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Less - Cash Societies: A Paradoxical Roadmap Revamped through Unified Payment Systems and Electronic Currencies

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Abstract: ***Unified payment technologies serve as a model for countries to adopt in the transition towards a less-cash economy. Following a literature review on what makes this system feasible and easy to adopt, this paper uses data analysis to investigate if there is a relationship between banknotes and coins in circulation and value of digital transactions. In addition to this, it also focuses on India, a country that has made use of such a system through its Unified Payments Interface (UPI) and analyzes the effects that it has had in contrast to other countries. While there have been numerous research on the rising trends in digital payments, not much exists in the role that this technology could play in developing less-cash societies, given that barring India and to some extent China, most developed and developing nations have not made use of any major coalescent system, relying majorly on cash or outdated digital systems. Therefore, there is an emphasis on the architecture and formation of a unified payments model for each country to idealize before the final step deemed as conversion to electronic currencies.***

Keywords: Electronic currency, ridge regression, cashless economies, device-based payments

1. Introduction

If we look back to before the dawn of civilization, the barter system was prominent, where one good was exchanged for another as at this time humans could not freely roam the earth to buy, trade and sell, but were limited to the confines of their community. It was simply more convenient to exchange goods and get along with one's life, without having to bother about the validity of such a system. But then began the age of explorers, and as people started moving across the globe more often, such a system could no longer be employed, and metallic currency such as coins made their way into one's life. Fast forward a few centuries and paper currency or representative currency became the norm, backed by the government or bank's promise to exchange it for a certain amount of gold or silver. Eventually, the 19th century gave way to our modern system of fiat money and currency exchanges. During these rapid changes, one thing remained common, the factor of convenience. We inherently do what is most convenient and although change is opposed at first, it is convenience that ensures a particular system sticks. This is what forms the basis for this paper, that it is no longer convenient to have so many outdated payment systems like cash, cheques, or even debit and credit cards for that matter exist parallelly when we can replace them with a unified payments system that can integrate the entire structure.

The question then arises of why it is inconvenient, and why we should abandon such a long-standing system that is deeply embedded in our way of life. The answer to this question is simple; the curse of cash is real and only becoming worse. To understand these problems caused by cash, let us imagine a regular six-sided die (*The same argument could have been made using a three-pronged stool that rests on its three legs, but it would not emphasize the governmental, societal, and individual impact that cash has and would thus not be sufficient to deal with these problems with the necessary depth. It is necessary to realize the visible problems of cash and the hidden ones that cause them through these 6 faces of a die*), which at any point has three apparent faces and three hidden faces behind the visible ones. This notion of the curse of cash similarly has three fundamental curses which are very apparent and visible to us as they impact major parts of our lives. These are regarding social problems, government implications, and individual convenience. These three facades are backed by their opposite hidden issues which are not as easily visible and solvable, those of organized crime, negative interest rates, and parallel systems. This hypothesis might seem daunting at first, but we will address each of these three faces and their underlying ones in tandem. The introduction will only deal with the 'curses' or the main problems caused by cash, and further information on how unified payment technologies could solve these problems will be highlighted in the discussions after the data analysis.

Our first face deals with social problems created by cash, which are prominent factors today. This is mainly because of the fact that the large denomination bills that dominate the global currency supply are hardly essential for retail transactions, and their overwhelming demand comes from criminals and tax evaders in the shadow economy (*All work and business activities for which taxes should be paid but are not. They occur 'under the radar*). It is this cash that funds and keeps transnational organized crime alive. (*We can see the same problem arise when it comes to digital payment systems like bitcoin or other cryptocurrencies as well. The Silk Road, one of the largest drug markets on the dark web, has resurfaced and thrived simply due to the anonymity of cryptocurrency transactions and the ease with which dealers can carry them out unnoticed. While they are also digital payment systems, anonymity is an important issue when dealing with such currencies, a problem which would not exist in the case of unified payment systems, as governments could track and hold those accountable with ease.*) Over $2 trillion worth of cash is laundered globally in just one year, and these are just

humble estimates as it very difficult to estimate the total amount of money that goes through the laundering cycle.[3] It is important to understand the impact of this on not only a governmental and economic level but also the impacts this has to society and individuals as it is this money that helps non-state actors expand their business into multiple facets, including drug trafficking, child trafficking and arms trade across the globe. Without this financial backing in the form of cash, such large-scale activities would not be possible. If this does not cause enough social harm in itself, we could go even further to understand the role that electronic money could play in empowering individuals. Today, significant percentages of women in developing and developed countries are forced to work and toil their lives only to hand over the cash to their husbands or parents. (*Even in the financial capital of India, Mumbai, I see working women having little or no independence of their own and only having to work for their husbands, who themselves do very little to provide for the family. Whether these are maids, restaurant employees, or those who work at factories, the importance of financial independence is something that many of us take for granted without realizing that many people cannot even earn for themselves and their needs and spend most of their lives working away for others*) Such a system is devastating and could carry on for generations, with daughters learning from their mothers and falling into a vicious cycle of spending their lives working for others with little or no independence of their own. Financial independence is another important aspect that unified payment technologies could strive to achieve while cash only worsens such issues. We have now addressed the societal problems face of our die, and with it its opposite deeper problem of organized crime and financial independence.

Our imaginary die, however, does not rest only on curbing organized crime and solving social issues. Negative interest rates, a much-debated upon monetary policy, could be looked at in a new light if cash was replaced by such unified payment systems. To understand why negative interest rates cannot truly be implemented when cash exists, we must first understand what they are.

In a normal economic system with positive interest rates, lenders are paid interest by borrowers, which is equivalent to the bank, a borrower, paying us money for lending our money to them. Now imagine if we had to pay the bank to lend our money to them. Such a policy turns the entire economic world upside down, with lenders having to pay borrowers to keep their money rather than the other normal way round that we all are so used to. This is an effective tool to shore up a shrinking economy. For instance, if people would have to pay banks to keep their money, they would much rather spend it on something rather their savings shrink, and this massive public spending would hopefully revive the economy and keep it ashore. This, however, is an ideal case scenario, because in the world of cash, you cannot truly implement negative interest rates on the public. Think about it, if you had cash and realized that you would have to pay banks to keep your money with them, you would much rather just stuff your cash in the mattress and let it hold its value. This would make it close to impossible to implement a negative interest rate policy on normal people, and the only way it has effectively been introduced is by central banks on financial institutions. These institutions, unlike the average person, cannot just withdraw everything and stuff it under the mattress, which means that they would have to accept the pain of rates being pushed a little way below zero as the price of knowing that their money is safe with their central bank. This goes to show that with cash dominating the payment landscape, it would not be possible to implement negative interest rates on the masses (*A caveat is that the role of negative interest rates would highly depend on the future of currency and the subsequent role of banks. If currency is electronic and society does not need much cash in hand, why would one have to store their cash in banks, it would be automatically stored as currency in their personal accounts. In such a scenario negative interest rate would be like high inflation, where the value of the money would be decreasing and thus individuals would be forced to spend quicker*).

This can be seen in the steps taken in 2016 by the European Central Bank, who announced that it would stop minting €500 notes, in a move that aimed not only to curb fraud and money laundering but also make it increasingly difficult to avoid the negative interest rate policy mandate. It was a kill-two-birds-with-one-stone sort of approach, given that it was relatively easy to hoard cash using €500 notes and eliminating them would reduce the holding of physical cash, which is exactly what negative interest rates are meant to incentivize. However, it was not a successful move as most of the cash was just replaced back in the economy with smaller and illegal denominations taking over and criminal organizations innovating to use digital currency or bank checks to elude law enforcement. Similarly, India in 2016 demonetized (*To understand the significance of this, imagine if the Head of State in your country, in a surprise address to the nation in the evening, announced that the largest and second largest denomination bills in the country would no longer be accepted as legal tender from that day onwards. It's the equivalent of the $100 and $50 bills no longer being recognized by the US government. It was a truly unprecedented move to combat black money, announced without any prior notice and no rumors leading up to it.*) their 500- and 1000-rupee notes, in hopes that the black money held in the form of cash would not be deposited into banks, given that people holding it would not want to be identified, and thus in turn a vast amount of illegal money would be destroyed. This, however, was a good idea but failed to be implemented successfully, as almost 99% of the "demonetized" money found its way into banks and thus was not really destroyed, as had been hoped (*Keep this event in mind, it's methodology will play a significant part in the latter half of the paper*). These two examples point towards a similar trend, that it is near to impossible for governments to monitor all the cash in circulation, whether it is for preventing criminal activities or implementing negative interest rate policies to incentivize spending.

We now come to the most important of the three faces, the issue of parallel systems, hidden behind the face of individual convenience. If you ask someone if they could pay their employee salaries, bills or annual expenses, and smaller amounts like buying from a local vendor or tipping a cashier with the click of a button, in some parts of the world you could get a yes, in others a mix of both, and in most cases a no. But if you were to ask a following question of whether the way they currently did so was convenient, the most apparent answer would be no. Think about it, if

you have to pay larger amounts like salaries to employees or maybe buying a house or car, you most probably would not have so much cash to spend and would use cheques or maybe net banking: wallets could not handle such large transactions and neither could most credit or debit cards. If you had to purchase a less expensive good, say a phone or a new watch, then maybe debit or credit cards could serve your purpose. (*This hypothetical example is speaking entirely in terms of digital payments and not taking cash into consideration. The aim is to look at the different number of digital systems that we have to use to make everyday payments*) If you were to buy a vegetable or coffee from a local vendor, you could use an e-wallet on your watch or phone to pay. For an average person living a moderate life, one would have to have multiple wallet accounts (*Not all countries have a prominent wallet system. Since most e-wallets exist within their own silos, it would mean that if the vendor or merchant does not have an account for that particular wallet, it would not serve the purpose for payment. Therefore, in many countries, people must maintain accounts for different wallets in hopes that the vendor would have at least one of them*), net banking services, readily available cheques, and deposit accounts, while simultaneously ensuring that they are paying hundreds of bills in time. Just some time back, we had proposed that convenience is a factor that ultimately decides which payment system sticks, and in what world is this convenient? Instead, imagine a system in which all your transactions, of larger ticket sizes or of the smallest, could be made through the same payment system, using the same methodologies each time. You would not need to sit and pay your bills each month but would automatically receive digital requests to pay your bills with a simple "Yes" click. There would be no worry about vendors not having the same wallet system, because all wallets could accept the transaction. This is the ideology and architecture around which a unified payment system would be based to combat the inconvenience caused by cash and current digital systems and is explained in detail later.

