The move towards a digital payment market

A cross-country analysis of the European Union

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Abstract:

The payment landscape is evolving rapidly and changes in technology allows for new payment solutions to arise. There are several factors that have an impact on the digital payment landscape. The focus of this thesis has been to analyze factors that seem to be related to the amount of digital payments in a country within the European Union and to test if the findings are consistent with previous research. Data from Eurostat and European Central Bank has been used. It consists of data from 28 member countries of the EU over a time period of four years, 2014-2017. The data has been analyzed using fixed effects regression in order to control for time fixed effect and country fixed effect, where the dependent variable is the amount digital payments per million inhabitants. Five of the variables are found to be significant in the data analysis, thus leading to the conclusion that they are related to the amount of digital payments in a country within the EU. These findings are also consistent with previous research.

Keywords:

Cashless, Digitalization, Payment systems

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Contents

1. Introduction

There is an ongoing change in the infrastructure of payments and the world is moving towards more digitized payment solutions. The average number of cashless transactions per inhabitant keeps increasing from year to year all over the world (BIS Statistic Explorer, 2017). As the world becomes more digital, new forms of payment systems are invented, which in turn changes the habits of payments.

Today a person can enjoy a taxi ride or eat at a restaurant without ever opening their wallet, buying clothes without entering a store as well as paying in a supermarket without interacting with a human. During 2017 the total number of non-cash payments in the European Union (EU) increased by 7.9 per cent (European Central Bank [ECB], 2018).

Sweden is one of the most cashless countries in the world, only two per cent of all payments are made with cash (Sveriges Riksbank, 2018). The United Kingdom, Denmark and France also have a higher degree of cashless payments compared to other countries (BNP Paribas & Capgemini, 2018). Because there are both positive and negative consequences associated to cashless societies, it is a subject that has been widely debated in many countries.

There are several factors related to how cashless a country is. However, it is not certain what factors move together with digital payments and how they affect each other. Is it possible to look at factors that affect the payment landscape in a country in order to understand the development of digital payments?

1.1. Problem formulation

A great deal of research has been done on the topic of cashless societies and the evolvement of digital payments. However, most research has either solely focused on the countries, such as Sweden, which are the closest to being a cashless or it has had a broad global focus by examining data from countries across the world. It is therefore of interest to investigate how the findings from such previous research fit to research with another focus. Countries within Europe that seem to have similar demography, technological development and monetary policy actually have very different levels of cashless payments. By examining what the landscape of digital payments look like and how different factors that are associated with this topic relate to it, Europe is an intriguing focus for research concerning cashless payments.

1.2. Purpose and research questions

The purpose of this thesis is to examine if the factors that have been found to be related to the use of digital payments in previous research, also are related to the amount of digital payments in a country within the European Union. Data on factors that, based on previous research, are assumed to be related to the amount of digital payments have been downloaded from the European Central Bank (ECB) and Eurostat. The reason for the delimitation of the EU countries is that the data is very comparable since it is gathered from the same source. Data of the years 2014-2017 has been used, since this is the most accurate and updated data. Considering these two delimitations the research questions that this paper aim to answer are:

1. What factors seem to be most related to the amount of digital payments in countries within the European Union?

2. Are the findings consistent with previous research?

1.3. Contribution

Technology is rapidly developing, causing a lot of changes during a short amount of time in the payment industry. Thus, analyzing new data to understand how the digital development changes payment habits is crucial. This paper is done with the latest data available, making it more up to date than previous research.

Many other investigations regarding cashless and payment methods have been done using case studies and qualitative research. The main focus of this research is quantitative, which makes it a good complement to previous papers on similar topics. Another basis for contribution is the focus on countries within the European Union.

2. Current state of knowledge

This section provides concise reviews of theories and information related to research on payment systems and cashless societies.

2.1. Theory

Previous research regarding payment systems have used theories of network effect as well as two-sided platforms. Following section will provide a brief description of these theories.

2.1.1. Network effect

Network effect refers to the effect that consumers of a product or service has on the value of that product or service to other users. When network effects are present, the value of a product or service depends on the number of users.

A formal classification of networks was composed by Economides (1996). He described networks as links that connect nodes, where the components complement each other. Typically in networks, different components have substitutes which give rise to differential features in services. One crucial factor in the creation of a network is that the different components are compatible, otherwise the complementary feature that create the network effect is not possible. The requirement of compatibility, especially in complex product structures, can result in specific technical standards where firm's production decisions are affected by the decisions made by other competing firms (Economides, 1996).

The theory of network effect has implications on payment systems. In many ways, the different parts of the systems work as networks, where the nodes consists of buyers, merchants and banks, and the links are made of the information exchanges that are sent between them. As the use of digital payments increase, the incentive for merchants to adopt the system increases as the number of consumers using that system grows since that may lead to sales growth. The value of the system increases for the buyers as well, as the numbers of merchants accepting that payment method increases. For example the credit card system, when the number of buyers having a specific type of credit card increases, the incentive for sellers to adopt that system and get the type of terminal needed to accept payments using that type of credit card increases. As more sellers have the appropriate terminals, the value of adopting to the system increases for buyers too. The two sides complement each other and give rise to network effects (McAndrews, 1997).

2.1.2. Two-sided platforms

Another theory that is relevant when examining the payment system is the theory of two-sided markets and platforms. Platforms are a phenomenon that is becoming increasingly relevant as they can be found in technology companies such as Google and Facebook. Platforms facilitates transactions between different groups by providing rules and infrastructure. They can take many different forms, it can take the form of a place providing services such as websites (e.g. Google search engine) but it can also depend on physical products such as credit cards. These platforms function as a link between two sides of a network, defined as two-sided markets, and give rise to network effects. Because of the network effects, platforms can benefit from increasing returns to scale since the interests in the product increases as the numbers of other users grows. The opportunities this implies often lead to intense competition and mature two-sided industries usually consists of a few large companies. One example of this is the credit card industry (Eisenmann, Parker, & Alstyne, 2006).

One factor that impacts a platform's pricing decisions is the extent users *multihome,* which is an expression for end-users using more than one platform with similar features. When users on one of the two sides *multihome*, platforms will lower prices for the users on the other side in an attempt to have that side steering the users away from other platforms (Rochet & Tirole, 2003).

Digital payments as two-sided platform

A digital payment system is a two-sided platform with customers on one side and merchants on the other side. The concept of *multihome* is a prevalent feature of the payment system since many customers and merchants use several different payments platforms, for example it is common to have both a Visa and an American Express credit card. It is therefore in a payment system's interest to make their platform more attractive to the merchants so that they steer customers towards paying using their platform (Rochet & Tirole, 2003).

Cash as two-sided market

Similar to digital payment systems, cash is also a two-sided market. The value of cash for buyers depends on if sellers accepts it as a payment method and the value of cash to sellers depends on the number of buyers that use it to make purchases. For merchandiser, the decision to accept cash as a payment method depends on if it is profitable for them. There are costs associated with accepting cash, such as cost of employees handling the cash, fees for depositing money to bank accounts and cost of cash handling system. If these associated costs become higher than the associated revenues, then it is no longer profitable for merchandisers to accept cash and they will then only allow customers to use other payment means. However, because of legislature, this is not the case in many countries. In many countries in the EU, legislature state that cash is always legal tender and therefore merchandiser cannot reject cash when buyers wish to use it as payment method. While in Sweden, a law stating that cash is legal tender exists but it is dispositive. The law on freedom of contract allow sellers to reject cash as payment method if they notify customers beforehand by for example setting up a sign. In Sweden it is therefore possible that as buyers decides to use digital payments instead of cash, because cash is a two-sided system where the value for each side is impacted by network effects, merchandiser can start to decline cash leading to a feedback loop (Arvidsson, Hedman, & Segendorf, 2018).

