

Die Hochschule im Dialog:

Resilience and the Cash Infrastructure:
The Role of Access, Acceptance, Availability, and
Affordability

Gerhard Rösl
Franz Seitz

Resilience and the Cash Infrastructure: The Role of Access, Acceptance, Availability, and Affordability*

Gerhard Rös# & Franz Seitz+

#) Technical University of Applied Sciences
(OTH) Regensburg
Seybothstrasse 2
D-93053 Regensburg
Germany
email: gerhard.roesl@oth-regensburg.de

+) Technical University of Applied Sciences
(OTH) Weiden
Hetzenrichter Weg 15
D-92637 Weiden
Germany
email: f.seitz@oth-aw.de

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Abstract:

We analyze the role of a well-functioning cash infrastructure for the stabilizing role of cash and the resilience of cash cycles. For that purpose, experiences from developed countries with low and high cash usage are assessed by distinguishing between demand and supply factors to demonstrate that cash has to keep a vital role as a means of payment not only to maintain its status of a highly liquid store-of-value but also as an efficient tool to combat crises. To do so, access, availability, acceptance, and affordability of cash are crucial building blocks of a robust cash infrastructure. Important aspects are also the public good characteristics of the “institution” cash which should encourage central banks to re-evaluate their position of “neutrality” as a player in the payments market to a more active role.

JEL: E41, E51, E58, O57

Keywords: Cash, banknotes, ATM, cash infrastructure

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Deutscher Abstract:

Wir analysieren die Rolle einer gut funktionierenden Bargeldinfrastruktur für die stabilisierende Rolle von Bargeld und die Resilienz des Bargeldkreislaufs. Zu diesem Zweck werden Erfahrungen aus entwickelten Ländern mit geringer und hoher Bargeldnutzung ausgewertet und zwischen Nachfrage- und Angebotsfaktoren unterschieden. Es wird abgeleitet, dass Bargeld als Zahlungsmittel wichtig ist, damit es als hochliquides Wertaufbewahrungsmittel fungieren kann und als effizientes Instrument zur Krisenbekämpfung zur Verfügung steht. Dementsprechend sind Zugang, Verfügbarkeit, Akzeptanz und Erschwinglichkeit von Bargeld entscheidende Bausteine einer robusten Bargeldinfrastruktur. Wichtige Aspekte sind auch die Öffentliches-Gut-Eigenschaften der „Institution“ Bargeld, die impliziert, dass Zentralbanken ihre „neutrale“ Position als Akteur im Zahlungsverkehr überdenken sollten, um eine aktivere Rolle bei der Unterstützung von Bargeld einzunehmen.

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I. Introduction

Recent studies (Rösl & Seitz, 2024; 2022b; 2021; Deutsche Bundesbank, 2024a; Judson, 2024; Pietrucha, 2021) show that cash demand typically increases in times of uncertainty regardless of the type of crisis. The nature of the crisis, however, determines which banknote denominations are demanded. In tendency, if the cashless payment infrastructure is in jeopardy, for instance, due to computer bugs, possible energy black-outs or natural disasters, people demand more small banknote denominations to ensure their ability to pay (transactional motive). By contrast, in times of confidence crises, such as financial crises, and political turmoil, the increase in cash demand is mainly concentrated on larger denominations as the desire for a highly liquid store-of-value typically grows (non-transactional motive). Consequently, central banks can strengthen the resilience of the economy by a fully elastic provision of cash (Rösl & Seitz, 2022a). The stabilizing role of cash in times of crisis can only work smoothly, however, if cash is used as a means of payment also in normal times so that the population is still accustomed to banknotes and coins in its payment habits. In addition, there must be a robust cash infrastructure to ensure a well-functioning cash cycle to meet the demand for cash very quickly if needed. This also implies safeguarding access to and acceptance of cash as well as availability of all denominations and affordability, i. e. not too high costs of cash usage.¹ These topics are the focus of the present study.

The paper is structured as follows. In chapter two, we provide a short overview on global cash in circulation and analyze the driving factors behind the declining use of cash at the point of sale (POS) in developed countries. In addition, we discuss why it is important to keep cash as a vital means of payment to maintain or even increase the resilience of the payment infrastructure especially in times of crisis. Chapter three presents a stylized view on the cash cycle with the main players involved. Chapter four discusses the four A's of the cash cycle (Access, Acceptance, Availability, Affordability) which constitute and provide the basis for a robust cash infrastructure. In chapter five, we emphasize the public good characteristic of the

¹ In June 2023 the Deutsche Bundesbank even organized a symposium on the topic "Secure cash supply - even in times of crisis", see <https://www.bundesbank.de/de/service/termine/sichere-bargeldversorgung-auch-in-der-krise-908504>. A similar initiative was launched in Austria by of the Austrian National Bank in cooperation with the Austrian Civil Protection Association, see <https://www.zivilschutz.at/bargeld-fuer-alle-faelle/>.

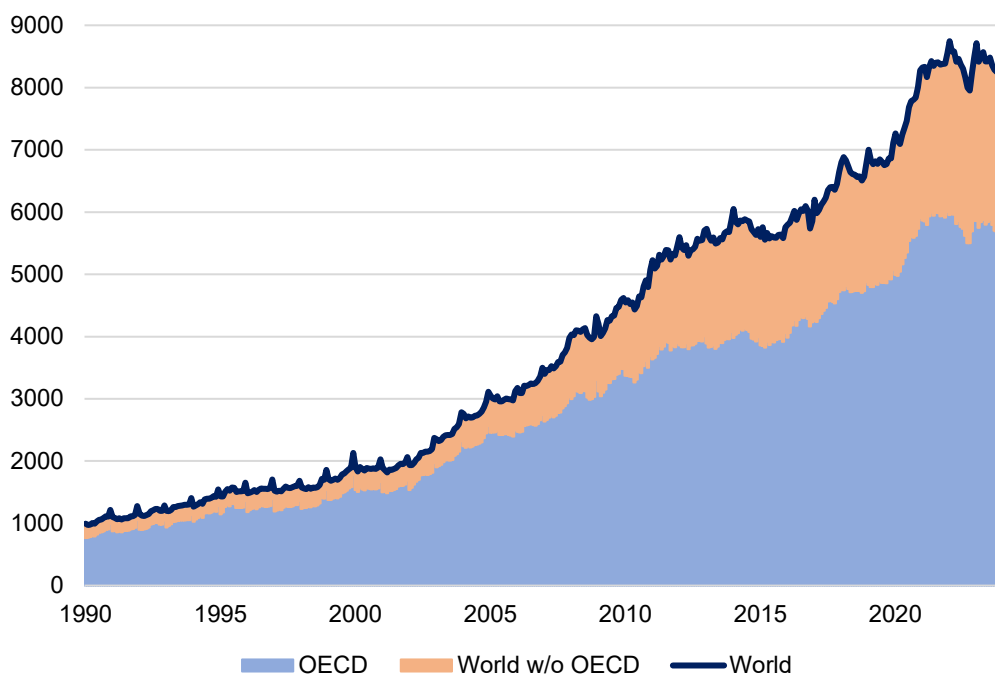
“institution cash” and ask if the so-called “neutral stance” of central banks² about cash as a means of payment is appropriate. Chapter six summarizes and concludes.

II. Cash in circulation in developed countries

II.1 Overview

Contrary to the popular notion that “cash is dead” (Longchamp, 2024), banknotes and coins are still highly in demand all around the world since “global cash” issuance continued to increase very robustly over the last decades, both in the developed and in the developing regions (see figure 1 as well as, inter alia, Heinonen, 2022; Rösl & Seitz, 2021; Zamora-Pérez, 2021; Ashworth & Goodhart, 2020; Jobst & Stix, 2017).

Figure 1: Global cash in circulation (US-Dollar billion)



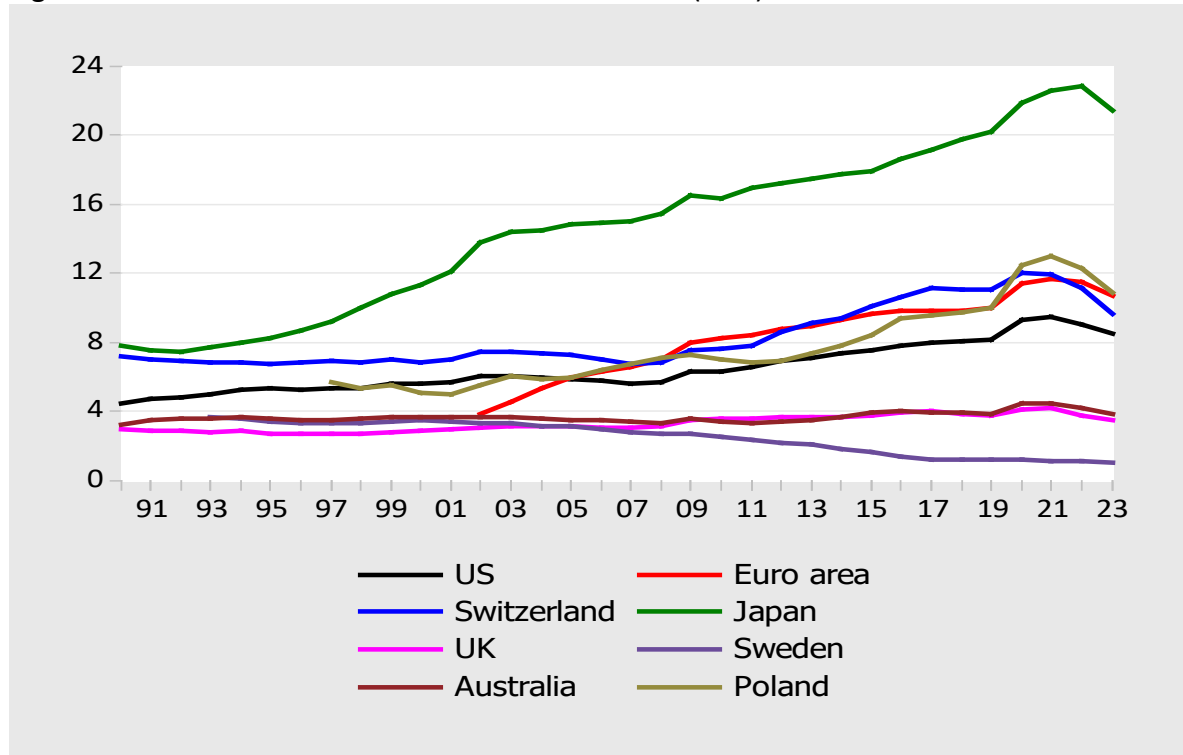
Notes: Data refer to cash or banknotes in circulation of 42 countries or currency areas. Sample period: 1990.01-2023.12. National figures converted in US dollar by using current exchange rates.

Source: National central banks, Monnaie de Paris.

In addition, cash in circulation increased even relative to nominal GDP in most parts of the developed world at the same time (see figure 2).

² See, for instance, Thiele (2018, 90f.).

Figure 2: Cash in circulation relative to nominal GDP (in %)



Source: National central banks.