We have now come to the crux of this paper. The agenda is not to argue over why a cashless or less-cash society is good or bad- that is already a given based on the negative impacts aforementioned- but the main goal is to look at unified payment technologies and the impact that they could have in this transition towards a less-cash society. We want to understand how these systems could solve the governmental, societal, and individual problems that cash creates and thus determine whether it would truly be likely to transition us towards a less-cash future.

Building on this, some terms must be clearly understood before analyzing the paper and its results. First and foremost, there is a stark contrast between electronic currency and digital currency that needs to be defined from the onset. Electronic currency is a system in which fiat money is converted to digital form and continues to function in the same manner, backed by a central bank or government. However, digital currencies are based on block chain technologies that advocate for the decentralization of the payment landscape. The former is what this paper focuses on and in no way does it refer to digital currencies being the primary mode of transaction. (*While this paper does not aim to compare unified payment systems to digital currency payments like Bitcoin and Ethereum, it is worth addressing that they could also serve as an alternative to them. If the ultimate goal is to have a more modern system where payments could be made faster and more easily, unified payment systems would serve as a better alternative as compared to cryptocurrencies. For those who argue that the premise of cryptocurrencies is this "decentralization" ideology and a common universal currency, it is a utopian dream, given that many countries like China, North Korea to name a few would go to incredible lengths to ensure that they are the ones in control of their currency, and it is not left to the whims of the universal market*) Additionally, it is important to understand the difference between a less-cash and a cashless society. Less-cash societies are systems where a majority of only small-ticket transactions are made using cash and larger denominations are transitioned out, mainly as a way of imposing negative interest rates. However, this paper focuses on less-cash societies, wherein a system exists such that transactions of all sizes could be made using electronic money and thus eliminates the need of having to phase out larger denominations to become a less-cash economy

We will now transition from an in-depth analysis of the ideal architecture and ecosystem of unified payment systems to the results of the data analysis, before finally discussing how the system could solve the 'curses' of cash and whether it serves as a viable alternative to the modern-day payment ecosystem to lead us to a less-cash future.

2. Methodology

This paper focuses not only on literature review but supports its claims through a data analysis. The literature review is aimed at explaining how unified payment technologies function and emphasizing on particular unique features about their architecture. For this, research was largely based on a paper published in the American Journal of Industrial and Business Management titled "Unified Payments Interface- An Advancement in Payment Systems" (Gochhwal, 2017). This review takes the ecosystem of the existing Unified Payment Interface present in India and expands on it to see how it has been implemented and the viable ways that other countries can make use of it as well. The latter part of the literature review is based on the report of the "High Level Committee on Deepening of Digital Payments" in India, which talks about the important features that the unified payment system model could build on.

Following this, the focus shifts to the data analysis section. The first step was to select 4 to 5 countries based on whom a cross country comparison would take place to explain a potential roadmap for different economies. To do this, the volume of digital transactions for prominent systems in countries across the globe was analyzed, only after which the countries could be chosen. This was done using data provided by the Bank of International Settlements (BIS) and using the BIS Statistics Explorer under the section on the features of selected payment systems in the 27 countries. From this point, only data for the 4 countries selected were considered. At first, the goal was to prove a direct relationship between the value of banknotes and coins in circulation as a percentage of Gross Domestic Product (GDP) (*Just using the value not represented as a percentage of the GDP would not work well since the*

economy grows over time and factors like inflation would make it impossible to compare values over time) and the value of digital transactions over years, which would help to determine whether the current existing digital payment systems are leading to a decrease in the amount of cash being used or not. However, since cash in circulation is also a representation of deposits in banks, it would not necessarily represent the cash that is being used by the public in that year, for which a more reasonable factor would be the value of ATM withdrawals as a percentage of the GDP of the country. Once again, using the BIS Statistics Explorer, under the payments and financial market infrastructures section, data on the banknotes and coins in circulation for the 4 countries from 2012 to 2020 could be found. This could be varied for several factors including percentage of GDP of the country. In addition, the section on retail payment services and instruments provided the necessary data for the value of withdrawals/deposits from ATMs in the selected countries. Another important thing to note is that data was only analyzed from 2012 to December 2019, just before the outbreak of the COVID-19 pandemic, beyond which data was not taken into consideration. This was because in many countries' factors such as the cash in circulation and ATM withdrawals was affected by the pandemic and people's inability to roam freely during lockdowns. As a result of this, we would see a decreasing trend in ATM withdrawals and an increasing trend in digital payments and make an incorrect conclusion that one was caused by the other. Thus, to prevent these anomalies from affecting our study and the data being collected, only this time frame was considered.

After this, the idea was to look at the various variables that have affected the value of ATM withdrawals as a percentage of GDP in these countries. While choosing these variables, it was imperative to keep in mind that our dependent variable was already in the terms of the GDP of the nation, and hence using factors like the inflation rate or interest rates would not be of much use and give incorrect results, since they already affect the GDP of the country. Thus, a wide range of social and economic factors including the value of cashless payments in the country, the percentage of employment in the agriculture industry, especially for nations heavily relying on agricultural produce, the number of Point of Sale (POS), the literacy rate, the median age, and the number of people with access to smart phones was considered. To study the effect of these factors, a multiple linear regression model (Y) seemed ideal at first.

$$Y = \beta_0 + \beta_1 X_1 + \ldots \beta_p X_p + \boldsymbol{\varepsilon} \qquad (1)$$

Where,

$Y = predicted\ value\ of\ the\ dependent\ variable$
$\beta_0 \ldots \beta_p = regression\ coefficients$
$X_1 \ldots X_p = independent\ variables$
$E = error\ terms$

In such a model, we would minimize the residuals of the sum of squares (RSS) to obtain the estimates of $\beta's$, the magnitude of which would tell us the most significant factor for determining the dependent variable, and the sign the direction of the change. The solution is called the ordinary least sqaures (OLS) and it is also the maximum likelihood estimator. The estimator is the best linear unbiased estimator, which means that among the possible unbiased estimators, the OLS achieves the minimum variance. However, there are situations when the OLS has high variance, particularly when there is high colinearity or multicolinearity and in such a case, the estimates are highly unstable, despite being biased. To test if there was multicollinearity between the independent variables, a correlation matrix for the factors and the Value of ATM transactions as a percentage of GDP was created using the same formula for the Person correlation coefficient r

$$r = \frac{\sum(x_1 - \bar{x})(y_1 - \bar{y})}{\sqrt{\sum(x_1 - \bar{x})^2 \sum(y_1 - \bar{y})^2}} \qquad (2)$$

If there is a high collinearity, we could not use a multiple linear regression model to get the strongest coefficient. So, we might be willing to allow some bias if we decrease the variance to obtain a better Mean Squared Error (MSE).

$$MSE(\beta) = var(\beta) + (\mathbb{E}(\beta) - \beta)^2 \qquad (3)$$

This trade off is achieved by adding a penalization term to the RSS

$$\sum_{i=1}^{n}(y_1 - \beta_0 - \sum_{j=1}^{p}\beta_j x_{ij})^2 + \lambda \sum_{j=1}^{p}\beta_j{}^2 \qquad (4)$$

Where λ is a tuning parameter that controls the amount of penalization, and to calculate its value, that is to choose the amount of penalization, we try different values and choose the one with the best MSE using cross-validation. The models for the coefficients for different values of λ were plotted in R Studio where the functions in the glmnet package standardize our predictors or variables and thus those being in different scales would not impact our analysis. Additionally, the package also returns the final coefficients in standardized scale.

Finally, given the focus on unified payment technologies, we would need to observe a country that had made use of such a system or a somewhat similar one. The closest match to the requirements was the Unified Payments Interface (UPI) introduced in India. This would be the second focus of our data analysis. To find the volume of UPI transactions in India after it was introduced in 2016, the National Payments Corporation of India database was used. On the database, under the 'What we do' section and within UPI Product Statistics, the monthly data for volume of UPI transactions from November 2016 to July 2021 was utilized to analyze the effects and the adoption of the system in India. To further strengthen the study on India and compare its cash circulation to the other countries analyzed before, the data under the quarterly publications of the Reserve Bank of India was used to see the mobile and card payments from 2013 to 2021 in contrast to the ATM withdrawals in the same time period. This would help to determine the impact of the UPI system and whether it had decreased the amount of cash being taken into the economy subsequently after its introduction.

3. Literature Review

a) Precursors to Unified Payment Technologies

A unified payment system is a single-device centric, real-time interbank payment system that if implemented has the potential to transform and universalize digital payments by relying on ease of use for consumers, API (*APIs or Application Programming Interface are middleman between any two machines that want to connect with each other for a specified task. They communicate through a set of rules that define how computers, applications or machines can talk to each other. For instance, when you google search the weather for your city, you see a rich weather snippet, however, Google isn't in the business of weather data, so they source this information from a third party. They do so by means of an API, which sends them the latest weather details in a way that's easy for them to reformat*) based architecture for developers, and a greater focus on security. In order to be able to introduce such a system, it is important that governments and central banks have a pre-existing system in place to facilitate such a transformation. While most nations do have these measures in place, it is useful to understand the process behind gradually developing this unified system. Firstly, it is necessary that the country have a common ATM network, that is, there must be digital interoperability between all banks which would serve as the backbone for the network. In addition to this, there must exist some sort of a digital payment system, whether card-based or net banking and regardless of ticket size and operating hours, what is important is that there is a system riding on the interoperability of the bank network. Given these precursors, it is possible for a central bank or government body to implement the unified system based on some key features and architecture.