2.2. Payment systems and money

This section will provide a brief definition of money and then continue to describe some of the most used payment systems worldwide.

2.2.1. Money

Historically, a variety of different objects have been used as money. Everything from shells and stones to gold and metal items. Paper bills came along when the printing press was invented. Today there are more and more digital solutions for money and less physical means of payments are used. Money is usually defined to possess three functions, *store of value*, *unit of account* and *medium of exchange* (Sveriges Riksbank, 2018).

2.2.2. Payment systems

Cash

Cash is money in a physical form and it is the simplest form of payment. Historically, cash has been the most commonly used mean of payment. Cash consists of bills and coins which represent the value they carry. The bills and coins are exclusively provided by a central bank but historically private banks were also allowed to provide cash. Cash allows for a payment in real time when a transaction is made, a unique feature of cash until mobile payment applications were invented (Investopedia, 2019) .

Check

A check is a document that allows for a monetary exchange without any physical money. Information about the receiver, the payer and the amount is stated on the check and the bank will carry out the order. It is rarely used in European countries, however in some countries like the United States it is still a widely used mean of payment (Investopedia, 2019).

Card payments

Cards are the biggest player regarding cashless payments. Cards can be used in several different situations, for instance when making a purchase in a *point-of-sale* terminal (POS terminal), withdrawing cash from an ATM as well as shopping online. Mastercard, VISA and American Express are the largest credit and debit card providers in the world (Statista, 2019).

There are two types of cards that are the most common ones, debit and credit card. When a consumer is paying with a debit card, money is directly deducted from the person's bank account. In this sense it is very similar to the way cash is used, however debit cards can be used to purchase items from a distance which cash cannot. Credit cards differ a bit from debit cards. Credit cards are issued by a financial institution where the customer is allowed to borrow funds. There is a certain credit limit that the owner of the card is provided with (ECB, 2019).

Emoney

Emoney (electronic money) is defined as an electronic solution to store monetary value and is backed by fiat currency. It can be described as various financial actions such as transactions and money keeping through computers and it-systems. The storage of monetary value can be done in two ways, either by hardware e-based products or by software e-based products (ECB, 2019).

Mobile payments

Due to the technology development new forms of payments has occurred. Today, many banks offer mobile banking and many countries in Europe have applications for transferring money via phone numbers (Swish in Sweden, Vipps in Norway and MobilePay in Denmark). These companies allow for payments in real time even though two people are not at the same place at the same time. Thus, it is a type of instant payment which allows for an immediate transfer of value from the payer to the payee (ECB, 2019).

The usage of e-wallets are constantly growing and according to Worlds Payment Report 2018 payments made with e-wallets amounted to 8.6 per cent of all global non-cash transactions in 2016 (BNP Paribas & Capgemini, 2018).

Cryptocurrency

Cryptocurrency is a digital and virtual currency which is based on blockchain technology. A cryptocurrency is not issued by a central authority. The technology behind cryptocurrencies allows for two parties to make a transaction without the trust of a third party (bank or card issuer). Bitcoin is one of the first and most known cryptocurrencies in the world. The impact cryptocurrencies may have on how cashless a country is will not be taken into account in this thesis since the impact is still considered to be very small. However, since the technology is moving in a fast pace, cryptocurrencies might play a major role in the future of payments (Investopedia, 2019).

Credit transfers
Credit transfer is a payment type which is initiated by the payer making an instruction to his or her payment service provider. This payment service provider, for example a bank, then moves the instructed amount of money to the payee's payment service provider (ECB, 2019).

Direct debits

Direct debit is a transaction where the payee instructs the bank to withdraw funds from the payer's bank account. The payer must authorize the transaction in order for the bank to carry it out, this is usually called *pre-authorized debit* (PAD) or *pre-authorized payment* (PAP) (ECB, 2019).

2.3. Demand for cash

An increase in demand for electronic payments does not necessarily result in decreased demand for cash. In fact, an analysis made by Bank for International Settlements (BIS) in 2018 showed that the Nordic countries are alone with substituting cash for electronic payments. In most advanced economies, the demand for cash has increased since the financial crisis in 2008. At the same time, so has the demand for card payments. The analysis explained this by differentiating between *store of value* and *means of payment*, and found that demand for cash was increasingly being driven by the demand to store value. The researchers were able to come to this conclusion by the fact that the demand for larger denomination notes grew more than the demand for smaller denominations and these larger denominations notes are used more as *store of value* compared to smaller denominations which are more used as *means of payment*. This demand for cash to store value is in part the result of the low interest rates that have prevailed post the financial crisis in 2008, which has resulted in a lower opportunity cost of holding cash (Bech, Faruqui, Ougaard, & Picillo, 2018).

2.4. Definitions

2.4.1. Definition of cashless

There are various definitions of cashless across the world. Cambridge Dictionary (2019) defines cashless as following: "using or operating with credit and debit cards and electronic systems, not money in the form of coins or notes". Merriam-Webster (2019) describes cashless as an adjective where cashless implies "relying largely or entirely on monetary transactions that use electronic means rather than cash".

Following these definitions of cashless, this thesis connects cashless to digital payment habits. However, since there is no clear definition of cashless, digital payments and non-digital payments will be defined.

2.4.2. Definition of digital and non-digital payments

Digital payments are payments where a digital or electronic device is used. Examples of this are debit or credit cards, mobile payments and transfers. All payments that are not paper-based counts as digital payments.

Non-digital payments are payments where non-electronic devices are used. Examples of this is cash such as bills and coins as well as checks, hence paper-based payments.

2.5. Cashless society – impact on society

To determine the relevance of our research regarding factors related to the use of digital payments, the consequences of societies moving towards a digitized payment market is investigated.

2.5.1. Benefits from a cashless society

One of the main arguments used to promote cashless societies is that it would lower criminal activity, especially drug crimes and money laundering. Because of the anonymity of cash, it is used by criminals when they perform activities in which they wish to not be tracked. In a cashless society, these activities would be easier to trace (Fabris, 2019). Evidence has also been found of a negative relationship between access to electronic payments and crimes such as burglary and robbery (Armey, Lipow, & Webb, 2014). Another benefit from a society without cash is that it would decrease the shadow economy. Shadow economy is defined as "those economic activities and the income derived from them that circumvent or otherwise avoid Government regulation, taxation or observation.". Cash enable privacy, which people take advantage of to evade taxes. A decrease of the shadow economy benefits society since public revenue would increase as a result of more transactions being subject to taxation (Achord, Chan, Collier, Nardani, & Rochemont, 2017).

2.5.2. Risks and issues from a cashless society

There are risks and problems associated to countries becoming cashless, both short-term and long-term. One short-term problem, that some countries are already experiencing, is the fact that certain groups that rely on using cash as payment experience problems. These are typically groups that have the habit of paying with cash, that find it hard to adapt to new technology or that have problem setting up a bank account. In Sweden, the groups that have been identified as vulnerable are elderly, people with physical/cognitive disabilities and immigrants (Arvidsson, 2019).

Another recognized problem is the loss of privacy a cashless society would entail. Because digital payments are trackable, there is a risk that people would become supervised. This supervision could result in companies and governments taking advantage of people's personal financial data and using it to their advantage.

Although one of the benefits of a lower cash level is reduction in some types of criminal activities, there are other types of criminal activities related to increase in electronic payments, such as cybercrimes (Fabris, 2019).

One potential long-term issue is concentration of the payment market. Large actors benefits from economies of scale, economies of scope and networks effects. Eventually the market would become concentrated to a few very large actors as smaller ones are pushed out (Sveriges Riksbank, 2018).