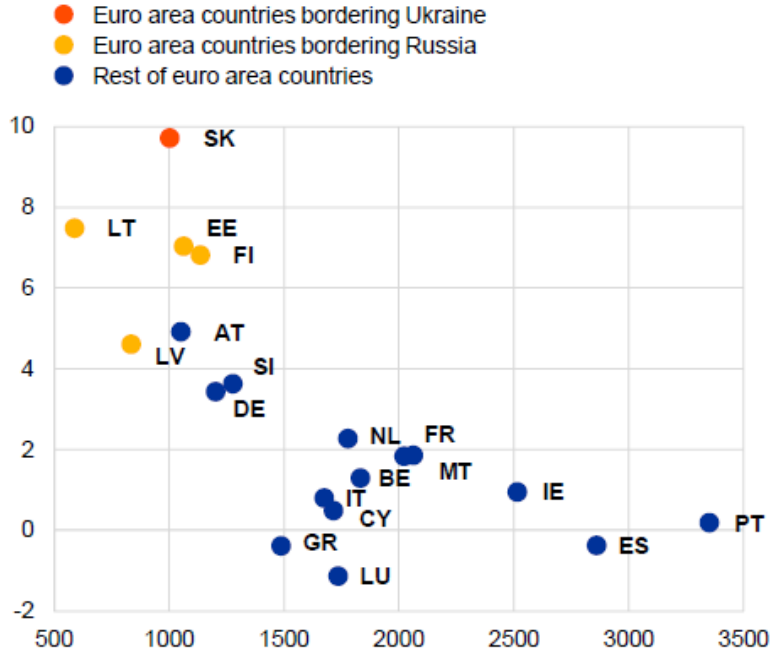
This ratio only declined in the past two years, mainly due to steeply rising prices as well as increasing interest rates and does not reflect a general decline in cash demand. To the contrary, even in low cash countries like the Scandinavian or the Baltic countries, the demand for cash increased drastically after Russia’s full-scale invasion of Ukraine in early 2022 (Norges Bank, 2023; Beckmann & Zamora-Pérez, 2023; Bank of Finland, 2023; Denmark’s Nationalbank, 2023; Sveriges Riksbank, 2022; Bank of Lithuania, 2022). Unsurprisingly, the closer a country is to the war theater, the higher the demand for cash (see figure 3).

The use of physical payment instruments such as cash and checks, however, decreased notably over the past decade in favor of digital payment instruments (see figure 4) creating the so-called “cash paradox” (Zamora-Pérez, 2021; Pietrucha, 2021; Ashworth & Goodhart, 2020; Gresvik & Kaloudis, 2001). It is well-known that this puzzle can be solved by emphasizing non-transactional motives and store-of-value purposes for holding cash (see, for instance, Deutsche Bundesbank, 2022a).³

³ By investigating the denominational structure of euro cash, Rösl & Seitz (2022c) show that the scope of the store-of-value function of euro banknotes has widened over time towards lower denominations.

Figure 3: Cash demand and the war in Ukraine

(x-axis: distance in km from the country's capital to Kyiv; y-axis: standard deviations from historical average)



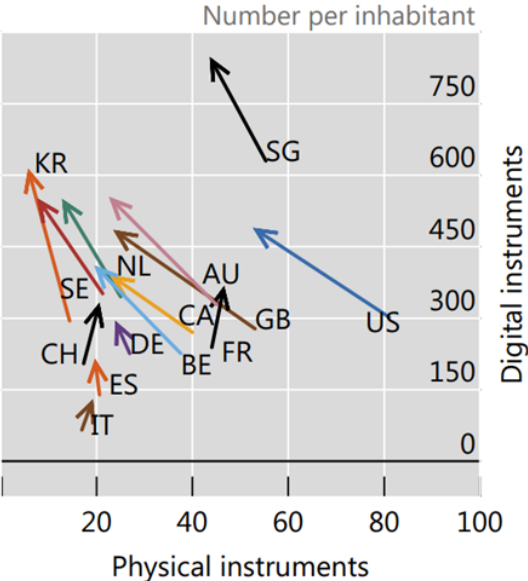
Source: Beckmann & Zamora-Pérez (2023, 38).

At any rate, the declining role of cash at the POS in developed countries is broadly confirmed by payment surveys and statistics (Khiaonarong & Humphrey, 2023). In the euro area, for instance, the share of cash payments at the POS in terms of volume (value) has declined on average from 79% (54%) in 2016 to 59% (42%) in 2022 (ECB, 2022, 12). However, cash was with 59% of transactions still the most frequently used payment method at the POS. But in terms of value, cashless payments with 58% surpassed payments in cash (42%) for the first time although there remain considerable differences in national payment habits among euro area member states (Meyer & Teppa, 2024; Groupe BPCE, 2023; De Nederlandsche Bank, 2023b; ECB, 2022; Deutsche Bundesbank, 2024). The Swiss National Bank also conducted several surveys in 2017, 2020 and 2022 on the payment methods of private individuals. In their latest survey of 2022 (Swiss National Bank, 2023) they found that the shift from cash to cashless payment methods is continuing, albeit at a slower pace than in previous years (2017, 2020).⁴ The trend toward digital payments is more pronounced in the United Kingdom where

⁴ In the three survey years, cash usage has declined from 70% (2017) to 43% (2020) and further to 36% (2022). Graf et al. (2024) estimate that the value share of cash in Switzerland decreased by 50% from 26% in 2019 to around 13% at the end of 2023. Most of the Swiss population, however, would like the option of using cash to remain unchanged in the future. Even those survey respondents who make little use of cash themselves still prefer it to be available (Swiss National Bank, 2023). See in the same spirit Deutsche Bundesbank (2024b, 51)

cash payments declined from 55% in 2011 to 15% in 2021 (UK Finance, 2022, 4). A slower, but nonetheless continuing declining trend is also present in Australia. The sixth triennial consumer payments survey (since 2007) of the Reserve Bank of Australia reveals a cash share falling from around two-thirds (nearly 40%) in 2007 to 13% (8%) in volume (value) terms in 2022 (Livermore et al., 2023). The same is true for China where cash accounted in 2017 for 21% and in 2022 only for 8% of all payments at the POS (Statista, 2024). Even in Japan, where 65% of all payments at the POS are still made in cash, the share of cashless payments increased from 13% in 2010 to 35% in 2022.⁵

Figure 4: Change in use of digital versus physical payment instruments from 2012 to 2019



Source: Boar & Wehrli (2021).

In the US, however, the declining trend of cash usage from 31% of all payments in 2016 to 18% in 2022 seems to have somewhat slowed down lately (Cubides & O’Brien, 2023, 6; Federal Reserve Board, 2022). A similar trend is discernible in Canada where the volume shares of cash declined from 2009 to 2020 from 54% to 21% and stayed roughly at that level in the following years. Interestingly, the value shares also fell from 2009 to 2020, from 23% to 9%, but increased afterwards again to nearly 13% in 2022 (Henry et al., 2024).

Of special interest are countries with already extraordinary low levels of currency in circulation, like Sweden and Norway. In their surveys on the payment habits, the Sveriges Riksbank (2024b) and Norges Bank (2023) ask the question “How did you pay for your last

whose latest payment survey of 2023 shows that around 75% of the respondents wish to continue their current cash usage or even increase it in the next 5 to 15 years.

⁵ <https://flow.db.com/cash-management/japan-joins-the-journey-to-a-cashless-society>

purchase in a shop?”. The share of respondents answering “by cash” fell from 23% in 2014 to 10% in 2023 in Sweden, with a slight increase from 2022 to 2023. The respective figures for Norway reveal a fall from 11% in 2017 to 3% in 2023.⁶ Also Denmark saw a declining trend in cash usage bottoming out in the last years. The volume (value) share of cash in store-based trade decreased from 23% (16%) in 2017 to 11% (9%) in 2023 (Denmark’s Nationalbank, 2023). To summarize, although total cash demand (including cash holdings as a store-of-value) increased in tendency over the past decades and especially in times of crisis, a huge variety of payment statistics, surveys and economic studies confirms that the use of cash as a means of payment is on a declining trend in the developed world. By contrast, the global cashless payment volume increased by 60% from 2016 to 2019 in a quite steady fashion even before the pandemic started (Capgemini, 2023). In the following chapter, we analyze the main determinants of this remarkable decline in cash use at the POS.

II.2 Factors driving the declining role of cash at the POS

From a theoretical point of view, one can easily distinguish between demand and supply factors to explain the declining importance of cash as a means of payment. In practice, however, identifying those factors is challenging as only the respective equilibrium values (which are determined by demand and supply factors at the same time) can be observed. Nonetheless, the next section intends to structure the discussion by using a supply and demand framework.

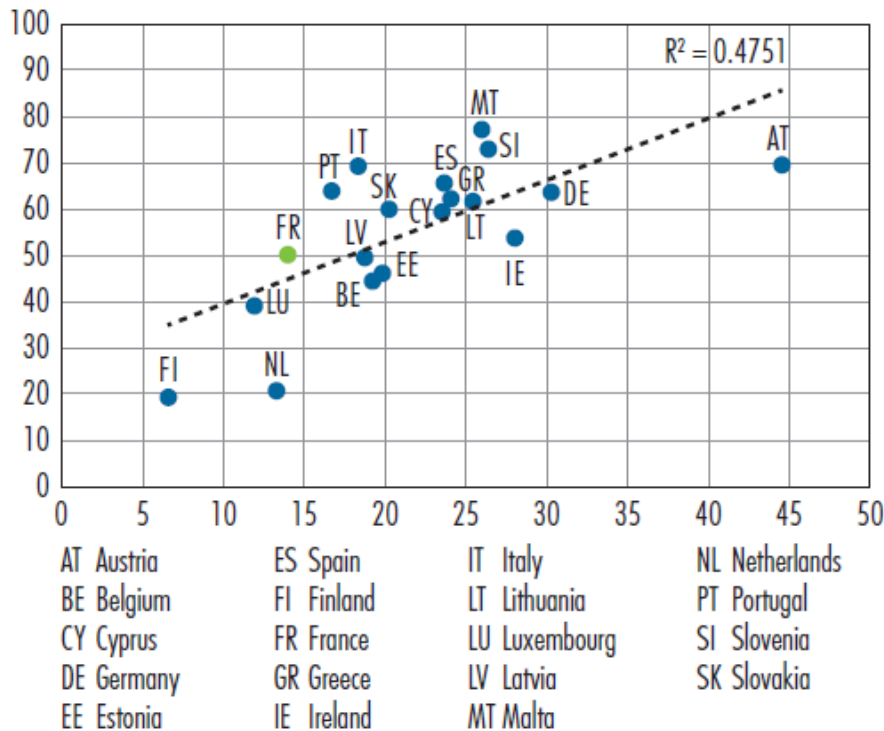
II.2.1 Demand factors

A way to find out why some customers prefer cards or mobile payments over cash at the POS are payment surveys. As shown in figure 5, however, the correlation between the preference for cash in the euro area countries stated in the ECB survey and the actual use of cash is just under 50%. This quite low figure indicates that either the “stated preferences” in the survey are not the “real preferences” of the customers and/or that buyers cannot realize their preferred payment pattern in practice due to lack of sufficient supply (see also De Nederlandsche Bank, 2023b). Take, for instance, Italy and Austria. Both countries have the same usage of cash at the POS of 70% but huge differences in their stated preferences for cash

⁶ In value terms, the Norwegian cash share at the POS stood at 2% in 2023.

(around 18% in Italy and just below 45% in Austria). Or take the Netherlands and France with nearly the same preference for cash, but a huge difference in cash payments.

Figure 5: Preference for and use of cash



Notes: x-axis: share of households surveyed preferring cash (%); y-axis: share of POS payments made in cash (volume terms, %)

Source: Des Bauvais (2023, 6).

When interviewees were, however, asked by the ECB “If you were offered various payment methods in a shop, what would be your preference?” “cash” as an answer showed on average a steady decline – from 32% in 2016 down to 27% in 2019 and 22% in 2022 although in some countries stated cash preferences increased since 2019.⁷ Nonetheless, 60% of the euro area population considered having the option to pay with cash to be “very” or “fairly important” although the age group of the 18 – 24-year-olds was with 54% slightly below the average (Des Bauvais, 2023; ECB, 2022,39).⁸

Payment surveys are also used to find out the motivation why cash continues to lose importance at the POS. For instance, respondents declared when asked by the ECB what the top three advantages of payment cards, especially contactless cards, are that they enable

⁷ These countries are Belgium (up 9 percentage points), Estonia (up 7 percentage points), France (up 5 percentage points), Austria (up 3 percentage points) and Slovenia (up 2 percentage points), see ECB (2022, 41).

⁸ In a recent German study (see Knümann et al., 2024) cash achieves the lowest popularity ratings in the group of 30 to 44-year-olds, not the youngest surveyed people.

them to not carry lots of cash, others emphasized that card payments are quicker and easier than using physical money (ECB, 2022, 44). Similar results prevail in other countries, see Deutsche Bundesbank (2024b) for Germany, Henry et al., (2024, 12) for Canada and Coletti et al., (2023, 17f.) for Italy.

