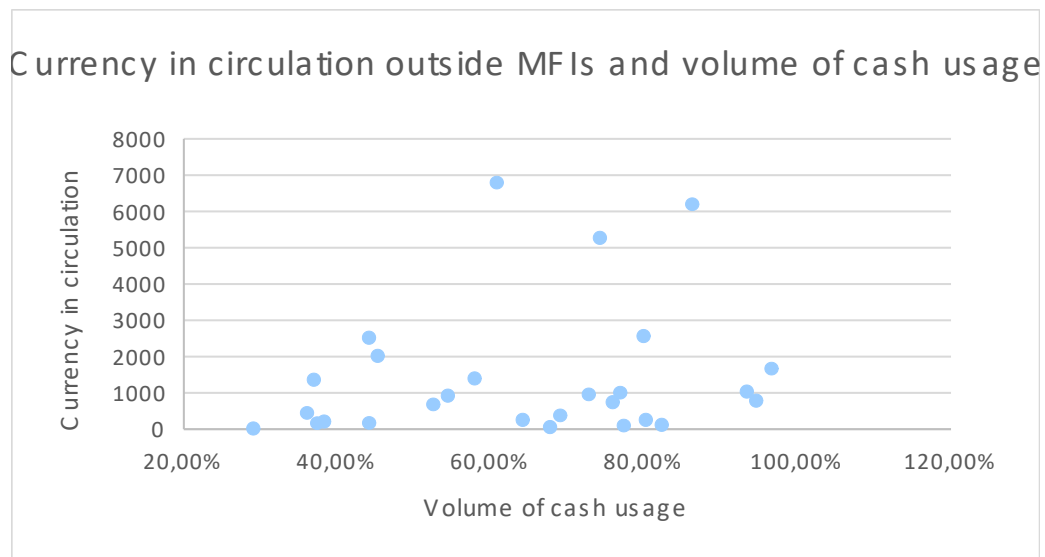


Fig. 10 Currency in circulation outside MFIs and volume of cash usage

## 4.5 Population with at least one bank account and share of cash in the total payment volume

### 4.5.1 Population with at least one bank account<sup>17</sup>

It is reported that 86 % of the EU population older than 15 years holds at least one bank account in a formal financial institution. Bank account enables its owners using more non-cash transaction tools, such as direct debit, credit card and so on.

It is expected, that countries with a higher share of people owning one or more bank accounts, would have a smaller share of cash transaction. Data are entered in percentage of population.

#### Endogenous variable

- Cash\_usage = share of cash in total payment volume (in %).

#### Exogenous variable

- Population\_with = Population with at least one bank account (in %).

The research question is: Does a volume of population with at least one account have effect on share of cash in the total payment volume in EU countries?

$$\text{Cash\_usage} = \alpha + \beta_4 \text{Population\_with} + \varepsilon,$$

where  $\alpha$ ,  $\beta_i$  ( $i=1, \dots, 7$ ) = Estimated variables,  $\varepsilon$  = random component (error).

<sup>17</sup> Data of population with at least one bank account are available on [www.statista.com](http://www.statista.com).

#### 4.5.2 Assumption

Bank account should lead to higher education of population in the means of electronic payments. The prediction is that higher percentage of population with a bank account, should lead to higher use of electronic types of payments. To make bank accounts more affordable and accessible for higher percentage of population could be an easy way for governments to decrease cash usage, if the assumption will be proven. Meaning this variable should decrease share of cash in the total payment volume.

Hypothesis tested in this section is H4: Volume of population with at least one account has a negative effect on share of cash in the total payment volume in EU countries.

#### 4.5.3 Linear regression

Volume of population holding at least one bank account has a negative impact on share of cash in the total payment volume.

Coefficient of determination is  $-0.98$ , which means that each percentage of population with at least one bank account will decrease the volume of cash payments by 0.98 %.

P-value is  $9.85e-07$ , which is lower than 0.05, meaning that the result is statistically significant. There is no reason for rejection of hypothesis H4.