3. Research design

Having an established payment system is a necessity for the development of nations. The division of labour, which is the base for the modern economy, would not have been possible without the establishment of a system which facilitated the exchanges of specialized services and products. What type of payment system to use in a society, is a question whose answer has changed over time and it is a question that once again has become relevant due to the digital revolution. The change in payment behavior from the use of cash towards to use of digital payment has implications on society, both positive and negative. It is therefore of great interest to society to know the factors that are related to people changing the way that they make their purchases.

The purpose of this paper is to examine which of the factors that have been found to be related to use of digital payments in previous research, can be found to be related to the amount of digital payments in a country in the EU. Thus, the research questions intended to answer are:

1. What factors seem to be most related to the amount of digital payments in countries within the European Union?

2. Are the findings consistent with previous research?

3.1. Specification of detailed research focus

Recent research has shown that an increase in demand of digital payments does not necessarily result in decreased demand of cash, since cash is used both to make payments and to store value (Bech et al., 2018). Much of the previous research related to the move towards cashless societies has used models to explain cash in circulation. However, because of the dual use of cash, this method of focusing on the level of cash in a society does not directly relate to change in choice of payment method. The questions which this paper aim to answer is related to the choice of payment system, and not the choice of saving method. In order to accomplish this, the focus has been laid on the change in volume of digital payments and not on the level of cash.

3.2. Methodology

3.2.1. Panel data analysis

Panel data analysis is appropriate for answering the research questions since it makes it possible to control for the individual heterogeneity of different countries by incorporating repeated observation for each country. Example of such unobserved predictor variables are cultural factors. Another advantage of using panel data is that by adding a time dimension one can detect changes for units over time which may make the estimates of effects by predictor variables closer to the truth (Mehmetoglu & Jakobsen, 2017).

3.2.2. Fixed effects model

$$y_{it} = \beta_1 x_{it1} + \beta_2 x_{it2} + \cdots + \beta_k x_{itk} + a_i + u_{it}, t = 1,2 \ldots, T.$$

The equation above represents the original unobserved effect model or fixed effect model, where a_i is the unobserved effect. Since a_i does not change over time, this variable captures all unobserved, time-constant factors that affect y. The error term u_{it} is referred to the idiosyncratic error term and it represents all unobserved factors that does change over time and affects y (Wooldridge, 2013).

The data set in this paper contains of both time series data and country set data. In order to correct for both time fixed effects and country fixed effects the regression has been done with above mentioned equation, with dummy variables for countries and years.

3.2.3. Variables

Dependent variable

The dependent variable is annual total volume of digital payments per million inhabitants. The World Payment Report defines total non-cash circulation as "the sum of check, debit card, credit card, credit transfer, and direct debit transactions" (BNP Paribas & Capgemini, 2019). This definition of total non-cash circulation is too broad to be appropriate to this paper since it includes non-digital paper-based payments. ECB's data on total payments is the sum of *credit transfers, direct debits, card payments, e-money, cheques*, and *other payment services*, where *credit transfers* is divided into two groups; *credit transfers initiated in paper-based form* and *credit transfers initiated electronically*. In order to only include digital non-paper-based a more narrow definition than the one made by World Payment Report has been chosen. This definition only includes *credit transfers initiated electronically*, *direct debits*, *card payments*, and *e-money*. *Other payment services* are payment services which cannot be included in any of the other categories, it is therefore not certain that these payments are digital. The example made by ECB of the type of payments included in this group is bills of exchange, indicating that that there are paper-based payments are included (ECB, 2018). Therefore, the group *other payments services* has been excluded since including it may result in including non-digital payments. However, since the group may also consist of digital payments, a comparison of the change in regression result caused by not including these payments can be found in Table 1 in the appendix.

To make the numbers comparable between the different countries the number of payments is divided by million inhabitants. Since the interest of the study is payment habits, the number of transactions per payment system has been used and not the value per payment system.

A preferred dependent variable would be the share of digital payments to total amount of payments per country. However, due to lack of data on total cash payments this is not a viable option. To reduce the risk of the variable capturing a general change in the amount of all transactions and not a change in payment habit, a control variable capturing change in income is included in the model. Also, by dividing the amount per million inhabitants the risk of capturing a general change in total number of payments caused by changed population size is reduced.

Independent variables

The independent variables have been chosen based on previous research on payment systems and availability of data. To facilitate answering the paper's second research question, regarding if the findings using data from countries within the EU are consistent with previous research, variables are assigned a hypothesis of the direction of its beta coefficient.

- **GDP per Capita**
  GDP per capita is a measure of economic activity and can be used to describe living standards in an economy. As income increase, one is able to improve their living standard and increase their amount of purchases, both cash and digital.

- **GDP per capita$_{t-1}$**
  The effect of GDP per capita may not only have immediate effect on the amount of digital payments, therefore a variable is added that affect the dependent variable with a one-year lag. The effect that is of primary interest is therefore the cumulative effect $(\beta_1 + \beta_2)$, which according to theory have a positive relationship to the amount of digital payments.
  Hypothesis 1: $(\beta_1 + \beta_2) > 0$

- **Number of ATM terminals per million inhabitants**
  The number of ATM terminals per million inhabitants indicate the ease for people to obtain cash. High availability of ATMs reduces the energy and expense for people to obtain cash (Humphrey, Pulley, & Vesala, 1996). However, higher availability of ATMs may also lead to people choosing to withdraw lower amounts of cash since they do not have to worry about being able to find an ATM when they are in need (Bech et al., 2018). Although research show that high availability of ATMs lead to people holding lower amount of cash, its relationship to the use of digital payment methods is negative.
  Hypothesis 2: $\beta_3 < 0$

- **Number of POS terminals per million inhabitants**
  The number of POS terminals per million inhabitants indicate the availability of

equipment necessary to pay using cards. It therefore indicates the possibility and ease of paying using digital methods (Humphrey et al., 1996). Thus, high availability of POS terminals is positively related to the use of digital payments.
Hypothesis 3: $\beta_4 > 0$

- **Number of cards per million inhabitants**
  Many of the ways to make digital payments rely on payment cards. Thus, this variable can be an indication of the share of people in the country that are able to use these kinds of digital payments and its expected relation to the use of digital payment is positive.
  Hypothesis 4: $\beta_5 > 0$

- **Population density**
  Research regarding the relationship between population density and use of digital payment systems is not clear. The degree of population density is related to the cost of cash handling services. In countries such as Sweden, where population density is very low compared to other EU countries, the high cost of supplying cash to rural areas may result in less accessibility of cash. Reduced availability of cash forces people to adopt digital payments (Arvidsson, 2019). This points towards a negative relationship, where low population density is associated to high levels of digital payments. However, there are also articles stating that that areas with high population density are associated with a higher usage of digital payment systems and that the adoption of new payment methods are higher in cities than on the countryside (Segendorf & Wretman, 2015). This division in previous research makes it difficult to make a hypothesis of the direction of the coefficients to the population density variable.

- **Concentration ratio of banks**
  Concentration of banking system is an institutional factor that may have an impact on the available electronic payment networks. When a banking system is concentrated, individual banks are more likely to cooperate and create jointly owned and centralized digital payment networks (Humphrey et al., 1996). High concentration ratio of banks is therefore, according to research, associated with more centralized digital payment system, which create possibility to pay using digital methods in a greater amount of purchasing situations. Thus, this variable is expected to be positively related to the use of digital payments.
  Hypothesis 5: $\beta_7 > 0$

- **Education**
  Previous research show that level of education attainment is related to the probability of bank account ownership. Adults with low educational attainment have a higher probability of being unbanked, thus having no available substitution to making purchases using cash (Ansar, Demirgüç-Kunt, Klapper, Singer, & Hess, 2017).