In addition, the outbreak of the corona virus accelerated cashless payments in developed countries significantly (Deutsche Bundesbank, 2022a; ECB, 2022; UK Finance, 2022; Ardizzi et al., 2020) when government recommendations and unsubstantiated fears of contagion (Tamele et al., 2021; Auer et al., 2020) encouraged customers not to use cash.⁹ Consequently, Worldpay (2024) finds that the value share of global cash transactions fell from 32% in 2017 to 16% in 2023 and forecast a further drop to 11% in 2027. In one of the first surveys after the pandemic years 2020 – 2022, Knümann et al. (2024) interestingly find that the German population's most preferred means of payment in 2023 was again cash, closely followed by the debit card. The first preference for cash is surprising as cash payments lost popularity during the pandemic beyond the trend decline (see e.g. Coletti et al., 2023; Deutsche Bundesbank, 2022b, 26). However, it coincides with a survey conducted by YouGov on behalf of Utimaco in 2023 (Utimaco, 2023).

Part of the decline in cash usage at the POS might also be attributed to incentive programs such as bonus points, retailers and Payment Service Providers (PSP) offer customers (and retailers) for cashless payments.¹⁰ Okina (2022) finds evidence that loyalty point systems are indeed one reason for the increased ratio of cashless consumer spending in Japan in recent years. In 2019, the Japanese government even introduced a temporary program to offer points redeemable for future discounts to customers who use cashless payments which increased the number of card users by 9-12% (Sekine et al., 2022). Already at the beginning of this century, South Korea successfully incentivized consumers with tax deductions and a lottery system to use cashless payment media more intensively (World Bank, 2020, 30). Similar results seem to be present in Greece. Panagiotidis (2019) reports of a popular lottery which pays out €1,000 each for 1,000 persons per month who use electronic payments at the POS.

What might also be an important demand determinant is the information available on the characteristics of different payment options. Jonker et al. (2015) assess the impact of a

⁹ Interestingly, in the UK 15% of the population were using cash more due to the pandemic (Hall et al., 2022).

¹⁰ In the US, there are even rankings on the best reward programs for credit cards, see, e. g., <https://www.forbes.com/advisor/credit-cards/best/rewards/>.

campaign in the Netherlands that encouraged consumers to use debit cards more often. They find positive effects of the national campaign both in the short and in the long run. Such campaigns became more widespread after the start of the covid pandemic. On the other hand, the Austrian Mint together with retailers started an initiative in 2022 at the POS and with YouTube videos on the special characteristics and advantages of cash (see “Truths about Cash”, <https://www.muenzeoesterreich.at/infothek/bargeld/wahres-ueber-bares>) which led to a further rise in the popularity of cash in Austria.

II.2.2 Supply factors

Since 2005, when MasterCard declared its “war on cash” (Adams, 2006), also other major players of the FinTech industry, representatives from “law-and-order” and few economists (e.g., Buitter, 2023; Rogoff, 2016; Sands, 2016) lobbied for cash restrictions. These measures include upper limits and reporting obligations for cash payments, withdrawal of high banknote denominations from circulation or even the complete abolishment of cash (see also Rösl & Seitz, 2022c). By such means, it should be much easier to fight corruption, tax evasion, drug trade, and financing terrorism (EU Commission, 2024). From a monetary policy perspective, abolishing cash should also help to break through the “effective lower bound” of the risk-free interest rate (Buitter, 2023; Buitter & Rahbari, 2015).

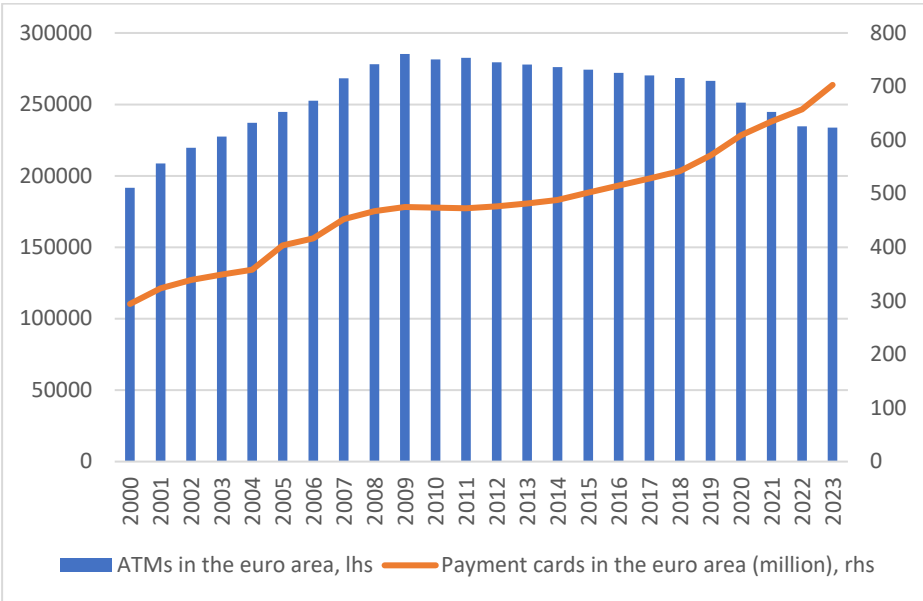
As shown in the annex, there are 19 countries in the sample of 36 developed countries from North America, Europe, Asia, and Oceania in which cash payment limit restrictions are currently in place. All of them, however, are in Oceania (Australia and New Zealand) and in the EU whose number will soon rise from 17 to 27 once the harmonized cash payment ceiling of EUR 10,000 becomes effective in all member states (Council of the EU, 2024). In addition, most countries have reporting obligations for cash payments.¹¹ Such regulations also impede the usage of cash at the POS in tendency. Baldo et al. (2021), for instance, show in the case of Italy how the introduction and the change in payment limits affects cash uses, with tighter limits decreasing banknotes in circulation, especially large denominations. However, a comprehensive analysis of these measures together with unambiguous results is still missing (Deutsche Bundesbank, 2019, 46; 2015, 37).

Cash usage can also be limited by supply-side restrictions imposed by commercial banks

¹¹ See, for instance, in the US, USD 10,000, in Canada CAD 10,000, in Germany EUR 2,000 for cash paid gold purchases, and in New Zealand NZD 10,000. In the EU, there already exists a limit of cash payments of EUR 10,000 within the Fourth Anti Money Laundering Directive (“customer due diligence”).

which put banknotes in circulation on behalf of the central bank, mainly via Automated Teller Machines (ATMs). As shown in figure 6, the number of ATMs with a cash withdrawal function in the euro area decreased over the past decade by 18% from its peak of 285,230 in 2009 to 233,836 in 2023 making the access to cash for the public more and more difficult.¹² At the same time, however, the issuance of payment cards by PSPs in the euro area went up enormously by 48% from 475 million in 2009 to 703 million units in 2023, equipping euro area residents with around two cards per capita in 2023.

Figure 6: Number of payment cards in million (right scale) and pure number of ATMs (left scale) in the euro area



Notes: Data for 2013, 2014, 2017 (ATM) and 2015 – 2017 (cards) estimated by linear interpolation due to lack of data and one obvious reporting error. ATMs with cash withdrawal function. Cards issued by resident PSPs, all cards except e-money function.

Source: ECB Data Portal.

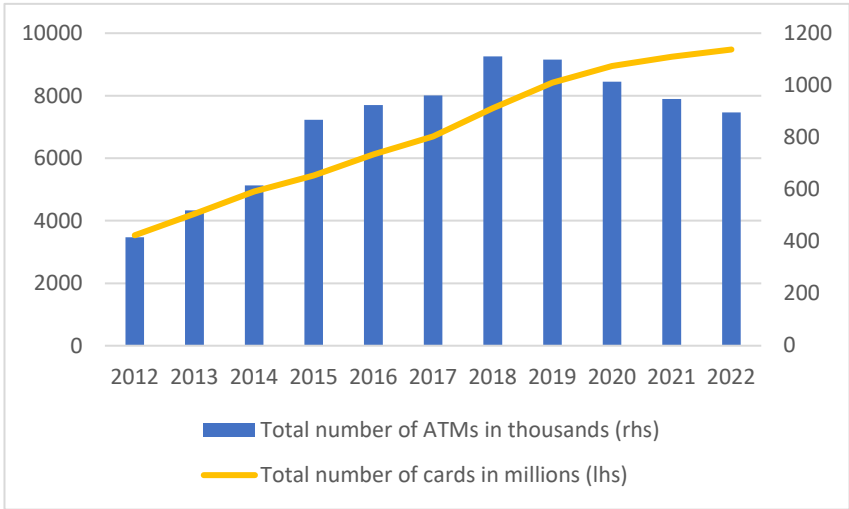
Although this development might be supply- and/or demand-driven, the sudden break in both time series after an astounding phase of parallel movements from 2002 until 2011, however, seems to show that consumers were at least to some extent pushed towards cashless payments by banks. These not only made cards and mobile payments more attractive but also actively limited access to cash by removing ATMs and closing branches (Rösl & Seitz, 2022c).

¹² Initiatives like Cash Back or Cash-in-Shop could up to now only partly compensate the decrease in ATMs.

A broader set of 32 European countries with more recent data is presented by the European Association for Secure Transactions, see figure 1A in the appendix (<https://www.association-secure-transactions.eu/>). These figures show a falling trend since 2016 by around 18%. The countries with the highest density of ATMs are Portugal and Croatia, those with the lowest Sweden and Norway (see figure 2A).

With a delay of several years, a similar pattern as in Europe can be observed in China (see figure 7) when the Peoples Bank of China (PBoC) started to restrict large cash payment transactions in 2019.

Figure 7: Number of payment cards and ATMs in China



Source: BIS payment statistics.

Although denied by PBoC officials who justified these measures with their fight against criminal activities, analysts suggested at that time that the cash payment restrictions are in line with promoting China’s upcoming Central Bank Digital Currency (CBDC), the digital Renminbi (Cointelegraph, 2019). The declining number of available ATMs in China since 2019, however, might also be attributed to strong government recommendations to use cashless payment systems after the outbreak of the SarsCov2 virus which especially pushed mobile and contactless payments.

But supply-side restrictions include a broader set of measures than only access to and acceptance of cash. Sweden again is an illustrative example in this respect (Claussen et al., 2023, ch 4). First, practices regarding the validity of older banknotes: In Sweden (and to a lesser extent also in Norway), older banknotes become invalid shortly after new banknote series have been introduced. Invalid notes are usually redeemable for some short period, but

the process of redeeming old notes may be cumbersome. It often requires a fee, documentation of origin, delivery at specific geographical locations. The notes can only be redeemed at the Riksbank office in Stockholm. Second, the denominations available in ATMs. For example, denominations above 500 Swedish Krona (approximately 50 euro) are not available in Swedish ATMs and also not at bank counters as usually bank branches do not offer any OTC cash services. Obviously, all these measures do not encourage people to hold cash.