b) Key Features

1) A single device, for instance, a mobile phone or a laptop, would become the primary device for all payments, whether to a person or another entity. It would have an interoperable system where one would not need to be a part of the same silo or closed network, as is the case in digital wallets, but rather payments across interfaces would be possible. That is, the payment could be requested on one interface and the transaction can be authorized on another, removing the need for multiple applications or accounts.
2) Payments could be initiated by the payer and the payee. Thus, one can pay as well as collect from someone using a device. This would be a unique feature as current digital-based payment systems including cards and online payments are based on transactions initiated by the customer. This system adds another dimension by allowing a merchant to initiate a payment request which a customer can approve and pay. This could also be used to pay bills, for instance, in the case of electricity bills, the request could directly be sent to your account and could be paid by a simple "Yes" click after verifying the details. The disintermediation aspect of such payments is also apparent since the payment would no longer be needed to be done through signing into bank accounts and transferring money to the electricity company (payee), which could directly take place through the push payment feature.
3) Payments would be done using a Digital Payment ID, removing the need to enter or share bank account numbers or credentials every time you make a purchase on a website or application. This abstraction of bank details is another significant feature of the unified payment system, which would also disintermediate the process because it would not be reliant on needing external signing into bank accounts, verification of identity and passwords, or any other such checking or data sharing, but would directly take place through these Digital Payment IDs.
4) The system would provide a standard set of APIs to enable transactions on supported platforms, thus enabling a fully interoperable system across all banks, financial institutions, and payment systems without the need for closed systems.

c) Architecture

The unified payment system would orchestrate and maintain transactions across bank accounts using the pre-existing interoperability between various banks. Banks, financial institutions, and other entities that would provide such services would have to connect to the national interoperability network through standard APIs to enable transactions from Digital Payment IDs avoiding the need to share account de- tails or credentials. In such a system, payment authentication and authorization are always done using a personal phone. Since this layer offers a unified interface, any-to-any interoperable payments can be accomplished using a standard set of APIs.

These APIs are asynchronous in nature meaning once the request is sent, a response is sent back separately via the corresponding response API. This allows the response to the API call to return to the caller immediately after queuing the request. All request-response correlation must be done via the transaction ID set by the originating point. Callers are expected to call the API with a unique transaction ID for which a response is sent via a response API exposed by the caller. This allows the same APIs to be used for instant payment as well as delayed payments. This also allows APIs to scale without having to wait in a blocking mode.

There would have to be a set of standard APIs exposed to various participants of the unified ecosystem. A set of Financial and Non-Financial transactions can be done using these APIs. Apart from transactional APIs, there is a set of Meta APIs to ensure that the entire system can function in an automated fashion. These Meta APIs allow PSPs to validate accounts during customer on boarding, validate addresses for sending and collecting money and provide phishing protection using whitelisting APIs. (*To help prevent unauthorized access, only IP addresses in your API's whitelist can make API calls to your network. Whitelisting is necessary to ensure the safety of such transactions and prevent access from unknown IP addresses*)

Some of the key APIs to enable these transactions are:

1) **Payment API**: This is the primary APIs used for routing the transaction and is used to initiate Pay Request (Push Payment) and Collect Request (Pull Payment). The API

contains remitter and beneficiary details.

2) **Authorization and Address Translation APIs** are used to obtain appropriate authorization details and translate the specific Digital Payment ID to the common global addresses (Bank Account Number, Social Security number or any other national financial identity metric). This allows users to simply provide such virtual (tokenized) addresses to others (individuals, entities, etc.) without having to reveal actual account details.
3) **Keys List APIs**: These APIs enable secure capture and communication of credentials to authenticate transactions by various entities in the unified ecosystem. These APIs are used to request for and cache the account providers and other entity's list of public keys. Trusted and certified libraries and utilities are used for credential capture and Public Key Infrastructure (PKI) encryption at capture time.

d) Security

The unified payment system would orchestrate and maintain transactions across bank accounts using the pre-existing interoperability between various banks.

It should be mandatory to enable two-factor authentication to make any digital transaction. Two-factor authentication means one component is required to establish the bona fide identity of a person and the second component is password/ credentials known only to the user. Unified payment technologies could uniquely employ a one-click-two-factor authentication system whereby in a single click user is able to authenticate both the factors of authentication. The mobile device fingerprint is used as the first factor of authentication and to establish the bonafide identity of the user. The most critical aspect of security is to bind the mobile number with the device at the time of profile creation of the user on the PSP App. This is done by sending an encrypted outward message from the bank registered mobile number of the user. This message creates a device fingerprint of the mobile phone by binding the mobile number with the Device ID, SIM Number and PSP App ID. In case there are any changes in the mobile fingerprint, that is, Mobile Number, Device ID, SIM Number and PSP App ID are changed, the user is required to re-authenticate the mobile device. The second factor of authentication is the 4 - 6 digits PIN that the user creates and uses to authenticate the transaction.

For data security, data has been classified into different classes of information:

4) **Sensitive data**: Such data is not to be stored and can only be transported in encrypted format. Sensitive data includes passwords, PINs and biometrics.
5) **Private Data**: Data such as bank account numbers. Private data can be stored by the PSP but only in an encrypted format.
6) **Non-sensitive data**: Data such as Name, transaction history, amount, timestamp, response code, location can be stored in unencrypted form.

4. Results

The results of the first data analysis are shown in Fig .1, Fig. 2. and Fig.3. Fig. 1 gives a broad overview of all the digital payment systems in different countries, with the most popular ones being named in the chart. From here, the volumes for the transactions of only these systems were analyzed, as shown in Fig.1, to give the range of the top four systems across the world. Given the much greater volume of the China UnionPay System (CUPS), the map does not really give us a clear outline of the biggest systems in the world, and thus the same data was mapped excluding the Chinese system, as shown in Fig. 2, and gives us much better understanding of which countries to pick. The most populous systems were those of China, India, the USA, and France, but given the restricted data available on France, and the conflict in values for the United Kingdom with regards to data on the Pound and Euro being separate, Germany's was chosen instead as the fourth. Table I summarizes the varying features of these four payment systems.

From here on, as discussed in the methodology, the results are now explicitly with regards to these four countries.

Fig.4 shows the rate of change of both the value of cash in circulation (CIC) and the ATM withdrawals in India as a percentage of its GDP as indicated by the slope of the linear regression curve. For India, we can see an almost parallel scenario, where although both the CIC and the value of ATM withdrawals are decreasing, they both are at an almost insignificant rate of 0.08 and 0.0018 respectively. In such a scenario we can consider that both the trendlines are parallel to each other and more or less stable.

Following this, Fig. 5 portrays the results of the ridge regression analysis performed, with the variation of the coefficients for the six different variables graphed for the different log log λ. These variables are mentioned in the table below, and we can clearly see that it is the second variable which has the strongest standardized coefficient among the six, that is, we can say that looking at the change in the ATM withdrawals in India over the past few years, it is the number of Point of Sale (POS) terminals that have played the largest role in affecting them. The direction of its effect is indicated by its negative sign, which tells us that as the number of POS terminals increased, the cash in circulation decreased. The same can be indicated through the graph, where the curve for the second variable starts from the lowest point downwards, an indicator of both the direction of change and its magnitude. Another factor that plays a significant role in decreasing ATM withdrawals is the access to smartphones, with its curve starting slightly above that of the number of POS terminals and taking a similar curve length to as it for the variation in λ. On the contrary, the variable that had the largest effect in increasing the ATM withdrawals is the literacy rate in India, shown by the green curve starting from the topmost point and the largest positive value in the table. As the literacy rate has increased in the country, so have ATM withdrawals. Subsequently, we see that as the population employed in the agriculture industry in India decreases and a greater number of younger generations shifts to urban areas, ATM withdrawals increase. These two trends could indicate the fact that the educated younger rural population moving away from their family occupation and towards urban areas or other jobs is more attracted to cash, either

due to lack of knowledge about digital payments, comfort with cash, or any other of numerous societal issues, the implications of which will be highlighted in the discussion section later. Fig. 5 can also be interpreted in the manner that keeping all other factors similar to those from 2012 to 2019, the number of POS terminals in India, the literacy rate of the country, and the number of people with access to a smartphone would play the biggest role in decreasing the CIC and ATM withdrawals, albeit to a very small extent.

The second country, China, has its variation for the CIC and ATM withdrawals as a percentage of its GDP shown in Fig. 6, where we can see a stark contrast from the results for India, such that both of the factors are decreasing over time. The ATM transactions are decreasing at a significantly higher rate while the CIC decreases much slower. It is worth mentioning that China is the only country from our cross-country analysis that has both its CIC and its ATM decreasing at a significant rate, and with India, they are the only countries that show a decreasing trend over time.

Fig.7 displays the results of the ridge regression model for the variables in the table below it. It indicates that the number of people with access to smartphones had the greatest effect on the ATM withdrawals, with its graph starting from the lowest value and the negative sign for its coefficient indicating that as the number of people with access to smartphones increased, the two factors decreased. It is worth noting that the regression coefficients are greater than 1 due to the significant difference between the units of certain variables, which vary from percentages to billions. The second most significant factor is the number of POS terminals, which on increasing would increase the CIC. Data collected earlier indicated that the number of POS terminals has increased in China during our time frame between 2012 and 2019, however, since the only factor coefficient is stronger than it is for access to smartphones, it would have to mean that smartphone-based payments in China, whether Alipay, WeChat Pay, or UnionPay based mobile payments, are the most significant contributors to the decreasing cash trend their country has seen. It is also an indicator that payment systems based on card systems, all of which require POS terminals, are not the way forward in China, and a greater emphasis must be put on mobile-based payments, something that we see the Chinese government doing at this very moment [*A detailed analysis of what the Chinese government is doing has been discussed a little later*]. Another interesting point is that unlike India, whose coefficient for the agricultural population had a negative sign, China does have a positive one, which means that as the population employed in agriculture has decreased, the number of ATM withdrawals has decreased as well. This same inverse of India's scenario can be seen for the literacy rate, whose increase leads to a decrease in the two factors. This goes to show that, unlike its Asian counterpart, as more and more educated people start switching to modern jobs and moving to urban or more developed areas, they are less attracted to using cash and more willing to adapt to digital systems. The significance and plausible explanations behind this will be discussed later.

