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Cash demand in times of crises: a global perspective

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Abstract

We analyse the repercussions of different kinds of crises on cash demand in an international perspective. Our case studies are based on time series of banknotes in circulation in a selection of 16 countries and currency areas across all continents over the period from 1990 to 2022. We distinguish between six different kinds of crises: (1) uncertainty of the digital infrastructure, (2) confidence crises of the financial system, (3) natural disasters, (4) political crises, (5) inflationary crises, and (6) exchange rate crises. Our case studies suggest that crises are likely to have contributed to the dynamic growth in demand for banknotes in the countries analysed. This applies both to small and large banknote denominations.

Keywords: cash, banknotes, crises

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1. Introduction

Contrary to public perception, cash demand has continued to increase globally over the past decades, especially in times of uncertainty (Heinonen 2022; Rösl, Seitz 2022b; Zamora-Pérez 2021; Jobst, Stix 2017). Most notably, cash in circulation surged worldwide during the Covid pandemic when money holders stockpiled their precautionary cash holdings considerably (Deutsche Bundesbank 2022; Rösl, Seitz 2021; Goodhart, Ashworth 2020). In addition, even in the Scandinavian and Baltic countries, which are known for their intensive usage of cashless payment instruments, the demand for cash increased drastically after Russia's full-scale invasion of Ukraine in early 2022 (Norges Bank 2023; Bank of Finland 2023; Danmarks Nationalbank 2023; Sveriges Riksbank 2022; Bank of Lithuania 2022a). Unsurprisingly, the closer a country is to the theatre of war, the higher the demand for cash (Beckmann, Zamora-Pérez 2023). However, this came as no surprise since demand for cash typically increases not only in times of political crisis and natural disasters, but also in periods of increased uncertainty about the cashless payment infrastructure, the solidity of the financial system, and in times of inflationary risks (Rösl, Seitz 2024a).

The present paper extends previous analyses by considering a multitude of different crises on a global scale and their impact on cash demand. It widens the scope to a broad international perspective by using cash data from 16 countries across all (inhabited) continents. In particular, it complements a recent international comparison study conducted by the Deutsche Bundesbank by using the same data pool (see Deutsche Bundesbank 2024a). In our paper, we follow a case study approach and analyse several examples in which crises affected banknote demand. The approach is useful as it documents many instances in which crises are likely to have contributed to the development of banknote demand. As such, the paper provides a first step towards a later, more comprehensive (econometric) study.

The paper is structured as follows. In chapter 2, we address the question as to whether cash is really losing its importance in a global perspective by analysing the development of cash in circulation in 16 countries and currency areas. Chapter 3 provides a conceptual view on crisis-related cash demand by briefly discussing the special features of cash and distinguishes between the crisis-related cash demand for domestic and foreign cash depending on its intended use as a means of payment or as a store of value (non-transactional motives). In chapter 4, we provide a short overview of how crises are defined, and which sub-variants of crises are distinguished. Following Rösl and Seitz (2024a), we then analyse the crisis-related cash demand in times of uncertainty of the digital infrastructure, during confidence crises of the financial system, natural disasters, political uncertainty as well as inflationary and exchange rate crises. Chapter 5 summarizes and concludes.

2. Is cash really losing its importance in a global perspective?

In developed countries, there seems to be a belief that "cash is dead" (Longchamp 2024), since contrary to developing countries, banknotes and coins are here becoming less and less used as a means of payment (Khiaonarong, Humphrey 2023; Boar, Wehrli 2021) and even total cash in circulation has been decreasing lately in some currency areas after central banks started to increase interest rates.[1]

[1] See, for instance, banknotes and coins in circulation in the euro area, https://www.ecb.europa.eu/stats/policy_and_exchange_rates/banknotes+coins/circulation/html/index.en.html.

In the euro area, for instance, the share of cash payments at the point of sale (POS) in terms of volume (value) declined on average from 79% (54%) in 2016 to 59% (42%) in 2022 (ECB 2022a, p. 12), although there remain considerable differences in national payment habits among euro area member states (Meyer, Teppa 2024; Deutsche Bundesbank 2024b; Groupe BPCE 2023; De Nederlandsche Bank 2023; ECB 2022a). In its latest survey of 2022, the Swiss National Bank (2023) also found that the shift from cash to cashless payment methods is continuing, albeit at a slower pace compared to the rapid changes during the pandemic. The trend toward digital payments is more pronounced in the United Kingdom where cash payments declined (in terms of number of total payments) from 55% in 2011 to 15% in 2021 (UK Finance 2022, p. 4). A slower, but nonetheless continuing declining trend is also present in Australia (Livermore et al. 2023). The same is true for China where the share of cash in all payments at the point of sale dwindled from 21% in 2017 to only 8% in 2022 (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.[2] 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, p. 6; Federal Reserve Board 2022). A similar trend is observed in Canada where the volume shares of cash declined from 2009 to 2020 from 54% to 21% and have stayed roughly at that level in the following years (Henry, Rusu, Shimoda 2024). In developing countries, however, there are virtually no indications that cash is losing its importance as a means of payment, although in some emerging countries cashless payments have gained momentum at the POS recently (see, for instance, Khiaonarong, Humphrey 2023).

Despite the declining role of cash as a means of payment in developed countries, however, global cash demand continues to increase and for most countries even relative to GDP (Rösl, Seitz 2021). This observation is confirmed by Figure 1, which refers to 16 selected countries from all (inhabited) continents, including developed and developing countries.

The strongest trend-increase is observed in Morocco, but also in Japan, the euro area, USA, and Switzerland cash issuance increased considerably, as is true for most other countries of our sample.[3] This observation creates for those countries with a declining role of cash at the POS the well-known cash paradox of increasing cash in circulation in spite of the declining use of cash as a means of payment (Zamora-Pérez 2021; Pietrucha 2021; Goodhart, Ashworth 2020; Gresvik, Kaloudis 2001). This paradox can be easily solved by pointing to non-transactional motives and store-of-value purposes for holding cash (see, for instance, Deutsche Bundesbank 2024a).

Exceptions, however, are found in Sweden and Norway (see Figure 1). In these two countries, but also in the Netherlands, Finland, Denmark, and Lithuania, cash largely lost its importance as a means of payment at the POS and, hence, it also cannot fully function anymore as a highly liquid store of value (Rösl, Seitz 2024b).[4] Among other reasons, this is one explanation why total cash in circulation (comprising transactional and non-transactional balances) went down sharply, bringing some countries close to a tipping point where cash might be completely driven out of the payments market (Claussen, Segendorf, Seitz 2023).

Figure 1 also shows for most countries eye-catching peaks around the millennium (Y2K), at the beginning of the global financial crisis in 2008/2009, and after the outbreak of the Sars-Cov-2 virus in

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

3 In India, even the demonetization of the then highest rupee banknote denominations in 2016 could not affect cash demand in India substantially (Rösl, Seitz 2022a).

4 For references to national payment surveys, see Sveriges Riksbank (2024), Bank of Finland (2024), Norges Bank (2023), Danmarks Nationalbank (2023), De Nederlandsche Bank (2023), Bank of Lithuania (2022b).

late 2019, already indicating increased demand for cash in times of crisis. But also, other types of crises, such as inflationary and political crises, typically led to a surge in cash demand in past decades, too (Rösl, Seitz 2022b). This can be attributed to the unique characteristics of cash, which help to stabilize the economy at times of turmoil and uncertainty (Rösl, Seitz 2024a; 2022a).

3. A conceptual view on crisis-related cash demand

3.1. On the special features of cash

Cash has special features which represent a potentially unreachable benchmark for any electronic or digital substitute. In short, these characteristics are (see also Rösl, Seitz 2022a):

– anonymity in use,
– cash is central bank money and therefore particularly trustworthy,
– cash does not necessitate the further involvement of service providers,
– cash is an offline payment medium,
– cash can be used for both small and large payments,
– cash payments are simple, convenient, and quick,
– cash payments are definitive and final,
– cash guarantees financial and payments inclusion,
– cash facilitates overview and control of spending,
– cash helps to avoid (deeply) negative nominal interest rates,
– cash is relatively secure against counterfeiting.

Of these, some are especially important from an individual perspective to safeguard liquidity and protect wealth in uncertain times: once being in circulation, cash can be used for payments without any electronic infrastructure. This offline functionality is especially important when fears of hacker attacks on energy facilities and/or electronic payment systems spread amongst society (see, for instance Sweden after its declaration of intended NATO membership), but also in times of natural disasters and wars. In addition, being central bank money, cash is the safest form of money.[5] Therefore, in times of economic or political turbulences, these elements usually lead to higher demand for domestic/and or foreign cash, because cash holders tend to trust central banks more than private institutions facing potential bankruptcy. Furthermore, cash has the characteristic that it can by physically touched: in contrast to electronic means of payments, the tactile nature of cash is a psychological factor which is especially important in times of heightened uncertainty. To sum up, due to the unique characteristics of cash, it comes as no surprise that the demand for cash usually increases in times of crisis.

3.2. Demand for cash in uncertain times

In times of uncertainty, a potential increase in cash demand is not limited to domestic banknotes (and even coins), but might also include foreign cash (see Figure 2). The latter, however, is only possible

[5] In the future, central bank digital currency (CBDC) might be another form of central bank money. Depending upon the chosen CBDC design, money holders could get direct access to central bank accounts.

if the foreign currency is fully convertible and can be provided sufficiently. There are three major ways of importing foreign cash: by private travel, e.g. tourism; by cash remittances; and by international banknote shipments of specialized financial institutions (Rösl, Seitz 2024a). Through the third channel of cross-border cash deliveries, only a handful of currencies are provided in substantial quantities: US dollars, euros, and Swiss francs (see, for instance, ECB 2022b; Judson 2012, 2017; Bartzsch, Rösl, Seitz 2011; Hellerstein, Ryan 2011).[6]

Figure 2 shows in a stylized way how different types of uncertainty might affect the demand for domestic and foreign cash as a means of payment and/or a store of value.

4. Crisis-related demand for cash from an international perspective

4.1. Data description and methodology

Rösl and Seitz (2022b) show in their econometric analysis that crises can have a statistically significant effect on cash demand. This notion is also supported by several case studies (see, for instance, Rösl, Seitz 2024a; Goodhart, Ashworth 2020; Spicer 2017; Davies et al. 2016) and the following analysis provides further anecdotal evidence. We analyse the evolution of banknotes in circulation at times of crisis for 16 countries for the period from 1990 to 2022 and distinguish between small and large denominations to separate between transactional and non-transactional motives.[7]

The countries/currency areas investigated are: Morocco from Africa; the euro area, Norway, Poland, Sweden, Switzerland, the United Kingdom from Europe; India, Indonesia, Japan, Türkiye from Asia; Brazil from South America; Canada, USA and Mexico from North America; and Australia from Oceania. For those countries, we were able to collect monthly data on all denominations.

Table 1 shows the six different types of crises and the respective examples analysed. The paper presents several case studies on the effects of crisis on banknote demand. In particular, we show crises for which we find indications that the crisis/uncertainty affected cash demand by means of conspicuous increases (by at least one percentage point) in the annual growth rates of total (small, large) banknotes in circulation. This case study approach allows us to document the impacts of crises on banknote demand in many instances. As such, the paper enables the formulation of a hypothesis on the link between crisis and banknote demand. However, owing to the non-consideration of the other influencing factors of banknote demand, the approach does not allow causal inference to be drawn on the link between crises and banknote demand. A crisis calendar in the Appendix provides more information on the crises analysed in this paper.

For each selected crisis, we define the crisis response period. The respective (cash) response period refers to the time when the annual growth rate of cash reacts to the crisis, which is usually shortly after the outbreak of the crisis. In some cases, however, cash demand is already affected in anticipation of a crisis which might eventually not even materialize, such as the breakdown of the digital payment

[6] In some African countries like Zimbabwe, the South African rand (SAR) also circulates as foreign cash, see, for instance, Hanke (2018a); Berg and Borensztein (2000).

[7] We define small and large-denomination banknotes in the same way as in Bech et al. (2018). The threshold is a purchasing power-adjusted value of USD 75. For currencies where all banknote denominations are lower than this value, the "large-denomination banknotes" category corresponds to the largest denomination. Due to data restrictions, however, no grouping of small and large denominations is possible for the Indian rupee.

infrastructure around the millennium change (see chapter 4.2). The (cash) response period is deemed to be over once the growth rates stabilize again (usually at the pre-crisis levels). For illustrative purposes, we report in each case the amplitude of growth, which refers to the maximum increase in the annual growth rate, i.e. the difference between the highest value during the response period and the value recorded immediately before the crisis began.