Model 4: OLS, using observations 1-28 (n = 27) Missing or incomplete observations dropped: 1 Dependent variable: Cash_transaction_volume Heteroskedasticity-robust standard errors, variant HC1				
	coefficient	std. error	t-ratio	p-value
<b>Const</b>	1.50219	0.127492	11.78	1.06e-011 ***
<b>Population_with_~</b>	-0.979550	0.152333	-6.430	9.85e-07 ***
<b>Mean dependent var</b>	0.655715		<b>S.D. dependent var</b>	0.188037
<b>Sum squared resid</b>	0.379311		<b>S.E. of regression</b>	0.123176
<b>R-squared</b>	0.587394		<b>Adjusted R-squared</b>	0.570890
<b>F(1, 25)</b>	41.34883		<b>P-value(F)</b>	9.85e-07
<b>Log-likelihood</b>	19.26934		<b>Akaike criterion</b>	-34.53869
<b>Schwarz criterion</b>	-31.94701		<b>Hannan-Quinn</b>	-33.76805

Tab. 5

Recommendation for the governments resulting from this thesis is to make bank accounts more accessible in order to decrease the usage of cash. This could be achieved by introduction of subsidized accounts for crisis groups, such as students, seniors and lower income families. After the estimation of the data it can be af-

firmed that percentage of population with at least one bank account has a relevant effect on changing the cash and non-cash transaction ratio in Europe.

Fig. 11 shows the relation between population with at least one bank account (Y) and share of cash in the total payment volume(X).

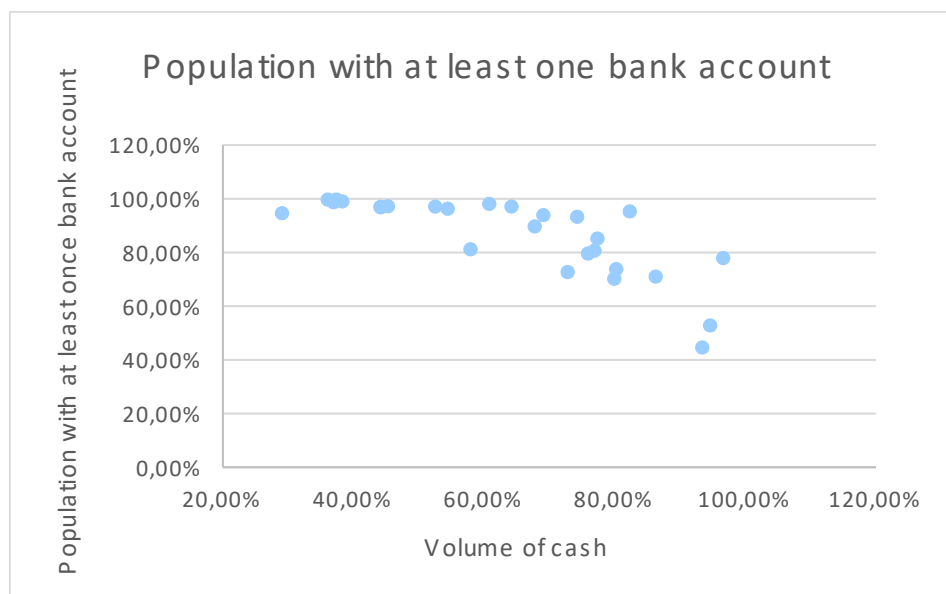


Fig. 11 Population with at least one bank account

## 4.6 Post-communist countries and share of cash in payment volume

### 4.6.1 Post-communist countries<sup>18</sup>

Is a variable, which differs if the country was during Russian occupation in Eastern Block. Thoughts behind the inclusion of this variable are that Russian occupation has a significant negative impact on political and economic development of affected countries. Hence, by constructing this OLS model, we want to find out, if the negative effect also includes lower possibilities of usage modern, non-cash transactions.

From our sample, it were countries Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia, Slovakia and Eastern Germany. Eastern Germany was decided not to classify as a post-communist country because of the quick reviving of the economy after the occupation, caused by reunion with the Western Germany. It is a dummy variable (1- yes, 0- no),

### Endogenous variable

<sup>18</sup> Data are available on: [https://en.wikipedia.org/wiki/Soviet\\_Union](https://en.wikipedia.org/wiki/Soviet_Union)

- Cash\_usage = share of cash in total payment volume (in %).