Moving on to our third country, Fig.8 shows the chart for the CIC and ATM withdrawals in the USA as a percentage of its GDP. However, it is important to note that the analysis for the USA is constrained by the fact that the US Federal Reserve only published data for the value of ATM withdrawals in 2012, 2015 and 2018, and there is no data available for the years in between. In addition, even data on the number of POS terminals were available only on a bi-yearly period, which is why the data points for the ATM withdrawals is limited to three. In spite of this, we get a good overview of the general trend in CIC and ATM withdrawals and can see that they both are increasing at significant rates. While the ATM withdrawals to GDP are increasing at a much greater rate with a slope of 0.189, the cash in circulation to GDP is also increasing at a significant rate of 0.0026, although much smaller than the former. The magnitude of these values is hidden by the fact that they are both percentages of the GDP, while the actual value in billions or millions of USD is significantly larger.

Fig.9 shows the ridge regression curve for the variables in the table below it. The reason most of the curves are concentrated around each other has to do with the lack of data points for our independent variable ATM withdrawals, because of which we cannot differentiate between their values to a great extent but can only compare their signs since that would remain the same regardless because of the overall trend in the ATM withdrawals remaining the same. Based on this, the conclusion that we can draw is that the value of cashless transactions is the most significant factor in the US for decreasing ATM withdrawals, but since we know that they are significantly increasing as shown by their slope in Fig.8, we can also say that the current systems in place are not doing enough to drive the trend downwards. While in other countries the value of the cashless transactions are not necessarily the driving factors but possibly other socio-economic issues, the USA has the benefit that none of these issues would serve as a roadblock for their path to less-cash societies and that if they were to develop a better payment system that enabled a greater value of cashless transactions, a lot of their problems could be solved. This is where unified payment systems come into the picture, as if we were to see the effect of the UPI system in India, we would see the trend shown in Fig.10. Not only are the values of transactions significantly increasing in a relatively shorter period, but an almost similar trend is also seen in the volume for these transactions, as shown in Fig.11.

The increase in the value is an astonishing 9594 Crore Rs. each month, nearly a billion dollars each month. A similar staggering increase in the volume of UPI transactions is shown through the rate of change of the volume in payments being over 48 million every month on average. UPI sees a sluggish start for the first year, barely crossing the 100 million volume mark in the first 10 months but following this, it does not look back and grows at an unprecedented rate. In the next 10 months, its transaction volumes increase over 500%, and it continues to pick up pace even after this, only to further double its volume in the next ten months as well. Although it was introduced a few months before demonetization and contrary to popular belief, it saw the least adoption during that year and the months following the announcement. It was not the immediate announcement of demonetization that made

people switch to this system, so that argument in itself would be flawed and would instead work in favor of UPI because it was factors other than governmental decisions that made it rapidly grow in popularity, This could have very well been the fact that as it was around November 2017 when more banks across the countries started integrating UPI more easily and openly, a move followed suit by a lot of e-wallet based payment systems in India including Paytm, that led to a 200% increase in the volume of UPI transactions in only 2 months, exactly proceeding the months that Paytm integrated it into its own app. The reason that so much emphasis has been laid out on this data is because like the USA, there are many developed nations whose CIC and ATM transactions are significantly determined by their value of transactions, but unlike their current systems which have had no significant impact on these factors, the unified payment system could solve the problem.

Finally, in Fig. 12 we see the CIC and ATM transactions for our last country Germany. Germany differs from the other countries studied in the sense that while its ATM withdrawals show a decreasing behavior with a slope of -2.66, the CIC shows an increasing trend on the other hand. A plausible explanation for this could be the fact that while the demand that people have for cash in hand is decreasing, the cash deposits in banks is increasing. In such a scenario, our concept of electronic currencies could play a significant role in transitioning towards less-cash societies and will be discussed in detail in the next section.

Moving on, in Fig.13 we see variables in the table that affect Germany's ATM withdrawals. The most significant factor in leading this move towards lesser ATM withdrawals has been the decreasing median age, as a result of which it has decreased as well. In addition, we see that the existing ecosystem in place for digital transactions has not played a significant role in reducing the withdrawals since it has a positive coefficient with a greater magnitude, indicating that a better or more proficient system could magnify the already decreasing trend. On the other hand, we see that the reducing number of people employed in the agriculture industry could have also been a strong contributor to the decreasing withdrawals, something unexpected from a rather developed nation like Germany. However, over 80% of the total land area is used for agriculture and forestry and reducing the number of people employed on these lands will play a big role if they were to take the decision to transition towards a less-cash economy.

5. Discussion

This paper started out with a somewhat unscientific premise that an increase in cashless and digital payments leads to less-cash societies. The reason that this was unscientific is that it was based on a preconceived notion that if people spend more money digitally, it will mean that less money would be spent using cash and thus the total banknotes in circulation would decrease. This analysis has directly attacked this claim by showing that even where there has been an increase in the volume of digital payments in various countries, it does not necessarily mean that it leads us to less-cash societies or has any relation to the banknotes in circulation. Correlation and causation are different concepts and while digital payments and cashless societies are correlated in the sense that one could promote the other, we can assume that they are the direct causes without looking at other factors in play. This is where the 'paradox' comes into the picture. All the countries that we have seen have increasing values and volumes of digital payments each year, but in spite of this, the amount that people withdraw from ATMs or the CIC for that matter continues to increase in most countries around the world. What the ridge regression analysis for the various countries has shown us is that the value of the cashless systems does not play the sole role in reducing the cash in circulation and withdrawal values, and those even socio-economic factors have their say. In the case of the USA, the one country that showed a strong relationship with the value of digital transactions, it had the highest increase in both CIC and ATM withdrawals in recent years. This could very well mean that the current digital infrastructure in such countries is not proficient enough to lead towards a digital future and this is one of the main reasons behind the 'paradox'.

Another thing to consider is how easy it is for other parts of the world to adopt the predominant systems in these countries. Some of the systems which are card-based like China, make it difficult for developing countries to adapt to such a system due to lack of infrastructure and the costs of maintaining POS terminals being too high. They would rather simply accept cash using smaller denomination bills rather than spend hundreds of dollars each month on maintaining this system. For others that rely on net banking like Russia and United States, people make only larger size transactions using such a system as it is inconvenient to go through such a tedious process to pay smaller amounts and they rather use cash to get over with it. Some wallet-based systems seen in countries like China and the USA solve most of these problems as they can be used for smaller size transactions and do not require POS terminals, with the majority of populations already owning a smartphone, around which they are centered. However, such e-wallets function inside their own silo, and the money can only be transferred to an individual using the same wallet ecosystem. At the same time, there are also security risks for using these wallets for much larger transactions, which once again leads to the creation of a diverse range of payment systems. People start using individual wallets for smaller transactions, credit cards for slightly larger transactions, and cheques or net banking for the largest volume payments.

This is highly inconvenient, especially when all these different systems could be replaced by the said unified payments system. As the results indicate, continuing this track of using a diverse range of digital payment systems will not have much of an effect on the cash in circulation and will at most lead to different systems being adopted depending on the kind of transaction. This is where the unified payment technologies would serve as an ideal to not only move towards a less-cash society but also integrate the payment experience.

While we have spoken about how unified payment technologies would thus serve the purpose of being much

more convenient, we are yet to reflect on how they could fix the other 'curses' caused by cash. Such a system would be ideal not only on an individual level but would massively benefit governments and central banks. With automatic money trails, financial crime would dry up and with it a major part of the transnational crime industry; as money laundering becomes much harder if the source of funds is always clearly identifiable. It is much harder to hide income and evade taxes when there is a record of every transaction. This is not the only benefit, as such a system would also make it easier to implement negative interest rates. Unlike old fashioned, digital fiat or e-money can be programmed. For now, interest rates cannot go negative, because savers can always demand and store cash, however, if such a system was programmed to have a negative interest rate, people would have fewer fallbacks and central banks more flexibility. Electronic money could also help provide financial independence to individuals and release them from these shackles forced upon them by family or society. Having no physical cash to give to hand over to anyone, they could start over and become fully reliant on their own money, in their own accounts, untouched by others. While such steps are vital towards financial independence for individuals, it does not mean that they are the absolute solution for such problems, as we must realize that such social issues are deeper rooted than they appear and must be understood and dealt with carefully by each government.

If you have analyzed the CIC and ATM graphs for the various graphs carefully, you would have noticed that each of these scenarios is unique. In India, there is almost a parallel or stasis scenario, whereas China shows a decreasing trend. The USA, on the other hand, shows the opposite, an even greater increasing trend while Germany has a converging graph. This happens to be a coincidence, neither was this the initial goal or the ideology, but we will take advantage of this to talk about the roadmap ahead for these countries and countries with trends like them to follow and come out of any paradoxical scenario.

The Roadmap Ahead

The first and most primary step for all these countries would be to build the infrastructure for unified payment systems, as detailed in the literature review section. Assuming that this system is in place, let us consider what each of these countries should look to do.

India was shown to have a great number of social issues affecting the usage of cash. While India does have the UPI system in place, for other countries that do not and begin the process of establishing one, working towards these issues while simultaneously building on infrastructure would go a long way in the long run.

We saw that many people moving towards more developed areas or leaving agricultural jobs are attracted towards cash, while even people who complete their education are attracted to the same. This would have to be addressed through a greater number of government programs to ensure that people fully understand the benefits of having a digital system, while also making sure that adequate infrastructure and technologies are available in remote regions as well. Improving the data and smartphone industry would also go a long way in achieving the goal. To attract merchants to promote such payments over other methods, the governments can subsidize the system to ensure that no fees are charged to the merchants. This would be a definite boost over other card-based systems, whose accumulated fees account for a considerable loss for merchants over time. This is already in place in India, with Paytm and Google Pay charging no fee on UPI transactions as compared to bank provided cards which take a significant chunk of their transactions, and thus serves as a roadmap for other countries to promote the same.