Therefore, the share of population with a higher educational degree have a positive relationship to digital payments.
Hypothesis 6: $\beta_8 > 0$

- **Age**
  Demographics is a factor that, according to previous research, has a clear relationship between the adoption of new digital payment systems. Elderly are more set in their ways and are therefore less likely to substitute cash payments to digital ones compared to younger age groups (Arvidsson, 2019). Thus, according to previous research the relationship between the median age in a country and use of digital payments systems is negative.
  Hypothesis 7: $\beta_9 < 0$

Unaccounted for variables

The drawback of this method using data analysis, is that there are several factors that cannot be incorporated due to lack of data. To answer the first research question, the regression is therefore complemented with theoretical analysis. The factors that have been highlighted in research related to cashless payments systems which lack reliable data are:

- **Trust**
  Payment systems are only useful if people have trust in them. Cash have a long tradition in society and thus people have strong trust in that system due to previous experience using it. The trust that people feel for different digital payment systems depends on a large number of subjects, such as issues related to privacy, integrity and technology. People's adoption of new digital payment system are impacted by their trust in society in general, in the banking system and in other people (Arvidsson, 2019). There has been surveys trying to capture the level of trust that people have, but none where a similar framework has been employed over time allowing for comparison between countries in the EU during this time period.

- **Crime**
  Even though there is a lot of research regarding economics of crime, the effect crime has on digital payments has been left out of the regression. The share of crimes and type of crimes that are reported differ between countries, and including data on crime in the model could therefore result in biased results.

- **Mobile payments**
  The selection of mobile payment systems varies between the countries and their features can be very different. Some countries have well developed features of banking applications and others have not come as far. Since the landscape and types of features differs so much between the countries, these factor is better explained outside the model.

- **Cost of payments**
  According to demand theory, a person's demand of a payment instrument depends on income, the expected utility of that instrument and the relative price of that instrument compared to other substitutes (Investopedia, 2019). Thus, according to this theory, the volume of digital payments is related to its cost compared to the cost of cash. However, due to the complexity and increasing variety of different payment systems, there are no available trustworthy data on the cost of digital payments for the concerned countries.

- **Legislature**
  The countries that are examined have very different laws regarding money which may play a very important role when examining how cashless a country is. This is a factor that is more difficult to explain in the model since it is hard to find specific data on it and it is also complicated to explain different laws as an explanatory variable. Also, since this variable is likely to be time insensitive it would not be appropriate to incorporate it in a fixed effects model.

4. Data

4.1. Data overview

Name	Description	Data source
Digital payment transactions	The natural logarithm of number of total digital payment transactions involving non-MFIs per million inhabitants	ECB, Payments and Settlement Systems Statistics
GDP per capita	The natural logarithm of GDP per capita in EUR, chain linked volume	ECB, National accounts
GDP per capita$_{t-1}$	The natural logarithm of one year lagged GDP per capita.	ECB, National accounts
ATM terminals	The natural logarithm of number of ATM terminals per million inhabitants	ECB, Payments and Settlement Systems Statistics
POS terminals	The natural logarithm of number of POS terminals per million inhabitants	ECB, Payments and Settlement Systems Statistics
Cards	The natural logarithm of number of cards per million inhabitants	ECB, Payments and Settlement Systems Statistics
Population density	The natural logarithm of inhabitants per square kilometre	Eurostat, Population change - Demographic balance and crude rates at regional level (NUTS 3)
CR5	CR5 - (asset) Concentration ratio of the five largest banks	ECB, Banking structural statistical indicators

Education	Share of population between age 15 to 64 years with completed tertiary education	Eurostat, Educational attainment level and transition from education to work
Age	Median age of population - The age that divides a population into two numerically equal groups	Eurostat, Population: Structure indicators

Data on all 28 countries in the EU between year 2014-2017 has been used. As the data encompass units (28 countries) observed over several time points (four years) it is defined as panel data. *Country* represents the entities or panels (i) and *year* represents the time variable (t). A list of the 28 countries included can be found in the appendix. Because there is a probability that past income impact the amount of payment transactions a variable with one year lagged GDP per capita is included in the model. To facilitate calculation including this variable data on GDP per capita for year 2013 has been included as well.

The longitudinal dimension has been limited to four years. This is typical of panel data, which usually consists of 2-4 time points. Although panel data analysis can be made using more than four time points, it is not recommended since it increases the risk of systematic drop-out (Mehmetoglu & Jakobsen, 2017). This risk of systematic dropout is not as relevant when the units are countries compared to when the units are individuals. However, in year 2013 there was a break in the times series for data on education due to changes in the classification from ISCED 1997 to ISCED 2011. Also, data on number of transactions was missing for four countries in year 2013 due to lack of information regarding credit transfers initiated electronically. Because of these factors the number of time points in the analysis is limited to four, year 2014-2017.

Six of the variables has been transformed into logarithmic form. These variables are digital payments, GDP per capita, cards, ATM terminals, POS terminals and population density. None of the transformed variables have any negative values or zeros, so the transformation does not result in any loss of data. Although using a dependent variable with skewed distribution is not a violation of any assumption, it is recommended to transform it because it increases the chance that the model adhere to the assumption of normally distributed errors. The choice of also transforming the independent variables was made due to the rule of thumb of log transforming variables with large integer values. (Wooldridge, 2013)

5. Results

5.1. Results of regression analysis

Table 1. Fixed effect regression

Dependent variable: Digital payments excluding "other payments"

Variable	Column 1	Column 2	Column 3
GDP per capita	**1.209035*** **	**1.359768*** **	**-2.742599**
	0.50690437	0.4615794	2.608567
	(0.2803088)	(0.3162533)	(2.953326)
GDP per capita$_{t-1}$	**-0.7796927*** **	**-0.8577833*** **	**3.189158**
	0.4451455	0.4184332	2.580041
	(0.2273664)	(0.197013)	(2.907413)
ATM	**-0.2560985**	**-0.2711044**	**-0.4353286**
	0.1373178	0.1339572	0.176666
	(0.2096583)	(0.1969575)	(0.2934633)
POS terminals	**0.73988009*** **	**0.7525972*** **	**0.1208393**
	0.0775337	0.0751531	0.1411343
	(0.0875234)	(0.0766525)	(0.3219491)
Cards	**0.4999445***	**0.5104846***	**1.22659***
	0.2071067	0.2016919	0.3379732
	(0.2530513)	(0.2534039)	(0.6023766)
Population density	**2.232114*** *	**2.619677*** **	**-0.1018763**
	0.8114799	0.6856781	0.0831503
	(0.9670317)	(0.8279246)	(0.1327835)
Concentration ratio of banks	**0.0032552**	**0.0030544**	**-0.0061139**
	0.0057642	0.005654	0.0040237
	(0.0051449)	(0.0051083)	(0.0087109)
Education	**-0.0115233**	**-0.0072279**	**0.019189**
	0.0116256	0.0105218	0.0129822
	(0.0079025)	(0.008056)	(0.0222903)
Age	**0.0613463**	**0.0858161***	**-0.0388247**
	0.0507652	0.043369	0.0362247
	(0.0633284)	(0.049757)	(0.071737)
Constant	**-17.95516*** *	**-21.65576*** **	**3.825483**
	5.331416	3.625241	3.188092
	(6.536895)	(4.860654)	(6.319789)
Observations	106	106	106
Within R^2	0.7243	0.9028	0.7138
Time fixed effect	Yes	No	Yes
Country fixed effect	Yes	Yes	No