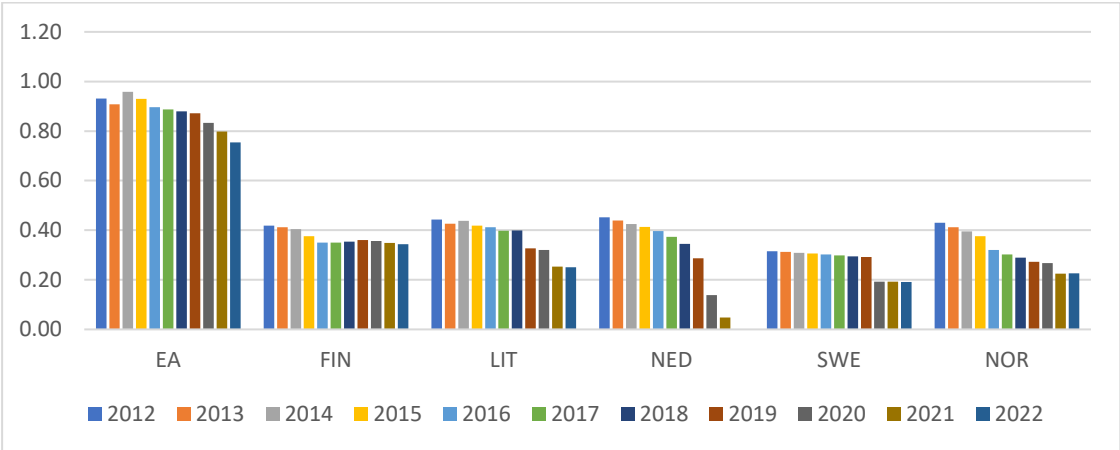
II.3 On the necessity of keeping cash as a vital means of payment

There is a growing fear (Khiaonarong & Humphrey, 2023, 4) that cash usage reaches a lower threshold below which it is no longer reasonable for merchants to accept cash (Arvidsson et al., 2017) and for banks to provide access to cash, but also from the users' perspective no longer comfortable to use cash as a means of payment if network externalities are too low. The latter not only implies increased uncertainty when and where cash can be spent but also a rise in cash acquiring costs if ATMs are more and more dismantled due to a decrease in cash in circulation. This would create a possible self-reinforcing vicious circle which might end in the effective abolishment of cash with all its negative consequences for an efficient payment mix from a society's perspective and for the resilience of the payment infrastructure in times of crisis (Rösl & Seitz, 2024, 2022b, 2021; Deutsche Bundesbank, 2024a; Sveriges Riksbank, 2024a).

Consequently, legislators and monetary authorities especially in countries with already very low cash payment shares such as Sweden, Norway, the Netherlands, Finland, and Lithuania are currently intensifying their efforts to protect the possibility to pay with cash. In Sweden, for instance, some banks are now obliged to offer cash withdrawal points where companies and associations across the country can also deposit their daily takings (Sveriges Riksbank, 2024a, 55). Furthermore, it should be mandatory for Swedish banks to accept consumers' cash deposits and enable customers to withdraw cash. A similar regulation is in place in Norway where banks must take in from and supply cash to their customers either directly or through an arrangement with other cash service providers (Norges Bank, 2022). In the Netherlands, the Dutch Central Bank found an agreement with the local financial industry to keep the total number of ATMs at a minimum of 3,850 units and to ensure that as many citizens and businesses as possible have access to an ATM within a 5 km radius (De Nederlandsche Bank,

2020, 20).¹³ And also in Finland, where only 12% of all payments (in value terms) at the POS were conducted in cash (ECB, 2022, 19), the Bank of Finland proposed a legislative initiative in 2022 for safeguarding a sufficient level of cash services. This may be interpreted as a direct consequence of Russia’s invasion of Ukraine which led to a considerable increase in cash demand (Bank of Finland, 2023). By now, 95% of all Finns consider it crucial for cash to continue being a valid payment instrument alongside digital alternatives (Helsinki Times, 2023). In addition, the Lithuanian Central Bank reached very quickly a memorandum of understanding with the local banking community after Russia’s full-scale invasion in Ukraine to improve access to cash by installing further ATMs (Bank of Lithuania, 2022, 5). Indeed, in all five countries mentioned the number of ATMs per 1,000 inhabitants declined over the past 10 years even on their already low levels compared to the euro area average.¹⁴

Figure 8: ATMs per 1,000 inhabitants in low cash countries



Source: Data for Euro area (EA), FIN, LIT, NED from ECB Data Portal, SWE from BIS, NOR from Norges Bank. NED data for 2022 not available. Missing data for EA for 2017 replaced by linear interpolation.

But also in countries where cash is still substantially used as a means of payment at the POS, governments and central banks are increasingly willing to secure the national cash cycle to

¹³ According to ECB statistics, in 2021 the number of ATM in the Netherlands stood only at 836, <https://data.ecb.europa.eu/data/datasets/PTN/PTN.A.NL.W0.2221.T.PN>. See also figure 8.

¹⁴ Surprisingly, the Danish Central Bank recently moved completely in the opposite direction and risks to repeat the mistakes neighboring countries have made in the past (see Danmark’s Nationalbank, 2023, ch. 04). In 2023 it announced to issue a new series of banknotes. Together with that announcement it was decided to recall all older Danish banknotes other than the current ones and issued since 1945 which means that they will become invalid as tender after 31 May 2025. These older series of banknotes can no longer be exchanged in banks or used in stores after this date. Moreover, the central bank will stop producing and issuing the largest denomination, the 1,000 DKR note. As the higher denominations have proven to be important in crisis periods (Rösl & Seitz, 2022b), this might be a risky way. Danmark’s Nationalbank (2023) argues that the declining use of cash indicates that citizens are choosing not to pay with cash, even though they have the right to do so and there is a general obligation among stores to accept cash payments.

foster the resilience of the national payment infrastructure, see, e.g., Panjwani & Browning (2024) for the UK, Department of Finance (2022) for Ireland, Guttman et al. (2023) for Australia, Reserve Bank of New Zealand (2023) for New Zealand, the launching of the Payment Choice Act of 2021 (US Congress, 2021) for the US, and European Commission (2023) for the EU.

One might ask, however, if such regulations are really necessary since for most countries cash in circulation increased enormously over the past 30 years (see figures 1 and 2) and there should be more than enough banknotes and coins stored in the economy to be used in case of a severe crisis. But this is not necessarily the case in the long run. The experience of Sweden shows that once cash almost vanished as a means of payment at the POS, the desire of holding cash for precautionary reasons also might diminish and the critical cash payment infrastructure will eventually erode over time (Claussen et al., 2023). We might therefore conclude that keeping cash as a vital means of payment is a necessary condition for keeping total cash in circulation (held for transactional *and* non-transactional motives) which, in turn, depends on a well-functioning and cost-competitive cash infrastructure. Or, to put it differently, “the decline in the use of banknotes also risks reducing their attractiveness as a store of value in the long term” (Cipollone et al., 2024).

III. A stylized view on the cash cycle and cash infrastructure

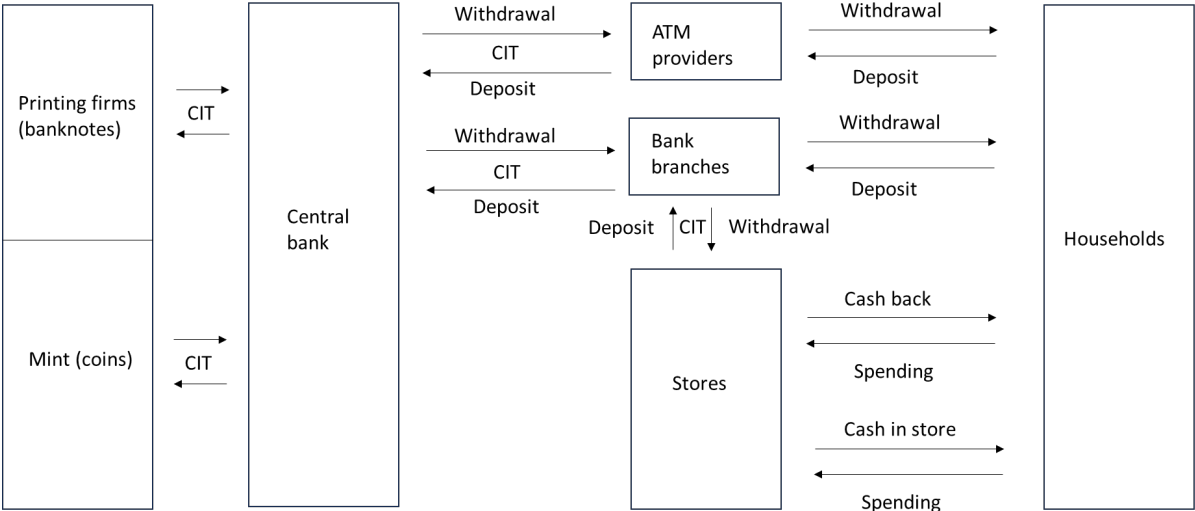
Although cash cycles have distinct national characteristics even within monetary unions,¹⁵ one can nonetheless identify its most important actors in a stylized way as shown in the following figure 9.

The production of cash is usually done by specialized (public and private) printing firms and mints which provide the newly produced banknotes and coins to be stored in the vault of the central bank. Typically, on demand of commercial banks, cash in transit (CIT) companies transport cash from the central bank to bank branches, ATMs, and to a much lesser extent also to merchants who accept cash payments and provide cash back and cash-in-store services. Of those four access points to cash, ATMs are currently by far the most important channel to provide households with cash. Cash deposits at bank branches and through special

¹⁵ See, for instance, Germany, the Netherlands and Finland in the euro area.

ATMs that allow for cash intakes are conducted by households and stores.¹⁶ Excess cash in the hands of banks and (independent) ATM providers can be returned to the central bank via banks in exchange for central bank deposits (reserves). Banknotes and coins unfit for circulation are often returned by central banks to its producers for supervised destruction.

Figure 9: A stylized version of the cash cycle



Source: own figure.

IV. The 4 A's of the cash cycle

The following four A's of the cash cycle (Access, Acceptance, Availability, Affordability) constitute the basis of a robust cash infrastructure.¹⁷ Only if all four categories are guaranteed, can cash fulfill its functions as a means of payment, store-of-value, and, if provided fully elastically by central banks, also as a stabilizer in times of crisis.

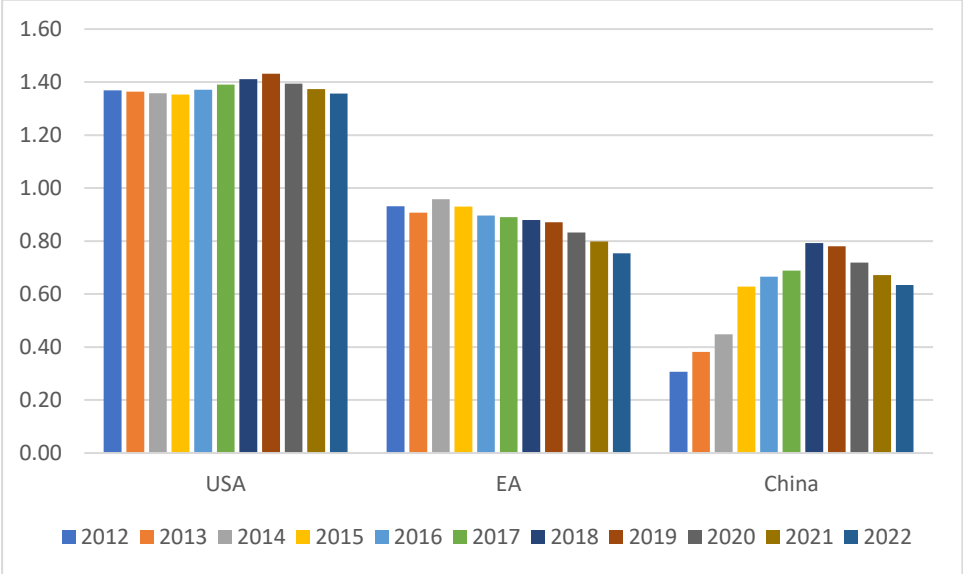
IV.1 Access

As shown in figure 9, there are currently four different channels of providing households with cash in developed countries. Of which, cash provision by means of ATMs is by far the most important way. In the three major currency areas (USD, EUR, CNY), the number of ATMs per 1,000 inhabitants decreased noticeably after 2019, especially in China (see figure 10).

¹⁶ Logistically, excess cash of stores is often directly transported to the (branches of the) central bank but depositing takes nonetheless place with the commercial bank of the store owner.

¹⁷ Others may use a slightly different classification, see, e. g., the 5 A's in Giesecke & Devrient (2024): Access, Acceptance, Availability, Authenticity and Affection.

