CASH DEMAND IN UKRAINE:
A REGIONAL PERSPECTIVE

by

Vladyslav Honcharenko

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Thesis Supervisor: _____ Professor Olesia Verchenko

Approved by _____

Head of the KSE Defense Committee, Professor

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Date _____

Kyiv School of Economics

Abstract

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Cash demand was observed to be growing in the advanced countries after the Global Financial Crisis. Moreover, a substantial increase in cash usage was observed both in emerging and advanced economies during the COVID-19 pandemic. In this work we study the structural determinants of the cash demand in Ukraine, exploring the possible regional differences.

Results indicate, that interest rate is negatively associated with cash usage. At the same time, there are several factors positively related to the cash demand. First of all, regions with higher-than-average employment in the construction sector are likely to demand cash more. Secondly, the impact of COVID-19 (measured by the dummy variable) was found positive and statistically significant. This confirms the findings from the data of a substantial increase in the cash demand during the pandemic. Thirdly, the impact of uncertainty was found to be positive as well. However, the result is sensitive to the specification and type of robust standard errors employed.

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Chapter 1

INTRODUCTION

After the Global Financial Crisis (GFC), most economies experienced an increase in currency in circulation, especially advanced countries (the USA, Eurozone, Switzerland). Nonetheless, the studies reveal, that only part of it is explained by conventional factors, such as lower interest rates (Jobst and Stix, 2017). Despite the macroeconomic evidence of the cash demand increase, the micro-level studies show us that the US consumers decreased their holdings in years after the GFC (Briglevics and Schuh, 2014). Thus, the reasons for growing cash demand in the world should be further investigated.

In February 2020 the COVID-19 spread around the world. It led to lockdown of almost every country in the world and has become a significant reason for the subsequent economic crisis. One of the features of crisis is the rise of cash demand both in advanced economies and in emerging market countries.

Interestingly, cash holdings have risen despite the risk of taking the virus and recent developments of cashless payments and their indispensable convenience as a medium of exchange under the lockdown measures. As the studies show, cash demand actually was negatively associated with infectious disease (Cevik, 2020).

Also, this crisis is different from the previous recession, which characterized by the bankruptcy of big financial institutions (Lehman Brothers, Bear Sterns), bank runs in advanced (Northern Rock case) as well as emerging countries. The abovementioned factors led to the loss of consumer confidence in the financial institutions and an increase in cash demand.

On the other hand, at the very beginning of this recession, the majority of central banks responded by enormous liquidity support and softening monetary policy to mitigate any possible disruptions in the financial sector (Cavallino and De Fiore, 2020).

A considerable surge in cash demand was observed in Ukraine as well. To determine its reasons, we are going to use a unique dataset from the National Bank of Ukraine, which allows accounting for the regional differences. Ukraine is an emerging market, with a high share of the shadow economy (Medina and Schneider, 2018)[1], as well as a level of dollarization (Khvedchuk et. al, 2019). The country also experienced two systemic banking crises during the last ten years: in 2009 and 2014 (Laeven and Valencia, 2018) and a substantial increase in the cash demand during 2020.[2]

Preceding factors can be seen as reasonable to explain the surge in cash usage. On the other hand, during recent years, macroeconomic and financial stability was achieved, as a result of implementing the Inflation Targeting regime. Financial inclusion has also developed substantially leading to an increase in the volume of cashless payments. Therefore, these factors altogether should have offset each other.

This research is aimed to answer several research questions. Firstly, what are the regional differences which determine the intensity of cash demand? Can they be explained by the region's employment specialization? Namely, do regions with a higher share of employed in agriculture and retail sectors are the drivers for higher cash usage?

Secondly, can cash demand, among others factors, be driven by uncertainty, which always increases during crises? Does the Google Trends Uncertainty index

[1] The shadow economy constitutes around 45 percent
[2] Cash in circulation has grown by 34 percent y-o-y

account for the increase in cash demand?[3]

The results of the research can be useful for monetary policy implementation. Substantial increase in cash may lead to reducing the effectiveness of the monetary policy, especially in the emerging countries, which are characterized by a higher fraction of shadow economy, absence of financial markets, and, as a result, higher incentives for the cash demand.

Also, the results can help policymakers to understand, which regions are the main drivers of the cash demand. The latter fact may be useful to disaggregate the total increase in cash: the increase can be just due to some regions, but not the whole country's trend.

To proceed with the analysis, we employ the methodology of Bartzsch et. al (2019) and determine the structural determinants of the cash demand using panel data on Ukrainian regions from January 2013 to December 2020.

As the determinants, we consider not only the conventional variables from the literature, but also augment the money demand function by the Google Trends Uncertainty index, which is constructed for each of the regions separately.

The estimation is done in several stages. First, we estimate a static panel model. Then, as a robustness check the dynamic panel model is estimated as well.

Our findings suggest, that apart from the conventional determinant, such as interest rate, which in line with literature was found to be negatively related to the demand for cash, we also found several other factors positively related to the cash demand.

First of all, the share of employed in the construction sector was found positively related to the cash usage. This impact is not only statistically significant, but also

[3] Google Trends serve as a rich source for real-time data. Also, there are no uncertainty indexes available and calculated for Ukraine.

it robust to different specifications and types of robust standard errors. This result implies, that regions with higher than average employment in the construction sector are associated with a higher demand for cash.

Secondly, the impact of COVID-19 (measured by the dummy variable) was found positive and statistically significant. This confirms the findings from the data of a substantial increase in the cash demand during the pandemic.

Thirdly, the impact of uncertainty was found to be positive as well. However, the result is sensitive to the specification and type of robust standard errors employed.

The rest of this paper is organized as follows. In chapter 2, the literature review is presented. Chapter 3 provides data description and Chapter 4 explains the methodology. Chapter 5 presents estimation results and Chapter 6 concludes.

Chapter 2

LITERATURE OVERVIEW

The issue of money demand and especially demand for cash has been studied by many researchers. The famous studies of Baumol (1952) and Tobin (1956) resulted in the model, where the demand for cash had related cost. In this model, the demand for cash is inversely related to the associated opportunity (forgone interest) and transaction cost (which individuals face when withdrawing money from a bank). Keynes (1936) in his liquidity preference theory determined that money demand is positively related to income and negatively to interest rates. These works have become fundamental for further investigation of issues related to money demand.

One part of the money demand literature is seeking an answer to the question whether the money demand remains stable in the long-run? That is, can the demand for money be explained by the conventional determinants such as GDP (transaction motive) and interest rate (opportunity cost)? To study this issue, authors either look at each country separately and model a relationship as cointegration or consider a panel of countries.

Ball (2001) obtained precise estimates for the income and interest rate elasticities and showed, using data for the postwar period in the United States, that these variables have consistent with the theory signs. On the other hand, he admits that his money demand function does not contain a trend, inclusion of which may change the obtained income elasticities.

A recent study of Benati et al. (2019) extends the previous framework and considers the issue of long-term money demand for 38 countries. The findings

suggest a stable money demand relationship for most of the countries. The interest rate elasticity was between 0.3 and 0.6, which is in line with the findings of Baumol and Tobin. The same findings were obtained by Carrera (2016), who conducted analysis for a panel of Latin America countries.

Hamori and Hamori (2008) employ panel data on 11 EU countries to estimate the money demand. In this analysis, the authors consider demand for all monetary aggregates, except M0. Apart from the conventional framework, which employs either quarterly or annual data, this study works with monthly frequency. The stable money demand function was found for each of the monetary aggregates.

Some studies extend the conventional framework and consider not only GDP and interest rate as the determinants of the money demand, especially in the case of emerging market countries.

Dregert et al. (2007) while modeling money demand (M2 aggregate) for New EU Member States also included the exchange rate in order to control for the possible currency-substitution effect in small open economies. The findings suggest a consistent with the theory signs for income and interest rate and significant currency-substitution effect of exchange rates with the U.S. dollar (negative sign), while the impact of Euro FX rate is not statistically significant. Similar results were obtained by Korhonen and Mehrota (2010), who estimated money demand in Russia (M2 aggregate as in the previous study).