Robust standard errors in parenthesis
***p<0.01, **p<0.05, *p<0.1

Table 2 represents the results from regressions using both time and country fixed effects, only using country fixed effects and lastly only using time fixed effects. The model with only time fixed effects show the result when eliminating the bias caused by excluding unobserved variables that are constant across countries but change over time. While the model with only country fixed effects show the result when eliminating bias caused by excluding the unobserved variables that change across countries but are constant across time within countries, for example factors that are associated to the specific culture of a country. When only regulating for time fixed effects the results of the beta coefficients and the significance of the independent variables differs distinctly from the other two results. These results especially illustrates the importance of controlling for country fixed effect since this is the result that differs the most from the other two. When only controlling for country fixed effect and not time fixed effect the result does not differ that much from when controlling for both of them (compare column 1 and column 2). Hence, differences in time invariant variables related to different countries varies much more which is why it is more important to control for country fixed effects in order to avoid the result being affected by omitted variables bias. However, the result of the regression with both time and country fixed effects is the most reliable since it makes it possible to control for the time invariant factors related both to different years and countries. Thus, by employing this combined model, one is able to both eliminate bias from unobserved variables that are constant over time but is different across countries and from unobserved variables that change over time but are constant across countries. Therefore, these are the results that is highlighted in the discussion of this paper.

The robust country and time fixed effect regression with total number of digital payments excluding *other payments* per million inhabitants results in 106 observations, a F-value of 20.77 and within R^2 equal to 0.7243. Independent variables that are statistically significant at ten percent significance level are GDP per capita (4.31), GDP per $capita_{t-1}$ (-3.43), POS terminals (8.45), cards (1.98) and population density (2.31). ATM (-1.22), CR5 (0.63), education (-1.46) and age (0.97) are not found to be statistically significant. The independent variables with highest respectively lowest t-value are POS terminals and CR5.

The robust country and time fixed effect regression:

$$\ln(digitalpayments) = -17.96 + 1.21 * \ln(gdppercapita) - 0.78 * \ln(gdppercapita_{t-1}) - 0.26 * \ln(atm) + 0.74 * \ln(pos) + 0.50 * \ln(cards) + 2.23 * \ln(popdensity) + 0.0033 * cr5 - 0.012 * education + 0.061 * age$$

$n = 106, within\ R^2 = 0.7243$

The ceteris paribus effect of the independent variables on the dependent variable according to the time and country fixed effects regression result:

- GDP per capita
  For a given country, holding other factors constant, as GDP/capita increase across time by one per cent, the volume of digital payments per million inhabitants increase by 1.21 per cent.
- LGDP per capita$_{t-1}$
  For a given country, holding other factors constant, as lagged GDP per capita increase across time by one per cent, the volume of digital payments per million inhabitants decrease by 0.77 per cent.
- Number of ATM per million inhabitants
  For a given country, holding other factors constant, as number of ATMs increase across time by one per cent, the volume of digital payments per million inhabitants decrease by 0.25 per cent.
- Number of POS terminals per million inhabitants
  For a given country, holding other factors constant, as number of POS terminals increase across time by one per cent, the volume of digital payments per million inhabitants increase by 0.74 per cent.
- Number of cards per million inhabitants
  For a given country, holding other factors constant, as number of cards increase across time by one per cent, the volume of digital payments per million inhabitants increase by 0.50 per cent.
- Population density
  For a given country, holding other factors constant, as population density increase across time by one per cent, the volume of digital payments per million inhabitants increase by 2.25 per cent.
- Concentration ratio banks
  For a given country, holding other factors constant, as the concentration ratio of the five largest banks increase across time by one per cent unit, the volume of digital payments per million inhabitants increase by 0.33 per cent.
- Education
  For a given country, holding other factors constant, as the share of population with completed tertiary education increase across time by one per cent unit, the volume of digital payments per million inhabitants decrease by 1.15 per cent.
- Age
  For a given country, holding other factors constant, as the median age of the

population increase across time by one year, the volume of digital payments per million inhabitants increase by 6.33 per cent.

5.1.1. Correlation

According to the correlation matrix, which can be found in Table 4 in the appendix, there is evidence of some correlation between the independent variables. Variables that have a high level of correlation are GDP per capita and GDP per capita$_{t-1}$ (-0,8057), which is expected. Otherwise, the overall level of correlation in the regression is low (below 0.4).

5.1.2. Statistical inference

For statistical inference both coefficients and standard errors are important. Therefore, different methods for producing robust standard errors have been performed in order to test the significance of the results. By applying clustered standard errors, situations where observations within a cluster are not identically and independently distributed are accounted for. In the regression model, two different types of clusters have been identified; country clusters and year clusters. In these different types of clusters, it can be predicted that errors are correlated within the cluster and uncorrelated across them. For example it is reasonable to believe that the error term is not independent within countries. However as can be seen in Table 3 in the appendix there are very little change in the significance of the result comparing the different types of cluster-robust standard errors.

One aspect to take into consideration is the size of the clusters. When there are few clusters there is a risk of inconsistency. There is no clear rule for the number of clusters that are needed, it depends on the situation and can range from 20 to 50 clusters (Colin Cameron & Miller, 2015). The year cluster only contains of four clusters which increases the risk of inconsistency. However, the size of the country cluster is greater, containing 28 clusters. Therefore, the cluster-robust standard errors obtained using only country clusters have a lower risk of producing inconsistent standard errors. The country cluster robust standard errors are therefore the best choice for inference of the result from the fixed effects model and are thus used throughout this paper to obtain standard errors that are robust for heteroscedasticity.

It should be noted that although country cluster is the better choice its size may still not be large enough and therefore the conventional standard errors are also reported to facilitate comparison of significance using different methods. The main reason for not using the conventional heteroskedasticity-robust standard errors is that it has been found to be inconsistent for this type of fixed effects regression (Stock & Watson, 2008).

6. Discussion

6.1. Independent variables

Following the purpose of this paper to examine the relationship between certain factors and the use of digital payments in a country within the EU and to test if these findings are consistent with prior research regarding the move towards digital payments, a discussion of the result of the data analysis is performed. Out of the seven hypothesis made in order to check if the result of the data analysis is in line with previous research, two are found to not be true according to the regression results. Neither one of these two results are significant, nonetheless the implication of this is discussed below. Regarding the other five hypothesis that according to the regression result are found to be true, three of them are significant.

GDP per capita and GDP per capita$_{t-1}$

$$Hypothesis\ 1: (\beta_1 + \beta_2) > 0$$

Because $(\beta_1 + \beta_2) = (1.21 + (-0.78) = 0.43 > 0$, the first hypothesis is true according the regression result. Thus, the result is consistent with previous research regarding GDP per capita having a positive relationship to the volume of digital payments per million inhabitants in a country. Both coefficients are significant at one per cent significance level.

Since the dependent variable in the model is the volume of digital payments and not the ratio of digital payments to total payments, this result does not necessarily indicate that countries with higher GDP per capita have higher use of digital payment systems relative to non-digital payment systems. Instead this result is an indication that countries in the EU with higher GDP per capita have higher amount of digital payments, which is to be expected since higher income enable higher amount of consumption.

Countries with high GDP per capita are associated with factors, such as trust, that are linked with higher adoption rate of digital payment systems. Therefore, it can be of interest for future research to examine the relationship between GDP per capita and relative use of digital payments to total payments. Although the result of these two variables cannot be used to obtain a clear indication regarding change in payment habits, they are still important to include in the model as control variables. By including them, the result of the other independent variables can be controlled for change in income. Thus, the results of the other independent variables are more likely to give an indication of the effect of these variables on change in payment habits and not on change in consumption in general.

