

## Die Hochschule im Dialog:

# Cash demand in times of crises

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# Cash demand in times of crises<sup>\*</sup>

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## **Abstract:**

In this paper, we focus on the role of different types of crises (technological crises, financial market crises, natural disasters) and their effects on the demand for cash in an international context. It becomes evident that over the past 30 years cash demand always increased in times of crises, independent of the nature of the crisis itself. However, the type of crises determines whether small or large banknote denominations are affected more. In case of payment uncertainties, we find a crisis-related increased demand for small denominations, probably reflecting an increased demand for transaction balances. In times of uncertainties regarding the financial and/or general economic development (also possibly driven by natural disasters), large banknote denominations were comparatively more in demand indicating that the crises-related need for non-transaction balances was the dominant driver.

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### **Deutsche Zusammenfassung**

Das vorliegende Papier analysiert die Rolle verschiedener Arten von Krisen (Technologiekrisen, Finanzmarktkrisen, Naturkatastrophen) für die Nachfrage nach Bargeld im internationalen Kontext. Es zeigt sich, dass in den letzten 30 Jahren die Bargeldnachfrage in Krisenzeiten immer gestiegen ist, unabhängig von der Art der Krise selbst. Die spezielle Natur der Krise entscheidet jedoch darüber, ob kleine oder große Banknotenstückelungen stärker betroffen sind. Im Falle von Zahlungsunsicherheiten stellen wir eine krisenbedingte erhöhte Nachfrage nach kleinen Stückelungen fest, die wahrscheinlich eine erhöhte Transaktionsnachfrage widerspiegelt. In Zeiten von Unsicherheiten hinsichtlich der finanziellen und/oder allgemeinen wirtschaftlichen Entwicklung (möglicherweise auch getrieben durch Naturkatastrophen) waren große Banknotendenominationen vergleichsweise stärker nachgefragt, was darauf hindeutet, dass der krisenbedingte Anstieg der Bargeldnachfrage vor allem durch Nicht-Transaktionsmotive getrieben war.

# Cash demand in times of crises

## 1. Introduction

Over the past years, there was an intense discussion about restricting the use of or even abolishing cash (see, e. g., Rogoff, 1998, 2016, Agarwal & Kimball, 2015, Sands, 2016). The advocates of such drastic measures typically refer to the “fact” that cash will become obsolete anyway as electronic payments gain more and more importance. However, global cash in circulation increased enormously over the past 30 years (Jobst & Stix, 2017; Bech et al., 2018; Shirai & Sugandi, 2019; Arango-Arango & Suárez-Ariza, 2019, Ashworth & Goodhart, 2020, Rösl & Seitz, 2021). For the major currencies, growth in cash holdings even exceeded GDP growth in the last decades (Rösl & Seitz, 2021). On top, the Covid-19 pandemic led to an exceptional strong increase of cash demand all around the world (Ashworth & Goodhart, 2021; Goodhart & Ashworth, 2020; Heinonen, 2020) although in many countries cashless payments were more frequently used at the point of sale creating the so-called *cash paradox* (Ardizzi et al., 2020, Caswell et al., 2020, Mitchell, 2020, Zamora-Pérez, 2021). The present paper intends to provide a deeper insight into cash demand in times of crises more generally. For that purpose, we distinguish between three different types of crises and analyze large and small denominations of eight currencies over the last three decades.

## 2. Cash demand in times of crises

Since the early 1990s, worldwide inflation rates and opportunity costs for cash holders decreased quite considerably (Razin, 2005, Hakkio, 2009, Forbes, 2019). This should have contributed to the steep increase in global cash holdings (Deutsche Bundesbank, 1995; Fish & Whymark, 2015; Haas et al., 2018; Fujiki, 2019). In such an environment, it is not surprising that cash will be demanded more intensively especially once a crisis occurs since it provides a secure means of payment and it is at the same time the most liquid store of value. In order to identify crises-related cash demand over the past 30 years we distinguish three types of crises<sup>1</sup>:

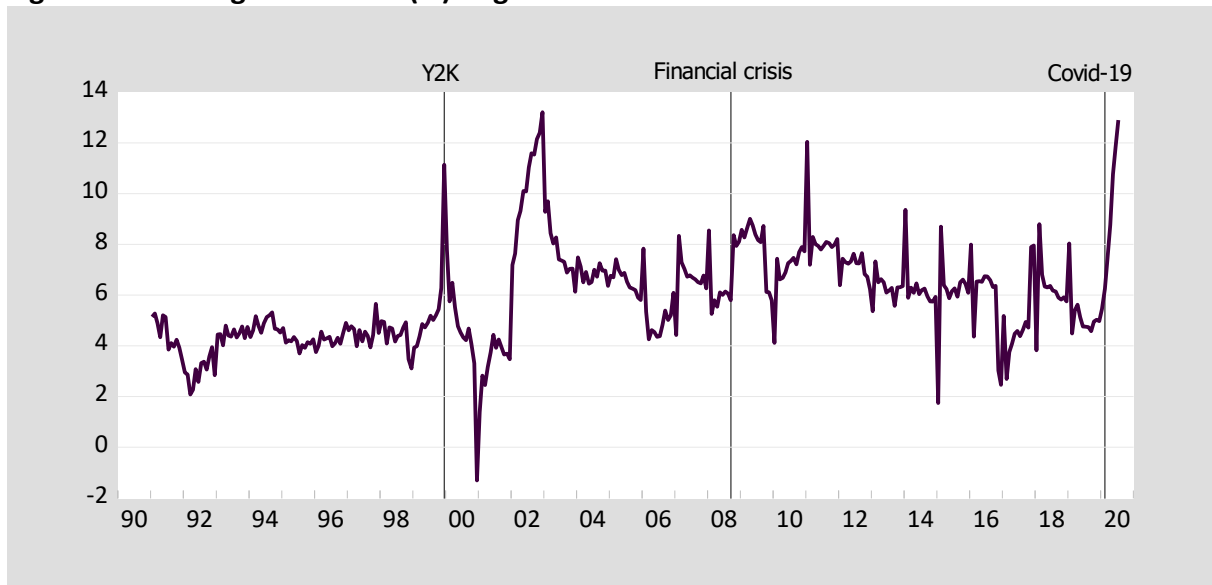
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<sup>1</sup> In principle, other crises like the crises in the European Monetary System in 1992/93, the (geo-) political crisis after 9/11 in 2001 or the Euro crisis in 2010/11 could also be analysed. In their nature, however, these crises were effectively confidence crises and, hence, do not differ too much from the financial market crises in October 2008. For a more detailed analysis of cash demand for single currencies, see the econometric section in chapter 3.

1. Technological crisis (e. g., the Y2K crisis),
2. Financial market crisis (e. g., the Lehman Brothers insolvency in October 2008),
3. Natural disasters (e. g., the Covid-19 crisis).

The following figures show the annual growth rates of cash holdings at a global (figure 1) and individual currency scale (figure 2).