Previous studies estimated money demand using time-series or panel framework on the national level. On the other hand, Fujiki (2013) applies this analysis to the panel of Japanese regions. His findings suggest that income elasticities decreased over time. Population density is positively related to the money demand, while the impact of age (share of the population aged 65 or older) is negligible.

Despite the preceding studies, we are more interested in determining factors that affect the narrowest monetary aggregate – cash in circulation. And while the

determinants of the money demand are interest rate and GDP, the structural determinants of cash are much broader, and different researchers consider different possible determinants of cash usage. Thereby, there are several approaches in the literature to deal with this issue.

The first approach relates cash demand to the underground economy, apart from the conventional determinants. Jobst and Stix (2017) conducting cross-country analysis, found that increase in cash to GDP ratio observed for 72 countries in the sample, but only part of this increase is explained by GDP and interest rates. Shadow economy has no statistically significant impact on cash demand, while countries with the financial crisis in 2008 on average experienced an increase in cash demand.

On the other hand, Herwartz et. al (2015) found a significant impact of the shadow economy (measured by several variables such as self-employment and unemployment rates as well as tax burden) on the money demand (both M1 and cash) in OECD countries. The results suggest consistent signs for income and interest rates, while variables related to the shadow economy are not significant separately, but are significant jointly.

Some researchers focusing on the panel of regions, rather than countries. The study of Ardizzi et al. (2013) employs data on Italian provinces to find out the structural determinants of cash demand and estimate the level of the shadow economy. Their findings suggest that drug-related crimes, as well as variables related to tax evasion, are positively related to the demand for cash. On the other hand, interest rate, bank per capita accounts, and share of electronic transactions hamper it. Another study of Ardizzi et al. (2018) indicates, that regions which either are touristic or located in mountains are likely to demand cash more. Also, the higher number of construction firms in the region is associated with a higher demand for cash.

A similar study, but on the German regions was conducted by researchers from the Bundesbank. Bartzsch et. al (2019) augmented the previous specification with several other variables. Their findings suggest that self-employment rate and drug-related crimes are positively related to cash usage. On the other hand, the share of employed in the agricultural sector has no significant impact, while the share of the construction sector is associated negatively with the demand for cash.

The latter three papers are of great interest to us since they estimate the cash demand on the regional level. Also, the study of Bartzsch et. al (2019) exploiting the possible patterns in employment and their impact on the demand for cash, augmenting the research of Ardizzi et al. (2013). In addition, the possible impact of employment coincides with one of our research questions. Thus, the methodology we are going to use will be based on these papers.

The second approach extends the conventional framework and also includes uncertainty in the models. In this part of the literature, there is no consensus among researchers.

Cusbert and Rohling (2013) considered factors that led to substantial currency demand in Australia during the GFC. They found, that most of this increase is explained by GDP and interest rates as well as variables related to transaction costs (number of POS terminals and ATMs etc.). The impact of uncertainty is small and it disappears if the dummy variable for GFC is included.

On the other hand, Rua (2020) indicates heterogeneous impact of uncertainty on the cash demand in the Euro area. His findings suggest that financial uncertainty leads to an increase in cash demand, while uncertainty regarding economic policy hampers it.

A significant impact of uncertainty was also found by Ardizzi et. al (2019) who exploited a dataset on daily withdrawals in Italy. Unlike in the previous study, an increase in the economic policy uncertainty was found to be positively related to

the cash demand while curbing debit card purchases (a proxy for consumption).

The third approach which has emerged recently due to the COVID-19 pandemic in 2020 relates cash demand to infectious diseases. The cash during this period has grown despite the risk of disseminating the virus.

A novel study of Cevik (2020) is seeking the answer to the question: how the cash demand is affected by infectious diseases? The author employs annual data for 133 countries for the period from 1995-2017. This research considers two diseases that took place through the observed period: Ebola and SARS. His findings suggest that infectious diseases are negatively associated with cash demand, while the control variables had expected signs. The results are significant economically and statistically: 1 percent increase in the number of infected is associated with a decrease in cash to GDP ratio of 1.68 percent. Thus, the question remains open: why has the cash demand increased during the COVID-19 pandemic even despite infectious disease around?

Some authors also link the demand for cash and demographics. A comprehensive study of Dunbar (2019) applies an analysis for the data on Canadian provinces. He found that young cohorts (15-24) and retail trade are the main sources of the demand for low-denomination banknotes. On the other hand, older cohorts are associated with lower demand for cash. There is no heterogeneity in cash demand with respect to the employment status, while females tend to increase cash holdings more than males.

Chapter 3

DATA OVERVIEW

For the purposes of this analysis we use monthly data from the different sources. The main variable of interest, volumes of cash, comes from the National Bank of Ukraine. This measure represents inflows and outflows of cash through the banks' cash desks. The banks submit information about the turnovers on the monthly frequency to the regulator.

Banks submit the report on a disaggregated basis, which allows directly determine why the cash either left or entered the cash desk. Therefore, total volumes of inflows and outflows are disaggregated into different items (cash withdrawals by the banks' clients, retailers' revenue, the inflow of UAH cash due to selling FX, inflows on cards).

To proceed with the analysis, I aggregated all items of inflows and outflows and calculated a new measure — net cash demand by subtracting total inflows from total outflows. This allows obtaining a cash demand on a net basis. If the variable takes negative values it means that cash enters the cash desks, thus demand on it from the public decreases and vice versa.

The data has also a regional breakdown, which allows to aggregate all operations of banks in the region and obtain a panel of regions with the correspondent volumes of cash.

Figure 1 depicts the dynamics of the dependent variable (since 2010). One may observe, that during the last recession (2014-2015) most of the regions experienced a reduction in the cash demand. The latter fact can be explained by

the huge depreciation of the Hryvnia, hence, the public converted UAH to dollars.