Number of ATM terminals per million inhabitants

$$Hypothesis\ 2: \beta_3 < 0$$

$\beta_3 = -0.26 < 0$, thus hypothesis number two is true according to the result of the regression. This result is consistent with earlier research, although not significant. This indicates that the number of ATM terminals per million inhabitants is negatively related with the volume of digital payments in a country within the EU.

As the number of ATM terminals per million inhabitants increase, so does the ease of attaining cash for the population in that country. The ease of attaining cash impacts the perceived cost of cash to people. In areas where cash is difficult to obtain the perceived cost of cash is higher because it is linked to lost time and energy. This change in perceived cost of cash associated to the availability of ATM terminals, also result in changed relative cost of cash to substitutes such as digital payment systems. According to demand theory, people's demand for a digital payment system depends on income, the perceived utility of the system and the relative cost of that system compared to substitutes (Investopedia, 2019). The influence of income on the volume of digital payments has already been established by the GDP per capita variables in the data analysis. The impact ATM terminals have on the relative cost of digital payment systems compared to cash makes it connected to the demand of digital payment systems. Thereby, the number of ATM terminals have an impact on people's payment habits.

Although the result points to this negative relationship between the number of ATM terminals and the number of digital payments, because the result is not significant this data analysis cannot be used as proof of it.

Number of POS terminals per million inhabitants

$$Hypothesis\ 3: \beta_4 > 0$$

Because $\beta_4 = 0.74 > 0$, the result of the regression analysis indicate that the third hypothesis is true. Thus, the result is consistent with previous studies regarding the number of POS terminals per million inhabitants being positively correlated with the volume of digital payments in a country within the EU. This result is significant on one per cent significance level.

The result is in line with the theory of network effects and two-sided market. The value of a digital payment system to buyers depends on the number of sellers that accept it as payment method. Thereby as the number of POS terminals increase, buyers are able to use digital payment methods in a greater variety of purchasing situations, which give rise to network effects increasing the value of the system to buyers. This increase in value result in higher demand and adoption of card payment systems among buyers. Because card payment systems work like a two-sided market, this increase in adoption among buyers result in higher value to merchants as well, resulting in more merchants choosing to invest in a POS terminal. Thus, a positive feedback loop is created resulting in changing payment habits towards to use of digital payments. This show the importance of the role that POS terminals have in a society's move towards cashless payment habits.

It is however important to recognize that this role may change in the future as technology concerning payments evolve. One example of such technological development that could impact the importance of availability of POS terminals is new types of mobile payments that does not rely on these types of payment instruments.

Number of cards per million inhabitants

$$Hypothesis\ 4: \beta_5 > 0$$

Because $\beta_5 = 0.50 > 0$, the fourth hypothesis is true according to the regression analysis. This indicates that the number of cards per million inhabitants is positively correlated with the volume of digital payments in a country within the EU and this result is consistent with previous research. The result is significant on a ten per cent significance level.

The importance of cards to the volume of digital payments can, just like POS terminals, be explained by network effects. By viewing card payment systems as a two-sided platform, cards are the instruments on the buyer's side of the platform necessary to create compatibility between the two sides. As the number of cards increase on the buyer's side, this give rise to network effects which increase the value of the card payment system to merchants. This increase in value results in higher probability that merchants decides to adopt the system and invest in the instruments, such as POS terminals, that is needed for merchants to be able to accept card payments. Just as previously discussed regarding POS terminals, as more sellers decide to adopt the system the value of it increases for buyers as they are able to use that payment method in more purchasing situations and thus they are able to rely more on the digital payment system. This increased value result in more buyers deciding to adopt the system and obtain a card, in this way a positive feedback loop is created.

However, cards are also the instrument used by people to obtain cash through ATM terminals. Therefore, it is not exclusively an indication of buyer's ability to pay using digital payment systems since it can also indicate the ability to attain cash. Therefore, the decision to get a payment card does not necessarily result in changed payment habits. However, the significant result of the regression analysis show that an increase in number of cards in a society in the EU is correlated with increased amount of digital payments.

Population density

$\beta_6 = 2.23 > 0$, hence the regression result using data from countries that are member states of the EU show a positive relationship between population density and the amount of digital payments per million inhabitants. This result is found to be significant on a five per cent significance level.

Because previous research has pointed towards different conclusions regarding the relationship between population density and use of digital payment this significant result is of added interest. The result is consistent with previous research that have concluded that the use digital payments are more likely in areas with higher population concentration.

However, it is important to recognize that this result does not necessarily suggest that research suggesting a negative relationship have been wrong in their discussions. For example the argument that areas with low population density is associated with higher cost of cash handling could still be correct. In that case, another associated factor that could influence the implications of this higher relative cost of cash compared to electronic payment systems is legislation. For example in Sweden, because legislation allow sellers to reject cash as payment method, the higher cost of cash in sparsely populated areas may result in sellers only accepting digital payment methods. While in other countries, where sellers are obliged to always accept cash, the higher cost of cash in areas with lower population density may not lead to the same result on choice of payment method.

Concentration ratio of banks

$$Hypothesis\ 5: \beta_7 > 0$$

Since $\beta_7 = 0.0033 > 0$, the fifth hypothesis is also found to be true. The result from the regression analysis is consistent to previous studies regarding a positive relationship between the concentration ratio of banks and the volume of digital payments in a country. However, the result is not significant.

High level of concentration among banks in a country have in past research been linked to increased possibility of centralized and jointly owned digital payment networks (Humphrey & Pulley & Vesala, 1996). Creating payment infrastructure and developing new technology connected to digital payments are often associated to large costs. Such high investment costs may discourage actors that do not want to take on the risk all by themselves, especially when each actor have a small part of the market share. Therefore, these types of large investments are more likely to be made when the concentration ratio is high since that means that there are large actors on the market that may have the necessary capital and ability to take them on. Centralization of digital payment networks and tech development increase the benefits of digital payments by making them more accessible and by enhancing their features, thereby increasing the utility and demand for digital payments.

This regression analysis suggest that previous research have been correct regarding a positive relationship between concentration ratio of banks in a country and the amount of digital payments, however because the result is not found to be significant it is not sufficient to prove it.

Education

$$Hypothesis\ 6\colon \beta_8 > 0$$

Since $\beta_8 = -0.0011 < 0$, the sixth hypothesis is not true according to the regression result. The regression analysis indicates that the share of population with a higher educational degree (tertiary education) have a negative relationship to the volume of digital payments in a country, which is contrary to previous research. However, the result is not significant.

Reports regarding financial inclusion have found that education is a factor related to the use of digital payment systems as people with low educational attainment are more likely to be unbanked, thereby not having access to the instruments needed for digital payments (Ansar et al., 2017). Hence, the relationship between the share of population with tertiary educational attainment and the volume of digital payments are expected to be positive and not negative which the regression analysis show. However, the result is not significant and it is therefore not sufficient to disprove earlier theories. Also, the result can be impacted by spurious relationship to other variables that have not been controlled for in the model. It could therefore be of interest for future research to further investigate the impact of demographic factors, such as age and education, on the choice payment methods by producing data to facilitate research where more variables, such as crime, can be controlled for.

Age

$$Hypothesis\ 7\colon \beta_9 < 0$$

$\beta_9 = 0.061 > 0$, therefore the result of the regression is not in line with hypothesis seven and inconsistent with previous research. The result is not found to be significant.

