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The Effects of Negative Interest Rates on Cash Usage: Evidence for EU Countries

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Abstract

Changes in interest rates below the zero lower bound could have potential effects on the payments market by making cash more attractive for consumers as a medium of payment and wealth storage. This paper studies how cash usage has been affected by the recent introduction of negative interest rates in European countries. Using a difference-in-differences methodology over the period 2006 - 2018, results show an increase in cash usage in negative interest-rate environments. We also find that the increase in cash usage was less pronounced in countries with superior monitoring capacity of banks (i.e. high levels of financial intermediation).

Key Words: Negative interest rates, Europe, Cash, Bank monitoring, Financial intermediation.

1. Introduction

Negative interest rates policies (NIRP hereafter) have been introduced by several Central Banks in Europe to stimulate economies affected by the 2008 financial crisis, after conventional monetary policy options were ineffective. The aim of NIRPs was to increase lending and economic growth by taxing banks' excess reserves at the central bank, and has had consequences for banks' profitability (Molyneux et al. 2019; Boungou 2020) and systemic risk (Nucera et al. 2017).

NIRPs also served to further increase the interest on the likely impact of these policies on payments and the demand for cash (Humphrey 2016). A possible consequence of NIRPs is for consumers to rely more on paper-based currency (cash) than interest-bearing deposits, given that the opportunity cost of cash fundamentally vanished. The reason is that individuals can avoid being charged negative rates on deposits (e.g. by the introduction of higher fees linked to holding a deposit account) by choosing to hold cash instead, which has effectively a zero-interest rate. Such scenario could have negative consequences for the whole economy as migration from paper to electronic payments have been found to be relevant to support economic growth and investments (Humphrey et al. 2001; Humphrey et al. 2006). Against this background, the purpose of this paper is to analyse the effects of negatives interest rates on cash usage for transactions. Following Humphrey (2016), we study whether the recent introduction of NIRPs provided an incentive to consumers to increase their transactions demand for cash.

In order to assess the effect of NIRPs on cash usage, we use cross-country data gathered from publicly available sources (ECB, Eurostat and World Bank) during the period 2006-2018. Using a diff-in-diff methodological framework, the main results suggest that *(i)* countries experienced an increase in cash usage after the introduction of negative interest rates and *(ii)* the effect has been weaker for countries with high levels of financial intermediation and banks' monitoring advantage, arising from reduction of asymmetric information in the customer relations proxied by the aggregate level of lending and deposit-taking activities of banks.[1] Financial intermediation helps lower the costs of

[1] Fama (1985) expresses the advantage explicitly in terms of information arising from the bank's role as being book-keeper of payment transactions. Both loans and deposits are normally used in

information and transaction so it might allow savers to achieve better diversification and liquidity of their funds compared to cash.

Our work contributes to the payment literature in two ways. First, this is the first study to provide cross-country evidence of the effect of the introduction of NIRPs on cash usage and second, it studies how the strength of a country's financial intermediation can influence the transmission of negative rates to the retail payment market.

The paper is structured as follows. Section 2 presents a more detailed literature review. Section 3 presents the data and methodology. Section 4 presents our empirical results and Section 5 concludes the paper.

2. Background and literature review

Innovations in financial markets and information technology have transformed the way individuals pay during the last decade. In most of countries a migration of payments from cash to electronics is taking place, but cash is still a preferred payment instrument for low-value transactions (Bagnall et al. 2016).

The theoretical literature has paid special attention to the role of interest rates in the context of payments and, in particular, as a driver of cash holdings (Baumol 1952; Tobin 1956). Most of the empirical research up to day has been undertaken in an environment of positive interest rates. Amromin and Chakravorti (2009) finds that short-term interest rates are negatively associated with the demand of high-denomination currency holdings in a sample of OECD countries during the period 1988-2003. Deungoue (2008) finds that cash usage increased when the rate of current deposits went down from 8.37% to 2.18% during the period 1990 to 2002. Cash holdings may spill-over to the transactions demand for cash. Attanasio et al. (2002) find that deposit interest rates have a strong and significant effect on the fraction of income received in cash by consumers in Italy, where bank-deposits are interest-bearing and therefore a natural substitute to cash. Briglevics

literature as they capture the strength of financial intermediation from savers to investors. The framework is motivated by the effect of negative interest rates on banks' opportunity cost of accepting deposits (i.e. banks could lose their monitoring advantage as cash usage increases).

and Schuh (2013) shows that the decline in short-term interest rates to nearly zero could explain the increase in US currency ratios since 2000.