4.2. Cash demand in times of crisis

Uncertainty of digital (payment) infrastructure

As already pointed out by Rösl and Seitz (2022b), the demand for USD, CHF, JPY, GBP, SEK, and AUD increased (at least for one denominational group) significantly around the millennium, when fears about the resilience of the digital (payment) infrastructure mounted.[8] At that time, people stockpiled their cash holdings for two reasons. Firstly, they reacted to the rising uncertainty of the cashless payment infrastructure by holding more transaction balances (small banknote denominations). Secondly, the demand for non-transaction balances in the form of larger denominations also increased to hedge against the mounting uncertainty of their digitally stored savings (Rösl, Seitz 2021; Assenmacher, Seitz, Tenhofen 2017, 2019). The anecdotal evidence provided by Table 2 seems to broadly confirm this view also for all other countries of our sample as the corresponding annual growth rates of all denominational groups increased perceptibly shortly before the end of 1999.[9]

As an example, Figure 3 illustrates the impact of Y2K on cash demand in three developed countries, namely the USA, Canada, and Japan and three developing or transformation countries (Morocco, Mexico, Indonesia). The effects across countries are, however, very similar.

This result is, of course, not surprising since the existing fears around the millennium about a potentially devastating computer bug affected the global economy considerably, even if these fears did not materialize in the end.

Confidence crisis of financial system

In times of a confidence crisis of the financial system such as the global financial crisis of 2008/9, the increased demand for cash was largely the result of consumers taking precautionary actions and building up non-transaction balances (Muñoz, Soons 2023; Deutsche Bundesbank 2022). For this reason, there was greater demand for large banknote denominations, both domestic and foreign, as a store of value at that time (see Table 3, Figure 4, and, for instance, Seitz, Devigne, de Pastor 2022; Rua 2021). The increase in demand was especially high for the three most traded currencies in the world cash market, the US dollar, the euro, and the Swiss franc. Even for these currencies, the demand was mostly concentrated on large denominations, except the euro, where the smaller ones also reacted visibly (see Figure 4).

[8] The methodological framework of the paper entails the analysis of correlations between crisis and banknote demand. No claims on causal effects of crisis on banknote demand are intended, as we cannot rule out that other influencing factors determining whether banknote demand in particular areas reacted or not reacted were also involved.

[9] However, there is hardly any evidence that Y2K affected the demand for foreign cash (Rösl, Seitz 2024a, p. 6).

Furthermore, Table 3 shows that large denominations were comparatively more in demand than smaller ones.

Cash demand during the global financial crisis in 2008/9, however, also demonstrates that if a country is not affected by such a confidence crisis, cash in circulation does not show any crisis-related changes as expected. As an example, neither small nor large JPY denominations increased (at least in comparison to other industrialized countries) visibly after the Lehman bankruptcy in autumn 2008. In essence, the same picture is true for China (for which only data for total banknotes in circulation are publicly available), see Figure 5.

Therefore, it comes as no surprise that only 10 out of 16 countries in our sample show a visible increase in cash demand at that time (see Tables 1 and 3).

The global financial crisis also did not lead to increased cash demand in Sweden and Norway (Rösl, Seitz 2022b). Engert, Fung and Segendorf (2019), and Armelius, Claussen and Reslow (2022) suggest that experience with previous banking crises made people confident that their bank deposits were safe at that time. However, Table 4 exemplifies that cash demand rose in these two Scandinavian countries at times of heightened uncertainty about the domestic financial system due to (mainly) domestic circumstances at the beginning of the 1990s. There were several banking crises from 1990–1992 originating in the housing sector (see, e.g. Englund 2015; Jonung 2009; Körnert 2002). Loan defaults and poor risk management eroded banks' equity. In view of the feared collapse of the whole system, governments intervened massively through bank rescue programmes. As during the crisis financial and real uncertainty increased, cash holdings soared. Whereas in Norway, it was mainly increased demand for large denominations, in Sweden both denominational groups reacted positively (see Table 4). Another example is Australia (Gizycki, Lowe 2000), which had been in recession from 1990 Q4 until 1991 Q4. In the process, the State Bank of Victoria, the State Bank of South Australia, the largest credit union (the Teachers Credit Union of Western Australia), and the second-largest building society (Pyramid Building Society) failed along with several merchant banks and other financial institutions (The Age 2006). Unsurprisingly, demand for cash increased enormously, comprising large and small AUD denominations (see Table 4).

In addition, the example of Canada shows that cash demand can also be affected if the solidity of public finances is more and more in doubt, or the national corporate bonds market gets under pressure.[10] Therefore, unsurprisingly, shortly after the dot-com-bubble burst in March 2000, the demand for large GBP banknotes also increased considerably, although small GBP denominations did not react visibly. The latter is also true for the demand of USD banknotes (small and large denominations) at that time, which shows that financial market turmoil which does not directly affect the banking system does not always lead to an increase in (total) cash demand.

On the other hand, domestic cash demand can also be affected by structural changes in the monetary system of other countries, such as the creation of monetary unions. As shown in Table 5, there are indications that the increase in demand for Norwegian krona from October 1997 – August 1998 might be at least partly due to the heightened uncertainty before the start of the European Monetary Union on 1 January 1999 when (future) euro area residents seemingly stockpiled their NOK cash holdings.

[10] A similar observation was found for Greece during the Greek sovereign debt crisis when banknote (net) issuance of the Bank of Greece skyrocketed (Rösl, Seitz 2022a).

Unsurprisingly, other neighbouring countries of the euro area, such as Sweden and Switzerland, also experienced a perceptible increase in cash demand shortly before the euro was introduced as cash on 1 January 2002 (see Table 6).

Natural disasters

Natural disasters usually affect cash demand in a significant way (Rösl, Seitz 2024a). For instance, Spicer (2017) shows an immense increase in cash issuances in regional branches of the US Federal Reserve System even shortly before hurricanes are expected to hit mainland USA. In those types of crises (heavy thunderstorms, earthquakes, flooding, etc.), access to cash for (basic) transactions is essential (Bautista-González 2023a, 2023b; CashEssentials 2021; Shephard-Barron 2016; Smith 2014). Table 7 provides further indications for a crisis-related increase in cash demand due to local natural disasters.

Take, for instance, the seaquake on 11 March 2011, which caused the Fukushima power plant incident. At that time, not only the demand for small denominations increased perceptibly, but also the highest denomination, the JPY 10,000 bn, which is also heavily used for transaction purposes in Japan,[11] see also Figure 6.

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 Sars-Cov-2 virus in December 2019, cash holdings around the globe surged drastically (Deutsche Bundesbank 2022, p. 81; ECB 2022b, p. 34; Bertaut, von Beschwitz, Curcuru 2021; Rösl, Seitz 2021; Goodhart, Ashworth 2020). This is confirmed by Table 8 on a broader global basis.

Except for Sweden, where the public stance about the virus was quite relaxed, cash demand reacted considerably in all other countries of our sample.[12] There are, however, interesting differences. In Japan, Morocco, and Switzerland the demand for small banknote denominations, which are typically used at the POS, showed a marked decline which might be due to (unjustified) fears of virus contagion (see Tamele et al. 2021; Auer, Cornelli, Frost 2020) and/or very strict lockdown policies. In Morocco, even the demand for large denominations decreased, causing an overall reduction in cash demand at that time. This is in stark contrast to all other countries (except for Norway), where large banknote denominations were highly in demand as a highly liquid store of value.

To illustrate, Figure 7 shows the annual growth rates of small and large banknote denominations for the USD, EUR and CHF at that time. Shortly after the outbreak of the Sars-Cov-2 virus in Wuhan, China, the demand for small and large banknote denominations of USD and EUR increased sharply once the virus started to infect the local population about 2 months later.

As already mentioned, the demand for small Swiss franc banknotes was not affected by the Covid crisis and continued its downward trend at that time (see also Table 8).

Political uncertainty

In the case of political uncertainty or even political crises, cash demand tends to increase as well. Due to the various types of political crises which have occurred over the past 30 years, we structure our

[11] Fujiki and Nakashima (2019) present evidence that around 40% of the Japanese population prefer to pay 'cash only' even for amounts above JPY 50,000.

[12] In Sweden, this might also be related to problems of access to and acceptance of cash at that time (Rösl, Seitz 2024b).

analysis in the following way: first, we look at cash demand in the wake of wars and terrorist attacks, and then focus on more domestic political issues such as sovereign debt crises, crisis-riddled elections, and other times of domestic political turmoil. In addition, although not being crises in a narrow sense, politically motivated interventions in cash supply are also analysed.

After Russia's full-scale invasion of Ukraine, the demand for cash in Ukraine increased considerably. As shown in Figure 8, however, only the demand for higher denominations was affected. This increase was so immense that it surpassed the extraordinary levels observed after the beginning of the Covid pandemic. At both times, the increase in higher denominations seems to reflect precautionary reasons, but the steep increase in domestic inflation rates shortly after the outbreak of military hostilities of up to 26.6% p.a. (Bank of Ukraine 2024) also seems to imply a structural shift of transaction balances towards higher denominations.

The Ukrainian war also affected cash demand in neighbouring countries perceptibly, although with decreasing intensity the further away the country is from the war theatre (Beckmann, Zamora-Pérez 2023; ECB 2023).

Table 10 also confirms this view on a broad scale.

But the heightened uncertainty around the globe due to the war seems to also have affected cash demand even in far-distant countries such as Australia and Indonesia, where annual growth rates of (especially small denominations of) cash in circulation also reacted visibly (see Figure 9).

It was, of course, not the first time that cash demand increased in the wake of wars. Table 11 illustrates how the first and second Iraq war stimulated cash demand in Morocco, USA and Poland in 1991 and 2003, respectively.

As shown by Table 12, cash demand also increased in the past decades visibly after terrorist attacks.

From a global perspective, most notable were the attacks of 11 September 2001 (see also Deutsche Bundesbank 2024a). At that time, the demand for large USD denominations increased perceptibly as US citizens stockpiled their precautionary cash holdings, but also small USD banknote denominations were in demand (see Table 12). But also in neighbouring Canada, the demand for small denominations increased notably, as was true for cash demand in some countries overseas (Australia, Poland, Sweden, and the United Kingdom). To illustrate, Figure 10 shows the impact of the 9/11 terrorist attacks on cash demand in Australia.

By contrast, the demand for cash in euro area countries which planned to exchange their national currencies for the euro on 1 January 2002 did not react perceptibly.[13]

Rösl and Seitz (2022a) demonstrate how the two Greek sovereign debt crises starting in 2009 and 2014, respectively, prompted the Greeks to demand more cash. At that time, net issuance of euro banknotes by the Bank of Greece unambiguously reacted to the heightened uncertainty of a possible state insolvency (see Figure 11).

Although total euro cash demand was not visibly affected during the first Greek sovereign debt crisis, the demand for large Canadian, Swiss, and US banknote denominations reacted quite vividly as shown in Table 13.

With the start of the second Greek sovereign debt crisis in autumn 2014 and the mounting risks of a possible exit of Greece from the European monetary union became apparent, however, total demand for euro banknotes also increased perceptibly, whereas (surprisingly) no visible increase in demand for foreign cash was observed.

[13] See for instance, the evolution of cash demand for Deutsche mark in Rösl and Seitz (2024a).

We also find indications that crisis-riddled national elections might influence national cash demand (see Table 14).

As an example, Figure 12 shows how the demand for British pounds evolved after the freshly re-elected British Prime Minister Cameron announced a referendum in May 2015 on exiting the European Union (Brexit) and after the vote for Brexit in June 2016. Especially large GBP banknote denominations were heavily in demand when British citizens stockpiled their precautionary cash holdings.

In addition, Lalouette et al. (2021, p. 10) and Rua (2021) find empirical evidence that demand for the EUR 100 and EUR 200 banknotes increased extraordinarily in the second quarter of 2016, which can be at least partly attributed to the heightened political uncertainty due to the UK's vote on leaving the EU (Brexit) in June 2016[14] – although total demand for euro cash was not perceptibly affected at that time.

Of interest are also politically motivated interventions in the cash supply and cash cycle which not only affect domestic cash in circulation, but might also have repercussions on the foreign demand for the respective currencies. For instance, the demand for large Swiss banknote denominations increased visibly when first rumours came up in the summer of 2015 that the ECB would stop the production of EUR 500 banknotes (see Table 15).

Sweden and India are two examples where actions of the domestic central bank and/or the government heavily led to a (at least temporary) reduction of the domestic cash supply in their pursuit of strengthening cashless payments. In this respect, Sweden is an extreme example. In two rounds of discouraging the use of cash, the Swedish central bank declared some older SEK banknotes invalid in 2013. Commercial banks hardly assisted in the exchange of those demonetized banknotes for new bills, for instance, by not providing larger denominations in their ATMs. At that time, the growth rate of smaller denominations remained quite stable, but this changed when in October 2015 a completely new series of SEK banknotes were issued with only a very short exchange time before all previous circulating notes became invalid (Claussen, Segendorf, Seitz 2023; Armelius, Claussen, Reslow 2022). The Swedish people then got obviously fed up with cash holdings and turned to cashless payment media (see also Figure 1).