#### Exogenous variable

- Post\_comunist\_co = Whether the country was occupied by The Soviet Union (1 - yes, 0 - no).

The research question is: Has the fact that some EU countries were under the occupation of Soviet Union influenced share of cash in the total payment volume?

$$\text{Cash\_usage} = \alpha + \beta_5 \text{Post\_comunist\_co} + \varepsilon,$$

where  $\alpha$ ,  $\beta_i$  ( $i=1, \dots, 7$ ) = Estimated variables,  $\varepsilon$  = random component (error).

#### 4.6.2 Assumption

This test cannot resolve in a recommendation for governments, as the states cannot change its history, the following test is purely descriptive. In spite of impossibility of using this data in practice, this test could be another proof that communism in European countries slowed down economy rapidly and still influence current happening in Europe. It is expected that the fact the countries, which was part of Soviet Union, will tend to have a higher share of usage cash as a mean of payment.

Hypothesis tested in this section is H5: Countries which was occupied by Soviet Union has a higher share of cash in the total payment volume.

#### 4.6.3 Linear regression

After estimation of model, assumption was proven to be correct. In post-communist countries is cash payment preferred by 0.15 %.

P-value is on an edge of statistical significance, but the value is smaller than 0.05 (0.03) so it can still be considered a statistically significant factor. There is no reason to reject hypothesis H5.

Fig. 12 shows the relation between post communist countries (Y) and share of cash in the total payment volume(X).

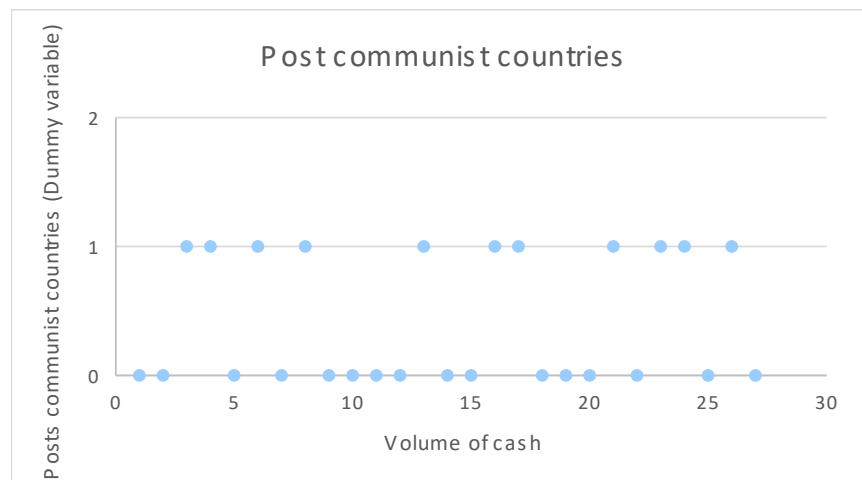


Fig. 12 Share of cash payments in post communist countries

Model 5: OLS, using observations 1-28 (n = 27)				
Missing or incomplete observations dropped: 1				
Dependent variable: Cash_transaction_volume				
Heteroskedasticity-robust standard errors, variant HC1				
	coefficient	std. error	t-ratio	p-value
Const	0.600353	0.0468828	12.81	1.76e-012 ***
Post_communist_co~	0.149477	0.0652298	2.292	0.0306 **
Mean dependent var	0.655715		S.D. dependent var	0.188037
Sum squared resid	0.778625		S.E. of regression	0.176479
R-squared	0.153029		Adjusted R-squared	0.119150
F(1, 25)	5.251173		P-value(F)	0.030629
Log-likelihood	9.560505		Akaike criterion	-15.12101
Schwarz criterion	-12.52934		Hannan-Quinn	-14.35037

Tab. 6

It is often discussed that countries occupied after The World War II are still losing on Western economics. This test supports this the claim and suggests that it is going to be difficult for the affected countries to keep up with the West. After the estimation of the data it can be affirmed that the communism has a relevant effect<sup>19</sup> on changing the cash and non-cash transaction ratio in Europe.

<sup>19</sup> Even though this value was proven to have an effect of the changing ratio of usage of cash, it was not included in final multi-regression model. Reason is that when compared with other variables, the significance in the final model is irrelevant.