China is often referred to as an outlier or a rare case scenario, where the government has a great amount of control over its population as compared to private institutions, and thus has the power to effectively employ any policy it deems fit. However, the fact of the case remains that it was systems like Alipay and WeChat Pay that revolutionized China's payment system by making it a device or mobile-centric mechanism instead of the traditional card-based one. This can also be interpreted through the fact that the ridge regression results showed us that the number of smartphone users increasing had led to a greater effect on a decrease in the ATM withdrawals. While China does have many systems in place like these mobile-based silos, as well as UnionPay mobile payments, there is no single integrated environment that can be used by them all. The goal is not to just have one single method, unified payment systems aren't one single application or one single website for all, they are a mechanism, a technology that can be used by all. Like the internet is for mobiles, it too is just an enabler, which is what we see in India as well, where WhatsApp Pay, Paytm and numerous other competitors continue to exist, competing and making use of the UPI technology, not being killed by it. This is where I would like to touch upon a subject that I have not yet mentioned in detail but will bring it up here especially due to its relevance with China's case study, cryptocurrencies. This is not about existing cryptocurrencies like bitcoin or Ethereum, but those that are currently being developed. Meta, for instance, is in the works to develop its own digital currency, and the reason I want to elucidate this is the similarity between the introduction of Alipay and its widespread success and the visions that Meta has. Alipay was successful because it made it easier to spend on a website that was already incredibly popular in China, riding on the factor of convenience and ease, and it is worth wondering what a company as large as Meta, owning platforms like Facebook, Instagram and WhatsApp, could do with the number of lives that they influence on a daily basis. In such a sense, moving towards unified payment systems is less with the goal of less-cash societies and more with the urgent requirement to prevent private players from having control of a money market. This is where the two visions for a country like China, which wants to take the next step towards a less-cash society, and one that wishes to maintain control like the USA would align.

The idea is to convert the existing currency into an electronic-based currency. There is no need to create a new Centrally Backed Digital Currency (CBDC) when you could simply convert the existing currency to an electronic one. Now in order to do this, I think countries should take

inspiration from the demonetization phenomenon that occurred in India in late 2016, wherein they ban all of the largest valuation notes in the country with immediate effect and tell people to deposit all cash that they can provide proof of income or earning for into their bank accounts. After a certain date, all the cash that would exist for those valuations would no longer be accepted by banks and the cash deposited would only be stored in electronic form. The difference in India's case was to print new notes and allow people to withdraw those, but in our "digitization" and "demonetization" ideology, we would not allow people to withdraw more than a few dollars in a week, simply to keep on an emergency basis or for ease of mind or comfort. This would mean that a great amount of the currency in circulation in the public's hands would be converted into our electronic counterpart with ease, while the cash that was deposited with banks could be destroyed and added to the electronic supply for them to lend out as well. Ultimately, what would take years through the painstaking process of ensuring and encouraging people to give up cash, with the proper unified infrastructure in place, could be pulled off in a month's time. This is the same roadmap that I propose for countries like Germany, which have a converging trend with cash in circulation increasing with decreasing ATM withdrawals. It works in our favor since it means that it is the money deposits in banks whose increase is affecting the CIC, and thus this part of the cash supply would be easier to convert into the electronic form, while the "digitization" on the cash held by the public could be decided on a case-by-case basis or in a less intense manner.

I believe that the heart of this paper could be summed up through the example of Vasco de Gama, standing on the port of Lisbon in Portugal, just before he embarked on arguably one of the most dangerous voyages ever. The reason I say this is to encourage you to take some time and put yourself in the position of such a man, understanding that this a feat hundreds had tried and failed miserably. There were over a hundred reasons why it was simply a suicide mission, whether it was the high probability of seasickness, a lack of proper equipment in those times, or the dangerous waters raging with thunderstorms. However, Vasco de Gama still chose to embark on the journey. Would you? It wasn't that the life he lived was all too pathetic, anything was better than years at sea with no land in sight, it was the hope that someday, somewhere along the line, that journey would open doors for possibilities, new experiences and new benefits that were previously deemed impossible. This is where we stand today, we can continue to use cash and be the Vasco who stayed back, afraid of the journey and the possibilities it would lead to or embark on an adventure that would benefit our civilization as a whole, no matter the journey.

6. Conclusion

1) There is a paradoxical relationship between cash in circulation and the value of digital payments in most countries, with both increasing simultaneously. This could be because many of the predominant systems have underlying issues or problems that prevent them from being used for a wider ticket size of purchases and thus would not be able to lead to less-cash societies.
2) Unified payment systems are bound to benefit individuals as they would replace the current model of 'different systems for different ticket sizes' and create a single for-all-use method of payment. These systems would differ from traditional digital payments through features such as push requests, Digital Payment IDs, and additional layers of security, while also being a single device-centric method of payment.
3) Governments, societies, and individuals will also reap benefits from such a system that would not only reduce transnational organized crime but would also serve as an effective tool of the government for introducing the negative interest rate mandate.
4) Electronic currencies serve as the end goal for countries through the process of "digitization" instead of demonetization. In this manner, Unified payment systems could be used to not only achieve less-cash societies but even completely cashless ones in the long run.

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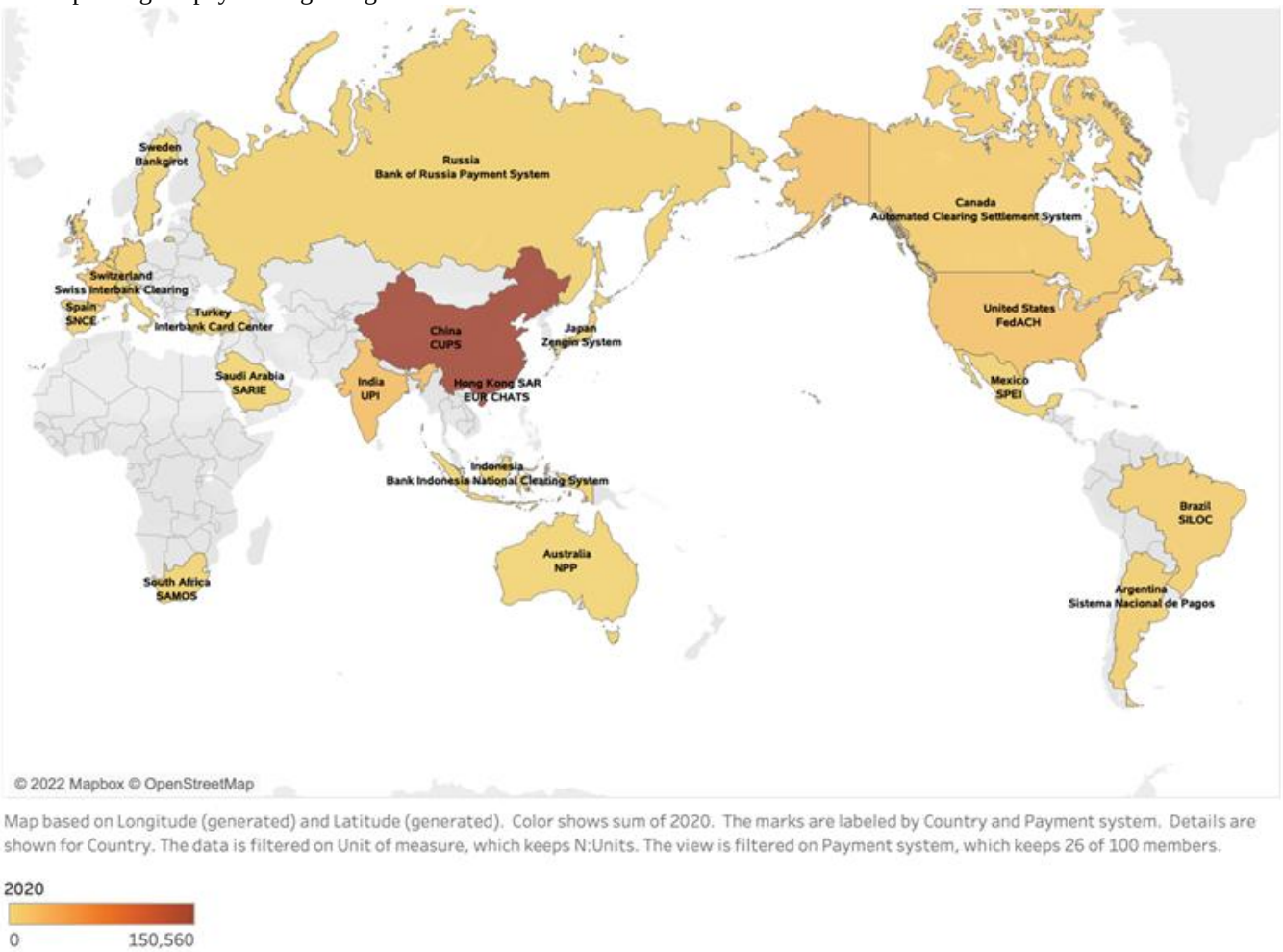


Figure 2: Volume of transactions for the most used Digital Payment System in Different Countries