Figure 10: Number of ATMs per 1,000 inhabitants in major currency areas



Source: USA: data estimated: for 2015 and 2019 – 2022 from Pothen (2023) based on estimates by Euromonitor; Data for 2012 – 2014 estimated by linear interpolation of latest available official data for 2009 (see FRED database) and 2015 Euromonitor estimate. Data for 2016 – 2018 estimated by linear interpolation from available data from Euromonitor in Pothen (2023). Euro area: ECB data portal. Data for 2013, 2014, and 2017 estimated by linear interpolation. China: BIS payment statistics.

As shown in the annex, this trend is also observed in almost all other parts of the developed world comprising the North Americas, Europe, Asia, and Oceania. Exceptions, however, are found in some European Countries (Austria, Slovakia, Croatia, and Czech Republic).¹⁸

Besides the number of ATMs, it is also their regional distribution which is important for access to cash. Especially the distinction between rural and urban areas matters in this respect. For that purpose, central banks register the time and distance needed to reach the nearest ATM. Deutsche Bundesbank (2022c) reports about a public survey in Germany on the general state of the nationwide network of cash dispensers. The results show that it is very easy for the German population to access cash. Overall, 94% of respondents say they need to exert “little” or “very little effort” to get to an ATM. The average time required per withdrawal is approximately nine minutes (Deutsche Bundesbank, 2022c). However, access to cash has deteriorated noticeably in 2023 compared to 2021 (Deutsche Bundesbank, 2024b, 17). In most euro area euro area countries, 95% of the population live at most five km away from their nearest ATM and nearly 100% 10 km (Zamora-Pérez, 2022;

¹⁸ For a detailed description of the situation in individual countries besides ECB (2022) see, e.g., Ministry of Finance (2022, ch. 7) for Ireland, Bautista-González (2024) for Australia, Woodford (2023) for New Zealand, Bautista-González (2023a) for South Korea, Banco de España (2024) for Spain, Lepecq (2023) for the Netherlands.

Banco de España, 2021; Banque de France, 2021).¹⁹ In 2019, 89% of euro area residents found it easy to obtain cash from an ATM (Zamora-Pérez, 2022, 100). Only about 10% of the respective survey respondents consider access to an ATM to be difficult. The countries with the highest share of respondents who deemed access to ATMs to be difficult were Malta (21%), Greece (17%), Lithuania (16%) and Belgium (15%).

Having an ATM close by is one aspect of accessibility. But not less important is whether the ATM is adequately accessible, is functioning properly and is not often out-of-order, whether there are regularly long queues at the ATM or whether the ATM only dispenses very specific denominations. If this is not guaranteed, this can also act as a barrier to access (Banco de España, 2024, 7).

Access to cash does not only mean possibilities to withdraw cash, but also access to depositing facilities for banknotes and coins (Ministry of Finance, 2022, 66f). This is more important for retailers than consumers. In the last years, there seem to be a tendency to impede especially these depositing opportunities (see, e.g., Mulqueeney & Livermore, 2023; Banco de España, 2024; Woodford, 2023).

Diagnosing and measuring ease or heaviness of access to cash is one thing. However, the ATM industry is predominantly privately organized. As we have seen, in tendency, there is a decline in the number of ATMs, even if, in general, their distribution across developed countries is satisfactory. Options to guarantee sufficient cash access points also in the future are to ensure viable business models (Ardizzi & Cologgi, 2022), regulation of the ATM industry (Markkula & Takalo, 2021), to strengthen alternative access possibilities besides ATMs, e.g., cash-back and cash-in-shop (Deutsche Bundesbank, 2022c) or public provision of ATMs (Labat et al., 2024). The Eurosystem cash strategy (ECB, 2024) especially highlights, inter alia, the important role of national central banks and the banking sector in supporting continued widespread access to cash.

IV.2 Acceptance

In most developed countries, there is no obligation for merchants to accept a certain payment method. Even legal tender banknotes can be refused with reference to contractual freedom.

¹⁹ See for similar results in the case of Australia Caddy & Zhang (2021), for Canada Chen et al. (2021; 2023) as well as Chen & Felt (2022), for Switzerland Trütsch (2022). All studies refer to increasing cash accessibility challenges in rural regions.

In other words, retailers may exclude cash and card payments – partially and in total (Department of Finance, 2022, 68). Ceeney (2019, 6), with reference to experience of Sweden, China, and the UK even concludes that cash acceptance by merchants and retailers is more likely to drive the end of cash than issues around cash access. McAndrews & Wang (2012) show that it can be beneficial for merchants to not allow cash payments if the marginal costs of cashless payments are below that of cash even if they must pay considerable fixed costs for the cashless payment infrastructure such as POS card terminals. From a customer's point of view, the restricted ability to use cash at the POS can have substantial repercussions on their basic attitude towards cash as a means of payment.

In general, the cash acceptance rate by merchants in developed countries is still very high. In the euro area, for instance, 95% of the POS transactions could be on average carried out using cash in 2022, slightly below 98% in 2019 (ECB, 2022, 57).²⁰ The range in 2022 varies between around 80% in Latvia and 98% in Greece. A similar picture emerges in surveys from Canada (Welte & Wu, 2023), where the cash acceptance rate remains high and stable around 97%, and Australia with an acceptance rate of 94% in 2022 (Guttman et al., 2023, 46).

However, Claussen et al. (2023) point to the Swedish situation where the share of businesses that accept cash has declined more and more since 2013. Sweden might even be close to a point of no return which implies huge consequences for the resilience of the national payment system. Consequently, the Sveriges Riksbank calls by now for a general obligation for merchants to accept cash for purchases of essential goods and services such as food, pharmaceuticals, and fuel (Sveriges Riksbank, 2024a, 55). Also, the ECB is worried about the general acceptance of cash at the POS in the euro area and addresses this issue in its “Eurosystem cash strategy” (ECB, 2024) as does the “Legal tender initiative” of the EU Commission (2023). The latter will broaden the scope of legal tender from physical cash (banknotes) to CBDC. For consistency reasons, the intended mandatory acceptance of CBDC should also be the case for cash, i. e., there should be no discrimination between physical and digital forms of central bank money.²¹

²⁰ This tendency of a small decrease is observed in every euro area country.

²¹ According to the Draft Regulation on Legal Tender of Euro Cash (EU Commission, 2023), the legal tender status for cash will be weaker than for the Digital Euro. For example, cash acceptance may be excluded ex ante for certain transactions or cash ceilings may be decided (under national responsibility and in the public interest).

IV.3 Availability

Cash availability comprises more dimensions than just having convenient access to banknotes and coins (see ch. IV.1.). It also implies that ATMs and other ways of cash distribution provide the people with the full variety of coins and banknote denominations. As shown in the following table, cash demand in developed countries increased over the past 30 years especially strongly during major crises reflecting a special need for small and/or large banknote denominations depending on the nature of the crisis.

Table 1: Domestic demand for small and large denominations during selected crises

Small banknote denominations								
	Euro area	USA	Switzerland	Japan	UK	Sweden	Australia	Germany
Y2K	n.a.	0.11	0.03	0.02	0.02	-	-	0.02
Fin	0.03	-	-	-	0.02	-0.02	0.05	n.a.
Cov	0.04	0.03	0.01	-	-	-	0.04	n.a.
Large banknote denominations								
	Euro area	USA	Switzerland	Japan	UK	Sweden	Australia	Germany
Y2K	n.a.	0.05	0.05	0.05	0.02	0.04	0.02	-
Fin	0.05	0.02	0.04	-	0.04	-	0.01	n.a.
Cov	0.03	0.02	0.02	0.02	0.02	0.04	0.02	n.a.

Notes: Small denominations: USD 1, 2, 5, 10, 20, 50; JPY 500, 1,000, 2,000, 5,000; DEM 5, 10, 20, 50, 100; EUR 5, 10, 20, 50, 100; CHF 5, 10, 20, 50, 100; GBP 5, 10, 20; SEK 5; 10; 20; 50; 100; 200; AUD 5, 10, 20, 50. Large denominations: USD 100; JPY 10,000; DEM 200, 500, 1,000; EUR 200, 500; CHF 200, 500, 1,000; GBP 50; SEK 10,000; 1,000; 500; AUD 100. The respective crisis periods are Q4/1999 (Y2K), Q4/2008 to Q1/2009 (financial crisis and Great Recession) and Q1/2020 to Q2(3)/2020 (Covid). Econometrically, they are captured via (impulse) dummy variables which are one in the respective periods and zero otherwise. Exclusively these crisis coefficients are shown, but only if statistically significant at least at the 10% level.

Source: Rösl & Seitz (2022b).

In times of heightened uncertainty about the resilience of the cashless infrastructure such as the (expected) technological crisis around the millennium change (Y2K), people tend to increase cash demand for two reasons: On the one hand, they react to the rising uncertainty of the cashless payment infrastructure by holding more transaction balances. This was, for instance, especially strong in the US where the crisis-related demand for small USD banknote denominations increased by 11%. On the other hand, the demand for non-transaction balances in the form of larger USD denominations also increased considerably (by 5%) to hedge against the mounting uncertainty of their digitally stored savings. Although on a comparatively lower level, cash demand for small and large denominations of other currencies

increased at that time perceptibly as shown in table 1. Interestingly, the same pattern can be observed after the start of the war in Ukraine when in several neighbouring countries, such as Poland as well as the Baltic and Scandinavian countries cash demand increased significantly due to a threat of possible attacks on the cashless infrastructure by Russia (Jaroszek, 2023; ESTA, 2022).

In times of a confidence crisis of the financial system such as during the financial crisis (2008/9), however, the increased demand for cash is largely the result of consumers taking precautionary actions and building up non-transaction balances (see table 1 and in a theoretical model Muñoz & Soons, 2023). For this reason, there is greater demand for large banknote denominations as a store-of-value, both at home and abroad (see, e.g., Deutsche Bundesbank, 2024a; 2022a; Rösl & Seitz, 2022b; Seitz et al., 2022; Rua, 2021; Assenmacher et al., 2019, 2017).

In times of natural disasters, cash demand usually also increases. For instance, Spicer (2017) shows an immense increase in cash demand in the US even shortly before hurricanes are expected to hit mainland USA. In those types of crises (heavy thunderstorms, earthquakes, flooding, etc.),²² access to cash for (basic) domestic transactions is essential (Bautista-González, 2023b; CashEssentials, 2021; Shephard-Barron, 2016; Smith, 2014). A special case for a crisis-related increase in cash demand due to a natural disaster is the Covid pandemic. After the outbreak of the SarsCov2-virus in December 2019, cash holdings around the globe surged drastically (Goodhart & Ashworth, 2020). This crisis, however, affected the demand for the whole range of banknote denominations (see table 1).

To conclude, central banks should not only meet the demand for cash in times of crisis in a fully elastic way (Rösl & Seitz, 2022a) but should also have the respective denominations printed and sufficiently stored beforehand. Especially in times of increased uncertainty, large banknote denominations help to stabilize the monetary system. Central banks should therefore keep large denominations in circulation and think of issuing even larger ones to provide a higher store of value more efficiently. Against this background, withdrawing the EUR 500 banknote from circulation by the Eurosystem, stopping to produce and issue the largest

²² There is a more than tenfold increase in (recorded) natural disasters in the last six decades— from 39 in 1960 to 416 in 2020 (<https://www.visionofhumanity.org>).

denomination in Denmark, the DKR 1,000 note, by Denmark's Nationalbank and not offering the SEK 1,000 banknote in ATMs in Sweden, are clear steps into the wrong direction.

IV.4 Affordability

Affordability is of crucial importance for cash being attractive as a means of payment. On the individual cost side, the ease of access to cash, i.e., time and effort to acquire cash, and possible fees charged for cash withdrawals and deposits are the main factors in this regard. In principle, cash can be accessed from ATMs, bank branches as well as cash-back and cash-in-shop services, both provided by retailers. According to European Commission (2022), 46% of all EU citizens find it "very easy" to withdraw cash at ATMs or a physical bank counter in the area where they live, and 40% find it "rather easy". In some euro area countries, however, difficulty of obtaining cash from ATMs, especially in Belgium, the Netherlands and Luxemburg (ECB, 2022, 48) increased which might be at least partly attributed to the increased intensity of ATM blow-ups in this region at that time.