In India, however, a similar attempt towards more cashless payments failed. As shown in Figure 1 and Table 15, Indian citizens filled-up their cash holdings within two years after the surprise demonetization of the IDR 500 and IDR 1,000 banknotes in November 2016 (see, e.g., Rösl, Seitz 2022a).

Inflationary crises

With respect to inflationary crises and cash demand, Rösl and Seitz (2024a) distinguish between the initial phase of a considerably increasing inflation and the move towards hyperinflation. Regarding cash demand for daily transactions in times of sizeable price increases, money holders at first tend to hold more domestic cash to compensate for losses in purchasing power of money (Cagan 1956). In our list of 16 countries, this can be observed in Türkiye, which had inflation rates above 100% in the 1990s and around 80% at the end of our sample and annual growth rates in these periods in the same order

[14] The increase in the demand for these two euro denominations at that time might also be related to the decision of the Governing Council of the ECB on 4 May 2016 that the EUR 500 banknote will be excluded from the Europa series and the issuance of this denomination will be stopped around the end of 2018. Using structural times series models, Bartzsch et al. (2023, Table 3) find statistically significant positive effects of this decision on German-issued EUR 100 banknotes and EUR 200 banknotes as well as Spanish-issued EUR 200 banknotes over the year 2016.

of magnitude. But for the same reason, the demand for cash as a store of value typically erodes quickly and money holders often turn to commodities or, if available, to stable foreign currencies (Imam 2022; Banegas et al. 2015; Hanke 2008a; Feige 2003; Kamin, Ericsson 2003). It is, however, extremely hard to estimate how quickly and to what extent domestic residents turn to foreign cash in times of high domestic inflation rates. Nonetheless, in the case of Türkiye, there are substantial amounts of euro cash holdings (ECB 2023) which can be attributed to high domestic inflation rates.

None of our 16-country sample, however, faced hyperinflation (given the Cagan definition of an inflation rate of 50% against the previous month, which corresponds to an annual inflation rate of 12,875%), but Türkiye and Brazil nonetheless showed quite high inflation rates in some periods. Brazil, for example, was nearly in hyperinflationary mode in the first half of the 1990s, with annual inflation rates up to 7,000%.[15] However, this did not completely destabilize the Brazilian economy as there was a close domestic currency substitute available in the form of interest-bearing money market accounts with near money liquidity (Garcia 1996). Consequently, Brazilians who had access to this asset were to some extent protected from inflation without sacrificing liquidity. The unbanked, however, had to rely on cash and barter. Finally, the government introduced a new currency in 1994, the real.

For hyperinflationary countries, we refer for illustrative purposes in the following to Rösl and Seitz (2024a), who analysed cash demand in Venezuela and Zimbabwe. After inflation went completely out of control in Venezuela between 2015 (122%) and 2018 (65,374%), when the Venezuelan government utilized the money press to compensate for the income losses from the oil industry, local currency in circulation, the bolivar, rose along with inflation to such enormous levels that the Venezuelan government has been forced to redenominate its currency three times since (see Figure 14).

In 2008, the original bolivar (Bs) was replaced by the bolivar fuerte (Bs.F) with a fixed conversion rate of 1 Bs.F/1,000 Bs.[16] In other words, this currency reform led to a cut of three zeroes in monetary value – a common practice in hyper-inflating countries. In 2018, the bolivar fuerte was exchanged again for the bolivar soberanos (Bs.S) at a rate of 1 Bs.S/100,000 Bs.F (further cut by 5 zeroes) and in 2021 1 bolivar digital (Bs.D) was renominated for 1,000,000 Bs.S (further cut by 6 zeroes), although Bs.S and Bs.D banknotes remained in co-circulation for some time (Banco Central de Venezuela 2018, 2021).[17] In total, one original bolivar is currently worth 1/100,000,000,000,000 Bs.D. These redenominations were necessary to retain the national currency in circulation as a useable unit of account and thus as a means of payment in daily practice.

As already mentioned, in countries with inflationary crises nominal demand for domestic cash as a means of payment usually increases initially to compensate for ever rising domestic sales prices at the POS. The enormous increase in the demand for bolivar banknotes, as shown in Figure 15, was therefore unambiguously driven by transaction motives. At the same time, however, the demand for bolivar banknotes as a store of value eroded completely due to the immense loss in purchasing power (Bushnell, Hanke 2017). However, US-dollar cash became finally the primary choice, not only in terms of storing value, but over the past years also as a means of exchange. According to recent estimates, around 60% of all transactions at the POS in Venezuela are currently conducted in US dollars (see Figure 15).

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15 Unfortunately, our banknote series only starts in 1995.

16 http://www.republica-de-venezuela.com/about-venezuela/currency-of-venezuela.php.

17 The term 'digital' is misleading since 'bolivares digital' are just ordinary banknotes, see www.banknoteworld.com.

This dollarization process had an immediate stabilizing effect on the Venezuelan economy in terms of stopping its free fall in 2019 (see for more details Rösl, Seitz 2024a) which was even openly admitted by President Maduro at that time.[18]

Similar experiences were made in Zimbabwe.[19] Take, for instance, the hyperinflation period from March 2007 to November 2008, when the annual inflation rate finally reached $89.7 \cdot 10^{22}$% (Hanke, Kwock 2009, p. 353). During that time, the Reserve Bank of Zimbabwe redenominated its currency, the Zimbabwe dollar, four times by eventually cutting 28 zeroes. At the end, however, even redenomination did not help anymore as the loss of purchasing power of the Zimbabwe dollar due to hyperinflation was quicker than banknotes could be printed (IMF 2009).

As expected, Zimbabwe was already heavily dollarized at the end of 2008, when its citizens turned to foreign cash as a means of payment, store of value, and unit of account.[20] Interestingly, the Zimbabwean population did not opt for a single, but a multiple currency system comprising several currencies such as the South African rand, euro, British pound, US dollar, Mozambique's metical, and the Zambian kwacha (Noko 2011, p. 348). Consequently, the (fourth) Zimbabwe dollar was officially suspended as legal tender on 12 April 2009 (VOA News 2009). Although the people seemingly favoured the South African rand at the time, the Zimbabwean government decided to adopt the US dollar for conducting official business (Bostrom 2017, p. 2). Consequently, nine foreign currencies served as official means of payment in Zimbabwe in June 2016, but it was estimated that 90% of transactions were made in US dollars and 5% in South African rands (International Finance 2017; Imam 2022, p. 772).

The use of foreign currency in general and foreign cash for daily transactions in particular also had an immediate stabilising effect on Zimbabwe's economy (Hanke 2008b). The multi-currency system adopted in early 2009 helped to restore price stability, permitted the banking system to stabilize, and imposed fiscal discipline by precluding the option of budget deficit monetization (IMF 2010, p. 4; Imam 2022, p. 771).

Exchange rate crises

Exchange rate crises and their impact on demand for cash are notoriously hard to detect since it depends on how such crises are defined. A broad definition of an exchange rate crisis refers to a wider economic crisis triggered by exchange rate fluctuations. Examples are the Asian crisis 1997/98 and the tensions within the European Monetary System in 1992/93 (Rösl, Seitz 2021, p. 18). Following a narrower definition of an exchange rate crisis, where cash demand directly reacts to the exchange rate changes themselves (and not to mounting economic and political uncertainty), one would expect an increase in demand for the respective cash which is believed to appreciate versus the other currency highlighting its store-of-value function.

An example of the first type of crisis is the Southeast Asian crisis at the end of the 1990s. Table 16 shows that in all Asian countries of our sample together with the UK with strong historical roots

18 In an interview, Maduro described dollarization as an "escape valve" that helps the recovery of the country, the spread of productive forces in the country and the economy (Reuters 2019).

19 Following Cagan (1956), the established definition of hyperinflation starts at a price level increase of at least 50% per month.

20 Then-finance minister Biti stated even before parliament while presenting a revised 2009 budget that: "The death of the Zimbabwe dollar is a reality we have to live with. Since October 2008 our national currency has become moribund." See, The Zimbabwe Independent (2009).

in Asia, cash holdings increased drastically, especially the (non-transactional) large denominations.[21] In Indonesia, for example, the crisis resulted in a devaluation of the IDR, a banking crisis and riots in the streets. These results imply that (1) the crisis was a regional phenomenon, (2) it predominantly had an impact on domestic currencies and (3) the main reason behind the increasing cash demand were the store-of-value and precautionary motives.

There were three more national exchange rate crises in our sample with repercussions on cash in circulation (see Table 17). The first was the crisis of the European Exchange Rate Mechanism 1992/93, which was in existence before the introduction of the euro in 1999 (see Deutsche Bundesbank 1993). The crisis of the European Monetary System (EMS) began in September 1992 with the withdrawal of the UK and a sharp depreciation of the British pound and lasted until July 1993. The tensions in the EMS intensified to such an extent that on 1 August 1993 the EU finance ministers decided to extend the range in the exchange rate mechanism from ±2.25% to ±15%, thus effectively suspending the fixed exchange rate system. We find a significant increase in the demand for small and large US dollar denominations (which might have originated from the US or overseas) as the US dollar was expected to appreciate.[22]

Davies et al. (2016) find that a short-term increase in cash demand for Australian dollars by foreign visitors to Australia who use cash intensively is a fairly usual occurrence when the Australian dollar depreciates. Our results confirm this analysis in 2015/16, when the Australian dollar heavily depreciated against the US dollar. In our case, the increased demand is not only concentrated on small denominations. Moreover, we find a perceptible effect in the case of Switzerland. In January 2015, the peg between the Swiss franc (CHF) and the euro (which had been in force since September 2011) was abolished, with the immediate consequence of a strong appreciation of CHF against the euro. This triggered a rising cash demand for store-of-value reasons, probably both from within Switzerland and abroad.

4.3. Empirical results

The results of our 16-countries study can be summarized by Table 18. Table 18 demonstrates that virtually all types of crises lead to an increase in cash demand as already suggested by Rösl and Seitz (2021, 2022a, 2022b, 2024a). Exceptions to this rule are only times when the government and/or the central bank actively discourages the use of cash. This was true during the Covid pandemic, but even then, only one country in our sample (Morocco) faced a decrease in total cash demand (see Table 8). Other examples are Sweden and India, whose public authorities tried to push their society towards cashless payment systems. Please note, however, that Table 18 can neither claim statistical significance nor completeness since it does not, *inter alia*, include euro area countries prior to the introduction of euro cash, such as Germany, whose currency was often heavily in demand in times of crisis (Rösl, Seitz 2024a).

The unique characteristics of cash (see chapter 3.1) help to protect its users from possible liquidity shortages and safeguard their wealth in times of crisis. Notwithstanding, as is exemplified by Table 20, demand for foreign cash usually only comes into consideration if the domestic eco-political system is under considerable strain.

[21] The effect for Japan is also confirmed by the econometric analysis of Rösl and Seitz (2022b), who additionally find a positive effect on the demand for large CHF denominations.

[22] Rösl and Seitz (2022b) also find a significant increase in the demand for large DEM denominations.

5. Summary and conclusions

In this paper, we focus on the relation between cash in circulation (in total and differentiated by small and large denominations) and different crises in an international sample of more than 16 countries from all over the world since the 1990s. We analyse six different types of crises: technological crises, confidence crises of the financial system, natural disasters, political uncertainty, inflationary, and exchange rate crises. The study follows a case study approach and broadly supports the findings of previous papers: in many crises of different types cash holdings increase. This increase might be temporary or more permanent, originate domestically or abroad, or be motivated by transactional or non-transactional purposes – crises often provide meaningful explanations of unusual changes in cash in circulation.

Due to its physical nature, cash can play an important role in mitigating the effects of crises, for example in cases of natural disasters or technological failure (Shepherd-Barron 2016). Indeed, the results in this paper suggest that consumers stockpile cash for various reasons in preparation for different types of crises. Cash, as it appears, plays an important role for the resilience and crisis preparedness of our societies (Rösl, Seitz 2024b). Of course, if cash is used less and less in normal times, it may cease to work in times of dire need. Consequently, central banks should ensure that cash remains in circulation and functions properly also in normal times. This includes access to and acceptance of cash as well as availability of all denominations and affordability.

Central banks all over the world are currently thinking about introducing a central bank digital currency (CBDC). With respect to crises, several questions arise in this respect. These are, *inter alia*: How does the concrete CBDC look like? Will it be cash-like or cashless-like? Can the non-transactional demand for cash be fully transferred to CBDC? Can a CBDC also stabilize in times of turmoil, or does it introduce new problems, e.g. for financial institutions, financial market stability and competition in the payments market? Answering these questions is left to future research.