## 4.7 Competitiveness index and share of cash in the total payment volume

### 4.7.1 The Global Competitiveness Index<sup>20</sup>

This variable was used, based on logical assumption. The index obtained from The Global Competitiveness Report 2014–2015. It is calculated from 12 pillars of each country and it should be indicator of competitiveness of each country. The pillars are:

- Pillar 1. Institutions.
- Pillar 2. Infrastructure.
- Pillar 3. Macroeconomic environment.
- Pillar 4. Health and primary education.
- Pillar 5. Higher education and training.
- Pillar 6. Goods market efficiency.
- Pillar 7. Labor market efficiency.
- Pillar 8. Financial market development.
- Pillar 9. Technological readiness.
- Pillar 10. Market size.
- Pillar 11. Business sophistication.
- Pillar 12. Innovation.

To calculate the index, multiple statistical data was used. For example life expectancy, enrollment rates, government debt, budget deficit etc.

The global competitiveness index is a number in a range 4.04 (Greece) and 5.4 (Finland).

#### Endogenous variable

- Cash\_usage = share of cash in total payment volume (in %).

#### Exogenous variable

- Competitiveness\_i = States competitiveness index by The Global Competitiveness Report 2014 (index/number).

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<sup>20</sup> Data are available on [www3.weforum.org/docs/WEF\\_GlobalCompetitivenessReport\\_2014-15.pdf](http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014-15.pdf)



The research question is: Does *The Global Competitiveness Index* have any effect on share of cash in the total payment volume?

$$\text{Cash\_usage} = \alpha + \beta_6 \text{Competitiveness}_i + \varepsilon,$$

where  $\alpha$ ,  $\beta_i$  ( $i=1, \dots, 7$ ) = Estimated variables,  $\varepsilon$  = random component (error).

#### 4.7.2 Assumption

GDP is not the only indicator of economic development. Competitiveness index should provide an alternative way to measure progress of a country. Even though GDP and competitiveness index are different indicators, the assumption applied here is the same. If a relationship is proven by the test, this could serve as a recommendation for governments to work more effectively on cash usage reduction. It is expected that countries with a higher competitiveness might have a higher share of electronic payments.

Prediction is that higher competitiveness index, should decrease usage of cash.

Hypothesis tested in this section is H7: Countries with a better competitiveness according to The Global Competitiveness Report has lower share of cash in the total payment volume.

#### 4.7.3 Linear regression

The econometric model proved assumption to be correct. Global competitiveness index has a negative impact on share of cash transactions in the total payment volume. Every point of competitiveness index will decrease usage of cash in a country by 0.32 %

P-value is lower than 0.05, meaning that the model is statistically significant. There is no reason to reject the hypothesis H6.

Model 6: OLS, using observations 1-28 (n = 27) Missing or incomplete observations dropped: 1 Dependent variable: Cash_transaction_volume Heteroskedasticity-robust standard errors, variant HC1				
	coefficient	std. error	t-ratio	p-value
Const	2.17298	0.216031	10.06	2.85e-010 ***
Competitiveness_i~	-0.318851	0.0450150	-7.083	2.01e-07 ***
Mean dependent var	0.655715		S.D. dependent var	0.188037
Sum squared resid	0.321046		S.E. of regression	0.113322
R-squared	0.650773		Adjusted R-squared	0.636804
F(1, 25)	50.17207		P-value(F)	2.01e-07
Log-likelihood	21.52075		Akaike criterion	-39.04149
Schwarz criterion	-36.44982		Hannan-Quinn	-38.27085

Tab. 7

After the estimation of the data was affirmed that competitiveness index has a relevant effect on changing the cash and non-cash transaction ratio in Europe. Another indicator of the fact is that higher cash usage is slowing down country's economy. This test provided a new motivation for governments to support cash usage reduction.

Fig. 13 shows the relation between competitiveness index (Y) and share of cash in the total payment volume(X).