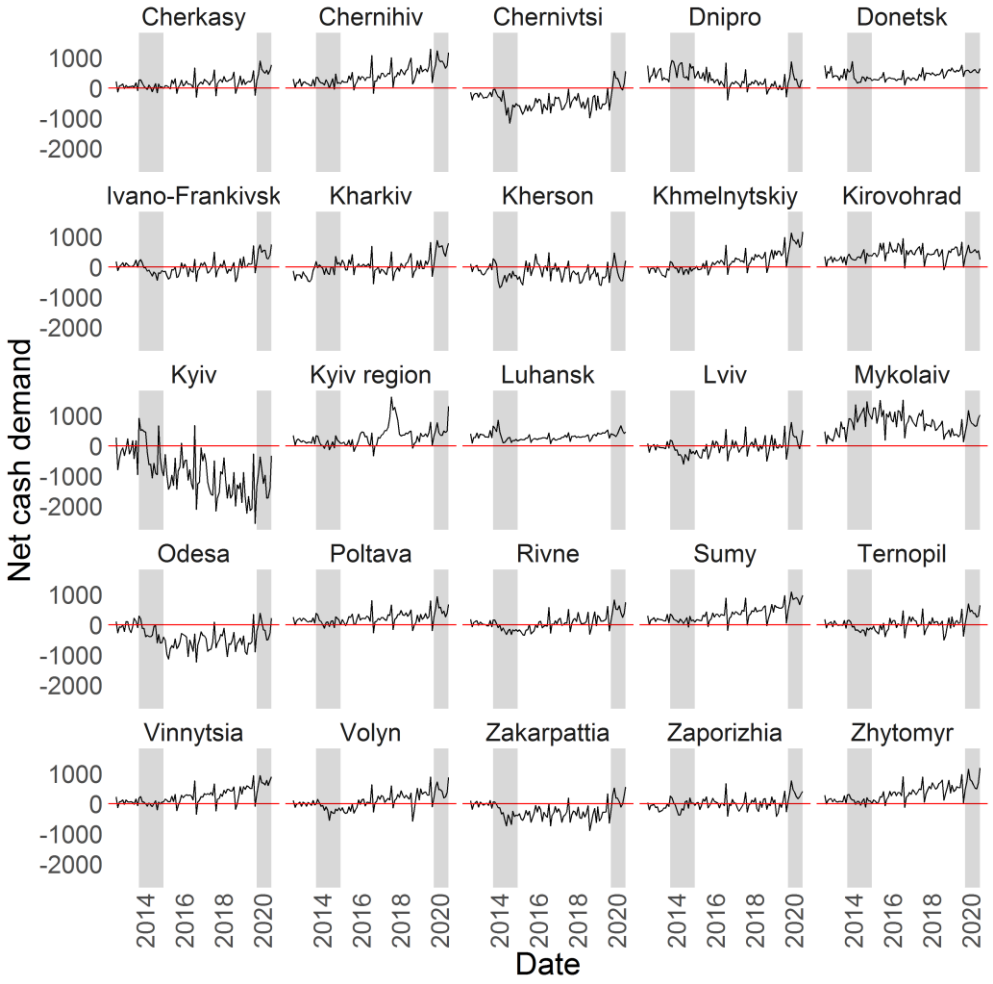

Figure 1. Cash dynamics over time, breakdown by region. Recessions are shaded

On the other hand, such a picture is not observed during the current crisis. Most of the regions reacted to the pandemic by an increase in cash holdings. On the other hand, some interesting patterns are observed. Some of the regions

experience consistently negative net result: Kyiv, Odesa, Chernivtsi, and Zakarpattia. While for the first two regions it can be explained by the higher financial inclusion, for the last two the reasons remain ambiguous.

Explanatory variables are taken from the State Statistic Service of Ukraine (SSSU), National Bank of Ukraine (NBU), Prosecutor General's Office (PGO), and Google Trends.

Volumes of retails sales, population, CPI's, employment by economic activity and unemployment rates are obtained from the SSSU.

The unemployment rate represents the number of people, registered in the State Employment Service of Ukraine. The reason to use this estimate and not calculated using International Labor Organization (ILO) methodology, is that the ILO's unemployment rate is reported only on a quarterly basis.

Due to the data limitation, SSSU calculates shares of employed only on the annual frequency. On the other hand, the shares are relatively constant throughout the time: regions which either industrial or agriculture, retain their specialization (Figure 2).

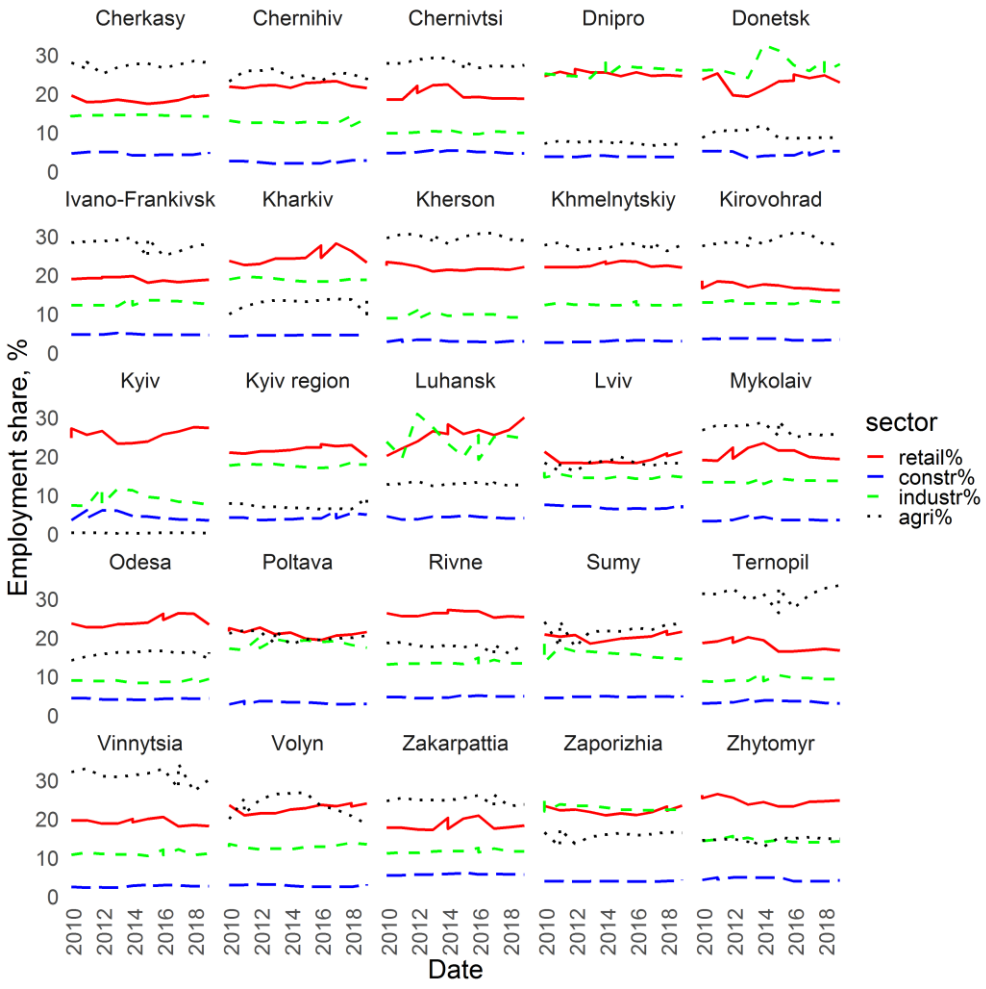

Figure 2. Employment shares, breakdown by region and sector

To extract at least some information from this variable and to cover the region specialization, we proceeded in the following way: for each of the sectors, we created the dummy variable which equals to one, if the share of employed in this sector for the given region exceeds average share per country. For each of the years, the dummy variables were constructed and then assigned to the correspondent months in the years.

Interest rates, which represent the opportunity costs of holding money, are taken from the NBU. These are the interest rates on the new deposits for non-financial corporations. The NBU does not report estimates separately for Kyiv, but only for Kyiv region. Due to this, we assigned to Kyiv estimates from Kyiv region.

The dynamics of the interest rates is presented in Figure 3.