Regarding cash withdrawal fees, in most euro area countries more than 50% of consumers report not having to pay a fee for withdrawing cash (ECB, 2022, 50). Outliers are Ireland, where nearly one fourth of consumers always pay a fee (and only 28% never pay a fee), and Belgium with 14% always paying a fee – a country where ease of access to cash has become significantly more difficult in recent years (ECB, 2022, 49). Carbo-Valverde & Rodriguez-Fernandez (2019) compare the (private and resource) costs of cash and debit cards in their multi-country study with 52 countries. The lowest cash costs for consumers are present in Europe, Africa and Asia-Pacific, while the highest costs are found in the Americas. One must keep in mind, however, that such cost comparison studies often face the problem that card fees are not always "directly visible" as many countries impose "no-surcharge rules" (e.g., in the EU) which do not allow price discrimination with respect to different means of payment. Therefore, besides direct fees, payment costs can only be estimated as they are either included in the current account fee or translate directly into higher product prices. At any rate, however, one should be careful to deem cash payments as being more expensive than cashless payments due to lack in cost transparency.

The cost dimension does not only affect the end user of cash but all members of the cash cycle (see figure 9). From the issuer's (i.e., central bank's) perspective, cash production and processing costs must be reasonably low to avoid inefficiencies (including environmental

concerns) and provide the government with substantial seigniorage. From a commercial bank's view, providing and withdrawing cash on behalf of the central bank usually comes with no cost compensation. This, however, has considerable consequences for the stability of the cash cycle. It provides an incentive for banks to actively foster cashless payments which might result in a downward-spiral once a lack of cash supply leads to lower use of cash, a dismantling of ATMs and so forth. The costs of cash also affect merchants' acceptance of banknotes and coins. Hayashi (2021) compares resource costs and fees of cash with the respective costs of debit card payments, each from a merchants' perspective (see also Carbo-Valverde & Rodriguez-Fernandez, 2019). In a comprehensive study for the United States, Australia, Canada, the Netherlands, Norway, and Sweden, the author finds a mixed picture. While cash-related costs for merchants in the US are comparatively lower than those of cashless payments, the opposite is true for the other countries. This result demonstrates that once the cash infrastructure is mainly reduced to rubble as is true for the Netherlands, Norway, and Sweden, cash-related costs per transaction increase significantly which might drive out cash of the payments market although the preference for cash might still be substantially. For several reasons, stated preferences for certain payment methods do not always correspond to actual payment behavior (see ch. II.2.1, figure 5 and De Nederlandsche Bank, 2023b). For example, in countries where cash payments are not widespread, even people with a preference for cash do not carry large amounts of cash.

The empirical analysis in Deutsche Bundesbank (2022c) does currently not reveal any statistically significant relationship between the individual effort for withdrawing cash and payment behavior in Germany. However, many survey respondents state that they would be increasingly inclined to move away from cash if provision were to deteriorate considerably. Consequently, a reduction in the cash infrastructure in place in the future, i.e., fewer ATMs and lower acceptance of cash at the POS, could be the start of a downward spiral whereby a poorer supply of cash leads to lower use of cash, and vice versa.

As we have seen in ch. IV.1., ATM numbers continue to decline in most developed countries (see also the comprehensive overview in the annex). One option to reverse this decline is to ensure viable, i.e. profitable, ATM business models. ATM interchange or reverse interchange is an essential aspect in this regard (see, e.g., Ardizzi & Cologgi, 2022). These fees compensate the acquirer of an ATM for the cost of accepting and processing a transaction from a payment card issued by another financial institution (<https://www.lawinsider.com/dictionary/reverse->

interchange-rate). The level of ATM interchange has declined over the years in many markets, and arguably has been weaponized to promote non-cash payments, even if the level of these fees varies significantly internationally. Ron Delnevo, the Chair of the Payment Choice Alliance, made this point very clearly and explicitly in his remark on LinkedIn concerning the situation in the UK in 2024: “The value of cash withdrawn from ATMs by the British public has barely changed, but the number of ATM transactions fell by 10% between 2022 and 2024. Not surprising at all, because the number of free-to-use ATMs available to be used by the British public fell by around 10% in the same period. So the public still want cash, but don’t see ATMs as nearly as often as they used to, so they take out more cash when they do see an ATM. This is leaving non-bank ATM operators delivering 80% more cash per ATM withdrawal to bank customers than they were 20 years ago. But receiving interchange from the banks via LINK Scheme Ltd that is around 40% lower than it was in 2004. (...) It is crystal clear that non-bank ATM operators are being asked to supply the British public with cash without being adequately rewarded for doing so. That is not a sustainable model, which, of course, suits the advocates of “cashless” to perfection.”²³

This leads us to the next section in which we discuss the public good characteristics of cash and its implications, especially with respect to the distribution of costs between the private and the public sector.

V. Public good characteristics of cash and the neutrality principle

There are several research papers and official statements from central banks who mention that cash as the physical form of public money is a public good (e.g., ECB, 2023, 3; Beretta & Neuberger, 2021). However, the meaning and understanding of the notion “public good” is usually not clarified in these statements. Labat et al. (2024) try to fill this gap: In a strict sense cash does not qualify as a public good which is defined in economics via non-exclusion and non-rivalry in consumption. However, the institution “cash” or cash as a social construct may still be interpreted as a public good. What does this mean? The cash system contributes to several positive societal aspects from which its members cannot be excluded, and certain services provided by cash for the individual do not come at the expense of others. These comprise, inter alia, privacy, payments inclusion, facilitation of control of expenditures,

²³ <https://www.linkedin.com/feed/update/urn:li:activity:7213094526528204800/>

macroeconomic stabilization in times of crisis (Rösl & Seitz, 2022a), resilience of the payments system, and safeguarding competition in the payments market. Therefore, cash as the usually safest asset in an economy is much more than a mere payments instrument as it also fulfills non-transactional purposes with distinct public good characteristics and, thus, the package of societal services inextricably linked to cash is a public good. Consequently, a payment and asset mix including cash is welfare enhancing as it contributes to a more efficient payment and asset allocation from a society's perspective while the private sector in its own "produces" with its focus on digital currencies too less of such public good services.

Since cash-related societal services or, in other words, "cash as an institution" is a public good, governments and central banks should actively support the cash infrastructure. Therefore, central banks should also re-think their "neutrality position" and the "costs by cause principle". With respect to the former, the head of the cash department of the Deutsche Bundesbank argued at a panel discussion on the occasion of the 20th anniversary of the euro for a new interpretation of the role of central banks towards neutrality (Hardt, 2022). Against the background of some interest groups who are actively opposed to cash and providers of private means of payment (e.g., card companies) who are vigorously advertising their products, the previous passivity of central banks, in his opinion, is no longer justified. In a nutshell, neutrality does not have to go hand in hand with passivity.²⁴ Consequently, the Reserve Bank of New Zealand, for instance, is launching cash trials in communities to test new ways for consumers and retailers to withdraw and deposit cash and inform about the role of cash in society with a special focus on New Zealand (see, e.g., Reserve Bank of New Zealand, 2019; 2022). As central banks (e.g., the ECB or the Deutsche Bundesbank) are actively fostering CBDC, this neutrality change would set the same level playing field for physical and digital central bank money. Finally, it is the central banks' and a currency area's own product. According to the "costs by cause principle", however, a supplier shall in an ideal world not only receive all the profits but should also bear all the costs associated with his product to ensure a maximum level of efficiency in the market. Today, the distribution costs of cash have to be covered mainly by the private sector, especially banks and retailers. This creates a kind of competitive disadvantage compared to private monies. Therefore, the current neutrality position is more a "negative neutrality" than a neutral stance towards payment choice.

²⁴ The Austrian central bank (OENB) calls its strategy towards cash "active neutrality". See also the initiative "Truths about Cash" in Austria (<https://www.muenzeoesterreich.at/infothek/bargeld/wahres-ueber-bares>).

However, one can even go one step further. If cash as a public good in the sense defined above is accepted, a well-functioning cash infrastructure needs profitable business models. If not, the provision of some cash services directly by the public sector might be in principle an alternative. To avoid such a measure of ultima ratio, however, a compensation of cash distribution costs for banks, at least partly, seems appropriate (Labat et al., 2024, 11). This would incentivize banks to enable further access to cash by maintaining or even increasing the number of ATMs. An infrastructure that does not meet the needs of consumers and merchants may sooner or later make them switch to cashless payments. The payment market is a two-sided market with network effects. If a lower bound of cash use (tipping point) is reached, below which it is no longer profitable for banks to grant access to cash and for retailers to accept cash, a vicious circle might evolve with exponentially decreasing cash usage. Given our reasoning, this development might have drastic negative consequences for the countries under consideration.

VI. Summary and conclusions

The benefits of cash, be it microeconomic, macroeconomic or societal (see, e.g., Krüger & Seitz, 2017) and the stabilizing role of cash in times of heightened uncertainty (e.g., Rösl & Seitz, 2022a; b) necessitate a well-functioning cash infrastructure. Experience from Sweden has shown that once the cash infrastructure has gone below a certain threshold, putting it back is close to impossible (see Claussen et al., 2023). Therefore, the present paper focused on the necessary conditions to keep this cash infrastructure alive. The main takeaways are:

- Cash is not dead. In the last decades cash holdings have increased nearly worldwide, even relative to GDP. However, this is predominantly due to the non-transactional demand for cash.
- There are negative repercussions of a diminishing role of cash used in daily transactions on cash usage for other purposes. A tipping point might be reached which implies drastically reduced cash holdings. Therefore, a lower threshold of cash use at the POS should be avoided with early counter-measures. The (active) use of cash has to remain above this level to keep the cash infrastructure alive and the processing of cash profitable for the private sector.
- Guaranteeing the 4 A's of the cash infrastructure (access, acceptance, availability, affordability) is a necessary pre-condition for a viable cash cycle not only in normal

times but also in crisis periods for the positive functions of cash to materialize. If the cash cycle does not function properly in normal times, it cannot work in times of crisis. Therefore, sufficient stocks of cash in the vaults of central banks are essential, both in total and by denomination. The quality of banknotes and coins should be high and at the newest technological level which helps to reduce counterfeits to a minimum.

- Supply-side driven problems – by governments, central banks, and commercial banks – with unintended and unexpected consequences should be avoided.
- Cash as an institution serves as a public good, i.e., the cash eco-system contributes to collective benefits for the society which qualify as public goods. Consequently, governments and central banks should actively support cash as an integral part of a broad payment mix available to society.
- Central banks should rethink the notion of neutrality to a more actively promoting stance and should also cover, at least partly, the costs of cash distribution. Against the background of the two-sided nature of payment markets with network effects, a more active engagement of central banks in the cash cycle is therefore desirable and warranted.

Do central banks have the mandate to actively support cash? It depends. For instance, in the euro area, Article 3 ("tasks") of the protocol on the statute of the European System of Central Banks and of the European Central Bank (ECB) states that one of the tasks of the Eurosystem (the ECB and the national central banks) is to promote the smooth operation of payment systems. In addition, Article 22 specifies that "the ECB and national central banks may provide facilities, and the ECB may make regulations, to ensure efficient and sound clearing and payment systems within the Union and with other countries". Payment systems refers to cash and cashless systems. And smooth operation implies a proper functioning of the cash cycle. If the smooth operation is no longer guaranteed, it is even the obligation of the Eurosystem to take counter-measures. At least, in principle, the same is true for Switzerland. The formulation in Art. 5 of the Federal Act on the Swiss National Bank is that it shall ensure the supply and distribution of cash. As for other currency areas, if the respective central bank mandate does not contain such provisions to safeguard the operability of the national payment system (including a resilient cash cycle), they should be adjusted accordingly. This seems to be the case, e.g., for the Federal Reserve System and the Bank of England whose statutes do not specifically address this issue.