**Figure 1: Annual growth rates (%) of global cash**



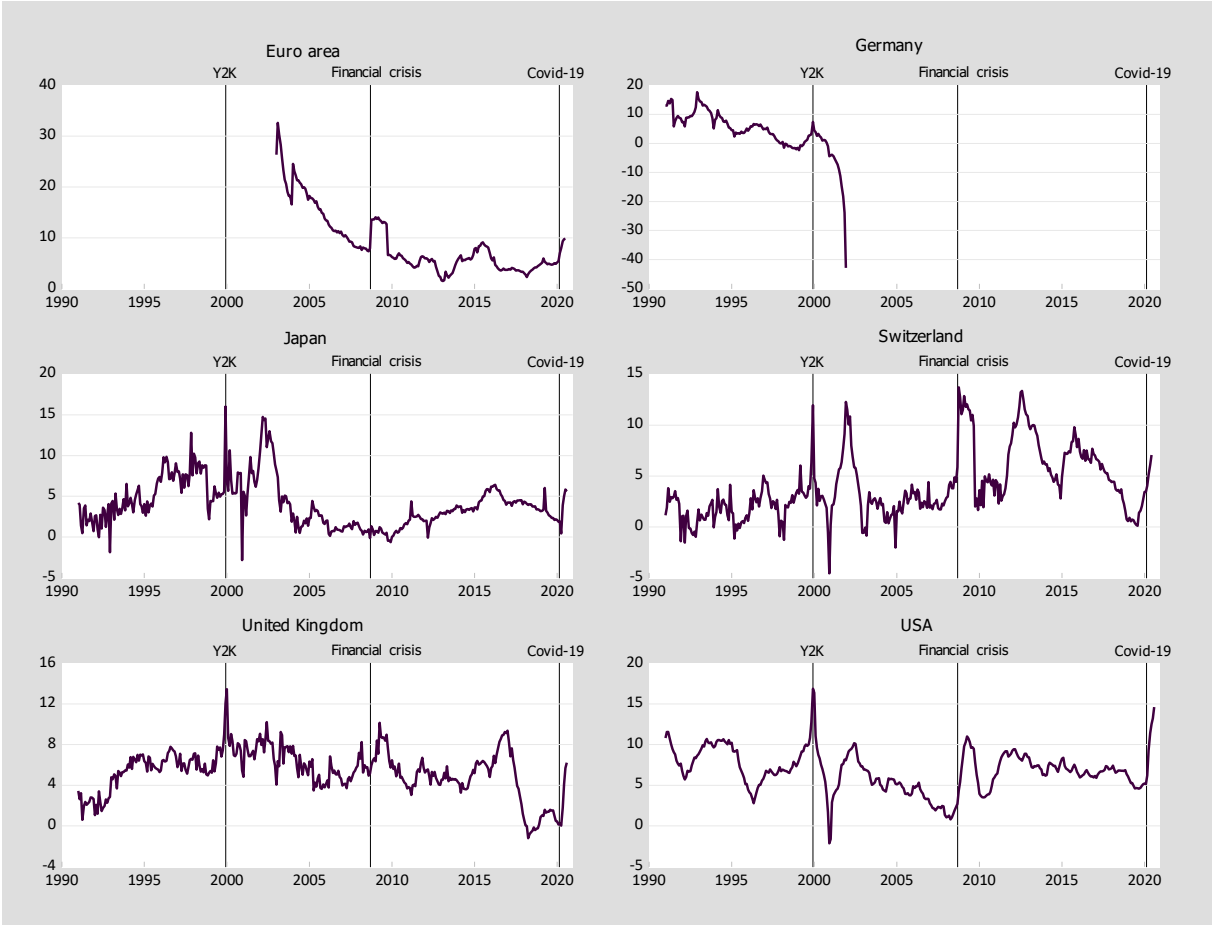
Notes: Data refer to cash or banknotes in circulation. Countries included are Australia, Brazil, Canada, China (since 2006), Denmark, Egypt, Euro area (since 2002), Germany (until end of 2001), India, Japan, Norway, Russia, South Africa, South Korea, Sweden, Switzerland, United Kingdom, USA; sample period: 1990.01-2020.07. National figures converted in US dollar by using the average exchange rate over the data period. The vertical lines highlight three crises (Y2K, financial crisis in October 2008, Covid-19 pandemic). The statistical breaks resulting from the inclusion of the Euro area 2002 and China 2006 are smoothed by means of simple linear interpolation.

Source: National central banks, IMF.