Despite the importance of payments for the economy, so far there has been no empirical analysis exploring (i) the effect of NIRPs (below the zero-lower bound) on cash usage and (ii) whether the relationship could be different depending on the financial intermediation (monitoring advantage). This paper attempts to fill these gaps and present new evidence about how demand for cash is affected in a context of negative rates.

3. Data and Methodology

3.1 Data

We examine the impact of NIRP on transactions demand for cash usage across 19 European countries over the period 2006-2018. We assemble a dataset from several sources (ECB, Eurostat and World Bank). Our sample of countries is divided into two subgroups: treated and control. Treated is the group of countries where negative rates have been implemented and conversely, control is the group of countries that have not adopted negative rates (See Table A1).

We measure cash usage using the residual approach that measures cash share as the difference between the value of household consumption and the value of all debit and credit card payments. We also use an adjusted version as a robustness check which excludes from household consumption any items that are usually paid by direct debit or transfer such as housing, utilities, education, health and financial services (Sisak 2011; Zhang et al. 2019).

In addition to the financial intermediation (measured by bank deposits and credit to the private sector as a percentage of GDP)), we control for a set of country-specific factors that are well known to influence cash usage. Previous research have shown there is significant variation of cash usage across countries due to payment infrastructure (e.g. POS and ATM terminals per 1,000 inhabitants) and socio-demographic characteristics (Boeschoten 1998; Koulayev et al. 2016). Therefore, we control for education level, urban population, age dependency ratio, GDP per capita and rule of law, capturing confidence in and abide by the rules of the country as the environment in which individuals make transactions. Definitions and summary statistics are reported in Tables A2-A3.

3.2 Methodology

To examine the effect of NIRPs on cash usage, we use a Difference-in-Differences (DiD) methodology. We compare the effects of NIRPs on cash usage for a treatment group of countries (Treated) with a control group of countries (Control) unaffected by NIRP.[2] Eq. (1) summarizes our baseline model:

$$Cash_{i,t} = \alpha + \alpha_1 \underbrace{(Treated_i * Post_t)}_{NIRP-Effect} + \alpha_2 X_{i,t} + \theta_t + \gamma_i + \varepsilon_{i,t} \quad (1)$$

where $Cash_{i,t}$ is the cash share in country *i* at time *t*, $Treated_i$ is a dummy variable that takes the value 1 if country *i* has been affected by NIRP and 0 otherwise, $Post_t$ is a dummy variable that takes the value 1 after the period that country *i* at time *t* decided to implement NIRP and 0 before that period, and α_1 represents the average cash usage between treated countries that switched to NIRP and control countries that didn't lower interest rates below zero (*NIRP-Effect*).[3] Our empirical specification also includes a vector of control variables ($X_{i,t}$) described in the previous Section, year (θ_t) and country (γ_i) fixed effects to limit the potential for bias in estimates of α_1. Standard errors are robust and clustered at country level, allowing for correlation in the error terms (Bertrand et al. 2004).

4. Results

Table 1 presents our main results. Our DiD estimator (NIRP-Effect) is found to be positive and significant across models, showing that the increase in cash usage has been higher in countries where NIRPs have been implemented compared to the control group not affected by negative rates. This result remains unchanged after considering different sub-samples and additional covariates (See Table A5).

[2] Table A4 shows sample test of means and correlation coefficients for GDP growth and Inflation in the treatment and control countries. Results suggest that the control group is a valid counterfactual for the treatment group.