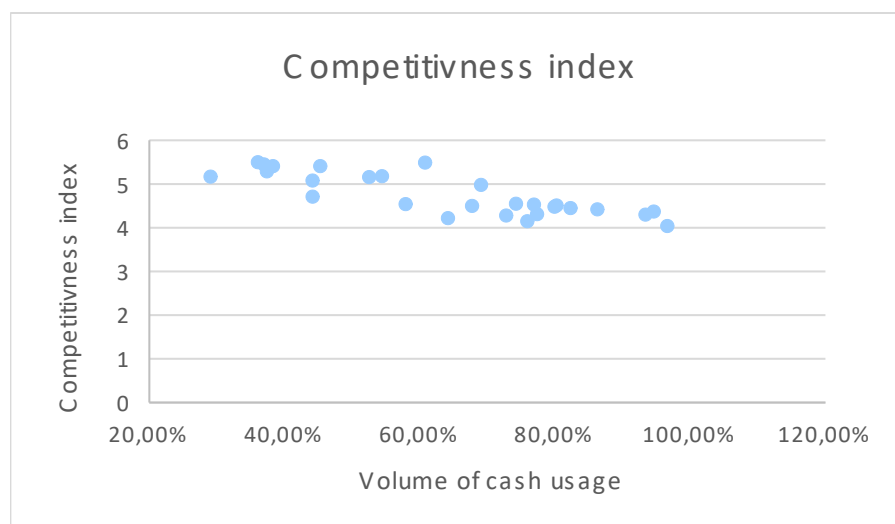


Fig. 13 Relation of competitiveness index and share of cash in the total payment volume

## 4.8 Share of cash in the total payment volume on shadow economy

### 4.8.1 Shadow economy

It is known that shadow economy is very hard to measure; the main reason is that it consists of activities deliberately hidden from government. It consists of work not declared for tax, black market transactions, etc. (SCHNEIDER, 2013)

According to An EY Study Commissioned by MasterCard and many other sources, there should be a positive relationship between reducing the usage of cash (increasing the usage of electronic payments) and shadow economy. Meaning that the higher cash transaction volume, allows subject involved in shadow economy better hide their transactions. The value of shadow economy is entered in percentage.

#### Endogenous variable

- Shadow\_economy = Level of shadow economy per country (in %).

#### Exogenous variable

- Cash\_usage = share of cash in total payment volume (in %).

The research question is: Does share of cash in the total payment volume in EU countries have effect on percent level of shadow economy?

$$\text{Shadow\_economy} = \alpha + \beta_7 \text{Cash\_usage} + \varepsilon,$$

where  $\alpha$ ,  $\beta_i$  ( $i=1,\dots,7$ ) = Estimated variables,  $\varepsilon$  = random component (error).

### 4.8.2 Assumption

The main reason why shadow economy was implemented in the study, are current events in India<sup>21</sup>. The government of India took out of circulation about \$2 trillion worth banknotes to fight corruption and other criminal activities.

The assumption is that if we decrease usage of cash, it should have a negative effect on shadow economy in a country.

Hypothesis tested in this section (H7) is: Share of cash in the total payment volume in EU countries has a positive effect on percent level of shadow economy.

### 4.8.3 Linear regression

The econometric model proved assumption to be correct. With each percentage decreased of using cash, the shadow economy will decrease by 0.23 %.

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<sup>21</sup> Full text on <https://hbr.org/2016/12/indias-botched-war-on-cash>

P-value is lower than 0.05, which indicates that the model is statistically significant. There is no reason to reject hypothesis H7.

Model 7: OLS, using observations 1-28 (n = 27) Missing or incomplete observations dropped: 1 Dependent variable: Shadow_economy Heteroskedasticity-robust standard errors, variant HC1				
	<b>coefficient</b>	<b>std. error</b>	<b>t-ratio</b>	<b>p-value</b>
<b>Const</b>	2.85967	3.51245	0.8142	0.4232
<b>Cash_transaction_~</b>	0.234513	0.0488839	4.797	6.30e-05 ***
<b>Mean dependent var</b>	18.23704	<b>S.D. dependent var</b>	6.945566	
<b>Sum squared resid</b>	748.6783	<b>S.E. of regression</b>	5.472397	
<b>R-squared</b>	0.403093	<b>Adjusted R-squared</b>	0.379217	
<b>F(1, 25)</b>	23.01452	<b>P-value(F)</b>	0.000063	
<b>Log-likelihood</b>	-83.16472	<b>Akaike criterion</b>	170.3294	
<b>Schwarz criterion</b>	172.9211	<b>Hannan-Quinn</b>	171.1001	

Tab. 8

After the estimation of the data it was affirmed that the cash and non-cash transaction ratio has a relevant effect on share of shadow economy. This estimation gives probably the highest motivation for the governments to reduce cash usage. This however is not a new finding, just a verification.