The huge increase in the global demand for cash during the technological crisis around the turn of the year 2000 (Y2K) was caused by heightened uncertainty. At that time, there were fears that the re-setting of computer program dates in order to adjust for the new millennium would have led to a shutdown of important institutions like public utilities, but also the smooth functioning of payment systems and cash withdrawals from ATMs were in question. After the insolvency of Lehman Brothers in October 2008, the resulting financial turmoil in the US quickly scaled up to a global financial crisis and led to a visible increase in cash demand worldwide (see figure 1). However, this increase was far behind that around Y2K mostly because cash demand only increased in those countries that were affected by the financial

crisis. In Japan, for instance, neither overall cash issuance nor single Yen denominations showed an unusual increase (see figure 2, tables 1 and 2, and Rösl & Seitz, 2021).

**Figure 2: Annual growth rates (%) of cash in selected countries in %**



Notes: Data refer to cash or banknotes in circulation.

Source: National central banks.

Obviously, there was a structural difference between the financial crisis 2008 and Y2K with respect to cash demand. Around the millennium, doubts of the public about the solidity of the digital infrastructure predominantly fostered the demand for cash. After the collapse of Lehman Brothers, however, the trust in banks and the financial system in some countries deteriorated and led to a flight into cash (crisis of confidence). In early 2020, a new type of crisis (natural disaster) affected the economy and cash demand on a global scale.<sup>2</sup> The outbreak of Covid-19 led into a deep recession worldwide in 2020 resulting in a stark decrease in turnover at the point of sale (see Auer at al., 2020; Chen et al., 2020) and due to fears of

<sup>2</sup> On a national level, it is not uncommon that natural disasters lead to a marked increase in cash demand. In the US, for instance, banks usually stockpile cash quite significantly if thunderstorms occur as observed for the Superstorm “Sandy” in October 2012 or prior to the anticipated landfall of hurricane “Irma” in September 2017.

virus contagion cash payments decreased (Cevik, 2020).<sup>3</sup> At the same time, however, global cash in circulation increased exceptionally (see figures 1 and 2).<sup>4</sup> Consequently, the main factor behind the increase in cash in circulation in 2020 is clearly non-transactional demand.

### 3. Cash demand for small and large banknote denominations in times of crises

Although the motivation for holding cash in times of crises will always remain somewhat opaque, the analysis of low-value and high-value banknote denominations may provide some insight into transaction versus non-transaction motives of cash users. In this section, we examine the long-term relationship between cash, its main determinants and crises. For that purpose, we augment standard long-run cash demand functions for small and large denominations with crisis-related dummy variables. In the classification of the two groups, we treat at least one denomination per country as a large one. As traditional potential determinants of cash holdings we include GDP (transactions variable), a short-term (money market) interest rate (opportunity costs variable) and an exchange rate argument (proxy for foreign demand) (see, e. g., Assenmacher et al., 2019).

Our sample consists of eight currencies: USD, JPY, DEM, EUR, CHF, GBP, SEK, and AUD. The sample is quarterly and ranges from the beginning of the 1990s until the third quarter of 2020. For the DEM, the sample ends in Q4/2000 due to the approaching cash changeover. From 2002 onwards, the EUR replaces the DEM. Our data is unadjusted; therefore, we include seasonal dummy variables. The general estimation equation reads as follows

$$(1) \quad bn_t = \beta_0 + \beta_1 y_t + \beta_2 i_t + \beta_3 e_t + \beta_4 ytk_t + \beta_5 fin_t + \beta_6 cov_t + \beta_7 x_t + \varepsilon_t,$$

where  $bn \in \{\text{large, small}\}$  is (the log of) large and small banknotes in circulation, respectively,  $y$  is (the log of) nominal GDP,  $i$  is a 3-month money market interest rate,  $e$  is the (log of the) exchange rate,  $x$  stands for other deterministic variables like trends (trend),<sup>5</sup> seasonal dummy ( $s(i)$ ,  $i=1,2,3,4$ ) or other dummy variables (dum) and  $\varepsilon$  is the error term. The main variables of interest on which we concentrate predominantly in what follows, are  $ytk$ ,  $fin$  and  $cov$ . These represent impulse dummy variables for the Y2K crisis, the financial crisis and the covid-19

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<sup>3</sup> This happened despite the fact that banknotes do not carry viruses very well in contrast to authorization devices for electronic payments. If this had really been the case, the number of infections would have been much higher, see Auer et al. (2020), Caswell et al. (2020), Panetta (2020).