As noted earlier regarding short-term negative consequences of cashless societies, many reports recognize elderly as a group that is more vulnerable to this change as they are found to be less likely to change their payment habits and adopt new digital payment systems (Achord et al. 2017). Also, it is found that younger age groups are more likely to adopt new financial service technology (EY, 2017). Therefore, as the median age of a country rises, adoption of new digital payment systems are less likely, hence the relationship between median age and volume of digital payments is expected to be negative. Opposite to this, the result of the regression analysis using data on countries within the EU indicate a positive relationship between median age and volume of digital payments. Of course, this is not enough to prove previous research regarding the relationship of age and digital payments to be wrong. First, the coefficient of age is not significant. Second, the median age of a country is impacted by many factors, for example the quality of the institutions in that country. Such factors can also impact the volume of digital payments and thus provided that these variables are time variant there is a risk of the result being impacted by spurious relationship. In future research it can therefore be of interest to clarify the relationship between age and the use of digital payments by using other age indicators, for example the share of elderly in the population, and by including more control variables.

6.2. Theoretical analysis

To provide a proper answer to this paper's first research question regarding which factors are most related to the to the level of digital payments in a country within the EU, data analysis is a descriptive and useful tool but it is not fully sufficient. There are factors which have been recognized as important in previous research, but due to their specific features they are not appropriate to add as variables in a regression model. Therefore, to complete the analysis, a theoretical analysis of these variables will be provided.

Mobile payment system

Mobile payment systems offer to provide payment services via mobile devices, a fairly new way to make transactions. The value of mobile payment systems is impacted by network effects since the value of the system depends on the number of users that are connected to it as well as the number of different situations where it is accepted. To judge how significant a mobile payment system is to a society's volume of digital payments it would therefore not only be of interest to know the availability of one, but to know its value one would need data on both the number of users and number of different types of nodes.

Similar to other types of digital payments, mobile payment systems consist of complex structures where compatibility is a crucial factor. The European central bank (ECB) strive to keep the European retail payments market from becoming fragmented, which has resulted in the development of a new infrastructure service named TARGET Instant Payment Settlement (TIPS) (ECB, 2019). This new infrastructure facilitate compatibility, thus increasing the value of mobile payment systems and the probability of it being a relevant factor.

The increase of adoption or value of mobile payment systems does not necessarily result in an increase in the volume of digital payments or that societies become more cashless, as they could simply be used as a substitute for other digital payments. However, mobile payment systems have features which other digital payments lack, features that make them more similar to cash. They can be used in instant peer-to-peer transactions where cash has been the only viable option in the past. In these situations, cash can be substituted by mobile payments resulting in a decrease in cash payments.

Cost of payments

According to demand theory, people's demand for a digital payment system depends on the price of that system relative to its substitutes. Technology has enabled establishment of new types of cashless payments, which complicate valid calculations of the average cost of digital transactions.

This increase in actors on the digital payment market increase the probability that users *multihome*, that is end-users having access to more than one digital payment platform with similar features. Theory regarding two-sided platforms suggest that an increase in *multihoming* impacts pricing decisions. Thus, according to this theory, as the number of different payment platforms increase, so does competition between them which results in lower prices as they try to steer users away from other platforms. Lower prices reduce the cost of digital payment systems relative to cash, which according to demand theory will increase the demand for it.

However, the theory of network effects proposes that these effects, which the value of digital payment systems depend on, create increasing returns to scale for platforms. In the past, this opportunity of increasing returns to scale have resulted in the card payment industry being concentrated to a few large companies. This theory can be applied to digital payment market as a whole suggesting that today's large variety of different digital payment systems created by the current technological development of the market will decrease as it matures. Thus, the low prices created by intense competition may not remain in the future.

Another aspect to consider when evaluating cost of payments is cost of cash. Accepting cash can be costly for businesses. There are many costs associated with cash handling, for instance cost of wages for employs controlling the cashier and depositing money to the bank. If cost of digital payments decrease, the relative price of cash payments will increase, further increasing the demand for digital payments.

Crime

Crime can impact the perceived utility of a payment system, and thus impact the demand for different payment systems according to demand theory. For the cash payment systems, the prevalence of cash related crimes can impact decisions on both sides of the retail payment market. For merchandisers, cash increase the risk of burglary which may lead them to promote other types of payment systems. In countries where stores are not required by law to accept cash payments, the risk of burglary has led companies to make the decision to reject cash altogether. For consumers, holding cash increase the risk of theft. Theft impact the perceived utility of cash in two ways, by the increased risk of losing wealth and by the reduced level of personal safety. Because cash related crime has an impact on the perceived utility of cash, the prevalence of these types of crimes in a country can be factor related to the volume of digital payments.

However, there are also crimes related to digital payments. Technological development does not only result in new innovative ways to make payments, it also results in new types of cybercrimes which may decrease the perceived utility of digital payments. An example of such crime is card skimming. Also, the risk of cyberattacks may impact people to prefer cash over digital money. Because there are crimes related to both the cash and the digital payment system, its impact on the volume of cashless transactions remain uncertain.

Legislature

Payment systems in different countries within the European Union are not regulated by the same laws. One example of this can be found in Sweden where although there is a principal rule stating that cash is legal tender, there is also a law regarding freedom of agreement which make it legal for sellers to reject cash as payment method (Arvidsson et. al, 2018). This can be compared to the recommendation by the European Commission regarding this issue made for countries within the Euro area, stating:

> "A retailer should not refuse cash unless the refusal is based on reasons related to the good faith principle, for example when the retailer does not have enough euro cash to give the change back… The refusal of cash payments cannot be permanent." (European Commission, 2010).

As previously noted in the section on current state of knowledge, cash is a two-sided market where the value of cash to a buyer or seller depends on the number on the other side of the market. In Sweden, because of the network effects, if buyers start substituting cash payments for digital payments the value of the cash payment system decrease for sellers and they may then decide to reject cash resulting in decreased value of cash to buyers. Thus, a feedback loop is created, which lead to increase in volume of cashless payments. While in countries where retailers are obliged to accept cash this feedback loop is not possible (Arvidsson et. al, 2018). This example show that legislature is an important factor to the level of digital payments in a country within the European Union.

Trust

Money is a social convention whose purpose is to build the trust necessary for economic transactions. Trust is a central component for any payment system, both paper-based and cashless. In order for a payment system to function, users have to believe that it can serve all the different functions of money, *unit of account*, *store of value* and *medium of exchange*. Therefore, for people to change their payment habits from one system to another, they have to have trust in this new system. If people perceive that there are risks associated to a system, which make them question its trustworthiness, this increase the perceived utility of it. An example of this, connected to digital payments, could be loss of privacy and supervision. Thus, the degree of trust people have in a digital payment system is a factor that impact the volume of payments.

6.3. How to improve the framework

The payment industry, just like many other sectors in the economy, is rapidly changing as technology is being given a greater role. Because the industry is going through such a rapid development, both by the establishment of new types of payment systems and by already established systems getting enhanced infrastructure and new features, there will be need for continued research in this field.

One potential future aspect that needs to be monitored is the development of cryptocurrency. This paper did not include these types of payments, due to the low impact it currently has on people’s payment habits. However, in the future this impact may grow resulting in a need for it to be included in research concerning society’s move towards cashless payments.

As previously highlighted in the discussion, there are many factors that because of lack of reliable data currently cannot be included in data analysis. By gathering data on these factors, such as crime and cost of payment systems, future research may improve the existing framework and thus have higher probability of finding evidence of the relationship between these factors and payment habits. Also, this would create the possibility of controlling for these variables, which could enhance the understanding of the relationships that the factors that are already included in the model have to digital payments.

Finally, collecting data on the total amount of payments in a country, including all cash payments, would result in the possibility of analysis with a clearer connection to payment habits. Because of the great implications a cashless society would entail, some of which has been noted in this paper, there is a need for the greater amount accuracy that this would provide for future research.