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Appendix

Calendar of selected crises

Due to difficulties in identifying the exact beginning and end of a crisis we focus on a quarterly perspective. The order of the different crises in this annex reflects the argumentation in the main text.

1. Millennium bug (Y2K): 1999 Q4

Increased uncertainty about the digital infrastructure started in 1999 Q4. In 2000 Q1 it became clear that the fears were broadly unjustified. For more details, see, for instance, https://education.nationalgeographic.org/resource/Y2K-bug/.

2. Global financial crisis (GFK): 2008 Q4 – 2009 Q2

Although the first signs of a financial crisis appeared in the US already during 2007, the outbreak of the global financial crisis is usually associated with the bankruptcy of Lehman Brothers in October 2008. The global recession lasted until 2009 Q2. For details, see, for instance, https://www.files.ethz.ch/isn/109461/LWP_fincri.pdf.

3. National financial crises (NFK)

a) Norway: national banking crisis: 1991 Q4 – 1992 Q4; for details, see Moe, Solheim, Vale (2004);
b) Sweden: national banking crisis: 1990 Q1 – 1991 Q4; for details, see https://www.diw.de/documents/publikationen/73/diw_01.c.94162.de/09-5-3.pdf;
c) Australia: national banking crisis: 1991 Q1 – 1991 Q4; for details, see https://www.rba.gov.au/publications/confs/2000/pdf/conf-vol-2000.pdf;
d) Canada: increasing uncertainty about the solidity of public debt: 1994 Q2 (downgrade by Moody's) – 1995 Q4; for details, see https://www.bankofcanada.ca/2001/01/canada-economic-future-what-have-we-learned/;
e) United Kingdom: dot-com crisis: 2000 Q2 – 2002 Q4; for details, see https://www.cazenovecapital.com/en-gb/uk/wealth-management/insights/dotcom-crash-20-years-of-hindsight/;
f) Canada: corporate bonds market under pressure: 2015 Q1 – 2018 Q1; for details, see https://www.bankofcanada.ca/2018/03/staff-analytical-note-2018-7/.

4. Uncertainty connected with the introduction of the euro: 1999 Q1 – 2002 Q1

4.1. As unit of account (EUR book money): 1999 Q1; for details, see https://european-union.europa.eu/institutions-law-budget/euro/history-and-purpose_en#:~:text=After%20a%20decade%20of%20preparations,changeover%20in%20history%20took%20place.

4.2. As cash (EUR cash): 2002 Q1; for details, see https://european-union.europa.eu institutions-law-budget/euro/history-and-purpose_en#:~:text=After%20a%20decade%20of%20preparations, changeover%20in%20history%20took%20place.

5. Natural disasters

5.1. Local disasters

a) Morocco: drought in 1995 Q1 – 1995 Q2; for details, see: Shimi, Saidi, Seitz (2024);
b) Japan: seaquake leading to nuclear power plant incident in Fukushima in 2011 Q1 (March); for details see, https://world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-daiichi-accident;
c) Indonesia: seaquake in 2004 Q4 (December); for details, see https://recovery.preventionweb.net/collections/recovery-collection-2004-indian-ocean-earthquake-and-tsunami;
d) Poland: thunderstorms and floods in 2001 Q3 – 2002 Q3; for details, see https://reliefweb.int/report/poland/poland-floods-final-report-appeal-no-232001.

5.2. Global disaster (Covid-19): 2020 Q1 – 2023 Q2

Outbreak of Sars-Cov-2 virus in December 2019 in Wuhan, China. Over the following months, spreading led to global pandemic. For details, see https://www.who.int/emergencies/diseases/novel-coronavirus-2019. WHO declares end of pandemic in June 2023.

6. Wars and terrorist attacks

6.1. Full-scale war in Ukraine

The Russian military invaded Ukraine on 24 February 2022. For details, see, for instance, https://www.defense.gov/News/News-Stories/Article/article/3686148/two-years-in-russias-war-on-ukraine-continues-to-pose-threat-to-global-security/.

6.2. Iraq wars

a) first Iraq war: 1991 Q1 – 1992 Q1; US-led coalition started military action on 16 January 1991; end of hostilities on 28 February 1991; for details, see https://www.britannica.com/event/Persian-Gulf-War;
b) second Iraq war: 2003 Q1 – 2011 Q4; US-led coalition started military action on 20 March 2003; US troops withdraw from Iraq on 18 December 2011; for details, see https://www.britannica.com/event/Iraq-War.

6.3. Terrorist attacks

a) attacks on 9 September 2001: 2001 Q3; the terrorist group Al Qaida attacks the World Trade Center in New York and the Pentagon in Washington D.C. with highjacked airplanes on 9 September 2001; for details, see https://www.911memorial.org/911-faqs;
b) attacks in Indonesia
   – bombing attack on 12 October 2002 in Kuta, Bali: 2002 Q4; for details, see https://www.bbc.com/news/world-asia-19881138;
   – several bombing attacks on 1 October 2005 in Kuta and Jimbaran, Bali: 2005 Q4; for details, see https://www.reuters.com/article/us-indonesia-militant-idUSJAK16935020080505.

7. Political uncertainty

7.1. Greek sovereign debt crisis

a) first Greek sovereign debt crisis: October 2009 – September 2014; unsound public finances let Greek sovereign bond yield increase to unsustainable heights; for details see Rösl and Seitz (2022a); a timeline of the Greek financial crisis can be found at https://www.esm.europa.eu/publications/safeguarding-euro/runaway-train-greece-sounds-alarm;
b) second Greek sovereign debt crisis: October 2014 – September 2019; unsound public finances let Greek sovereign bond yield increase again to unsustainable heights; for details see Rösl and Seitz (2022a).

7.2. Crisis-riddled elections and other times of domestic political turmoil

a) Brazil: 2001 Q3 – 2003 Q2; political crisis due to a struggling economy with high inflation rates and steep devaluation of the national currency with upcoming presidential election in October 2002; strongly increased bond yields reached their pre-crisis level in 2003 Q2, https://tradingeconomics.com/brazil/government-bond-yield; for more details, see https://www.imf.org/external/np/exr/articles/2007/112107.htm;
b) Poland: 2003 Q1 – 2004 Q1; increased uncertainty about possible accession to EU; in June 2003, Polish referendum about EU membership (to take effect from May 2004); for details, see https://www.robert-schuman.eu/en/monitor/205-all-together-the-poles-say-yes-to-their-country-s-entry-into-the-european-union;
c) Norway: 2005 Q4 – 2006 Q4; unpopular rises in whaling quota amongst fishers with decreasing sales prices; in January/February 2006 political tensions because of Mohammad caricatures;
d) Mexico: 2012 Q1 – 2012 Q3; political crisis around the upcoming presidential election on 1 July 2012; for more details, see https://en.wikipedia.org/wiki/2012_Mexican_general_election;
e) Poland: 2014 Q4 – 2017 Q3; European migrant crisis; for details, see https://en.wikipedia.org/wiki/2015_European_migrant_crisis;

f) United Kingdom: 2015 Q2 – 2016 Q4; re-elected prime minister Cameron in May 2015 announces a referendum on exit from the EU, which took place on 23 June 2016 with a slight majority who voted in favor of Brexit; for details, see https://www.euronews.com/2020/01/30/brexit-timeline-2016-2020-key-events-in-the-uk-s-path-from-referendum-to-eu-exit.

7.3. Politically motivated interventions in cash supply

a) Sweden: 2013 Q2 – 2014 Q4; Sveriges Riksbank heavily discourages the use of Swedish krona (SEK) banknotes by declaring older notes invalid in 2013; commercial banks did not assist in the exchange of old for new banknotes, leading to high denominations running out in ATMs; for details, see Claussen, Segendorf and Seitz (2023), and Armelius, Claussen and Reslow (2022);
b) Sweden: 2015 Q1 – 2018 Q4; in 2015, the start of a new series of SEK banknotes with very short exchange period and quick demonetization of existing notes further discourages the use of cash;
c) Switzerland: 2015 Q3 – 2016 Q1; the ECB decides to stop the production of EUR 500 banknotes on 4 May 2016; for details, see https://www.ecb.europa.eu/press/pr/date/2016/html/pr160504.en.html;
d) India: 2016 Q4; Prime Minister Modi announced demonetization of the two highest rupee denominations with immediate effect; for details, see, for instance, Rösl and Seitz (2022a);
e) India: 2017 Q1 – 2018 Q3; refilling of cash stocks by newly issued notes during 2017/8 reverses the monetary contraction of cash in circulation; see, for instance, Rösl and Seitz (2022a).

8. Exchange rate crises

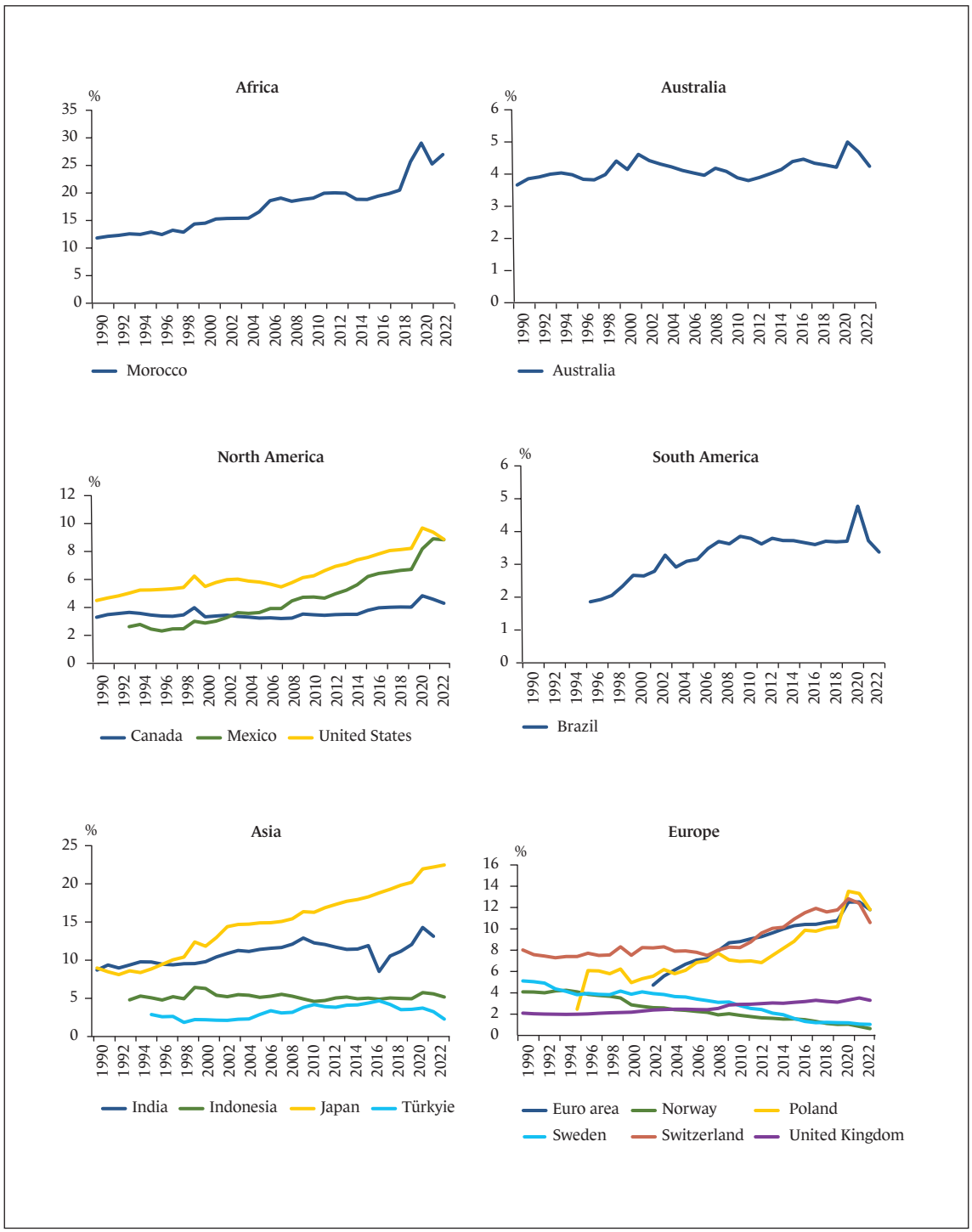
8.1. Asia crisis 1997–1999: 1997 Q3 – 1999 Q4

The Asia crisis started in Thailand in July 1997 and spread across East Asia, wreaking havoc on economies in the region and leading to spillover effects in Latin America and Eastern Europe in 1998.