<sup>4</sup> See also Heinonen (2020).

<sup>5</sup> A significant deterministic trend in the case of the US is also present in Judson (2017), ch. V.



crisis. *Y2K* is one in Q4/1999, *fin* is one from Q4/2008 – Q1/2009 and *cov* is one from Q1/2020 – Q2(3)/2020, zero otherwise.

Tables 1 and 2 summarize the results.

**Table 1: Estimation results for large denominations**

	Euro area	US	Switzerland	Japan	UK	Sweden	Australia	Germany
GDP	-	-	***	***	**	***	**	-
Interest rate	-	**	-	***	-	-	**	***
Exchange rate	**	***	***	-	-	-	-	-
Y2K		0.05 (0.01)***	0.05 (0.02)***	0.05 (0.01)***	0.02 (0.01)*	0.04 (0.02)**	0.02 (0.01)*	0.00 (0.01)
Fin	0.05 (0.01)***	0.02 (0.01)***	0.04 (0.01)***	-0.00 (0.01)	0.04 (0.01)***	0.01 (0.01)	0.01 (0.01)*	
Cov	0.03 (0.01)***	0.02 (0.01)***	0.02 (0.01)*	0.02 (0.01)*	0.02 (0.01)*	0.04 (0.02)**	0.02 (0.01)***	
x	$bn_{t-1}, bn_{t-4}, s(2), s(4)$	$bn_{t-1}, bn_{t-2}, s(1), s(4), dum_{us}, trend$	$bn_{t-1}, s(3), s(4)$	$bn_{t-1}, bn_{t-2}, s(1), s(4), dum_{ja}$	$bn_{t-1}, bn_{t-4}, s(1), s(3), s(4)$	$bn_{t-1}, bn_{t-2}, s(1), trend$	$bn_{t-1}, bn_{t-2}, bn_{t-4}, s(1), s(3), s(4)$	$bn_{t-1}, bn_{t-2}, s(4), dum_{de}$
Sample	03.1-20.3	90.3-20.3	90.2-20.3	90.3-20.3	94.1-20.2	93.1-20.3	91.1-20.3	90.3-00.4
Adj. R <sup>2</sup>	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
SE	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
LM(4)	0.83	0.67	0.01	0.00	0.02	0.04	0.00	0.07
Ramsey	0.83	0.85	0.07	0.15	0.21	0.17	0.33	0.08

Notes: 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. GDP: nominal GDP; interest rate: 3-month money market interest rate; exchange rate: Euro-dollar exchange rate (US, Euro area), effective exchange rate (Switzerland); x: additional significant variables; *dum\_us*: dummy variable for the extraordinary decrease in banknotes in 2000.1 in the US; *dum\_ja*: dummy variable for positive outliers in 1997.4 and 2002.1-2002.2 in Japan; *dum\_de*: dummy variable for an outlier during the EMS crisis in 1992.4 in Germany. Standard errors in brackets below coefficients; \*\*\*(\*\*, \*): 1 (5, 10) % level of significance; LM(4): p-value of Breusch-Godfrey serial correlation LM Test up to lag 4; Ramsey: p-value of Ramsey RESET misspecification test.

We get significant results in 31 of our total of 42 crisis cases (see tables 1 and 2). One denominational group per country is always positively affected by the crises. Obviously, the nature of the crisis influences which denominations are affected and how (see the explanations below). At least one of the economic determinants of cash holdings – GDP, interest rate, exchange rate – is significant in the equations. The statistical properties of the relationships are satisfactory: Taken together, the serial correlation LM test and the broader Ramsey mis-specification test do not reveal serious problems. The additional dummy variables

taken into account have economic significance: They are related to Y2K (decrease in cash demand in the US, after the potential problems of YTK have not materialized, see Judson, 2017, chs. II and V), the Asian and Russian crises (Japan and Switzerland), the introduction of Euro cash (Japan) and the EMS crisis (large denominations Germany).