Fig. 14 shows the relation between share of shadow economy (Y) and share of cash in the total payment volume (X).

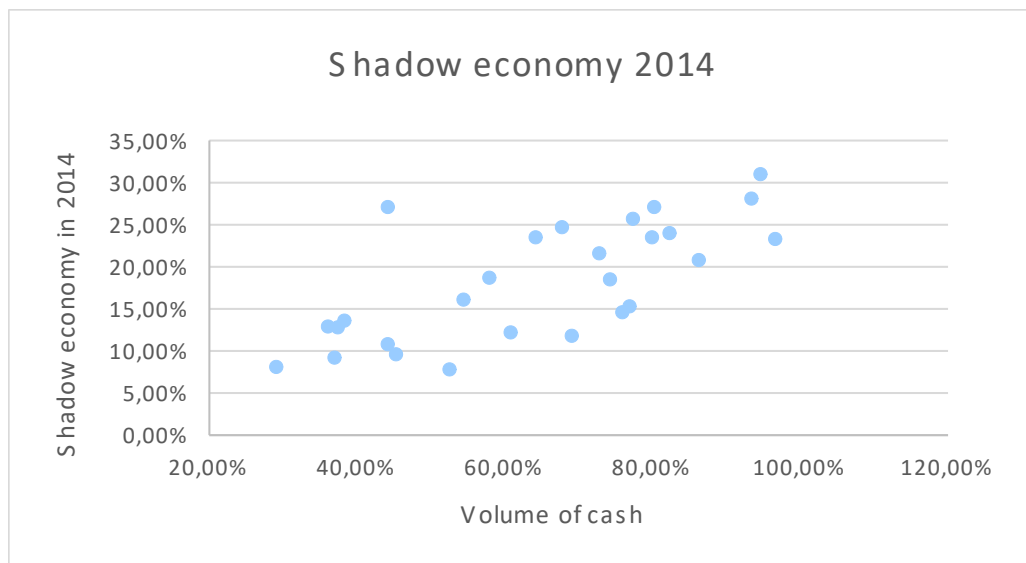


Fig. 14 Relation between share of shadow economy cash in the total payment volume

## 4.9 Multiple regression model

After testing the variables in one model, the variable post-communist countries was eliminated for its low statistical significance. It was decided to use only statistically significant variables: GDP per capita, Population with at least one bank account and competitiveness index.

$$\text{Cash\_usage} = \alpha + \beta_2 \text{GDP\_per\_capita} + \beta_4 \text{Population\_with} + \beta_6 \text{Competitiveness\_i} + \varepsilon,$$

where  $\alpha, \beta_i$  ( $i=1,..,7$ ) = Estimated variables,  $\varepsilon$  = random component (error).

### Endogenous variable

- Cash\_usage = share of cash in total payment volume (in %).

### Exogenous variables

- GDP\_per\_capita = Gross Domestic Product per capita (in euro).
- Population\_with = Population with at least one bank account (in %).
- Competitiveness\_i = States competitiveness index by The Global Competitiveness Report 2014 (index/number).

The research question is: What are the factors that affects share of cash in the total payment volume in EU countries?

### 4.9.1 Assumption

This model is included in the thesis to provide demonstration of proportional effectiveness of each formerly tested variable. Hypothesis tested in this section is H8: GDP per capita, population with at least one bank account and competitiveness index all has a negative effect on share of cash in the total payment volume.

### 4.9.2 Linear regression

It was achieved a result of R-squared 0.8, which means that the explained variable share of cash in the total payment volume was explained from almost 80 %.

P-values are all sufficient which means that all of the variables used are statistically significant.