8.2. Other exchange rate crises

a) exchange rate crisis in the European Exchange Rate Mechanism in 1992–1993: 1992 Q3 – 1993 Q3; it began in September 1992 after a steep depreciation of GBP and ended in August 1993; for details, see https://www.kansascityfed.org/documents/820/1993-Was%20the%20ERM%20Crisis%20Inevitable%3F.pdf;
b) Swiss National Bank cancels CHF-peg to EUR (since September 2011) in January 2015: 2011 Q3; this led to a steep appreciation of CHF; for details, see https://www.euromoney.com/article/b12kn1cddfjr4z/snb-abandons-euro-peg-ahead-of-expected-ecb-qe;
c) strong depreciation of AUD versus USD in 2015 Q4 – 2016 Q2; strong depreciation of AUD versus USD encouraged US tourists to demand large AUD banknotes; for details, see https://www.rba.gov.au/publications/bulletin/2016/dec/pdf/rba-bulletin-2016-12-the-future-of-cash.pdf.

Figure 1
Banknotes in circulation as percentage of nominal GDP for selected countries



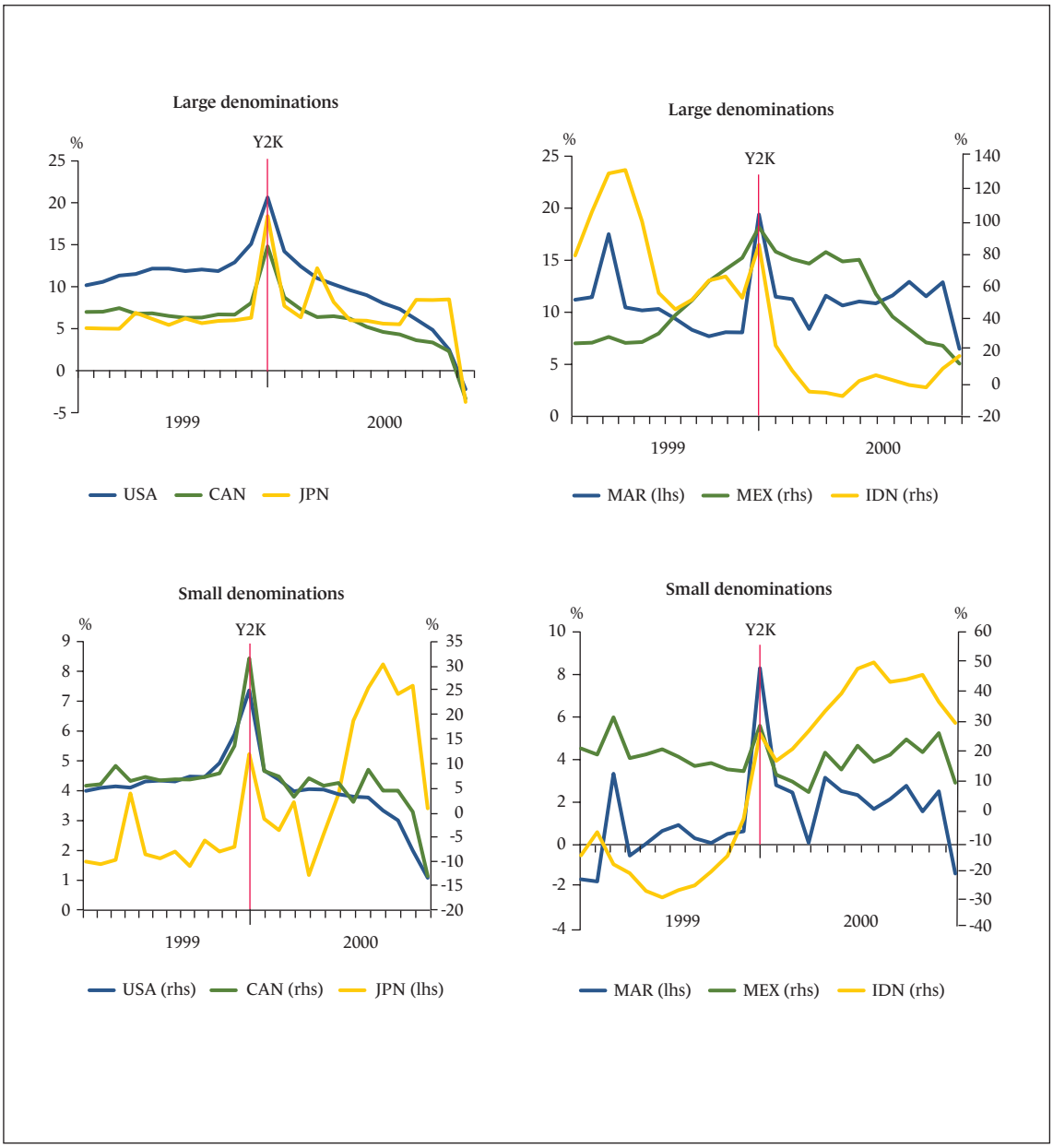
Source: national central banks. For a similar figure see also Deutsche Bundesbank (2024a).

Figure 2
Types of uncertainty and cash demand

<table>
<tr><td>Digital (payment) infrastructure</td><td rowspan="6">related uncertainty increases…</td><td rowspan="3">demand for domestic cash as a</td><td rowspan="3">means of payment</td><td rowspan="3">store-of-value</td></tr>
<tr><td>Financial system</td></tr>
<tr><td>Natural disasters</td></tr>
<tr><td>Politics</td><td rowspan="3">demand for foreign cash as a</td><td rowspan="3">means of payment</td><td rowspan="3">store-of-value</td></tr>
<tr><td>Inflation</td></tr>
<tr><td>Exchange rate</td></tr>
</table>

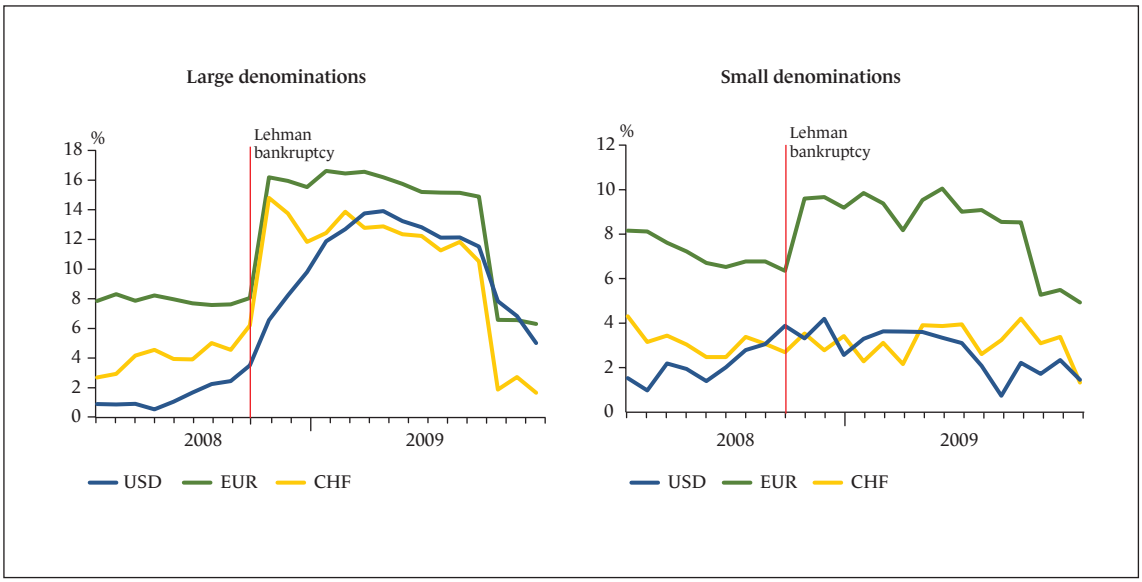
Source: own figure.

Figure 3
Annual growth rates of large and small banknote denominations around Y2K



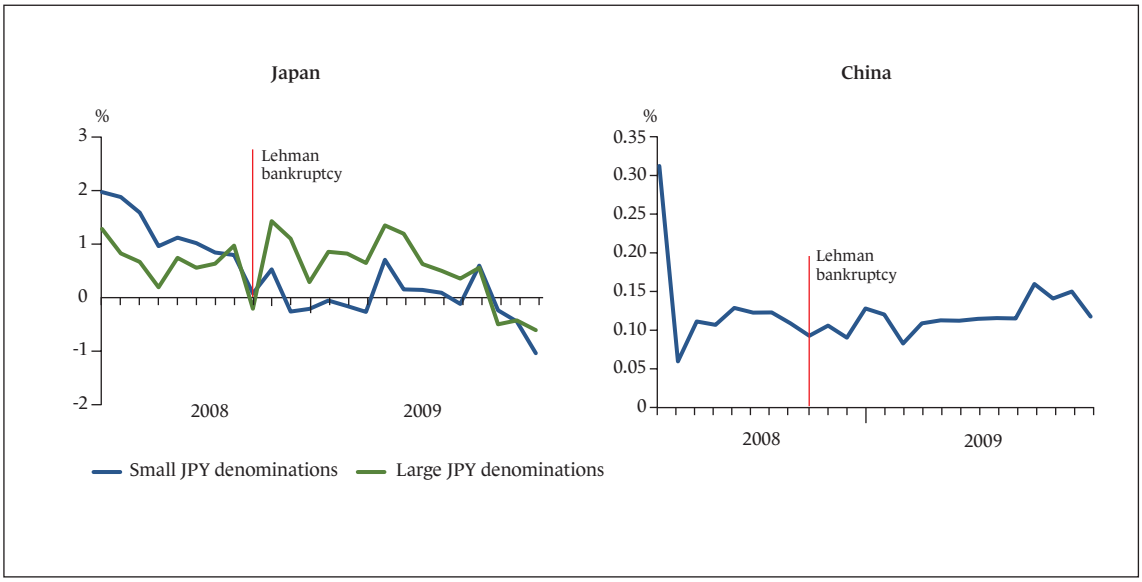
Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Figure 4
Annual growth rates of large and small banknote denominations around the global financial crisis



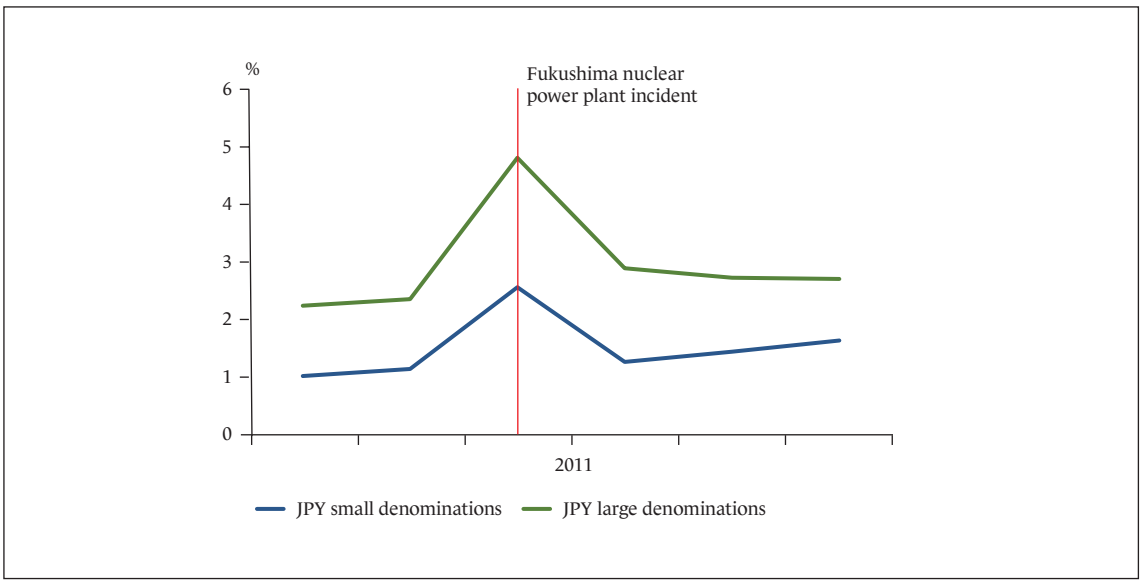
Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Figure 5
Annual growth rates for banknotes in circulation in Japan (small and large denominations) and in China (total banknotes)



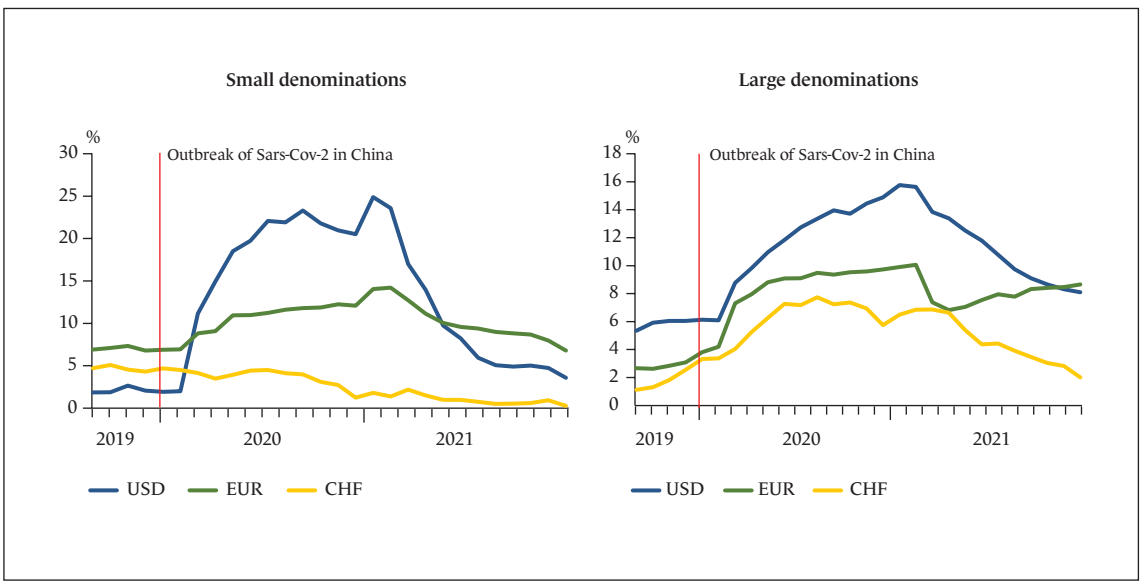
Source: own figure based on banknotes in circulation data from the respective central banks.