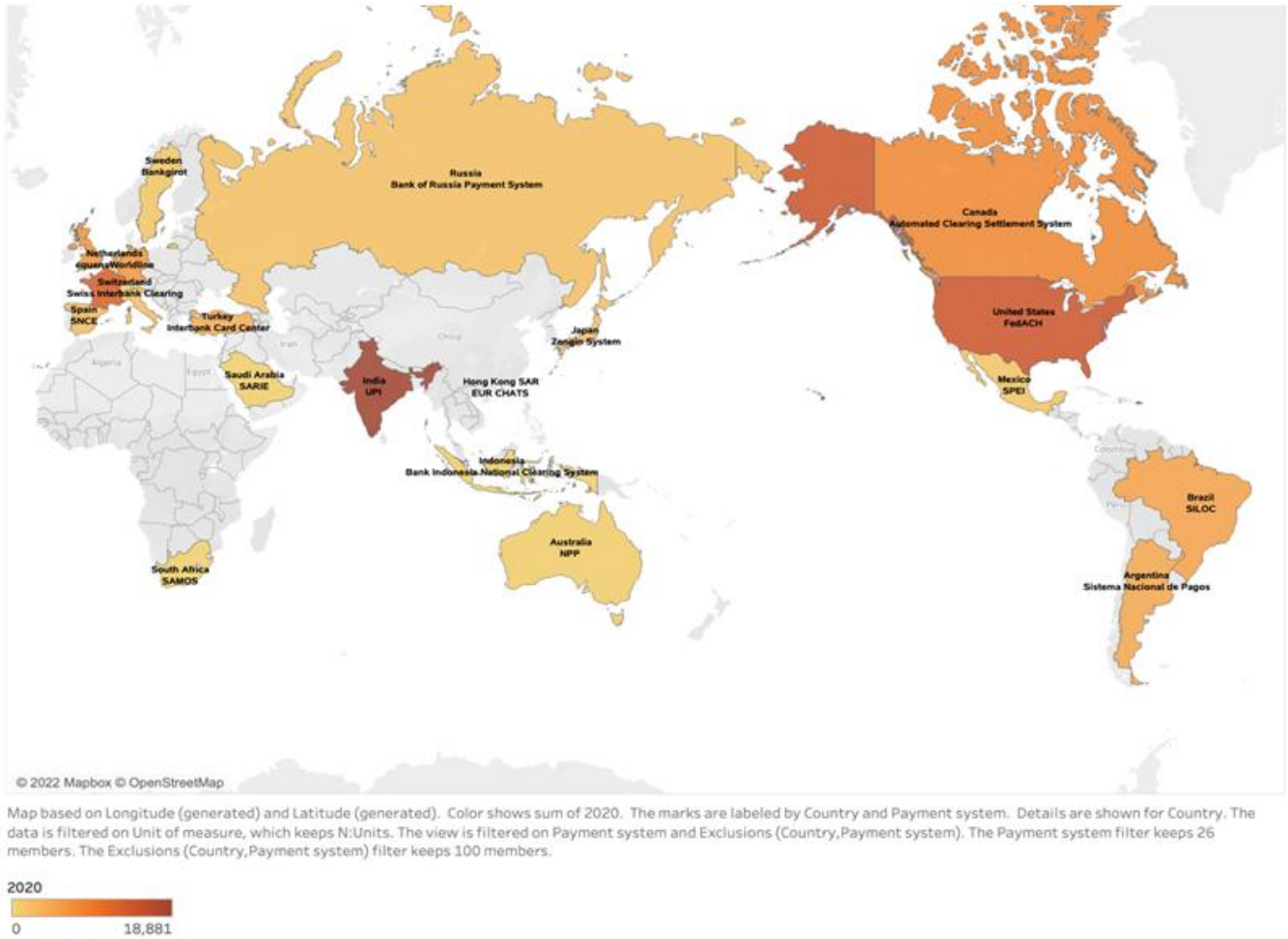


Figure 3: Volume of transactions for the most used Digital Payment System in Different Countries

Table I: Features of the Selected Payment Systems

Country	Name of System	Type of System	Settlement	Owner	Centralization
India	Unified Payments Interface	Fast Payment System	Multilateral netting	Payment Association	Centralized
China	Union Pay (CUPS)	Retail payment system	Multilateral netting	Payment Association	Decentralized
USA	FedACH	Retail payment system	Multilateral netting	Central Bank	Centralized
Germany	STEP2 Card Clearing (SEPA)	Retail payment system	Multilateral netting, Batch settlement	Payment Association	Centralized

Table II: Correlation Matrix for India

	Cashless transactions	*# of POS terminals*	*Literacy rate*	*Smartphone access*	*Popn. in agri*	*Median age*	*ATM withdrawals*
Cashless transactions	1						
# of POS terminals	0.97887953	1					
Literacy rate	0.914412673	0.952284953	1				
Smartphone access	0.959596834	0.974392145	0.979003453	1			
Popn. in agri	-0.909735374	-0.917840446	-0.963295986	-0.969171183	1		
Median age	0.892268981	0.936205539	0.985317361	0.962831803	-0.913364062	1	
ATM withdrawals	-0.081663458	-0.161068781	0.071696021	-0.007161684	-0.170889451	0.024898145	1

Table II: Correlation Matrix for China

	Cashless transactions	*Literacy Rate*	*Smartphone access*	*# of POS terminals*	*Popn. In agri*	*Median age*	*ATM withdrawa*
Cashless transactions	1						
Literacy Rate	0.877732842	1					
Smartphone access	0.892524359	0.993000877	1				
# of POS terminals	0.922841136	0.987631515	0.988132674	1			
Popn. in agri	-0.711944068	-0.93514349	-0.900722083	-0.88086543	1		
Median age	0.877732842	1	0.993000877	0.987631515	-0.93514349	1	
ATM withdrawals	-0.731234552	-0.942168778	-0.94648278	-0.904792307	0.93591427	-0.94216878	1

Table II: Correlation Matrix for Germany

	Cashless transactions	*# of POS terminals*	*Smartphone access*	*Popn. in agri*	*Median Age*	*ATM withdrawals*
Cashless transactions	1					
# of POS terminals	-0.958220753	1				
Smartphone access	-0.826160995	0.874224313	1			
Popn. in agri	0.738632123	-0.792648753	-0.985263821	1		
Median Age	-0.952636824	0.926101583	0.887783686	-0.80663372	1	
ATM withdrawals	0.894147512	-0.958692983	-0.958027345	0.918916713	-0.89211821	1

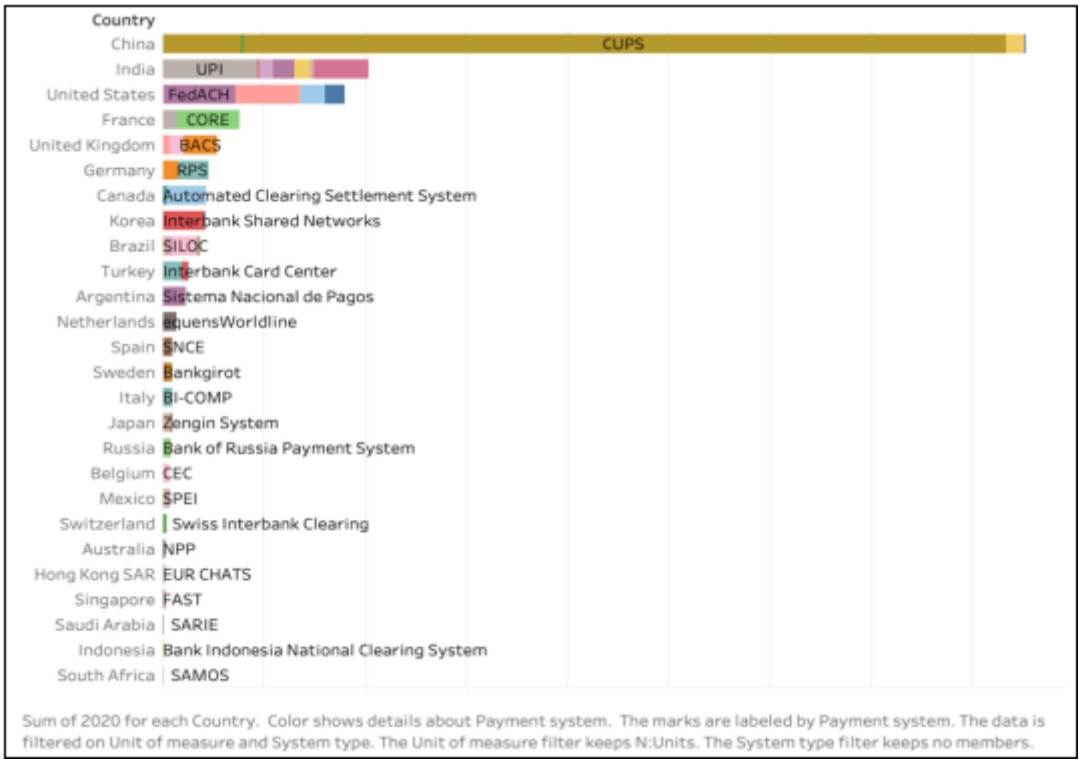


Figure 1: Volume of transaction for select payment systems in different countries

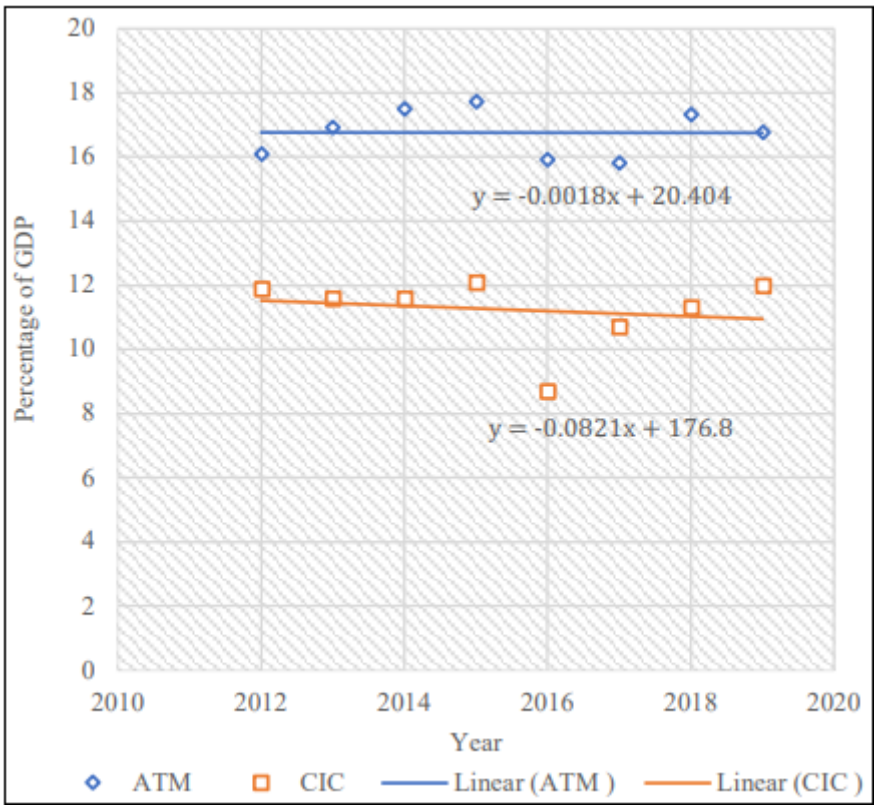


Figure 4: Value of ATM withdrawals and Cash in circulation in India as a percentage of its GDP