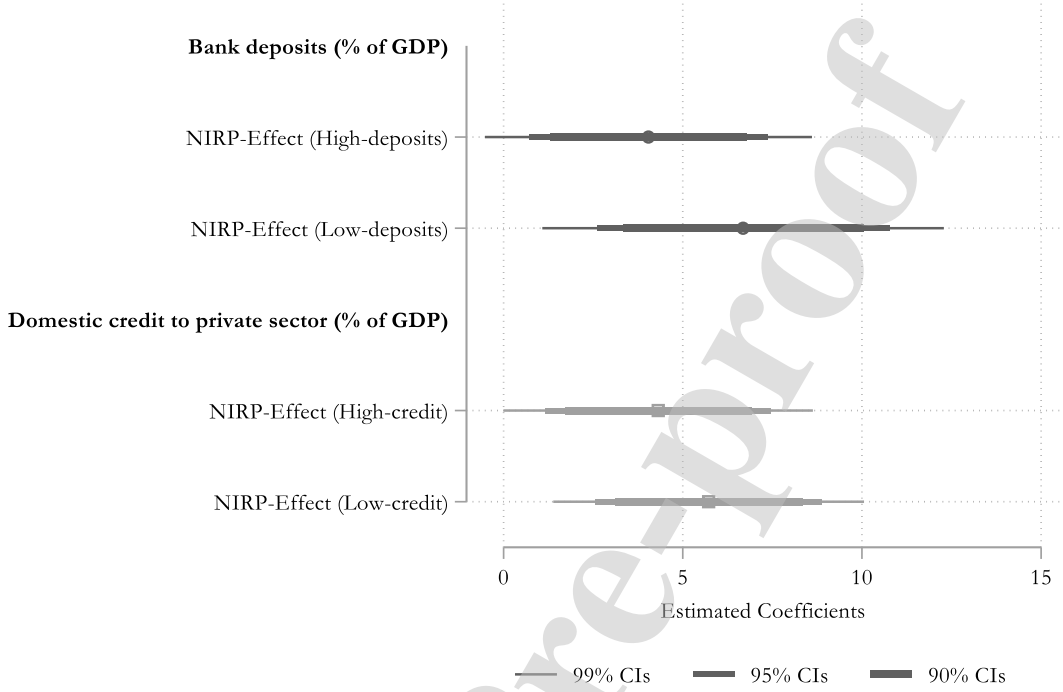
[3] The majority of NIRP countries in our sample introduced NIRP in 2014, hence $Post_t$ takes the value 1 from 2014 year-end, except for Sweden that introduced NIRP in 2015. In this case, $Post_t$ is equal to 1 from 2015 year-end.

Dependent variable:	CASH (a)								CASH (b)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DiD (NIRP-Effect)	3.140**	3.318**	3.715**	3.705***	3.749***	3.667***	2.982**	5.304***	8.439***
	(1.189)	(1.261)	(1.418)	(1.185)	(1.286)	(1.014)	(1.214)	(1.318)	(2.218)
ATM_P		1.512						0.0854	0.809
		(3.341)						(5.168)	(7.341)
EDU			-0.212					-0.365	-0.685
			(0.342)					(0.394)	(0.537)
URB				-0.602				-0.380	-0.406
				(0.746)				(0.568)	(0.925)
AGE_DEP					0.625			0.459	0.480
					(0.637)			(0.426)	(0.600)
GDP_PC						-0.444***		-0.444***	-0.844***
						(0.124)		(0.0997)	(0.118)
RL							-2.494	-2.602	-3.848
							(4.774)	(3.550)	(4.369)
Constant	78.64***	77.51***	88.67***	122.3**	63.91***	90.71***	81.86***	128.0**	147.3*
	(1.020)	(2.791)	(16.48)	(54.38)	(15.09)	(3.218)	(6.243)	(53.90)	(79.35)
Observations	246	246	246	246	246	246	246	246	233
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-square: overall	0.125	0.116	0.00671	0.239	0.108	0.258	0.230	0.151	0.137
R-square: within	0.743	0.744	0.748	0.749	0.752	0.788	0.744	0.808	0.816
Wald test	225.9***	232.9***	219.5***	636.8***	160.9***	417.2***	274.5***	132.2***	183.3***

Note: Fixed-effects regression. NIRP-effect is the interaction between the dummy Treated and the dummy Post. It takes the value 1 if country *i* has been affected by NIRP after NIRP implementation, 0 otherwise. All regressions include fixed country and time effects. Robust standard errors clustered at country level in parenthesis. ***, ** and * indicate statistical significance at 1%, 5% and 10%, respectively.