Model 8: OLS, using observations 1-28 (n = 27) Missing or incomplete observations dropped: 1 Dependent variable: Cash_transaction_volume				
	coefficient	std. error	t-ratio	p-value
<b>Const</b>	2.47559	0.231553	10,69	2,13e-010 ***
<b>GDP_per_capita</b>	3.65939e-06	1.52279e-06	2.403	0.0247 **
<b>Population_with</b>	-0.618423	0.162653	-3.802	0.0009 ***
<b>Competetivness_r~</b>	-0.290481	0.0591911	-4.908	5.87e-05 ***
<b>Mean dependent var</b>	0.655715		<b>S.D. dependent var</b>	0.089590
<b>Sum squared resid</b>	0.188037		<b>S.E. of regression</b>	0.799190
<b>R-squared</b>	0.184606		<b>Adjusted R-squared</b>	0.772997
<b>F(1, 25)</b>	30.51201		<b>P-value(F)</b>	3.42e-08
<b>Log-likelihood</b>	28.99114		<b>Akaike criterion</b>	-49.98228
<b>Schwarz criterion</b>	-44.79893		<b>Hannan-Quinn</b>	-48.44099

Tab. 9

### 4.9.3 Test for heteroskedasticity<sup>22</sup>

Test	Explained sum of squares	P-value
<b>Breusch-Pagan test</b>	5.97	0.94
<b>White's test</b>	0.49	0.57

Tab. 10

There was heteroskedasticity detected, we had to use robust estimate.

<sup>22</sup> Complete test viz. attachment

#### 4.9.4 Normality test<sup>23</sup>

There is a problem with normality. Hence this is a real data, it is not a problem.

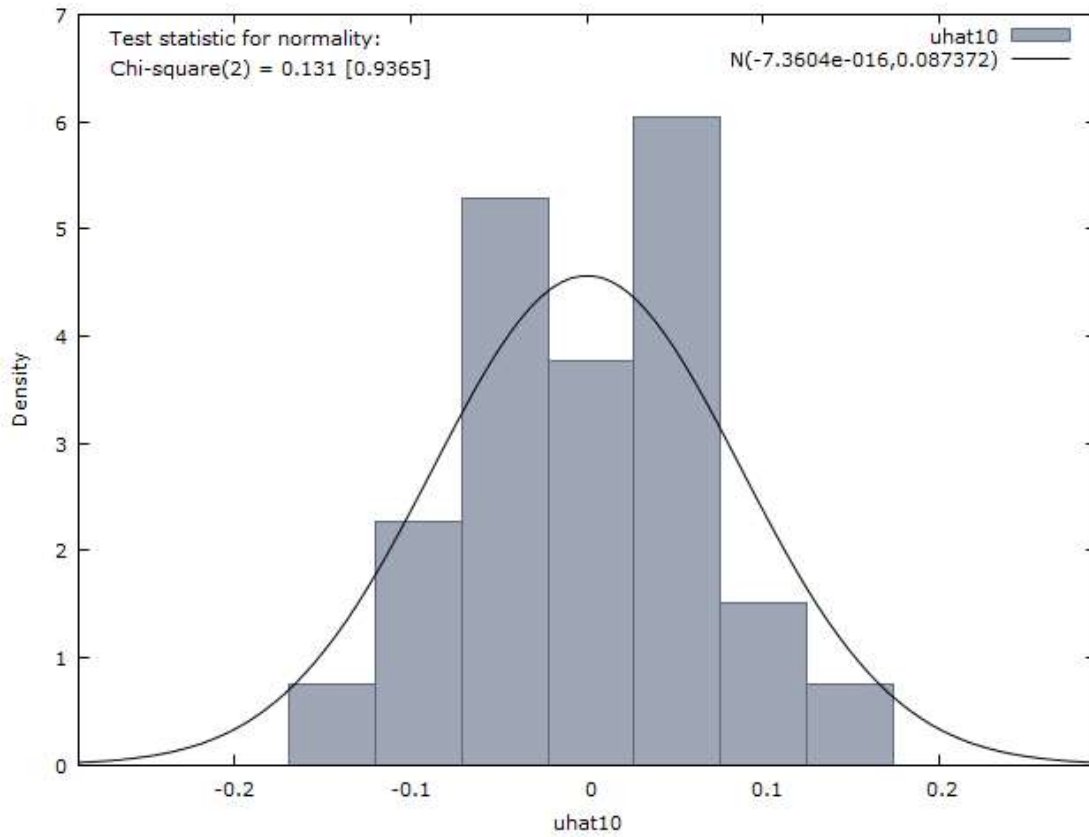


Fig. 15 Test for null hypothesis of normal distribution: Chi-square(2) = 0.131 with p-value 0.94

<sup>23</sup> Complete test viz. attachment

## 5 Discussion

In this section, new knowledge is gained during the writing of this paper by the author.