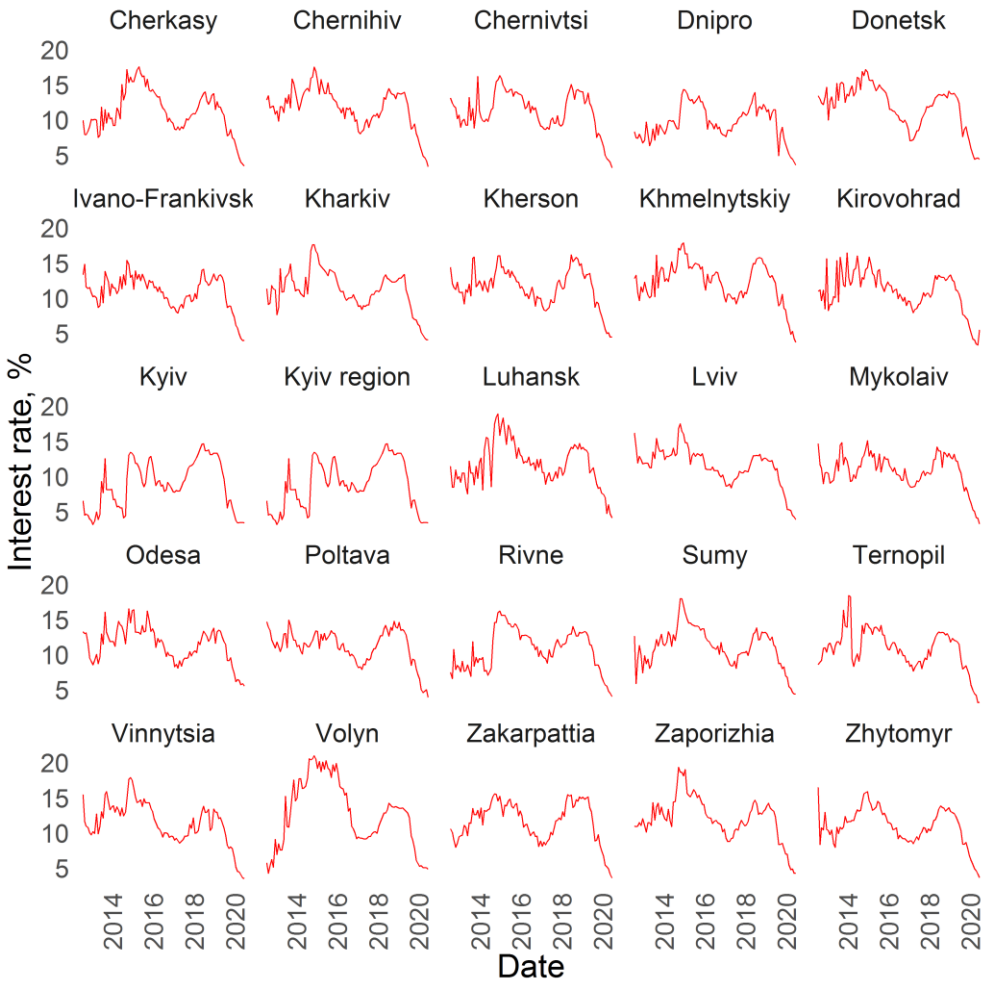

Figure 3. Dynamics of deposit interest rates. Breakdown by region

The number of registered crimes related to drugs was taken from PGO. Also, to account for the financial inclusion and its possible negative impact on cash usage we also used the number of terminals per 100K of population. This variable also comes from the NBU. Up to February of 2020, this data was available only on a quarterly frequency. Thus, we employed cubic spline interpolation to get the monthly estimates.

To construct the Google Trends Uncertainty index (GTU), we followed Castelnuovo and Tran (2017) who made GTU index for Australia and the USA. To find the words associated with uncertainty, they searched Federal Reserve's Beige Book for the United States and the Reserve Bank's Monetary Policy.

If the sentence included the word "uncertainty", they extracted words associated with it. For instance, in the sentence "A substantial majority of banks reported increases in deposits, which some banks attributed to continued consumer uncertainty about financial markets.", the words associated with uncertainty are: "bank deposit", "consumer confidence", "consumer uncertainty", "financial markets".

In a similar way, we searched for the uncertainty-related words in Inflation Report, Macroeconomic and Monetary Report as well as Annual Report (till 2015 the Inflation report was not published) of the National bank of Ukraine. The full list of the words is presented in the Appendix.

To extract the data from Google we imputed the words both on Ukrainian and Russian. Some words were rewritten to be consistent with how people are likely to Google them. For example, not only the word "minimum wage" was imputed, but also "mzp" (shortcut for the minimum wage in Ukrainian) and "minimalka" (slang analogue for it).

Since Google allows imputing only 5 words at the same time, the procedure was done in several stages. It is important to mention how Google assigns frequencies

to each of the words. When the words are imputed, for each of them, Google shows the frequency of searches relative to other words from the request and the most searched word receives a frequency of 100. Therefore, to correctly aggregate all frequencies, following Castelnuovo and Tran (2017), we chose the "benchmark"[4] word, which almost always has the highest frequency.

For each of the stages, we imputed the benchmark word plus 4 randomly selected words from the list. The procedure was repeated until all words from the list were employed. Since the frequency of the benchmark can be potentially different in some stages[5], the word, which we used to construct the index was the average of all stages. Then, we summed up obtained frequencies for our words and ended up with the uncertainty index:

The index is constructed for every region. Nonetheless, we observe that the regional dynamics are very similar, except for some minor differences (Figure 4).

Two major spikes occur during the two recession periods: in 2014-2015 and 2020. The words associated with spikes for the first recession are "maidan", "ATO", "bank" and "exchange rate". In 2020 — "coronavirus", "quarantine", "exchange rate".

[4] For most of the months it was the word "exchange rate"
[5] Consider, for instance, March of 2020. The most searched word was "coronavirus", and the benchmark word "exchange rate" had lower frequency comparing to it.

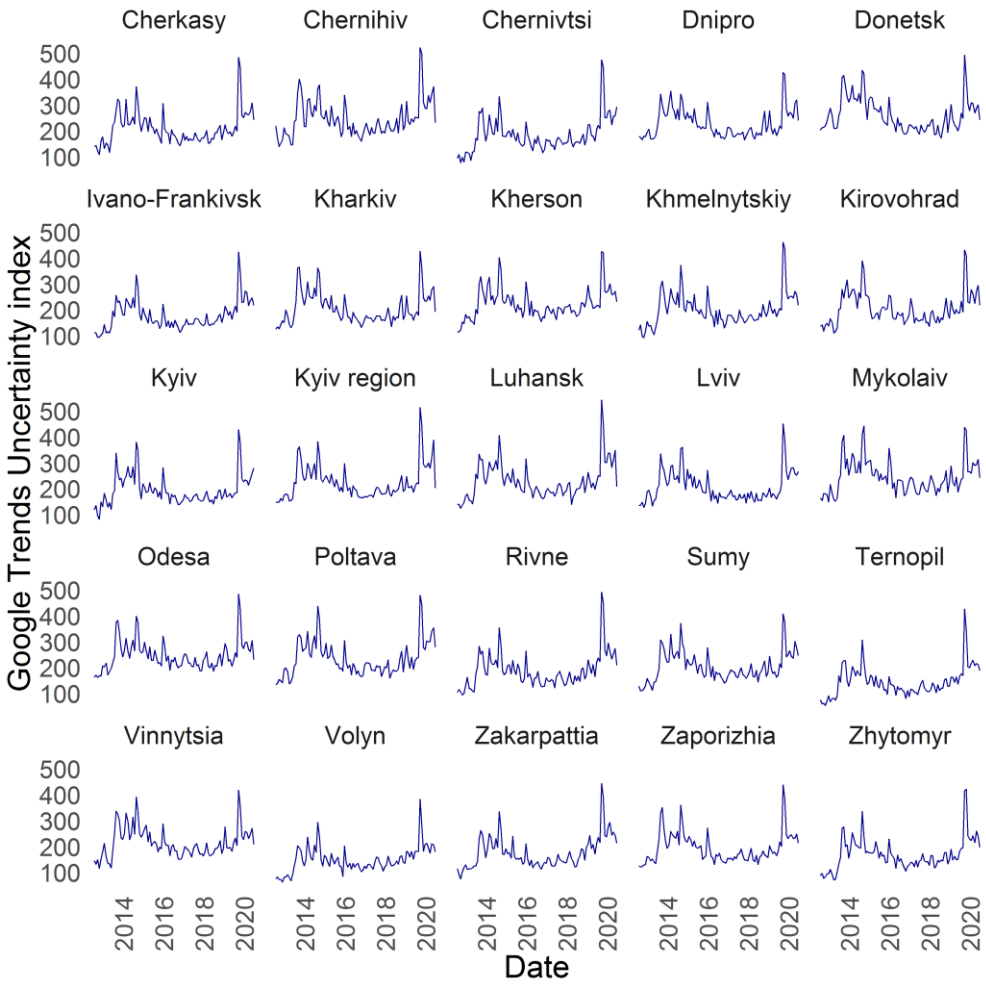

Figure 4. Dynamics of Google Trends Uncertainty index. Breakdown by region

From the data we also observe, that cash and retail sales both always increase substantially in December, but decrease in January. The latter fact can be explained by the New Year holidays.