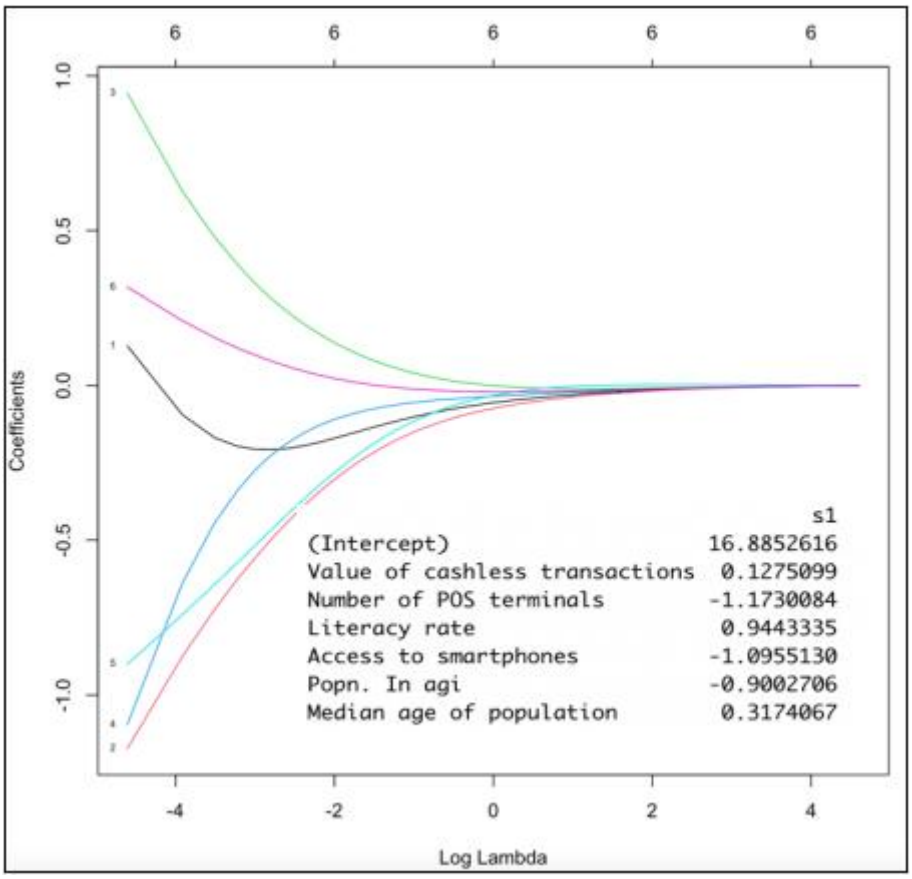


Figure 5: Coefficients of the variable affecting ATM withdrawals in India and for differeing values of λ

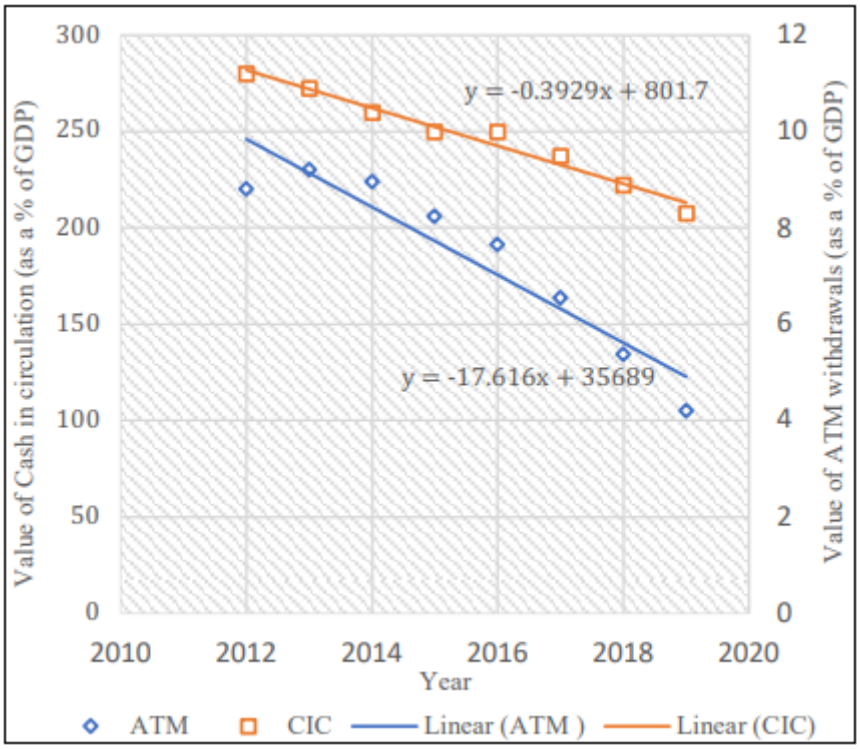


Figure 6: Value of ATM withdrawals and Cash in circulation in China as a percentage of its GDP

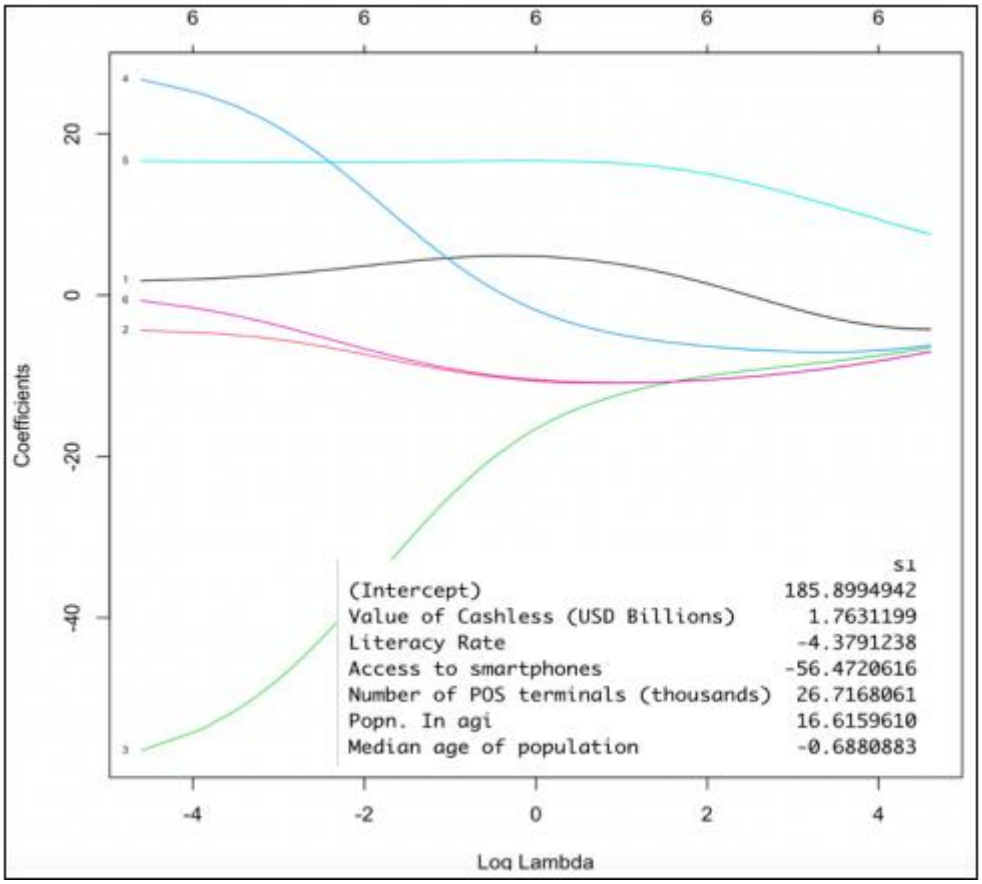


Figure 7: Coefficients of the variable affecting ATM withdrawals in China and for differing values of λ

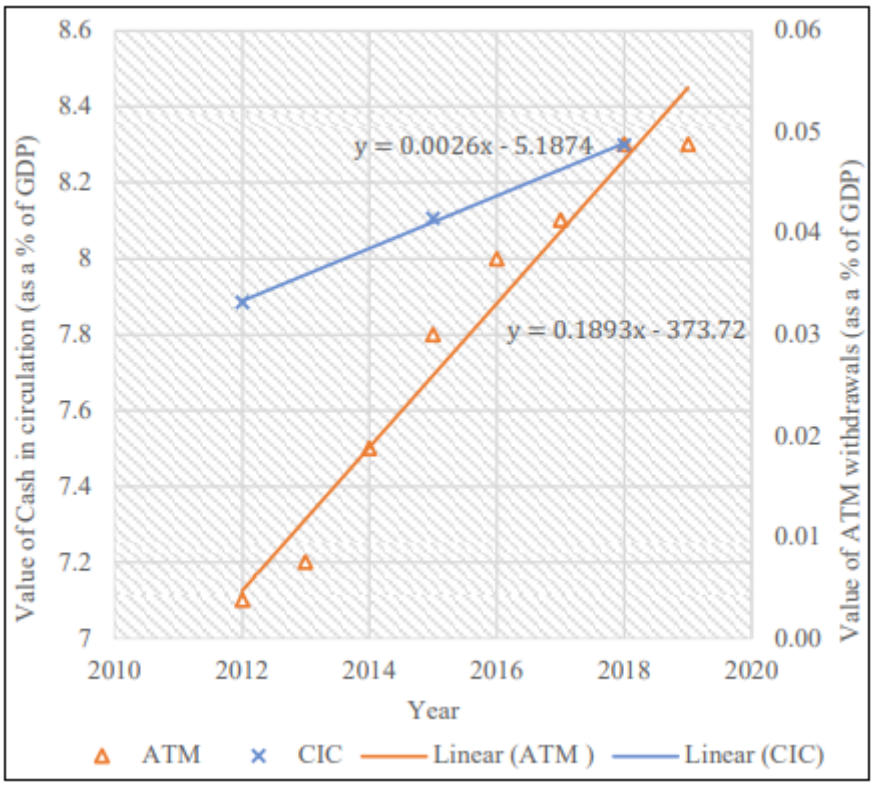


Figure 8: Value of ATM withdrawals and Cash in circulation in China as a percentage of its GDP