Figure 6
Annual growth rates of small and large Japanese yen banknote denominations around the Fukushima power plant incident



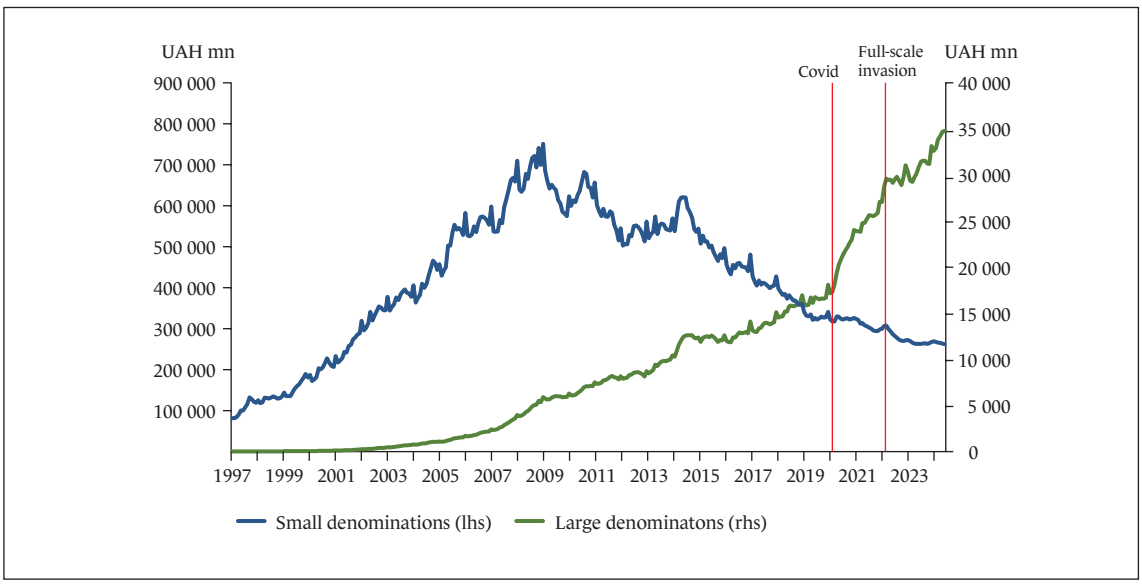
Source: own figure based on data from the Bank of Japan.

Figure 7
Annual growth rates of small and large USD, EUR, and CHF banknote denominations after the outbreak of the Sars-Cov-2 virus



Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

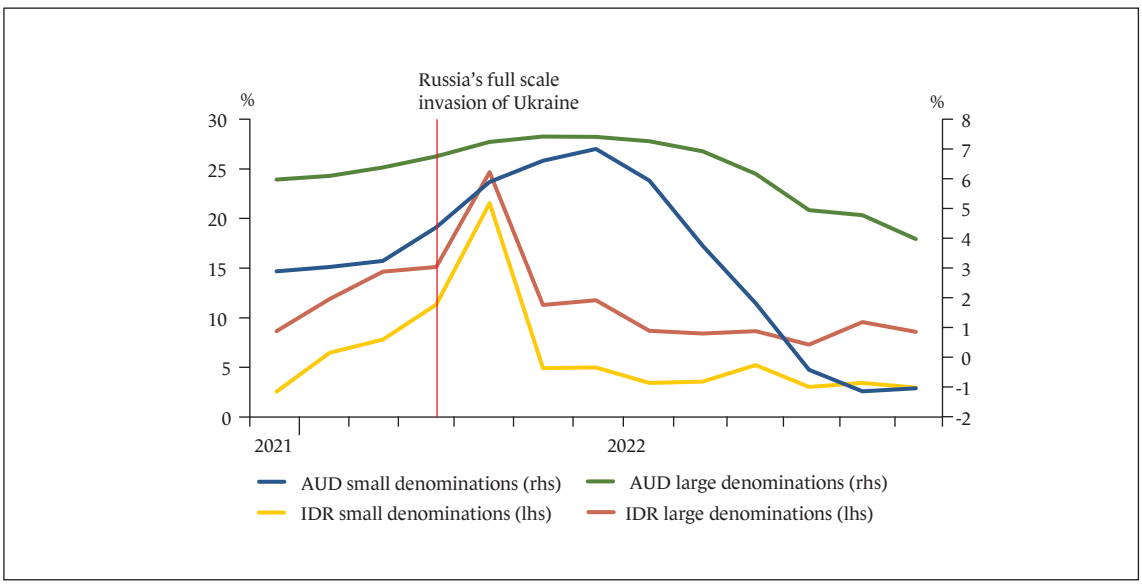
Figure 8
Banknotes in circulation in Ukraine



Notes: small denominations: UAH 1 – UAH 50, large denominations: UAH 100 – UAH 1,000.

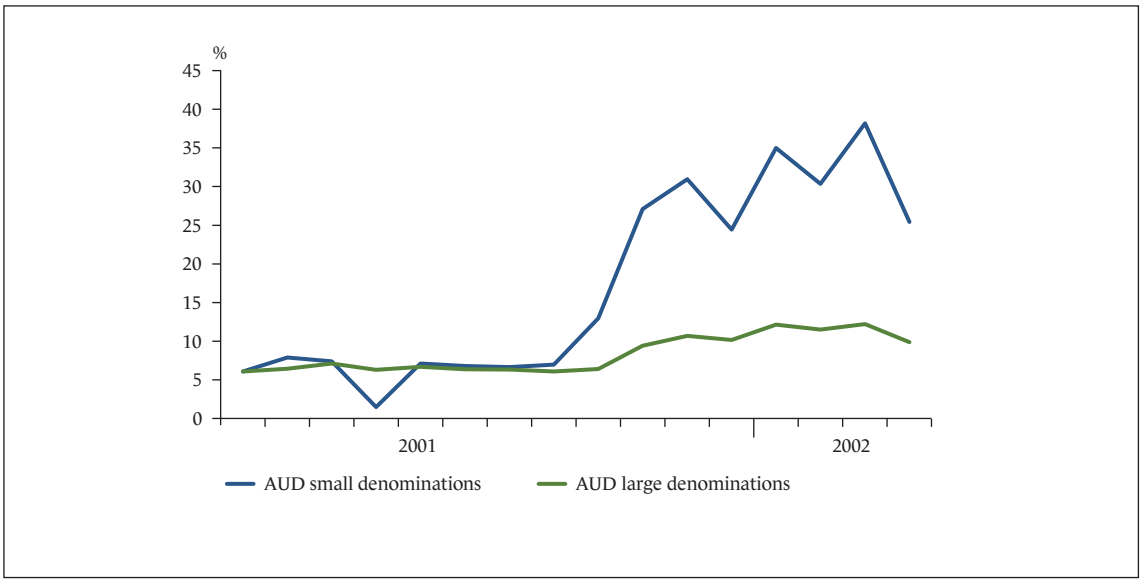
Source: National Bank of Ukraine.

Figure 9
Annual growth rates of banknotes in circulation in Australia and Indonesia after Russia's full-scale invasion of Ukraine



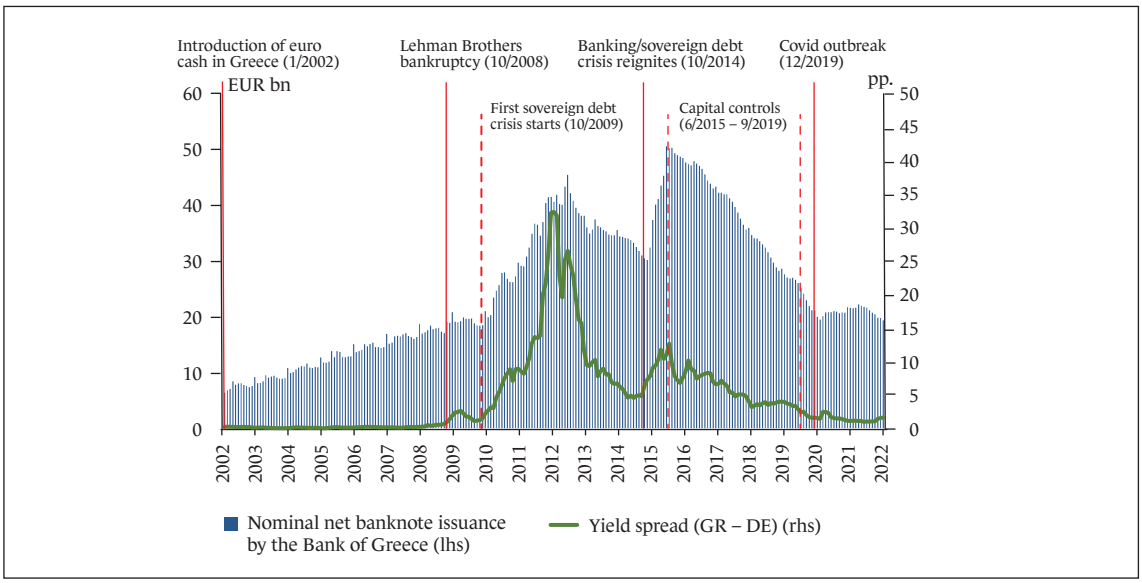
Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Figure 10
Annual growth rates of small and large AUD banknote denominations after 9/11



Source: authors' own calculations based on data from Reserve Bank of Australia.

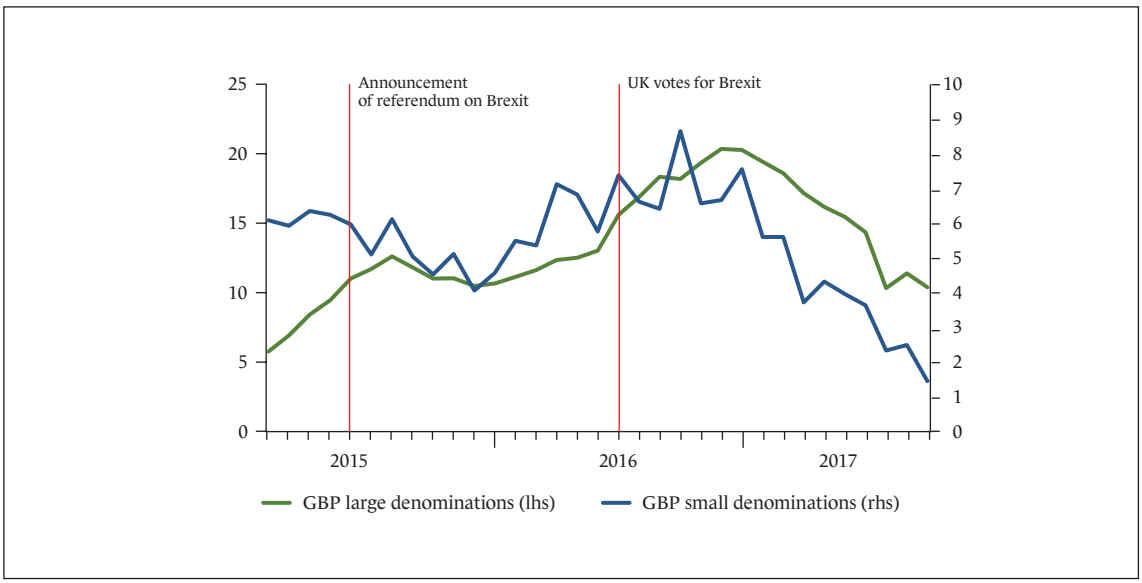
Figure 11
Net issuance of euro banknotes by the Bank of Greece and bond yield spread between Greece and Germany



Notes: monthly data, 10-year government bond yields; spread as risk measure.