Unemployment rate (Figure 5) exhibits seasonality as well (increases during the

winter period and decreases during the summer)[6]. Thus, these variables were seasonally adjusted using X-13ARIMA-SEATS method (Sax and Eddelbuettel, 2018).

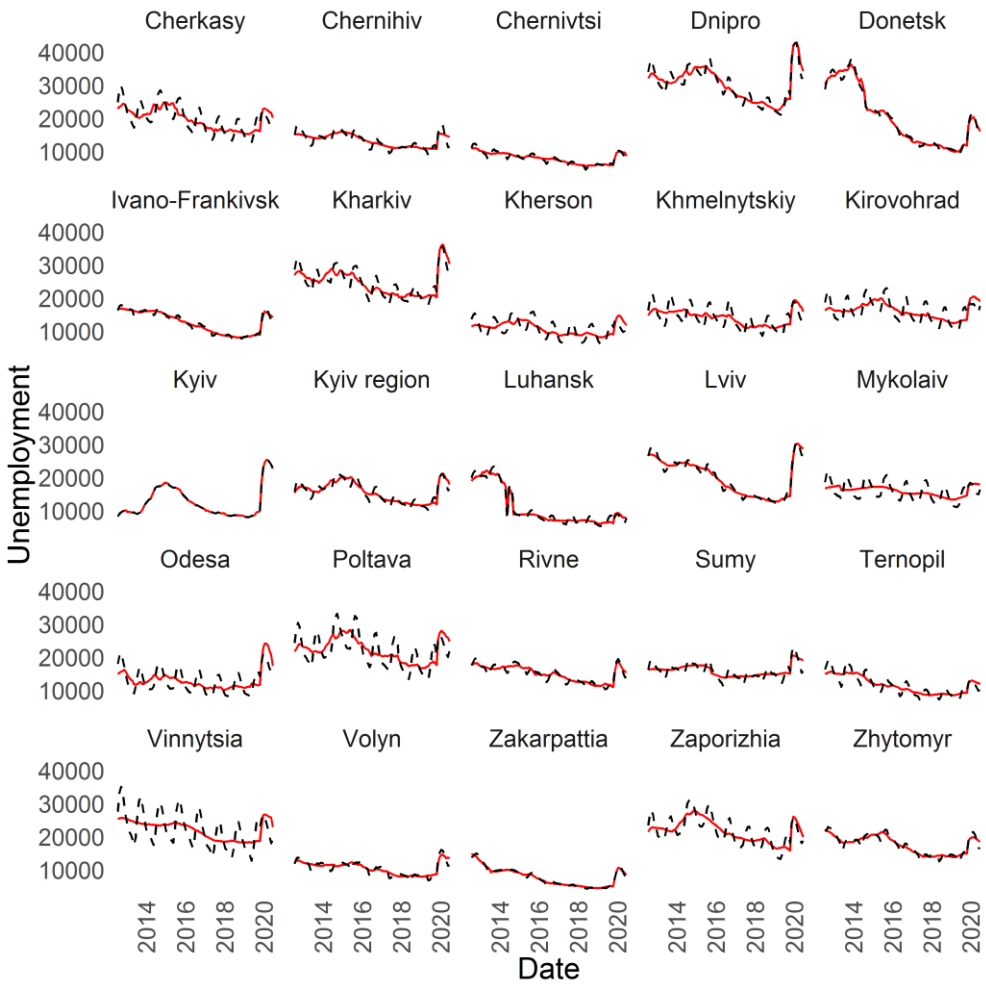

Figure 5. Dynamics of Unemployment. Breakdown by region. Seasonally adjusted series colored in red, raw data – in black

[6] Due to seasonal employment in the agricultural sector

It turns out, that the data on drug-related crimes is available only from 2013. The same is attributable to the Google Trends (prior to 2013 data is available not for all regions). Therefore, we ended up with the sample spanning from January 2013 to December 2020 (2400 observations overall). Given that the Crimea was occupied starting from March 2014, we excluded this region from our analysis.

To deflate the data, we constructed indexes and set them equals to 1 in January 2010, and then premultiplying each month by the correspondent value of CPI.

The descriptive statistics for all employed in regressions variables is presented in Table 1. The dependent variable and retail sales are deflated and expressed in per capita terms (to be comparable across regions).

The SSSU and PGO report data on retail sales and the number of crimes on a cumulative basis. Thus, to obtain monthly estimates we proceeded as follows: for instance, to obtain the numbers for February from the reported values for January-February we subtracted the reported values for January. Due to this, we received two outliers: negative retail sales and the negative number of registered crimes.

The first case is attributable to the Donetsk region when the war started and SSSU started to report values without occupied territories. Thus, the negative estimate took place due to a change in the basis of comparison. The negative number of registered cases is attributable to Kyiv region, yet it looks like an error in reporting. Both values were substituted by zeros.

Table 1. Descriptive statistics

	N	Mean	Standard Deviation	Min	Max
Net cash demand (per capita)	2400	44.956	192.88	-920.613	1280.952
Interest rate	2400	11.133	3.042	3.157	20.986
Retail sales (per capita)	2400	503.864	310.381	0	2244.185
CPI	2400	2.151	.676	1.06	3.378
Manufacture share	2400	.285	-	0	1
Retail share	2400	.405	-	0	1
Agri share	2400	.63	-	0	1
Construction share	2400	.45	-	0	1
Unemployment	2400	16078.59	6414.936	4464.073	42936.441
Drug-related crimes	2400	154.128	122.66	0	849
GTU	2400	206.662	67.227	54.81	542.667
Terminals	2400	.099	.097	.018	.677

Chapter 4

METHODOLOGY

To proceed with the analysis, we will use the methodology applied by Bartzsch et. al (2019) who estimated the cash demand for the panel of the German regions. They used pooled OLS while controlling for the possible differences across regions and time periods by introducing dummies.

The model which is expected to explain the cash demand is as follows:

$$Net\ cash\ demand_{i,t} = \alpha_i + \gamma_t + GTU_{i,t} + Employment_{i,t} + Retail_{i,t} + Int_{i,t} + x'_{i,t} + Region_i + u_{i,t} \quad (1)$$

where Retail stands for the volume of retail sales, Int – deposit interest rate, Region is the dummy variable for the Ukrainian regions, $Employment_{i,t}$ – employment specialization, $GTU_{i,t}$ – Google trends Uncertainty index, γ_t – time effects, $x'_{i,t}$ is the set of additional controls, i – region, t – months.

To assess the possible impact of the region specialization on the cash usage, we introduce shares of employed in different sectors. Bartzsch et. al (2019) controlled for the employed in construction and agriculture, but we also consider it relevant to introduce the share of employed in the retail and industrial sector to exploit possible interesting patterns.

The impact of agriculture and retail employment is expected to be positive. On the other hand, for industrial regions it's expected to be negative (due to the higher level of development), while for construction the impact is ambiguous.

The reason for that is the heterogeneous evidence from the literature: negative in the case of Germany (Bartzsch et. al, 2019), while positive in the case of Italy (Ardizzi et. al, 2018).

In order to investigate the second research question and apart from the previous study, we augment the model by adding uncertainty, which is measured by the GTU index. Overall, higher economic uncertainty was found positively related to the demand for cash (Ardizzi et. al, 2019). We expect that our index will have positive impact on the cash demand as well.

Volumes of retail sales serve as proxy of GDP and income motive in the money demand function. There are two reasons for that. Typically, in the literature, the GDP is used to cover the income motive of the money demand. Yet we are working with monthly data, on which GDP is not calculated.

Secondly, in Ukraine, even quarterly GDP is not calculated per region and only annual measures are available. Following Dunbar (2019) who used volumes of retail sales to explain the cash demand for Canadian regions, we adopt this approach as well. The sign on this variable is expected to be positive, as the literature suggests.