A well-functioning cash infrastructure is worthless if there is no or very little cash demand. If only a few people (e.g., the vulnerable and older) rely on cash, the effort of keeping the cash cycle alive might not be worth the costs. However, there are obvious benefits for a society as a whole of having cash. An information campaign of central banks or the mints (and possible other stakeholders in the cash cycle) on these benefits could be helpful in this respect. This might lead the population to consciously use cash. Simultaneously, it contributes to a positive mood towards cash, i.e. affection. The Reserve Bank of New Zealand's cash trials initiatives and the Austrian Mint's campaign on "Truths about Cash" seem to be a good model and starting point in this regard.

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Annex

1. Cash payment limitation in developed countries

North America

	Upper limit for cash payments
USA	No limits
Canada	No limits (?)

Sources: <https://orbograph.com/will-cash-restrictions-be-implemented-in-the-us/>

Europe

EU – Euro area	Upper limit for cash payments
Austria	No
Belgium	EUR 3,000; for precious metals EUR 500
Cyprus	No
Croatia	EUR 10,000
Estonia	No
Finland	No
France	Cash payments between private individuals with no limits. Limit for purchases in stores EUR 1,000 by residents; EUR 3,000 for real estate purchases;
Germany	No limits (except for anonymous gold purchases EUR 2,000). Cash payment for the purchase of real estate prohibited.
Greece	EUR 500, no limits for buying cars
Ireland	No limits
Italy	EUR 5,000
Latvia	EUR 7,200
Lithuania	EUR 5,000
Luxemburg	No limits
Malta	No limits, except for precious metals and other metals, antiques, real estate etc. (limit of EUR 10,000)
Netherlands	No limits
Portugal	EUR 3,000
Slovakia	EUR 15,000
Slovenia	EUR 5,000
Spain	For private persons EUR 10,000, for enterprises EUR 1,000

EU – non euro area	Upper limit for cash payments
Bulgaria	LEW 10,000
Czech Republic	CZK 270,000
Denmark	Not for private persons. Limit for traders DEK 20,000
Hungary	No limits for private persons, for enterprises HUF 1,500,000
Poland	No limits for private persons, for enterprises PLN 15,000 (≈ EUR 3,300)
Romania	Payments to enterprises LEI 5,000 (≈ €1,000) per day; For the delivery of goods and services, LEI 10,000 (≈ EUR 2,000) per day.

Notes: In the EU, an upper cash payment limit of (the equivalent) of EUR 10,000 is in the legislative process. Lower national limits will still be possible. Effective limits can even be lower due to reporting regulations.

Sources: <https://www.evz.de/en/shopping-internet/cash-payment-limitations.html>

Europe – Non EU	Upper limit for cash payments
Russia	No limits
Sweden	No limits
Switzerland	No limits
United Kingdom	No limits
Iceland	No limits
Norway	No limits, but government recommendation for business owners not to accept amounts exceeding NOK 10,000.

Sources: <https://www.evz.de/en/shopping-internet/cash-payment-limitations.html>

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Asia

	Upper limit for cash payments
China	Limits for large payments, 500,000 CNY for business, and 100,000 CNY – 300,000 CNY for private persons depending on region
South Korea	No limits (?)
Japan	No limits (?)

Sources: Cointelegraph (2019).

Oceania

	Upper limit for cash payments
Australia	AUD 10,000
New Zealand	NZD 10,000 for high value goods

Sources: https://www.aph.gov.au/Parliamentary_Business/Bills_Legislation/bd/bd1920a/20bd089

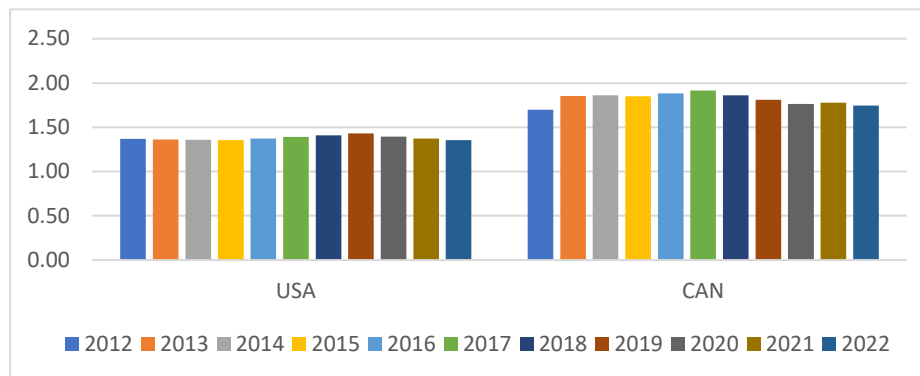
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2. Number of ATMs per 1000 inhabitants

North America

North America	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
USA	1.37	1.36	1.36	1.35	1.37	1.39	1.41	1.43	1.39	1.37	1.36
CAN	1.70	1.85	1.86	1.85	1.88	1.92	1.86	1.81	1.76	1.78	1.75

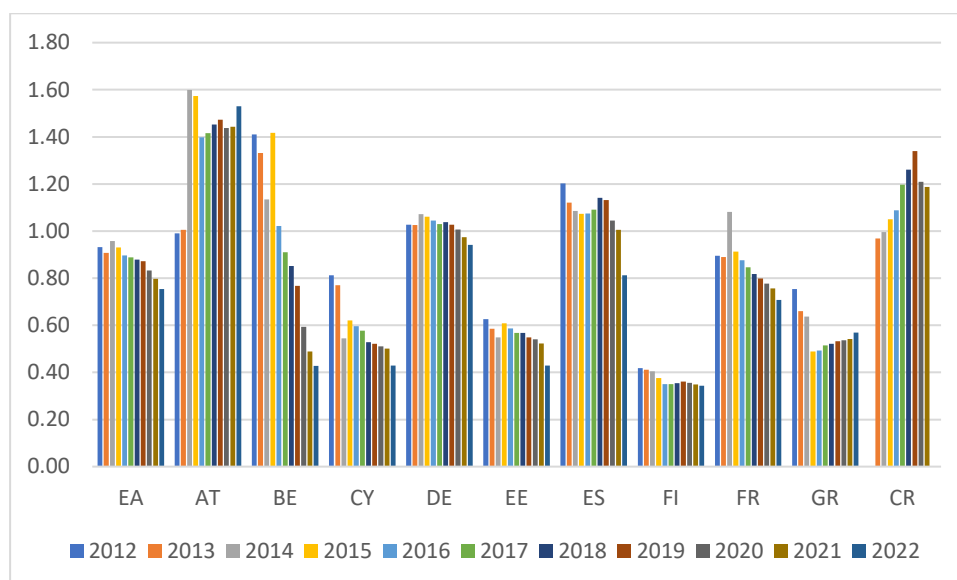
Source: USA: data for 2015 and 2019 – 2022 from Pothén (2023) based on estimates by Euromonitor; Data for 2012 – 2014 estimated by linear interpolation of latest available official data for 2009 (see FRED database) and 2015 Euromonitor estimate. Data for 2016 – 2018 estimated by linear interpolation from available data from Euromonitor in Pothén (2023). CAN: BIS payment statistics.

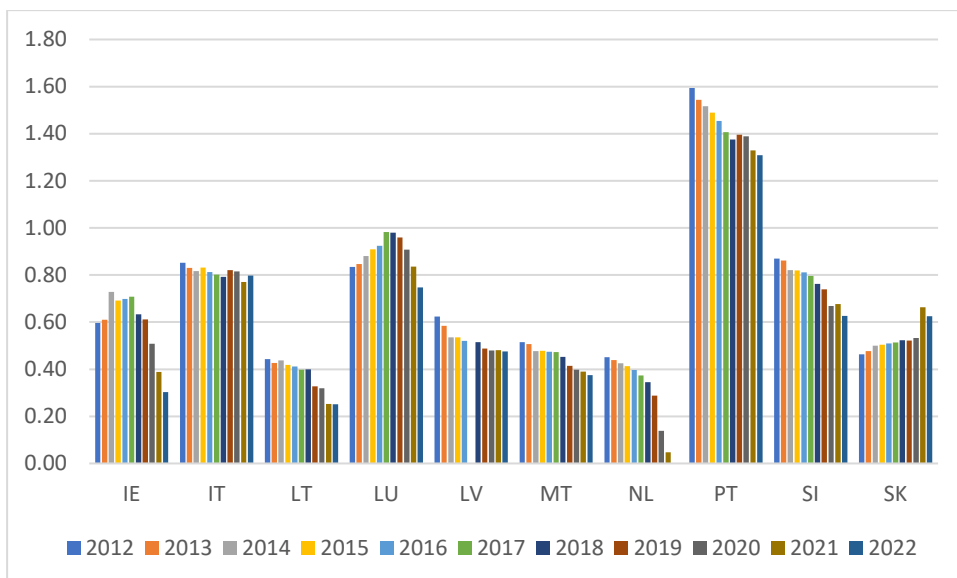


Europe

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
EA	0.93	0.91	0.96	0.93	0.90	0.89	0.88	0.87	0.83	0.80	0.75
AT	0.99	1.01	1.60	1.57	1.40	1.42	1.45	1.47	1.44	1.44	1.53
BE	1.41	1.33	1.13	1.42	1.02	0.91	0.85	0.77	0.59	0.49	0.43
CY	0.81	0.77	0.54	0.62	0.60	0.58	0.53	0.52	0.51	0.50	0.43
DE	1.03	1.03	1.07	1.06	1.04	1.03	1.04	1.03	1.01	0.97	0.94
EE	0.63	0.58	0.55	0.61	0.59	0.57	0.57	0.55	0.54	0.52	0.43
ES	1.20	1.12	1.09	1.07	1.07	1.09	1.14	1.13	1.04	1.00	0.81
FI	0.42	0.41	0.40	0.38	0.35	0.35	0.35	0.36	0.36	0.35	0.34
FR	0.89	0.89	1.08	0.91	0.88	0.85	0.82	0.80	0.78	0.76	0.71
GR	0.75	0.66	0.64	0.49	0.49	0.51	0.52	0.53	0.54	0.54	0.57
CR	0.00	0.97	1.00	1.05	1.09	1.20	1.26	1.34	1.21	1.19	
IE	0.60	0.61	0.73	0.69	0.70	0.71	0.63	0.61	0.51	0.39	0.30
IT	0.85	0.83	0.82	0.83	0.81	0.80	0.79	0.82	0.81	0.77	0.80
LT	0.44	0.43	0.44	0.42	0.41	0.40	0.40	0.33	0.32	0.25	0.25
LU	0.83	0.85	0.88	0.91	0.92	0.98	0.98	0.96	0.91	0.84	0.75
LV	0.62	0.58	0.54	0.54	0.52	0.00	0.52	0.49	0.48	0.48	0.48
MT	0.51	0.51	0.48	0.48	0.47	0.47	0.45	0.41	0.40	0.39	0.38
NL	0.45	0.44	0.42	0.41	0.40	0.37	0.34	0.29	0.14	0.05	
PT	1.59	1.54	1.52	1.49	1.45	1.41	1.38	1.40	1.39	1.33	1.31
SI	0.87	0.86	0.82	0.82	0.81	0.80	0.76	0.74	0.67	0.68	0.63
SK	0.46	0.48	0.50	0.50	0.51	0.51	0.52	0.52	0.53	0.66	0.63

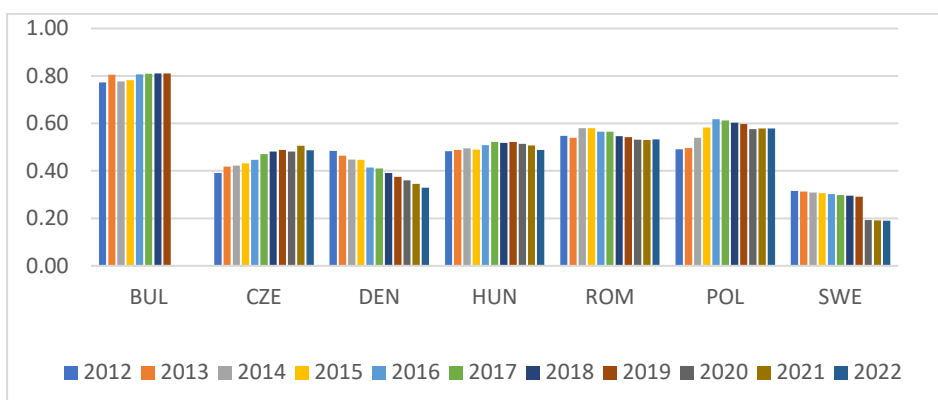
Source: ECB payment statistics. Data for EA in 2017 estimated by linear interpolation.