Table 1. The effect of NIRP on cash usage

Figure 1 illustrates the estimated coefficients according to the level of lending and deposit-taking activity (low or high based on whether the country is below or above the sample median value). Full results are available in Table A6. Results suggest that countries characterized by low levels of financial intermediation (i.e. low lending and deposit-taking activity) in which NIRPs have been implemented, have experienced high increases of cash usage compared to countries with a higher level of financial intermediation. This suggest that strong financial intermediation mitigates the effects of NIRP on the incentives of depositors to substitute card transactions for cash.



Note: This Figure shows estimated coefficients and confidence intervals (CIs) from models reported in Table A6.

Figure 1. Estimated coefficients of the effect of NIRP and he strength of financial intermediation on cash usage

5. Conclusions

A relevant question from a payment systems perspective is whether NIRPs could change cash usage behaviour. This paper attempts to fill this gap and present new empirical evidence based on sample of cross-country data during the period 2006-2018.

Our results indicate that countries where negative interest rates have been implemented, have observed an increase in cash usage. We also find that the increase on cash usage is less pronounced in countries characterized by high levels of financial intermediation and superior monitoring capacity of banks.

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Appendix

Country name	Country code	NIR adoption date
Austria	AT	Jun-14
Belgium	BE	Jun-14
Czech Republic	CZ	-
Germany	DE	Jun-14
Spain	ES	Jun-14
Estonia	EE	Jun-14
Finland	FI	Jun-14
France	FR	Jun-14
United Kingdom	GB	-
Greece	GR	Jun-14
Ireland	IE	Jun-14
Italy	IT	Jun-14
Luxembourg	LU	Jun-14
Netherlands	NL	Jun-14
Poland	PL	-
Portugal	PT	Jun-14
Slovak Republic	SK	Jun-14
Slovenia	SI	Jun-14
Sweden	SE	Feb-15

Notes: The majority of NIRP countries in our sample introduced NIRP in 2014, hence the post-intervention period starts from 2014. However, the post-intervention dummy is set to 1 at 2015 for Sweden since it introduced NIRP in 2015.

Table A1. List of countries and adoption dates of NIRs

Variable	Definition	Source
CASH (a)	(Consumption – Value all card transactions)/Consumption.	ECB/Eurostat
CASH (b)	(Adjusted consumption – Value all card transactions) / Adjusted Consumption	ECB/Eurostat
ATM_P	ATMs per 1,000 inhabitants.	ECB/Eurostat
EDU	Upper secondary and post-secondary non-tertiary education (% pop 25-64)	Eurostat
URB	Urban population (% of total population).	World Bank
AGE_DEP	Age dependency ratio, old (% of working-age population).	World Bank
GDP_PC	GDP per capita at market prices (EUR Thousands)	ECB/Eurostat
RL	Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.	World Bank/WGI

Notes: Adjusted consumption is computed as total final consumption of households from Eurostat less expenditures on Housing, water, electricity, gas and other fuels (CP04), health (CP06), education (CP10) and insurance and financial services (CP125 and CP126).

Table A2. Variable definition

Variable	Mean	SD	P5	P50	P95	Min	Max	N
CASH (a)	71.18	14.39	47.11	71.23	92.29	38.78	95.71	246
CASH (b)	58.68	20.75	23.43	60.13	90.30	14.08	93.70	233
ATM_P	0.80	0.35	0.34	0.80	1.45	0.26	1.67	247
EDU	46.55	14.72	21.60	42.40	72.70	13.70	76.80	247
URB	73.64	12.59	53.81	76.38	97.45	51.76	98.00	247
DEP	26.16	4.62	17.66	26.66	33.06	15.30	35.59	247
GDP_PC	30.61	17.16	10.68	30.33	71.49	7.20	98.64	247
RL	1.31	0.53	0.40	1.39	1.97	0.08	2.10	247

Table A3. Descriptive Statistics

	GDP per capita growth (annual %)	Inflation, consumer prices (annual %)
Control (Mean)	3.42	2.09
Control (Std. Err.)	1.33	0.23
Treated (Mean)	2.51	1.66
Treated (Std. Err.)	0.37	0.11
t-statistic	0.66	1.67
Ho: diff = 0, Ha: diff ≠ 0	0.51	0.10
N	228	247
Pairwise correlations (treated and control groups)	0.8873***	0.8751***

Notes: diff = Mean (Control) – Mean (Treated), ***, ** and * indicate statistical significance at 1%, 5% and 10%, respectively.