7. Conclusion

The payment landscape is evolving rapidly and changes in technology allows for new payment solutions to rise. There are several factors that have an impact on the digital payment landscape. The focus of this thesis has been to analyze factors that seem to be related to the amount of digital payments in a country within the EU and answer the research questions:

1. What factors seem to be most related to the amount of digital payments in countries within the European Union?

2. Are the findings consistent with previous research?

Factors that seem to be most related to the amount of digital payments in countries within the European Union, according to the regression analysis, are GDP per capita, GDP per $capita_{t-1}$, POS terminals per million inhabitants, number of cards per million inhabitant and population density. POS terminals per million inhabitants and number of cards per million inhabitants are directly connected to digital payments, which is why it is very reasonable for these two variables to be significant. GDP per capita is related to the wealth of a country and usually the wealthier a country is, a higher degree of consumption is possible, hence it is related to the amount of digital payments. Population density has, as previously mentioned, been debated to have both negative and positive impact on digital payments depending on if it is a city or rural area. However, the regression in this paper states that the population density in a country within the EU does have a positive relation to digital payments. All these variables are also in consistence with previous research.

The factors that were not significant according to the regression analysis are number of ATM terminals per million inhabitant, concentration ratio of banks, education and age. ATM terminals per million inhabitants could be more useful when examining the amount of non-digital payments, which is a probable reason for its insignificance in the regression.

Although all the variables that are found to be statistically significant are consistent with previous research, some findings of the regression analysis are not completely consistent with previous research about how the independent variables are related to the amount of digital payments in a country within the EU. The variables that do not seem to be in consistence with previous research are age and education. However, since these variables are not statistically significant it is rather difficult to judge the relevance of them as well as making a solid conclusion.

One thing that is worth mentioning is that the result provided in this paper is not enough to prove causality between the independent variables and the dependent variable. However, it is considered to be enough to show and explain how these variables move together and which variables seem to be significant when talking about digital payments in a country within the EU.

Another thing worth mentioning is that even though the amount of digital payments does increase, it does not necessary imply that the amount of paper-based payment decrease. Many people tend to use money in paper-based form as a store of value. As mentioned previous in this paper, it would therefore be interesting to examine digital payments relative to paper-based payments in order to draw a conclusion about how they relate to each other.

In conclusion, there seems to be some variables that are more related to digital payments than others. The variables that are statistically significant are also consistent with previous research which further proves their relevance to digital payments. However, cashless societies and digital payments are under constant change, making it very interesting to continue to analyze and understand this topic. New technologies and cryptocurrencies will probably have a great impact on the payment system in the coming years. It is hard to predict what the future will bring, but one thing that is for sure is that the payment landscape will not be the same as it is today.

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9. Appendix

9.1. Definitions

ATM - Automated teller machine

ECB - European Central bank

EU - European Union

PAD - Pre-authorized debit

PAP - Pre-authorized payment

POS - Point of sale

List of the 28 countries included as units in the panel data: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, United Kingdom, Greece, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia

Table 2. Comparison of regression result with dependent variable including and excluding *other payments*.

Dependent variable:	Digital payments including *other payments*	Digital payments excluding *other payments*
Variables	Coefficient	Coefficient
GDP per capita	**1.259317*** **	**1.209035*** **
	0.5231152	0.5069437
	(0.3260678)	(0.2803088)
GDP per capita$_{t-1}$	**-0.4769735***	**-0.7796927*** **
	0.4593455	0.4451455
	(0.2391124)	(0.2273664)
ATM	**-0.1595746**	**-0.2560985**
	0.1416982	0.1373178
	(0.2455234)	(0.2096583)
POS terminals	**0.5605929*** **	**0.73988009*** **
	0.080007	0.0775337
	(0.0867012)	(0.0875234)
Cards	**0.4262348***	**0.4999445***
	0.2137134	0.2071067
	(0.2311485)	(0.2530513)
Population density	**1.923448***	**2.232114** **
	0.8373659	0.8114799
	(0.9536833)	(0.9670317)
Concentration ratio of banks	**0.0023682**	**0.0032552**
	0.0059481	0.0057642
	(0.0052328)	(0.0051449)
Education	**-0.108882**	**-0.0115233**
	0.0119964	0.0116256
	(0.0076765)	(0.0079025)
Age	**0.059049**	**0.0613463**
	0.0523846	0.0507652
	(0.0628288)	(0.0633284)
Constant	**-18.65258*** **	**-17.95516** **
	5.501487	5.331416
	(6.551047)	(6.536895)
Observations	106	106
Within R^2	0.6280	0.7243

Robust standard errors in parenthesis
***p<0.01, **p<0.05, *p<0.1

Table 3. Comparison of cluster-robust standard errors

Dependent variable: Digital payments excluding *other payments*

Variable	Column 1	Column 2	Column 3
GDP per capita	**1.209035*** **	**1.209035*** **	**-1.209035*** **
	(0.1655793)	(0.2803088)	(0.0903594)
GDP per capita$_{t-1}$	**-0.7796927** **	**-0.7796927*** **	**-0.7796927** **
	(0.1597117)	(0.2273664)	(0.1904396)
ATM	**-0.2560985**	**-0.2560985**	**-0.2560985**
	(0.1820001)	(0.2096583)	(0.1140662)
POS terminals	**0.73988009*** **	**0.73988009*** **	**0.73988009** **
	(0.1092762)	(0.0875234)	(0.1441047)
Cards	**0.4999445* **	**0.4999445* **	**0.4999445** **
	(0.2035594)	(0.2530513)	(0.0995823)
Population density	**2.232114** **	**2.232114** **	**2.232114*** **
	(0.7011678)	(0.9670317)	(0.1274121)
Concentration ratio of banks	**0.0032552**	**0.0032552**	**0.0032552**
	(0.0051475)	(0.0051449)	(0.0052671)
Education	**-0.0115233**	**-0.0115233**	**-0.0115233* **
	(0.0055341)	(0.0079025)	(0.0041982)
Age	**0.0613463**	**0.0613463**	**0.0613463* **
	(0.0488761)	(0.0633284)	(0.0201463)
Constant	**-17.95516** **	**-17.95516** **	**-17.95516*** **
	(4.895563)	(6.536895)	(0.8095011)
Observations	106	106	106
Within R^2	0.7243	0.7243	0.7243
Time cluster	Yes	No	Yes
Country cluster	Yes	Yes	No

Robust standard errors in parenthesis

***p<0.01, **p<0.05, *p<0.1

Table 4. Correlation matrix of coefficients of regression model

	GDP/capita	GDP/capita$_{t-1}$	ATM	POS	Cards	Pop.density	CR5	Education	Age	Constant
GDP/capita	1.0000									
GDP/capita$_{t-1}$	-0.8057	1.0000								
ATM	-0.1674	0.0155	1.0000							
POS	0.0394	-0.1797	0.0983	1.0000						
Cards	0.2101	-0.0520	-0.2692	-0.2859	1.0000					
Pop.density	0.2073	-0.3108	0.0954	0.2588	-0.0685	1.0000				
CR5	-0.0843	0.0866	0.0491	0.1174	-0.1453	0.3778	1.0000			
Education	-0.0523	-0.0558	0.3190	0.0359	0.1178	0.1361	-0.2370	1.0000		
Age	-0.1071	-0.0712	-0.0217	-0.1749	-0.2768	0.2931	-0.2001	0.0471	1.0000	
Constant	-0.3563	0.2052	-0.1140	-0.1698	0.0750	-0.8520	-0.2556	-0.1257	-0.4012	1.0000