Since the cash demand can be driven not only by legal activity but also by the underground economy as well as criminal activities, we also augment the model by adding the unemployment rate and the number of registered crimes. This is consistent with Bartzsch et. al (2019) and Ardizzi et. al (2013).

The unemployment rate is expected to capture the effect of the shadow economy since it was found to be positively related to cash usage (Ardizzi et. al, 2013). The intuition is that the more people are unemployed, the more likely they will be involved in the activities associated with cash usage. Controlling for the shadow economy is quite important since the estimated level of it in Ukraine is more than 40 percent (Medina and Schneider, 2018).

As for the crimes-related variables those are number of drug-related registered crimes. The intuition to use this metric, but not the total crimes is that this measure represents a voluntary agreement between the parties to exchange goods on cash.

Following Ardizzi et. al (2013) we include the number of terminals within each of the regions. The variable is expected to have a negative impact on cash usage, since bigger financial inclusion typically reduces incentives for the cash demand, inducing consumers to switch to more modern and convenient payment methods.

Also, to control for the impact of COVID we introduce the dummy variable which equals one starting from the March of 2020. This variable is expected to capture possible behavioral patterns and unobserved factors which could impact cash demand at the start of the pandemic, but which cannot be directly included in the model.

In the data we observe, that for series attributed to Donetsk and Luhansk the structural break exists. A significant drop in cash volumes, as well as retail sales, is observed since October 2014. This is due to the fact, that SSSU started to report values for these regions without the occupied territories. To control for the break, we introduce the dummy variable ATO, which equals one if the region is either Donetsk or Luhansk and the date is bigger than April of 2014.

Both the dependent variable as well as most of the explanatory are non-stationary. To deal with this issue, we introduce dummy variables for each point in time (for each of the months). As the literature suggests, this may cause stationarity (Baltagi, 2012). The conducted tests on the estimated residuals show, that they are stationary.[7]

[7] The Levin-Lin-Chu test was conducted. The null hypothesis was that the residuals are non-stationary, against the alternative of the stationarity. The number of lags to include

It is important to mention, that the residuals of the model can correlate across regions. The reason for that is that people can withdraw cash in one region and then spend it in another. Consider, for instance, touristic regions: people who enter them may already have cash for holidays withdrawn in their home region. Also, our residuals can be autocorrelated since we use monthly data the analysis. Autocorrelation implies violation of Gauss-Markov assumptions about the OLS validity and, as a result, incorrect standard errors.

Therefore, we conducted two tests on the estimated residuals: Breusch-Pagan LM test (for cross-sectional correlation) and Wooldridge test (for autocorrelation). P-values from both tests strongly reject assumption of independence and absence of autocorrelation in residuals.

To account for these issues as well as possible heteroscedasticity we are going to employ two types of robust standard errors: Panel-Correcting Standard Errors introduced by Beck and Katz (1995) and Driscoll and Kraay (1998) standard errors. Both are robust to autocorrelation, contemporaneous correlation as well as heteroscedasticity and designed for panels, where T>N (in our case T=96, while N=25). The difference between these two methods is the degree of autocorrelation they assume. While the Beck and Katz standard errors assume that residuals are autocorrelated of type AR (1), which may be too strong, Driscoll and Kraay standard errors allow the autocorrelation of MA (q) type. And the lag length to be included in the autocorrelation structure is determined as floor $[4(T/100)^{2/9}]$ (Hoechle, 2018).

We will estimate the model using both OLS and FGLS. Also, as a robustness check, we will use the model with lags of the dependent variable. The choice of the lag will be based on the information criteria.

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was chosen by the AIC.

Chapter 5

ESTIMATION RESULTS

In this chapter, we first show the results of the baseline specification without the lags of dependent variable. In the next subsection, the model with lags is also presented.

5.1 Static panel model

The results from the first model are presented below. The standard errors are robust to autocorrelation, contemporaneous correlation between regions as well as heteroscedasticity. Dummies for the time periods as well as regions estimated, but not reported.

From the results, we can see, that the Interest rate variable has the expected sign and is significant for 2 specifications. The coefficients vary from -1.716 to -9.183 implying that an increase on 1 p.p. is associated with the decrease of Net cash demand from 1.716 to 9.183 UAH, depending on the specification.

The impact is pretty big, given that the mean value of the dependent variable is 44.95 in our sample, implying that the semi elasticity of the interest rate varies from -3.4 to -21 percent. This is much higher than in the similar studies for Italy (-1.1 percent; Ardizzi et. al, 2013) and Australia (-1.3 percent; Cusbert and Rohling, 2013). The latter can be explained by the fact, that interest rates in Ukraine are much higher than in these advanced economies, therefore in the case of their increase, the opportunity costs of holding money are higher.

Table 2. Results from the static panel model

Variable/Model	Net cash demand		
	(OLS DK)	(OLS PSAR)	(FGLS PSAR)
Intercept	-12.490	-15.270	1.674
	(66.92)	(55.34)	(22.92)
Interest rate	-9.183***	-2.785	-1.746***
	(2.44)	(1.447)	(0.511)
Retail sales	0.024	0.050	0.006
	(0.073)	(0.048)	(0.014)
GTU	0.631**	0.038	-0.007
	(0.205)	(0.081)	(0.028)
Terminals	-427.100*	-695.700*	-356.000**
	(163.9)	(297.000)	(113.800)
Unemployment	0.005*	0.004	0.004***
	(0.002)	(0.002)	(0.001)
Drug-related crimes	-0.179	-0.037	-0.011
	(0.126)	(0.046)	(0.016)
Dummy on COVID	55.820	170.100***	143.300***
	(35.620)	(33.800)	(13.740)
Construction share	98.520***	75.500***	38.990***
	(19.350)	(16.330)	(6.926)

Table 2 – Continued

Variable/Model	Net cash demand		
	(OLS DK)	(OLS PSAR)	(FGLS PSAR)
Retail share	-11.880	6.419	14.500**
	(8.033)	(11.390)	(5.096)
Agri share	-40.970**	-3.921	19.130*
	(15.220)	(18.790)	(9.458)
Manufacture share	1.697	-0.726	2.249
	(13.650)	(14.980)	(6.953)
N	2400	2400	2400
R^2	0.761	0.633	-

Note: Robust standard errors in parentheses. * *p-value*<0.1, ** *p-value* <0.05, *** *p-value*<0.01.

OLS DK – Pooled OLS with Driscoll and Kraay standard errors, OLS PSAR – Pooled OLS with panel specific autocorrelation, FGLS PSAR – FGLS with panel specific autocorrelation

The coefficient on terminals are also significant for all specification and negatively associated with the demand for cash. This is consistent with the findings from other studies (Ardizzi et. al, 2013). An increase in the 1 terminal per 100K of the population is associated with the decrease in cash demand, which varies from 356 to 695.7 UAH. From the policy perspective it means, that in order to decrease the demand for cash, financial inclusion should be developed.

Impact of uncertainty was found to be positive, even though the GTU variable is significant only for the first specification. The coefficient implies, that increase in 1 unit of Google Trends Uncertainty index is associated with increase in per capita cash holdings on 0.631 UAH. Such an increase can take place during

recessions when people google words, they are uncertain about (e.g. COVID at the start of this pandemic and the exchange rate during the recession of 2014-2015 years).

As for Unemployment, this variable is significant as well. An increase in unemployment is associated with higher cash usage, which is also consistent with the literature. But it is worth mentioning, that despite the statistically significant coefficient the economic significance of this result is quite limited. Also, the 95 percent confidence interval for the coefficient includes zero for all of the specifications.

The impact of COVID, which is measured by the dummy variable, was found to be highly significant for all of the specifications. The magnitude of the coefficients is quite big as well, confirming the findings from the data of a substantial increase in the cash demand during the pandemic.

At the same time, this variable may capture potential omitted variables, which are not included, but affecting the demand for cash during the pandemic times and correlating with the explanatory variables. This may be attributable, among others, to the stringency of lockdown measures implemented by the government. While now the restrictions are more or less the same across all regions, at the start of the pandemic they differed across regions. Which in turn could have induced people to increase the cash holdings.