**Table 2: Estimation results for small denominations**

	Euro area	US	Switzer-land	Japan	UK	Sweden	Australia	Germany
GDP	***	-	**	*	-	***	**	***
Interest rate	***	**	-	-	***	-	-	-
Exchange rate	-	-	-	-	-	-	-	-
Y2K		0.11 (0.01)***	0.03 (0.01)***	0.02 (0.01)*	0.06 (0.01)***	0.01 (0.01)	0.03 (0.02)	0.02 (0.01)**
Fin	0.03 (0.01)***	0.02 (0.01)	0.01 (0.01)	-0.00 (0.01)	0.02 (0.01)*	-0.02 (0.01)*	0.05 (0.02)**	
Cov	0.04 (0.01)***	0.09 (0.01)***	0.01 (0.01)**	0.01 (0.01)	0.01 (0.01)	-0.00 (0.01)	0.04 (0.02)**	
x	bn <sub>t-1</sub> , bn <sub>t-2</sub> , bn <sub>t-3</sub> , s(3)	bn <sub>t-1</sub> , bn <sub>t-2</sub> , s(1), s(2), s(4), dum_us	bn <sub>t-1</sub> , bn <sub>t-4</sub> , s(1), s(4), dum_swi	bn <sub>t-1</sub> , s(1), s(4), dum_ja	bn <sub>t-1</sub> , bn <sub>t-4</sub> , s(1), s(3), trend	bn <sub>t-1</sub> , bn <sub>t-4</sub> , s(1), s(4), trend	bn <sub>t-1</sub> , bn <sub>t-2</sub> , s(1), s(4)	bn <sub>t-1</sub> , s(1), trend
Sample	02.4-20.3	90.3-20.3	91.1-20.3	90.2-20.3	94.1-20.2	93.1-20.3	90.3-20.3	91.1-00.4
Adj. R <sup>2</sup>	0.99	0.99	0.99	0.99	0.99	0.90	0.99	0.99
SE	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
LM(4)	0.01	0.54	0.64	0.00	0.06	0.09	0.15	0.70
Ramsey	0.12	0.02	0.04	0.07	0.22	0.20	0.36	0.01

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; AUD 5, 10, 20, 50. GDP: nominal GDP; interest rate: 3-month money market interest rate; exchange rate: Euro-dollar exchange rate; x: additional significant variables; dum\_us: dummy variable for the extraordinary decrease in banknotes in 2000.1 in the US; dum\_swi: dummy variable for outlier in 1997.4 in Switzerland; dum\_ja: dummy variable for outliers in 1997.4 and 2002.1-2002.2 in Japan. Standard errors in brackets below coefficients; \*\*\*(\*\*, \*): 1 (5, 10) % level of significance.

With respect to the demand for large banknote denominations, all currencies analyzed show a crisis-related significant increase around the millennium except for the Deutsche Mark which was to be replaced by the Euro shortly afterwards. This general development seems to hold also roughly for the demand for small denominations at that time. In the case of the USD, CHF, GBP, JPY and DEM all estimates are significant whereas the results for the AUD and SEK are positive, but not significant. Hence, we can tentatively conclude that the drastic increase in global cash at end of the last century was caused by the desire to hold additional transaction

balances as well as non-transaction balances. Obviously, the public prefers physical money once confidence in the technological infrastructure deteriorates (technological crisis).<sup>6</sup> Insofar, cash is by nature a stabilising factor in times of raising doubts about the robustness of the digital infrastructure.<sup>7</sup>