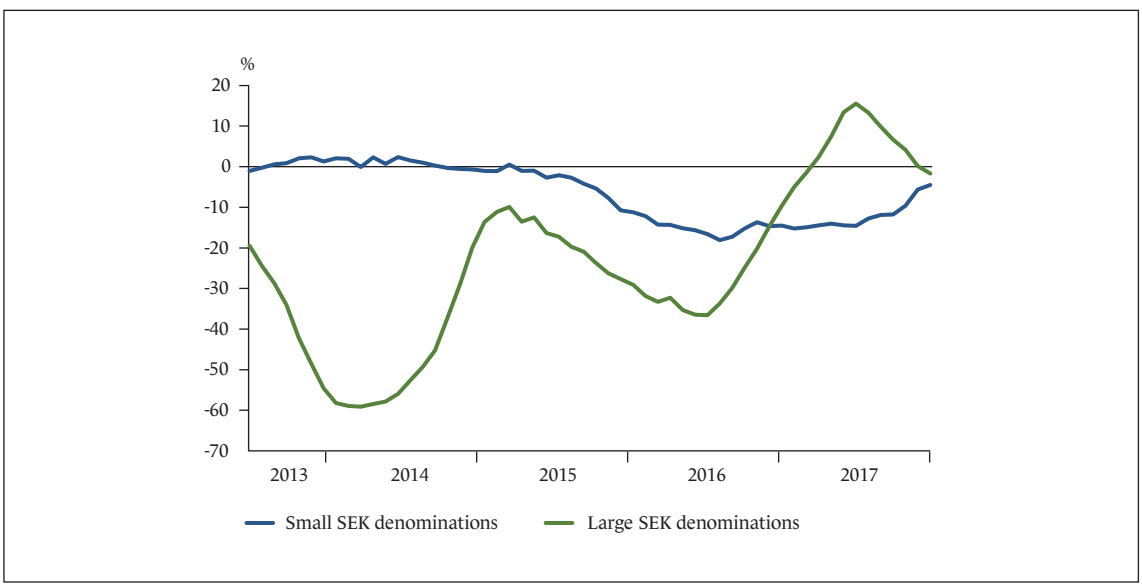
Source: Rösl, Seitz (2022a, p. 42).

Figure 12
Annual percentage growth rates of small and large GBP banknote denominations around the Brexit crisis



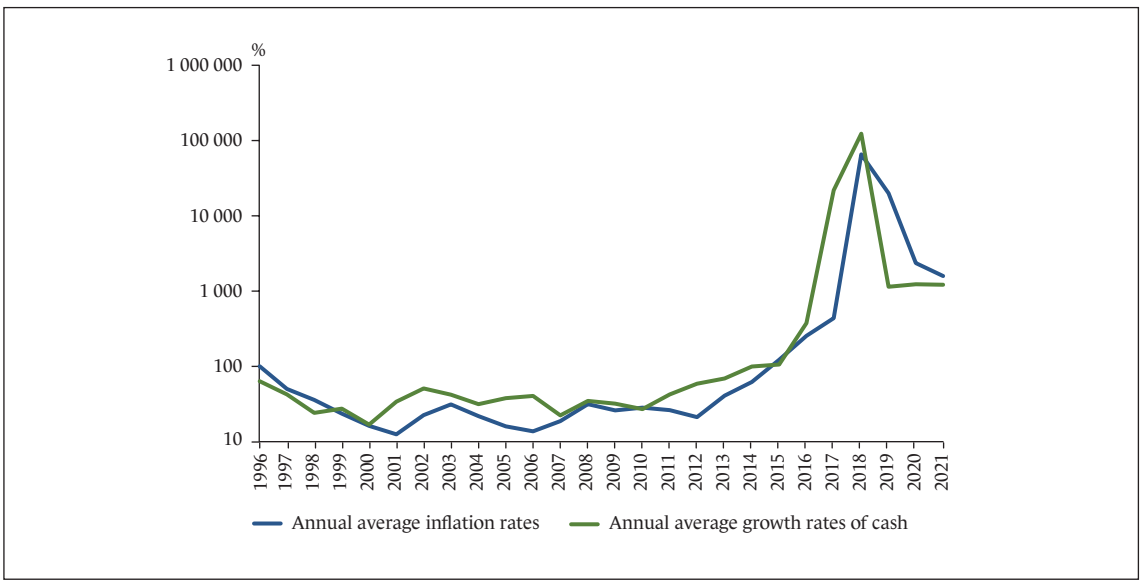
Source: author's own calculations based on banknotes in circulation data from the Bank of England.

Figure 13
Annual growth rates of small and large SEK banknote denominations



Source: authors' own calculations based on data from the Sveriges Riksbank.

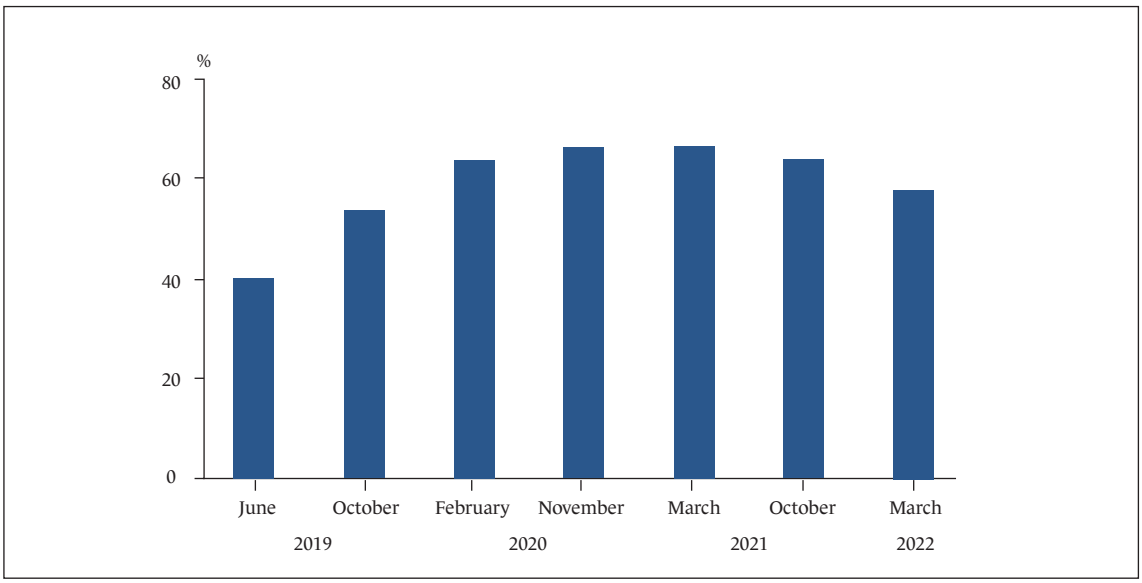
Figure 14
Cash and inflation in Venezuela



Notes: growth rates of cash in circulation are based on original the bolivar. Data: IMF.

Source: Rösl, Seitz (2024a).

Figure 15
Estimated share of US dollar transactions in total currency transactions at the POS in Venezuela



Source: Yapur (2022) based on data estimated by Ecoanalitica.

Table 1
Types of crises and uncertainties analysed

Type of crisis/ uncertainty	Examples
Digital (payment) infrastructure	Millennium change (Y2K)
Financial system	Global financial crisis 2008/2009
	National financial crises
	Introduction of euro (as unit of account) on 1 January 1999
	Introduction of euro cash on 1 January 2002
Natural disasters	Local natural disasters
	Global Covid pandemic
Politics	War in Ukraine
	Iraq wars
	Terrorist attacks
	Greek sovereign debt crises
	Crisis-riddled elections and other times of domestic turmoil
	Politically motivated interventions in cash supply
Inflation	Considerable and hyper inflation[1]
Exchange rate	Asia crisis 1997–1999
	Other exchange rate crises

[1] For illustrative purposes, we supplement our pool of 16 countries by selected (hyper-) inflation countries (Venezuela, Zimbabwe) for which we do not have a denominational breakdown of cash in circulation at that time.

Source: own table.

Table 2
Cash and millennium change (Y2K)

Country	Amplitude of annual growth rate in percentage points			Response period
	total currency in circulation	large denominations	small denominations	
Australia	9.8	4.9	13.3	November 1999 – February 2000
Brazil	15.2	2.3	15.8	November 1999 – January 2000
India[1]	5.2	NA	NA	November 1999 – February 2000
Indonesia	41.8	22.0	46.3	October 1999 – February 2000
Japan	11.2	12.1	3.1	December 1999 – January 2000
Canada	15.7	8.1	23.5	November 1999 – February 2000
Morocco	9.3	11.3	7.7	December 1999
Mexico	21.0	44.9	13.5	September 1999 – January 2000
Norway	6.5	5.8	8.1	December 1999 – January 2000
Poland[2]	10.1	22.0	5.3	1999 Q4 – 2000 Q2
Sweden	7.8	7.5	8.0	September 1999 – June 2000
Switzerland	8.2	8.7	3.9	November 1999 – February 2000
Türkiye	29.6	22.4	76.3	December 1999
USA	3.4	7.7	14.9	November 1999 – December 1999
United Kingdom	10.4	3.5	11.7	November 1999 – December 1999

[1] Data for denominational groups only available for annual data.
[2] Only quarterly data available.

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 3
Cash and the global financial crisis 2008/2009

Country	Amplitude of annual growth rate in percentage points[1]			Response period
	total currency in circulation	large denominations	small denominations	
Australia	11.8	7.3	17.4	October 2008 – September 2009
Euro area	6.4	8.6	3.7	October 2008 – September 2009
Canada	3.4	4.4	3.4	October 2008 – September 2009
Mexico	10.0	11.5	8.4	October 2008 – September 2009
Norway	2.5	3.3	–	October 2008
Poland[2]	8.3	19.4	6.4	2008 Q4 – 2009 Q3
Switzerland	9.3	9.3	–	September 2008 – September 2009
Türkiye	22.6	34.5	18.0	September 2008 – February 2009
USA	7.5	10.4	–	October 2008 – December 2009
United Kingdom	4.3	6.8	3.8	October 2008 – December 2009

[1] Amplitudes only shown if time series reacted visibly to the crisis.
[2] Only quarterly data available.

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 4
Cash and national financial crises

Country	Amplitude of annual growth rate in percentage points[1]			Response period
	total currency in circulation	large denominations	small denominations	
Norway[2]	7.0	13.1	-8.1	October 1991 – September 1992
Sweden[2]	4.7	5.1	5.1	March 1991 – November 1991
Australia[2]	10.3	11.8	9.5	January 1991 – November 1991
Canada[3]	2.3	4.0	2.4	February 1994 – April 1994
United Kingdom[4]	2.9	8.7	–	August 2000 – February 2002
Canada[5]	2.6	3.2	3.3	February 2015 – March 2018

[1] Amplitudes only shown if time series reacted visibly to the crisis.
[2] National banking crisis.
[3] Increasing uncertainty about the solidity of public debt.
[4] Dot-com crisis.
[5] Corporate bonds market under pressure.

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 5
Cash and the introduction of the euro (as unit of account) on 1 January 1999

Country	Amplitude of annual growth rate in percentage points			Response period
	total currency in circulation	large denominations	small denominations	
Norway	8.4	7.7	10.5	October 1997 – August 1998

Source: authors' own calculations based on banknotes in circulation data from Norges Bank.

Table 6
Introduction of euro cash on 1 January 2002

Country	Amplitude of annual growth rate in percentage points			Response period
	total currency in circulation	large denominations	small denominations	
Norway[1]	–	–	7.0	August 2001 – March 2002
Sweden	4.6	1.5	7.4	December 2001 – January 2002
Switzerland[1]	8.1	8.7	2.7	May 2001 – September 2002

[1] The rise in cash demand in Norway might also be due to the 9/11 terrorist attacks.

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 7
Cash and local natural disasters

Country	Amplitude of annual growth rate in percentage points[1]			Response period
	total currency in circulation	large denominations	small denominations	
Morocco[2]	1.9	3.0	1.4	January 1995 – April 1995
Japan[3]	2.4	2.5	1.4	March 2011
Indonesia[4]	16.6	–	16.3	December 2004 – February 2005
Poland[5]	–	–	15.8	2001 Q1 – 2001 Q2

[1] Amplitudes only shown if time series reacted visibly to the crisis.
[2] Drought in early 1995.
[3] Seaquake leading to meltdown of Fukushima nuclear power plant in March 2011.
[4] Seaquake in December 2004.
[5] Thunderstorms and floods in first half-year 2001.