Employment variables have also some useful insights. For instance, construction share was found positively associated with the cash demand and the result is significant for all specifications. While this result differs from the findings of Bartzsch et. al (2019), who found that the impact of this variable is negative in the case of Germany, the results of Ardizzi et. al (2018) in the case of Italy suggest, that construction is positively associated with the cash usage.

Given that the construction sector can potentially be involved in the shadow

economy activities, our results for Ukraine are more relevant to compare with Italy, rather than Germany. The reasons that Italy has almost two times higher level of the shadow economy, than Germany (25 percent versus 12 percent; Medina and Schneider, 2018).

Also, the share of those, who employed in retail is positively associated with the cash demand, yet the result is significant only for the model, estimated by FGLS.

Share of employed in the agricultural sector is significant for the first and the last specification, yet the signs are different. The result from the first model is inconsistent with our expectations, implying that agricultural regions are likely to decrease the cash holdings.

5.2 Model with lags

In this section, we present the dynamic panel model. Since we are dealing with the monthly data of cash it is relevant to assume, that current values of cash can be somehow dependent from the past values. Thus, as a robustness check we include the model with lags as well.

The test was conducted for each of the regions separately. The formal tests support our assumption: for each of the region, at least one lag should be included. Since the optimal number of lags was different for each of the regions, the number of lags to include into the final model was taken as average of proposed by the several information criteria (AIC, SBIC, HQIC). As a result, we ended up with a lag of length 2.

The results from the second specification are presented in Table 3. As we can see, the two lags of the dependent variable are highly statistically significant for all of the specifications. Moreover, the coefficients are positive and do not differ much from each other with respect to the specification.

Table 3. Results from the dynamic panel model

Variable/Model	Net cash demand		
	(OLS DK)	(OLS PSAR)	(FGLS PSAR)
Intercept	0	-16.445	10.673
	-	(-33.232)	(-11.74)
Net cash demand$_{t-1}$	0.578***	0.597***	0.585***
	(0.047)	(0.046)	(0.021)
Net cash demand$_{t-2}$	0.217***	0.182***	0.197***
	(0.063)	(0.046)	(0.020)
Interest rate	-2.212	-2.961*	-1.940***
	(1.455)	(1.199)	(0.358)
Retail sales	0.066	0.061	0.026*
	(0.048)	(0.044)	(0.012)
GTU	0.152	0.165*	0.019
	(0.110)	(0.082)	(0.028)
Terminals	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.000)
Unemployment	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Drug-related crimes	-0.056	-0.077	-0.034*
	(0.056)	(0.044)	(0.014)

Table 3 – Continued

Variable/Model	Net cash demand		
	(OLS DK)	(OLS PSAR)	(FGLS PSAR)
Dummy on COVID	59.313	82.347***	104.447***
	(48.643)	(20.358)	(7.180)
Construction share	14.67	16.266*	5.643*
	(8.352)	(6.907)	(2.59)
Retail share	-3.905	-0.514	0.788
	(3.229)	(4.945)	(2.123)
Agri share	-6.785	-7.183	0.105
	(6.105)	(7.368)	(3.715)
Manufacture share	0.964	1.246	2.048
	(6.601)	(7.482)	(3.925)
N	2350	2350	2350
R^2	0.895	0.901	-

Note: Robust standard errors in parentheses. * *p-value*<0.1, ** *p-value* <0.05, *** *p-value*<0.01

OLS DK – Pooled OLS with Driscoll and Kraay standard errors, OLS PSAR – Pooled OLS with panel specific autocorrelation, FGLS PSAR – FGLS with panel specific autocorrelation

As for the explanatory variables, most of them turned out to be insignificant, comparing to the base model without lags. On the other hand, as in the static model, the interest rate was found to be significant and negatively related to the demand for cash, even though the magnitude of the coefficient decreased.

Construction sector retains positively related to the demand for cash, even though the significance level is now only 10 percent. As in the previous case, dummy on COVID is highly significant, and positively associated with the cash usage.

5.3 Estimation without Donetsk and Luhansk

It's is relevant to assume, that two regions in our sample can be considered as outliers. These are the Donetsk and Luhansk regions, which were severely hit by the war, and part of their territory has been occupied since April of 2014.

Therefore, we also present estimation without them. As in the previous sections, we first estimate the static panel model, after which the model with the lagged values of cash is presented as well.

5.3.1 Static panel model

The results on the estimated regressions are presented in the table below.

Obtained results are similar to those, estimated on the whole sample. Interest rate and the number of terminals are statistically significant and negatively associated with the demand for cash. The magnitude of coefficients is similar as well. On the other hand, the unemployment rate is no longer significant.

As in the previous section, uncertainty is positively related to the demand for cash only for the model, estimated with Driscoll and Kraay standard errors, while construction share and dummy on COVID are statistically significant for all of the specifications.

Table 4. Results from the static panel model (Donetsk and Luhansk are excluded)

Variable/Model	Net cash demand		
	(OLS DK)	(OLS PSAR)	(FGLS PSAR)
Intercept	79.368	0.000	105.415***
	(71.370)	-	(31.432)
Interest rate	-7.867***	-3.178*	-2.187***
	(1.921)	(1.483)	(0.541)
Retail sales	-0.005	0.021	-0.017
	(0.062)	(0.052)	(0.015)
GTU	0.670**	-0.014	-0.032
	(0.219)	(0.083)	(0.030)
Terminals	-580.156***	-731.361*	-466.354***
	(152.350)	(293.697)	(121.139)
Unemployment	0.001	-0.002	-0.000
	(0.002)	(0.004)	(0.001)
Drug-related crimes	-0.191	-0.038	-0.003
	(0.129)	(0.050)	(0.017)
Dummy on COVID	86.648*	212.960***	182.755***
	(34.878)	(34.838)	(15.196)
Construction share	141.179***	103.443***	46.579***
	(28.900)	(23.558)	(9.160)
Retail share	-5.272	10.120	9.203

Table 4 – Continued

Variable/Model	Net cash demand		
	(OLS DK)	(OLS PSAR)	(FGLS PSAR)
	(9.489)	(10.432)	(5.826)
Agri share	-45.046**	-7.454	16.676
	(14.630)	(18.440)	(9.424)
Manufacture share	4.586	3.002	0.472
	(13.129)	(17.208)	(6.933)
N	2208	2208	2208
R^2	0.767	0.647	-

Note: Robust standard errors in parentheses. * *p-value*<0.1, ** *p-value* <0.05, *** *p-value*<0.01

OLS DK – Pooled OLS with Driscoll and Kraay standard errors, OLS PSAR – Pooled OLS with panel specific autocorrelation, FGLS PSAR – FGLS with panel specific autocorrelation

Obtained results are similar to those, estimated on the whole sample. Interest rate and the number of terminals are statistically significant and negatively associated with the demand for cash. The magnitude of coefficients is similar as well. On the other hand, the unemployment rate is no longer significant.

As in the previous section, uncertainty is positively related to the demand for cash only for the model, estimated with Driscoll and Kraay standard errors, while construction share and dummy on COVID are statistically significant for all of the specifications.

5.3.2 Model with lags

The results from the model which includes lags of cash is presented in the table below.