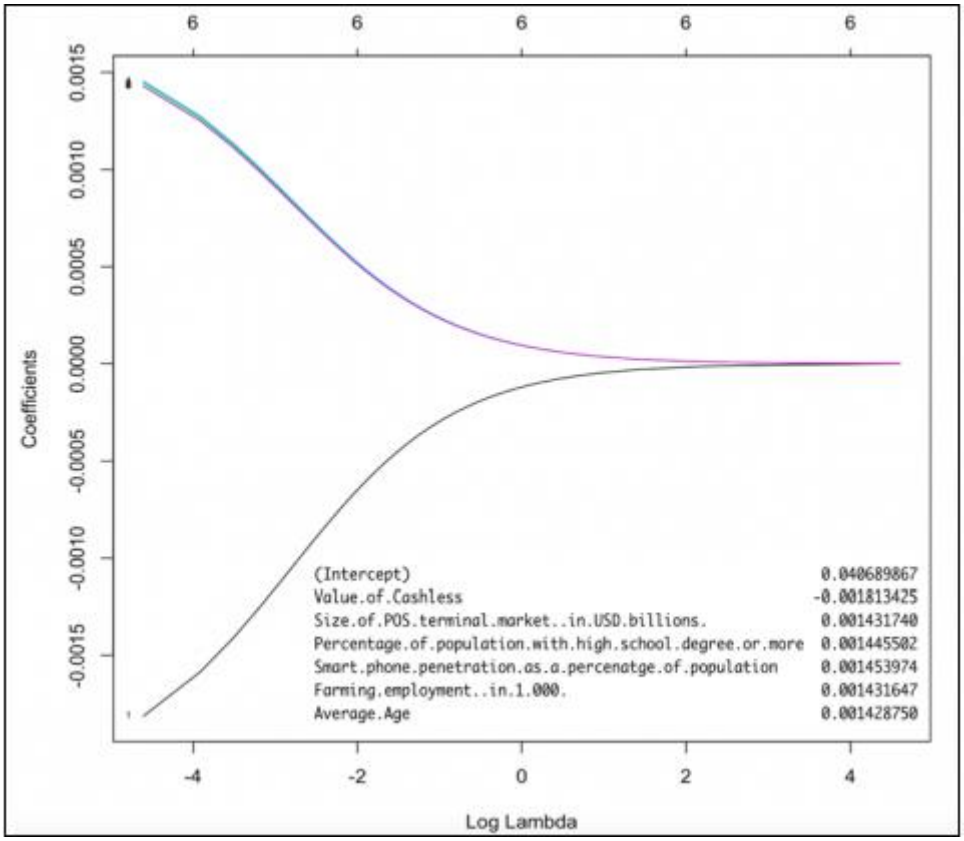
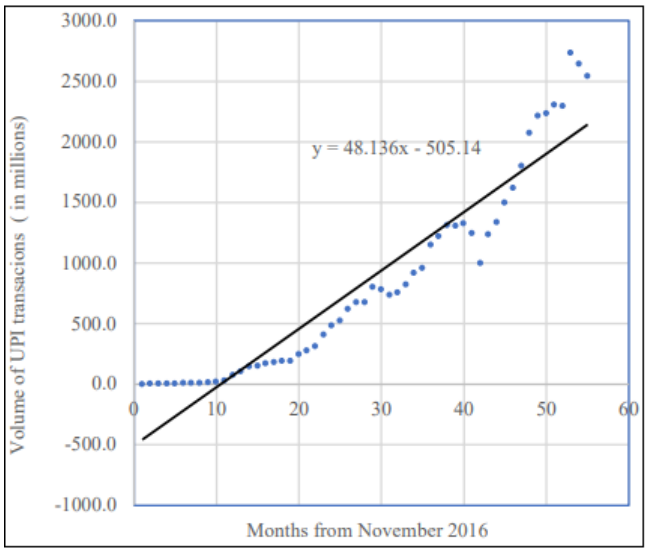


Figure 9: Coefficients of the variable affecting ATM withdrawals in USA and for differing values of λ



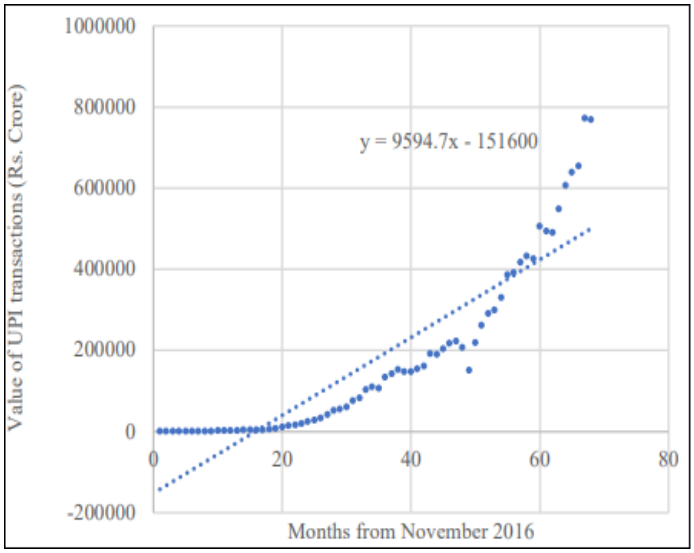


Figure 10 and Figure 11: Value and volume of UPI transactions in India GDP

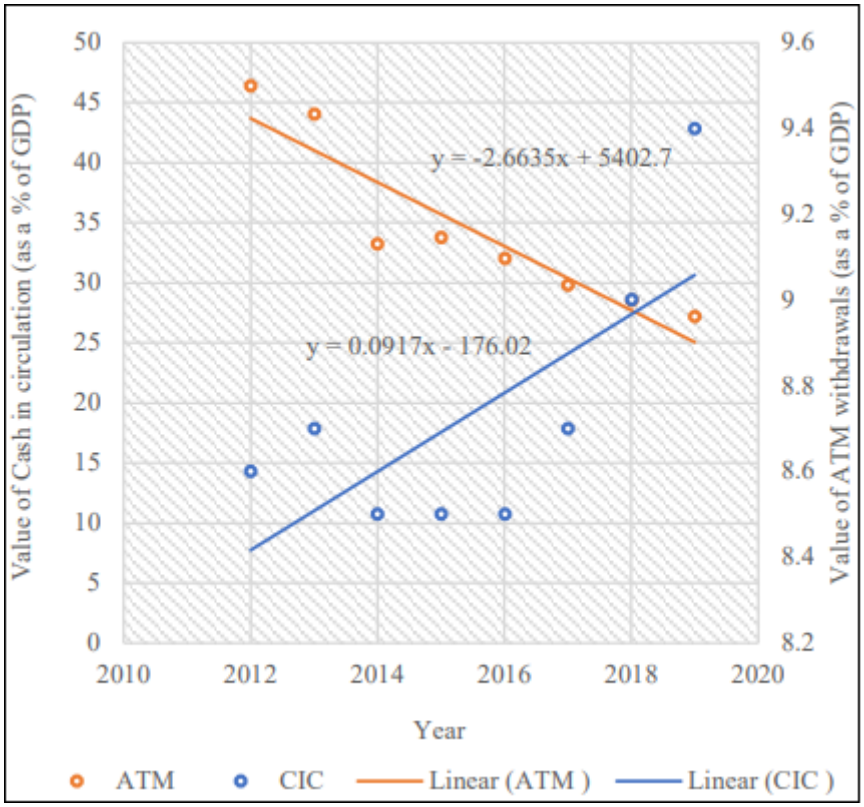


Figure 12: Value of ATM withdrawals and Cash in circulation in Germany as a percentage of its GDP

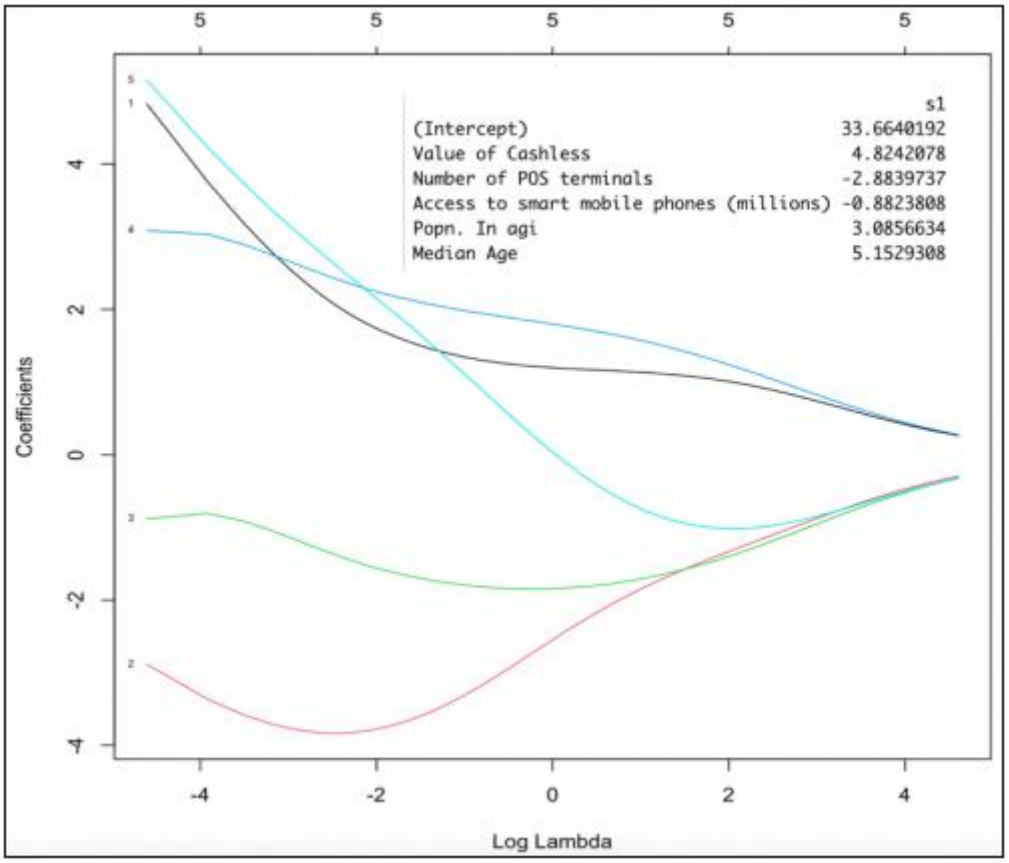


Figure 13: Coefficients of the variable affecting ATM withdrawals in Germany and for differing values of λ