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 8
Cash and the global Covid pandemic

Country	Amplitude of annual growth rate in percentage points[1]			Response period
	total currency in circulation	large denominations	small denominations	
Australia	13.9	11.0	17.5	March 2020 – June 2021
Brazil	42.9	42.9	42.9	February 2020 – June 2021
Euro area	6.6	5.9	7.3	March 2020 – December 2021
India[2]	7.1	NA	NA	May 2020 – February 2021
Indonesia	9.4	10.1	11.8	March 2020 – April 2021
Japan	5.7	5.7	-5.0	May 2020 – May 2021
Canada	14.2	13.8	16.8	March 2020 – August 2022
Morocco	-22.6	-32.3	-26.5	March 2020 – March 2022
Mexico	20.3	23.2	12.7	March 2020 – July 2021
Norway	11.0	-14.2	18.4	March 2020 – August 2021
Poland[3]	26.6	46.7	15.4	2020 Q1 – 2021 Q3
Switzerland	3.4	3.7	-3.2	April 2020 – May 2021
Türkiye	59.8	65.8	57.4	January 2020 – January 2021
USA	12.1	9.7	22.9	March 2020 – March 2022
United Kingdom	13.5	–	19.1	June 2020 – April 2022

[1] Amplitudes only shown if time series reacted visibly to the crisis.
[2] Data for denominational groups only available for annual data.
[3] Only quarterly data available.

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 10
Cash and war in Ukraine[1]

Country	Amplitude of annual growth rate in percentage points			Response period
	total currency in circulation	large denominations	small denominations	
Australia	2.6	1.0	3.8	March 2022 – July 2022
Euro area	1.2	1.7	0.8	March 2022 – June 2022
India	1.8	NA	NA	March 2022 – April 2022
Indonesia	11.1	10.0	13.8	March 2022 – April 2022
Morocco	12.3	13.2	9.7	April 2022 – December 2022
Norway	4.6	5.0	4.7	March 2022 – December 2022
Poland[2]	6.6	7.3	5.5	2022 Q1
Sweden	10.7	3.1	11.3	March 2022 – December 2022
Türkiye	12.9	19.3	9.4	April 2022

[1] Russia's full-scale invasion of Ukraine started on 24 February 2022.
[2] Only quarterly data available.

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 11
Cash and Iraq wars

Country	Amplitude of annual growth rate in percentage points			Response period
	total currency in circulation	large denominations	small denominations	
Morocco[1]	3.8	NA	4.1	January 1991 – March 1991
USA[1]	3.8	3.1	4.5	January 1991 – April 1991
Poland[2]	7.8	7.6	7.8	2003 Q1 – 2004 Q1

[1] First Iraq war 1991.
[2] Second Iraq war 2003.

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 12
Cash and terrorist attacks

Country	Amplitude of annual growth rate in percentage points			Response period
	total currency in circulation	large denominations	small denominations	
Australia[1]	20.1	6.1	31.2	September 2001 – September 2002
Canada[1]	3.5	–	6.9	January 2002 – October 2002
Poland[1, 2]	17.0	26.7	16.2	2001 Q3 – 2002 Q4
Sweden[1]	6.7	3.8	9.6	September 2001 – December 2001
USA[1]	3.2	4.2	3.3	September 2001 – October 2002
United Kingdom[1]	2.3	2.1	2.4	October 2001 – February 2002
Indonesia[3]	11.79	–	21.35	November 2002
Indonesia[4]	17.29	39.6	9.07	October 2005 – July 2006

[1] Terrorist attack on World Trade Center, New York, on 11 September 2001.
[2] Only quarterly data available.
[3] Bombing attack on 12 October 2002 in Kuta, Bali.
[4] Several bombing attacks on 1 October 2005 in Kuta and Jimbaran, Bali.

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 13
Cash and Greek sovereign debt crises

Country	Amplitude of annual growth rate in percentage points			Response period
	total currency in circulation	large denominations	small denominations	
Canada	1.3	4.1	–	November 2011 – October 2012
Switzerland	8.3	9.0	–	October 2011 – October 2013
USA	1.2	1.7	–	May 2011 – December 2012
Euro area	3.5	2.0	5.9	November 2014 – July 2015

Notes: the first Greek sovereign debt crisis (also sometimes called "euro crisis") started slowly in September 2009 and intensified visibly during the next two years, culminating in the ECB's president Mario Draghi's bail-out promise ("Whatever it takes") in June 2012. The second Greek sovereign debt crisis began in autumn 2014 when Greek government bond spreads again widened considerably.

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 14
Cash and crisis-riddled elections and other times of domestic political turmoil

Country	Amplitude of annual growth rate in percentage points			Response period
	total currency in circulation	large denominations	small denominations	
Brazil[1]	22.3	50.3	21.3	May 2002 – April 2003
Poland[2]	7.8	7.6	7.8	2003 Q1 – 2004 Q1
Norway[3]	6.9	–	14.4	November 2005 – December 2006
Mexico[4]	6.8	6.1	7.9	March 2012 – August 2012
Poland[5]	7.2	18.0	3.8	2014 Q4 – 2017 Q3
United Kingdom[6]	3.8	10.9	1.3	May 2015 – September 2017

[1] Political crisis due to a struggling economy with high inflation rates and steep devaluation of the national currency with the upcoming presidential election in October 2002.
[2] In June 2003, Polish referendum about EU membership (to take effect from May 2004). For Poland, only quarterly data available.
[3] Unpopular rises in whaling quota amongst fishers with decreasing sales prices. In January/February 2006 political tensions because of Mohammad caricatures.
[4] Political crisis around the upcoming presidential election on 1 July 2012.
[5] European refugee crisis in 2015/2016.
[6] Re-elected prime minister Cameron in May 2015 announces a referendum on exit from the EU, which took place on 23 June 2016 with a slight majority who voted in favour of Brexit.

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 15
Cash and politically motivated interventions in cash supply

Country	Amplitude of annual growth rate in percentage points			Response period
	total currency in circulation	large denominations	small denominations	
Sweden[1]	-9.9	-42.0	-1.6	June 2013 – November 2014
Sweden[2]	-17.3	-24.1	-17.1	June 2015 – January 2018
Switzerland[3]	2.5	8.7	–	August 2015 – January 2016
India[4]	-61.6	NA	NA	November 2016 – October 2017
India[5]	99.5	NA	NA	November 2017 – September 2018

[1] Sveriges Riksbank heavily discourages the use of Swedish krona (SEK) banknotes by declaring older notes invalid in 2013. Commercial banks did not assist in the exchange of old for new banknotes, leading to high denominations running out in ATMs.
[2] In 2015, the start of a new series of SEK banknotes with very short exchange period and quick demonetization of existing notes.
[3] The ECB decides to stop the production of EUR 500 banknotes on 4 May 2016.
[4] In November 2016, Prime Minister Modi announced the demonetization of the two highest rupee denominations with immediate effect.
[5] Refilling of cash stocks by newly issued notes.

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 16
Cash and the Asia crisis 1997–1999

Country	Amplitude of annual growth rate in percentage points			Response period
	total currency in circulation	large denominations	small denominations	
Indonesia	84.0	176.7	69.1	March 1997 – August 1999
Japan	7.2	7.9	2.1	October 1997 – October 1998
United Kingdom	1.8	3.8	1.5	October 1997 – February 1998
Türkiye	37.0	58.2	-49.1	January 1998
India	12.5	NA	NA	August 1998 – August 1999

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 17
Cash and other exchange rate crises

Country	Amplitude of annual growth rate in percentage points			Response period
	total currency in circulation	large denominations	small denominations	
USA[1]	4.9	4.2	10.5	September 1992 – July 1993
Switzerland[2]	7.0	7.7	–	January 2015 – March 2016
Australia[3]	3.6	4.3	4.7	January 2015 – June 2016

[1] Exchange rate crisis in the European Exchange Rate Mechanism in 1992/1993.
[2] Swiss National Bank cancels CHF-peg to EUR in January 2015 leading to a steep appreciation of CHF.
[3] Strong depreciation of AUD versus USD.

Source: authors' own calculations based on banknotes in circulation data from the respective central banks.

Table 18
Number of occurrences with crisis-related change in total cash demand

Type of crisis	Example	Number of occurrences in the sample with crisis-related change in total cash demand (+ increase, – decrease)
Digital infrastructure	Millennium change (Y2K)	15 (+)
Financial system	Global financial crisis 2008/9	10 (+)
	National financial crises	6 (+)
	Introduction of euro (as unit of account) on 1 January 1999	1 (+)
	Introduction of euro cash on 1 January 2002	2 (+)
Natural disasters	Local natural disasters	4 (+)
	Global Covid pandemic	14 (+), 1 (–)
Politics	War in Ukraine[1]	9 (+)
	Iraq wars	3 (+)
	Terrorist attacks	8 (+)
	Greek sovereign debt crises	3 (+)
	Crisis-riddled elections and other times of domestic turmoil	7 (+)
	Politically motivated interventions in cash supply	2 (+), 3 (–)
Inflation	Considerable and hyperinflation[2]	Considerable: 2 (+) Hyper: none
Exchange rate	Asia crisis 1997–1999	5 (+)
	Other exchange rate crises	3 (+)

[1] In addition, we reported a strong increase in cash demand in Ukraine, which is not part of our sample. See also Beckmann and Zamora-Pérez (2023).
[2] We supplemented our pool of 16 countries for illustrative purposes by two selected (hyper-) inflation countries (Venezuela, Zimbabwe), for which we do not have a denominational breakdown of cash in circulation at that time. In our sample, only Brazil and Türkiye faced considerable inflation during the sample period.

Source: own table.

Popyt na gotówkę w okresach kryzysów. Perspektywa globalna

Streszczenie

W artykule analizujemy w szerszym międzynarodowym kontekście różne rodzaje kryzysów i na tym tle rozważamy kwestię, w jakim stopniu te kryzysy mogą wpływać na popyt na gotówkę. Do empirycznej weryfikacji związku między kryzysem a popytem na gotówkę wykorzystujemy dane z 16 krajów w okresie od 1990 do 2022 r. Do celów analitycznych wyodrębniamy sześć rodzajów kryzysów i okresów o podwyższonej niepewności. Są to: (1) niepewność związana z funkcjonowaniem cyfrowej infrastruktury systemu płatniczego określana mianem „Problem roku 2000", (2) kryzys zaufania do systemu finansowego w związku z globalnym kryzysem rynków finansowych w latach 2008–2009, (3) katastrofy naturalne, takie jak trzęsienia ziemi i pandemie, (4) kryzysy polityczne, (5) okresy wysokiej inflacji, (6) kryzysy walutowe, takie jak kryzys azjatycki z lat 1997–1999. W badaniu staramy się pokazać, jak w zależności od rodzaju i specyfiki kryzysu kształtuje się popyt na gotówkę zarówno krajową, jak i zagraniczną w badanym okresie i w wyszczególnionych krajach.

Generalnie za uzasadnioną przyjmuje się tezę, że w okresach kryzysów, i to niezależnie od rodzaju kryzysu, popyt na gotówkę rośnie. Pogłębione badania dowodzą jednak, że rodzaj kryzysu ma wpływ na strukturę popytu. Niektóre rodzaje kryzysów w większym stopniu wpływają na popyt na banknoty o niskich nominałach, przeznaczane na cele transakcyjne, niż na banknoty o wysokich nominałach, które najczęściej służą do tezauryzacji. I odwrotnie, obserwuje się kryzysy, w których popyt na banknoty o wysokich nominałach w celach tezauryzacji rośnie szybciej niż popyt transakcyjny na walory o niskich nominałach. Z uwagi na specyficzne cechy gotówki, a przede wszystkim jej fizyczną formę, może ona obsługiwać transakcje również w sytuacjach przerw w dostawach energii elektrycznej i awarii czytników kart płatniczych. Fakt ten jest szczególnie istotny z punktu widzenia wzmocnienia odporności systemu płatniczego w sytuacjach zagrożenia kryzysem. Już choćby z tego powodu cyfrowy pieniądz banku centralnego nie może w pełni zastąpić gotówki, co najwyżej w „normalnych" czasach może ją jedynie uzupełniać. Nie powinien zatem dziwić fakt, że akurat w krajach, w których znacznie zredukowano obrót gotówkowy, coraz częściej podnoszone są argumenty, aby jednak infrastrukturę obrotu gotówkowego utrzymywać na zadowalającym poziomie.

Słowa kluczowe: gotówka, banknoty, kryzys