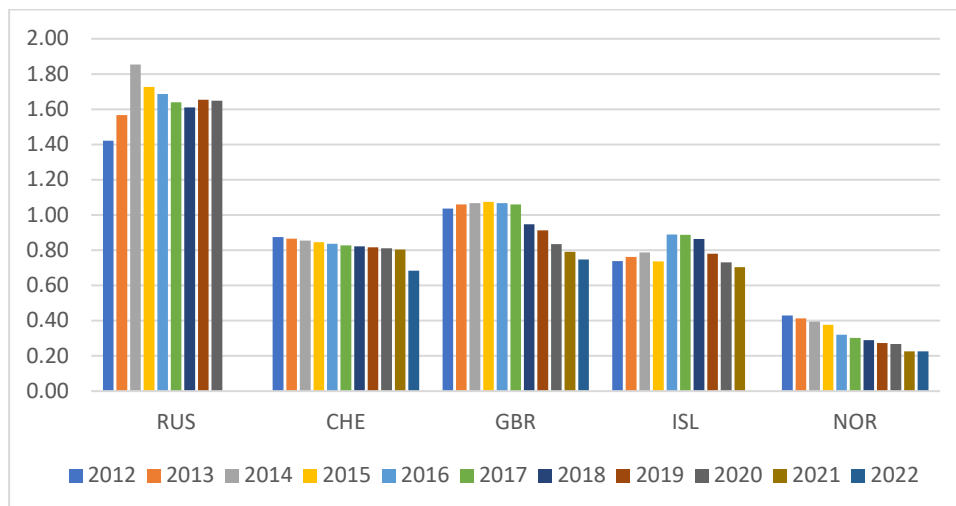
EU – non euro area	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
BUL	0.77	0.80	0.78	0.78	0.81	0.81	0.81	0.81			
CZE	0.39	0.42	0.42	0.43	0.45	0.47	0.48	0.49	0.48	0.51	0.49
DEN	0.48	0.46	0.45	0.45	0.41	0.41	0.39	0.37	0.36	0.34	0.33
HUN	0.48	0.49	0.49	0.49	0.51	0.52	0.52	0.52	0.51	0.51	0.49
ROM	0.55	0.54	0.58	0.58	0.56	0.57	0.55	0.54	0.53	0.53	0.53
POL	0.49	0.50	0.54	0.58	0.62	0.61	0.60	0.60	0.58	0.58	0.58
SWE	0.32	0.31	0.31	0.31	0.30	0.30	0.29	0.29	0.19	0.19	0.19

Source: Data for BUL, CZE, DEN, HUN, ROM, POL: ECB payment statistics; SWE: BIS payment statistics.



Europe – Non EU	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
RUS	1.42	1.57	1.85	1.73	1.69	1.64	1.61	1.65	1.65		
CHE	0.88	0.87	0.85	0.85	0.84	0.83	0.82	0.82	0.81	0.80	0.68
GBR	1.04	1.06	1.07	1.08	1.07	1.06	0.95	0.91	0.83	0.79	0.75
ISL	0.74	0.76	0.79	0.74	0.89	0.89	0.86	0.78	0.73	0.70	
NOR	0.43	0.41	0.40	0.38	0.32	0.30	0.29	0.27	0.27	0.23	0.23

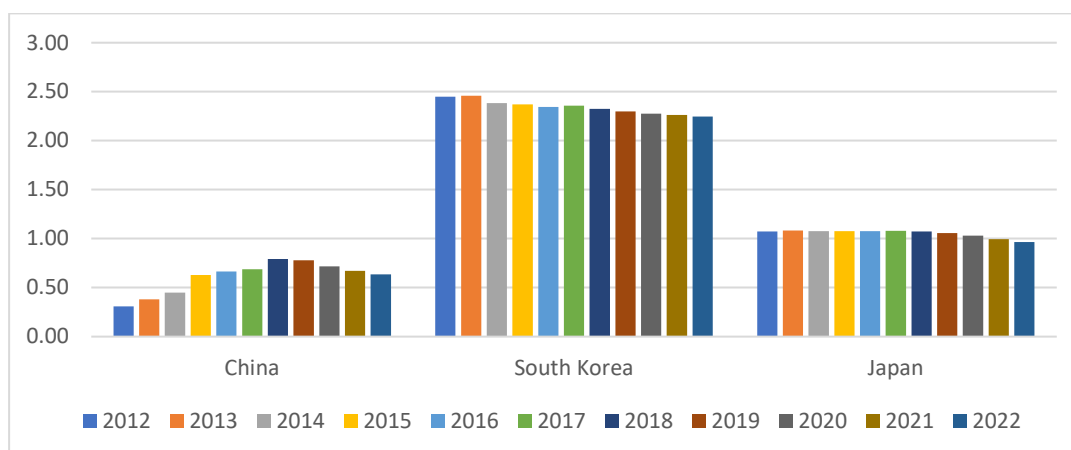
Source: Data for CHE, GBR: BIS payment statistics; RUS, ISL: IMF; NOR: Norges Bank.



Asia

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
China	0.31	0.38	0.45	0.63	0.67	0.69	0.79	0.78	0.72	0.67	0.63
South Korea	2.45	2.46	2.38	2.37	2.34	2.36	2.33	2.30	2.28	2.26	2.25
Japan	1.07	1.08	1.08	1.08	1.08	1.08	1.07	1.06	1.03	0.99	0.97

Source: BIS payment statistics.



Oceania

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Australia	1.32	1.30	1.32	1.34	1.36	1.30	1.20	1.11	1.05	1.01	0.96
New Zealand	0.75	0.72	0.71	0.69	0.66	0.66	0.64	0.63	0.54	0.54	

Source: BIS payment statistics.

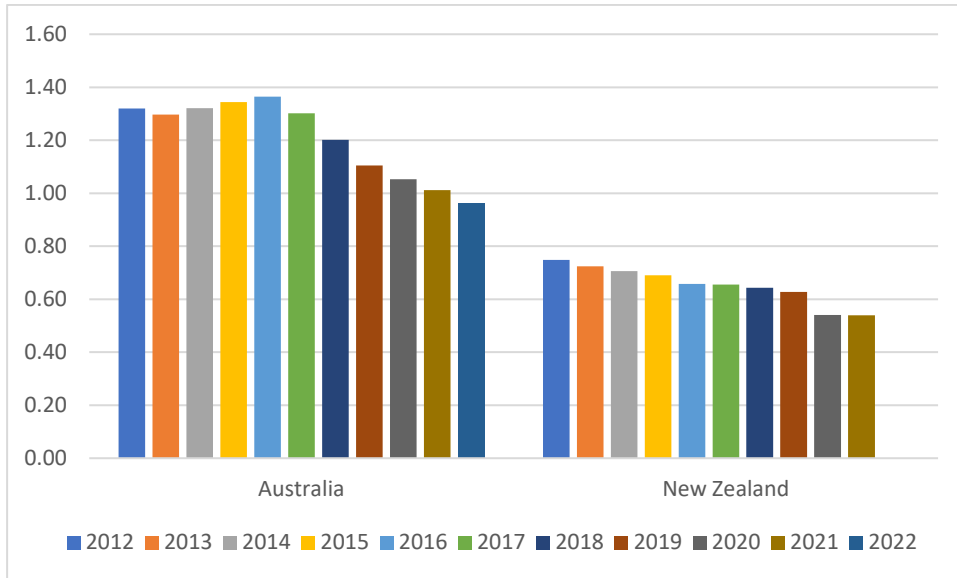
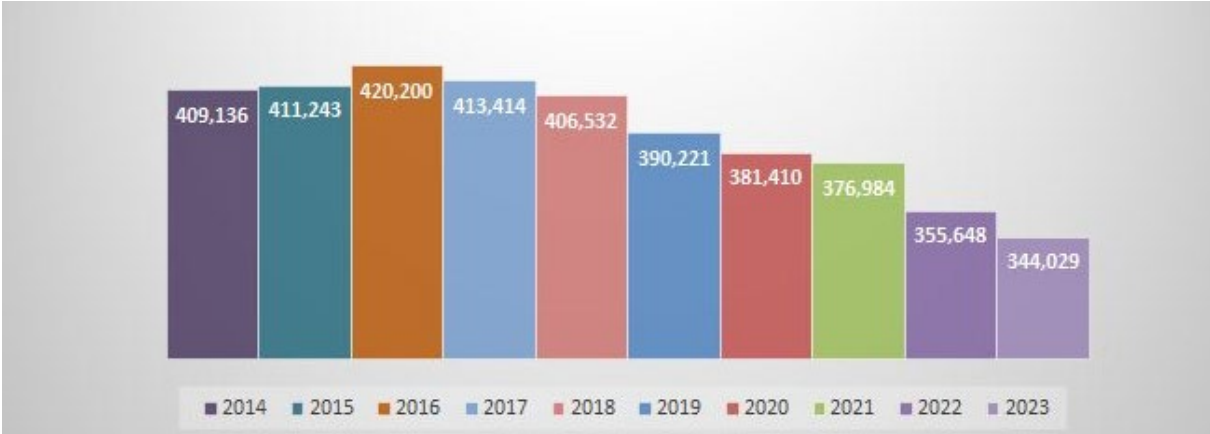


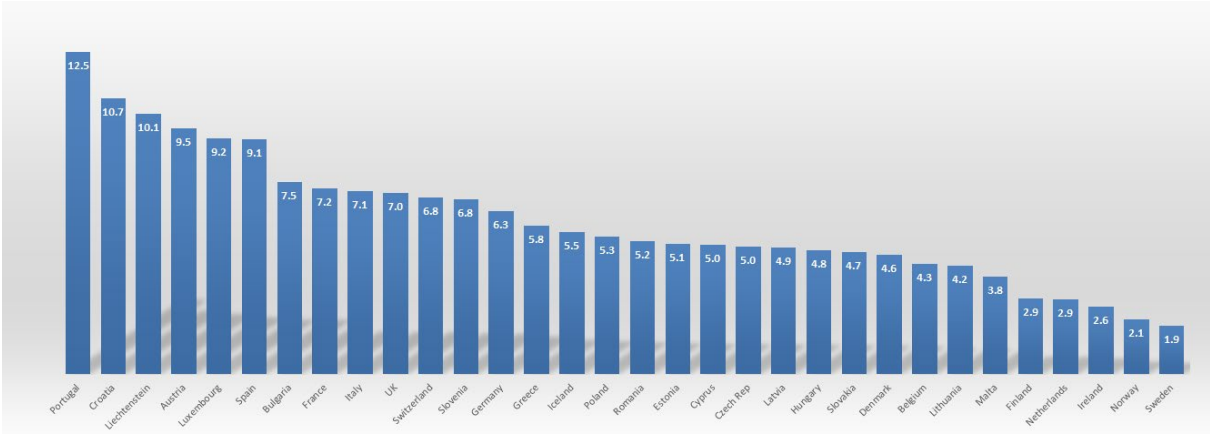
Figure 1A: Number of ATMs in Europe



Notes: 32 European countries (see figure 2A).

Source: European Association for Secure Transactions.

Figure 2A: Number of ATMs per 10,000 people at the end of 2023



Source: European Association for Secure Transactions.

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Fakultät Betriebswirtschaft

Presserechtliche Verantwortung:

Sonja Wiesel, Hochschulkommunikation und Öffentlichkeitsarbeit
Telefon +49 (9621) 482-3135
Fax +49 (9621) 482-4135
s.wiesel@oth-aw.de

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