Table 5. Results from the dynamic panel model (Donetsk and Luhansk are excluded)

Variable/Model	Net cash demand		
	(OLS DK)	(OLS PSAR)	(FGLS PSAR)
Intercept	57.414	0.000	28.150
	(54.215)	-	(15.464)
Net cash demand$_{t-1}$	0.574***	0.595***	0.588***
	(0.053)	(0.050)	(0.022)
Net cash demand$_{t-2}$	0.227**	0.189***	0.200***
	(0.068)	(0.049)	(0.022)
Interest rate	-1.809	-2.505*	-1.717***
	(1.391)	(1.222)	(0.388)
Retail sales	0.047	0.037	0.009
	(0.041)	(0.049)	(0.014)
GTU	0.153	0.154	0.008
	(0.117)	(0.086)	(0.030)
Terminals	-70.900	-50.636	-57.471
	(111.148)	(160.209)	(48.704)

Table 5 – Continued

Variable/Model	Net cash demand		
	(OLS DK)	(OLS PSAR)	(FGLS PSAR)
Drug-related crimes	-0.079	-0.102*	-0.040**
	(0.060)	(0.049)	(0.015)
Dummy on COVID	-97.928***	92.855***	115.380***
	(16.965)	(22.214)	(7.631)
Construction share	21.850	24.461*	7.258*
	(13.172)	(10.017)	(3.518)
Retail share	-2.565	1.620	0.094
	(3.756)	(3.981)	(2.357)
Agri share	-6.571	-7.141	-0.451
	(6.126)	(7.806)	(3.842)
Manufacture share	2.237	2.587	1.575
	(6.786)	(8.550)	(4.031)
N	2162	2162	2162
R^2	0.899	0.905	-

Note: Robust standard errors in parentheses. * *p-value*<0.1, ** *p-value* <0.05, *** *p-value*<0.01

OLS DK – Pooled OLS with Driscoll and Kraay standard errors, OLS PSAR – Pooled OLS with panel specific autocorrelation, FGLS PSAR – FGLS with panel specific autocorrelation

On the other hand, interest rate is found to be negatively associated with the cash usage, while the construction sector positively related to it in the two specifications.

Also, we obtained a significant and negative coefficient on the Drug-related crimes, but this result is not easily explained and consistent with the findings in the literature (Bartzsch et. al, 2019).

5.4 Limitations and drawbacks

It is conceivable, that study may have some limitations, due to which, variables expected to have an impact on the cash demand were found not to be significant.

First of all, some variables employed in the original paper are not available in the open access for Ukraine. The latter fact is attributable to the self-employment rate, which is not calculated on a regional basis. On the other hand, Bartzsch et. al (2019) found, that it has a significant and positive impact on the demand for cash (1 percent increase in the self-employment rate was associated with an increase in the cash usage on around 4 percent).

This variable potentially may correlate with the unemployment rate. Thus, not including it may cause an omitting variable bias affecting the significance and estimated coefficient of the unemployment rate. Also, as it was mentioned before, the shadow economy in Ukraine constitutes around 45 percent, therefore it's quite important to control for the variables related to it.

Secondly, the number of terminals that we used in the study for most of the observed period were interpolated from the quarterly data, meaning that for some of the periods we artificially created the data points. As a result, the negative impact of this variable dissipated, after we control for the lags of the dependent variable. On the other hand, the vast literature (Ardizzi et. al, 2018; Cusbert and Rohling, 2013) on the cash usage suggest, that higher financial inclusion is related negatively to the cash usage.

Chapter 6

CONCLUSIONS

The purpose of this research was to determine the factors, affecting the cash demand in Ukraine. In our analysis, we employed the panel framework and methodology of Bartzsch et. al (2019), exploring possible regional differences.

By this research, we contribute to the vast literature on the cash demand determinants, especially to the part, which is based on the regions inside the particular country. To our knowledge this is the first study on the structural determinants of cash demand in Ukraine.

Utilizing data from the National Bank of Ukraine we determined, that apart from conventional determinants, such as interest rate (which in line with the literature was found negatively related to it) there are several other factors affecting the demand for cash.

First of all, the share of employed in the construction sector was found positively related to the cash usage. This impact is not only statistically significant, but also it robust to different specifications and types of robust standard errors. This result implies, that regions with higher than average employment in the construction sector are associated with a higher demand for cash.

Secondly, the impact of COVID-19 (measured by the dummy variable) was found positive and statistically significant. This confirms the findings from the data of a substantial increase in the cash demand during the pandemic. It can also explain possible behavioral patterns and unobserved factors which impacted cash demand at the start of the pandemic, but which cannot be directly included in the model.

Thirdly, the impact of uncertainty was found to be positive as well. However, the result is sensitive to the specification and type of robust standard errors employed.

At the same time, some variables that were expected to have an impact on cash demand, and which are determined as the structural determinants of the cash usage by the literature were found to be insignificant. The latter fact can be explained by the data limitations.

The results of this study can be useful to both banks and the regulator (NBU). Banks can achieve better liquidity management, by allocating more cash into the regions with higher employment in construction. Given that the construction sector exhibits a double-digit growth in Ukraine over the last several years and was found to be a driver of the cash demand the NBU may consider it relevant to develop a policy, aimed to reduce cash usage among the businesses.

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APPENDIX

Table 6. List of words to construct GTU index

Minimization of exchange rate uncertainties	Britain's withdrawal from the EU
Increasing political uncertainty	Dynamics of commodity prices
Reduction of exports	Raising social standards
Political and economic risks	Pension payments
Capital outflow	Subsidies
Increasing demand for foreign currency	Cessation of trade with uncontrolled territories
Currency deficit	Weakening of the US dollar
Increased volatility	Euro
Weakening of the hryvnia	Tariff increase
Outflow of deposits	Tariffs for gas, heating, electricity
Reduction of real incomes	Food supply
Financial and geopolitical uncertainty	Harvest
Restrictions on withdrawal of deposits	Trade wars
Political uncertainty	Bringing natural gas prices for the population to market levels
Political reforms	Import parity
Removal of the President of Ukraine	Gas transit
Political instability	Rising energy prices
Debt crisis in Greece	Trade barriers
Events in the east	Geopolitical instability
Devaluation expectations	Growth in household consumption
Inflation expectations	Renewal of subsidies
Inflation	Pro-inflation risks
Decrease in income	High wage growth
Outflow of deposits	Continuation of cooperation with the IMF
Political uncertainty	Rising oil prices
Liquidity	Rising gas prices
Minsk agreements	Escalation in the Sea of Azov

Table 6 – Continued

External debt restructuring	External risks
Recession in Russia	Improving inflation expectations
US monetary policy	Political situation
Devaluation pressure	Escalation of the military conflict
Cash currency market	Gas transit
Decrease in export prices	Currency market
Devaluation pressure	Double elections
Slow budget process	Market pricing
Delay in official funding	Tariffs
Delay in resumption of cooperation with the IMF	Keeping tariffs below market levels
Political uncertainty	Successful cooperation with the IMF
Business expectations	Termination of transit
Britain's withdrawal from the EU	Structural reforms
Increasing the minimum wage	Pro-inflation risks
Election campaign in the United States	Manufacturers of tobacco products
Results of the constitutional referendum in Italy	Excise tax
Atomic weapons testing in North Korea	There is no market for financial instruments
BREXIT	OVDPs
Demand for currency	Uncertainty of the legislative field
Obtaining official external financing	Green energy
Exacerbation of the situation around Crimea and the east of the country	Alternative energy
Financial imbalances	Turbulence in the foreign exchange market
Low inflation	The spread of the virus
Macroeconomic policy	Panic in world markets
Structural reforms	Yield of OVDPs
Macrofinancial stability	The spread of coronavirus
Economy	Adaptive quarantine
IMF program	The situation with the coronavirus
Increasing the minimum wage	Reduction of investments

Table 6 – Continued

Budget deficit	Restrained fiscal policy
Administratively regulated tariffs	Terms of completion of quarantine measures
D. Trump's policy	Increase in social benefits
Exchange rate dynamics of the hryvnia	Consumer and business sentiment
Export receipts	Epidemic situation
Inflation and exchange rate expectations	Epidemiological situation
Inflationary pressure	Restraining demand growth
Escalation of hostilities in eastern Ukraine	Uncertainty of the legislative field for RES
Tariffs for gas and electricity	Development of a pandemic
Fiscal incentives	Regulatory field for alternative energy
Financing	