Table A4. Two-sample t-test with unequal variances and Pearson correlation test for the control and treatment group

	Excluding Sweden	Sample: Post-2007	Non-clustered SEs	Additional Control variables			
	(1)	(2)	(3)	(5)	(6)	(7)	(8)
DiD (NIRP-Effect)	5.096***	4.399***	5.304***	3.977***	3.928**	3.214**	4.394***
	(1.514)	(1.300)	(1.038)	(1.275)	(1.630)	(1.491)	(1.434)
Internet Banking (% population)				-0.260***			
				(0.0860)			
POS (per 1,000 individuals)					-0.190*		
					(0.0957)		
E-commerce (% population)						-0.0892	
						(0.0998)	
Control of Corruption							-4.218
							(2.772)
Constant	135.5**	108.4*	128.0***	150.8**	117.8*	145.5***	138.0**
	(54.25)	(55.28)	(18.65)	(54.44)	(59.38)	(44.77)	(54.61)
Observations	233	208	246	245	240	132	246
Country FE	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES
Full set of Controls	YES	YES	YES	YES	YES	YES	YES
R-square: overall	0.165	0.0516	0.151	0.235	0.208	0.135	0.199
R-square: within	0.820	0.815	0.808	0.827	0.822	0.821	0.813
Wald test	373.7***	96.87***	46.14***	1258***	47.80***	256.7***	158.1***

Note: Fixed-effects regression. NIRP-effect is the interaction between the dummy Treated and the dummy Post. It takes the value 1 if country *i* has been affected by NIRP after NIRP implementation, 0 otherwise. Full set of controls include all variables reported in Table 1 (model 8) Percentage of individuals using internet for banking activities and e-commerce is retrieved from Eurostat (E-banking and e-commerce database - isoc_bde15cbc). The number of Point of Sale (POS) terminals is retrieved from the ECB. Control of corruption is gathered from the World Bank and captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. All regressions include fixed country and time effects. Robust standard errors clustered at country level in parenthesis. ∗∗∗, ∗∗ and ∗ indicate statistical significance at 1%, 5% and 10%, respectively.

Table A5. The effect of NIRP on cash usage (CASH (a)) - Robustness checks

	Dependent variable: CASH (a)	
NIRP-Effect (High- Bank deposits (% of GDP))	4.042**	
	(1.575)	
NIRP-Effect (Low- Bank deposits (% of GDP))	6.683***	
	(1.933)	
NIRP-Effect (High- Domestic credit to private sector (% of GDP))		4.315**
		(1.499)
NIRP-Effect (Low- Domestic credit to private sector (% of GDP))		5.722***
		(1.507)
ATM_P	0.600	0.182
	(4.991)	(5.183)
EDU	-0.385	-0.343
	(0.357)	(0.400)
URB	-0.0755	-0.195
	(0.555)	(0.514)
AGE_DEP	0.326	0.461
	(0.411)	(0.382)
GDP_PC	-0.464***	-0.420***
	(0.0723)	(0.0924)
RL	-4.335	-3.318
	(3.456)	(3.659)
Constant	113.1**	113.6**
	(53.07)	(54.07)
Observations	233	246
Country FE	YES	YES
Year FE	YES	YES
R-square: overall	0.117	0.145
R-square: within	0.818	0.810
Wald tests (p-value)	91.05***	90.92***

Note: Fixed-effects regression. NIRP-effect is the interaction between the dummy Treated and the dummy Post. It takes the value 1 if country *i* has been affected by NIRP after NIRP implementation, 0 otherwise. All regressions include fixed country and time effects. Robust standard errors clustered at country level in parenthesis. ***, ** and * indicate statistical significance at 1%, 5% and 10%, respectively.

Table A6. The influence of NIRP on cash usage by splitting the sample based on aggregate deposits and credit