Despite of all its disadvantages, cash is the most trusted payment instrument. Even though among a younger generation are more popular different, more practical payment instrument, from authors point of view, cash is an inherent part of the economy of EU28.

The countries of European union should aim to reduce the share of cash as a payment method to lower the production costs, decrease a share of shadow economy and to increase their competitiveness. As an interesting tool to achieve decreasing tendency of cash usage is according to the results, for example higher percentage of population with at least one bank account. If governments could make bank accounts more accessible or affordable for higher share of population, it would have intended effect.

Hence, all of the outside interventions should be scrutinized to the smallest details, or they could have a major devastating effect on economy and customer satisfaction.

As a major success of this thesis is considered a statistical proof that the factors influencing share of cash payments. Also, a relationship between cash payments and shadow economy was examined.

Despite the fact, the results are quite satisfactory, there are a few factors that could have been done better.

Higher number of variables could provide better explanation, of what are the main reasons of cash maintaining the level of usage. For example, in this thesis is not included number of ATM machines in a country per squared kilometer. This factor could provide better understanding of the customer demand on cash, and policies of commercial banks.

This thesis is only focused on impact of the factors and do not answers a question of customer preferences. Why can be better, or more comfortable, for people to use cash? Is there a distrust of new technologies an important argument? Or is it a feeling of safety? These are questions, which could have been answered to deepen the understanding of the examined issue.



## 6 Conclusion

The first part of the thesis is focused on current situation in countries of EU28. In comparative statistics of internet penetration, GDP per capita, competitiveness index, cash usage and time series of shadow economy are graphically described V4 countries and compared to EU28 average. Also payment mix and country regulation table is included.

In second part of the thesis is examined each trend affecting share of cash in total payment volume separately. Research questions were answered accordingly:

“Does GDP per capita have effect on share of cash in the total payment volume in EU countries?” – Yes, internet penetration has a negative effect on total payment volume in EU countries. Despite the fact hypothesis H1 was proven to be correct, internet penetration was not included in the final multi-regression model. This variable was in comparison with others proven statistically insignificant.

“Has GDP per capita effect on share of cash in the total payment volume in EU countries?” – Yes, GDP per capita also has a negative effect on share of cash in the total payment volume in EU countries.

“Does currency in circulation per capita have effect on share of cash in the total payment volume in EU countries?” – No, this value was proven statistically insignificant. No effect on share of cash in the total payment volume in EU countries was detected.

“Does a volume of population with at least one account have effect on share of cash in the total payment volume in EU countries?” – Yes, this variable has significant negative effect on share of cash in the total payment volume in EU countries.

“Has the fact that some EU countries were under the occupation of Soviet Union, influenced share of cash in the total payment volume?” – Yes, this variable has a relevant effect on share of cash in the total payment volume. This variable was also in comparison with others proven statistically insignificant, so it was not included in multi-regression model.

“Does The Global Competitiveness Index have any effect on share of cash in the total payment volume?” – Yes, there was proven a relevant effect on share of cash in the total payment volume in EU countries.

In the last part, there was tested dependency of shadow economy on share of cash in total payment volume, and a final multi-regression model was constructed. Following questions were answered:

“Does a share of cash in the total payment volume in EU countries have effect on percent level of shadow economy?” – Yes, there was detected a relevant effect on share of shadow economy in EU countries.

“What are the factors that affects share of cash in the total payment volume in EU countries?” – Significant factor detected are GDP per capita, population with at least one account and competitiveness index.

### Topics for the further research

In the thesis are only examined cash and non-cash transaction ratios. It would be interesting to look into the problematic also from the perspective of amount that is transferred in the research transactions. How much does the average cash transaction vary over EU28 and what effects influence it? This could be an interesting question to examine in the future.

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