During the financial crisis in 2008/9 the overall picture of crises-related cash demand was somewhat different to the situation around the millennium. As already mentioned, overall cash demand only increased notably in those countries that were affected by the financial crisis. Hence, it is not surprising that cash demand was boosted quickly and promptly especially in the US, the Euro area, the UK, Switzerland, and to some extent also in Australia, but not in Japan and China.<sup>8</sup> The second difference to the situation around Y2K is that this time stockpiling of non-transactional balances was clearly the main motive behind the demand for large denominations of USD, EUR, CHF and GBP which all show highly significant coefficients in table 1.<sup>9</sup> By contrast, Japan – a country whose financial system was not affected by the financial turmoil around 2008/9 – had no significant increase in cash demand, neither for large nor small denominations. In general, the crisis-related demand for small denominations during the financial crisis was quite limited indicating that transactional motives should have played only a minor role at that time. This overall assessment seems to hold although the demand for small Euro denominations increased significantly during the financial crisis as shown in table 2. However, since 30% – 50% of all Euro banknotes issued circulate outside the Euro area (see European Central Bank, 2020, ch. 2.5 and Zamora-Pérez, 2021), non-transactional motives by foreign cash holders might still be the dominant factor.

Regarding the demand for cash during the Covid-19 pandemic, interesting international similarities show up. All countries analyzed were heavily hit by the SARS-CoV-2 virus in the first half of 2020 and the demand for high banknote denominations increased significantly, roughly between two and four percent (see table 1). Concerns of future tax increases might

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<sup>6</sup> For the advantages of "physical" money, see Ruberton et al. (2016).

<sup>7</sup> Such considerations can also be conferred on instabilities of power grids. In the US, those problems quite often occur during the hurricane season and lead to an increase in the demand for cash even in regions that are not directly affected by the hurricane itself, see for instance Cheney & Rhine (2006) and Smith (2014).

<sup>8</sup> The annual growth rate of total cash in China in Q4/2008 and Q1/2009 was 11% and 10%. This might look high by international standards but is in fact a continuation of an overall slowdown process since cash growth rates in the previous three quarters were even higher: 16% (Q1/2008), 12% (Q2/2008) and 11% (Q3/2008).

<sup>9</sup> Such a development was observed already shortly after the terrorist attacks of 11 September 2001 when the demand for high value CHF banknotes increased massively, see figure 9 in Assenmacher et al., 2019, for the CHF and Judson, 2017, for the USD.

have played a role in this respect, but also precautionary motives and the crisis-induced flight to physical cash due to psychological reasons. By contrast and surprisingly, a notable significant crisis-related increase in the demand for small denominations at that time can also be detected for some currency areas, notably the USD, the EUR, and the AUD (see table 2). For the US dollar and the Euro, again, foreign non-transactional demand provides a partly explanation. In addition, in both currency areas banks increased their vault cash, which might reflect precautionary motives.<sup>10</sup> Finlay et al. (2019) find that AUD are also in demand outside Australia for non-transactional purposes. Moreover, the results of the Reserve Bank of Australia's Consumer Payment Surveys reveal that the major reason why Australians hold cash outside their wallets is use in emergencies (see Caddy et al., 2020).<sup>11</sup>

#### 4. Summary and conclusions

In this paper, we analyzed the role of different types of crises (technological crises, financial market crises, natural disasters) and their effect on the demand for cash in an international perspective. We presented evidence that at least over the past 30 years cash demand always increased in times of crises, independent of the nature of the crisis itself. However, the type of crises determines which denominations – small or large banknotes – are affected more. In times of increased payment uncertainties, the crisis-related demand for small banknotes significantly increased, probably reflecting an increased demand for transaction balances. In times of uncertainties with respect to the financial and/or general economic situation (also possibly driven by natural disasters), large banknote denominations were comparatively more in demand indicating that the crises-related need for non-transaction balances increased since the 1990s. Since central banks provide cash in a perfectly elastic way, one can also conclude that cash seems to play an important role in successful crisis management.

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<sup>10</sup> See figure 7 in Rösl & Seitz (2021).

<sup>11</sup> One further explanation might be the accessibility of getting cash in rural areas.

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