DISCUSSION PAPER SERIES

DP12327

DOOMED TO DISAPPEAR? THE SURPRISING RETURN OF CASH ACROSS TIME AND ACROSS COUNTRIES

Clemens Jobst and Helmut Stix

ECONOMIC HISTORY

ISSN 0265-8003

DOOMED TO DISAPPEAR? THE SURPRISING RETURN OF CASH ACROSS TIME AND ACROSS COUNTRIES

Clemens Jobst and Helmut Stix

Discussion Paper DP12327
Published 22 September 2017
Submitted 22 September 2017

Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

DOOMED TO DISAPPEAR? THE SURPRISING RETURN OF CASH ACROSS TIME AND ACROSS COUNTRIES

Abstract

The circulation of cash has increased in many economies over the past decade. To understand this development we provide evidence from two perspectives. First, we analyze long time series from the late 19th century to 2015 for several economies. Second, we collect evidence from 70 economies from 2001 to 2014. The descriptive account provides two main findings: (i) Recent increases for the euro, the US dollar and the Swiss franc are strong if seen over a 100 year horizon, (ii) increases can be observed in the majority of the 72 economies over the period from 2001 to 2014. Panel money demand models show that interest rates or GDP can only partially explain the increases in cash demand. The size of the shadow economy is not found to be an important factor for this period. We find that cash demand has evolved in line with a standard money demand model in economies with no record of financial crises. For economies that had a financial crisis in 2008, we find an increase in cash demand, on average. However, an "unexplained" increase is also obtained for wealthier economies that did not have a financial crisis in 2007/08 but before. We conjecture that the level shift in cash demand is related to increased uncertainty.

JEL Classification: E41, E42, N10

Keywords: Demand for currency, cash, monetary history, international comparison, Financial crises

Clemens Jobst - clemens.jobst@oenb.at
Oesterreichische Nationalbank and CEPR

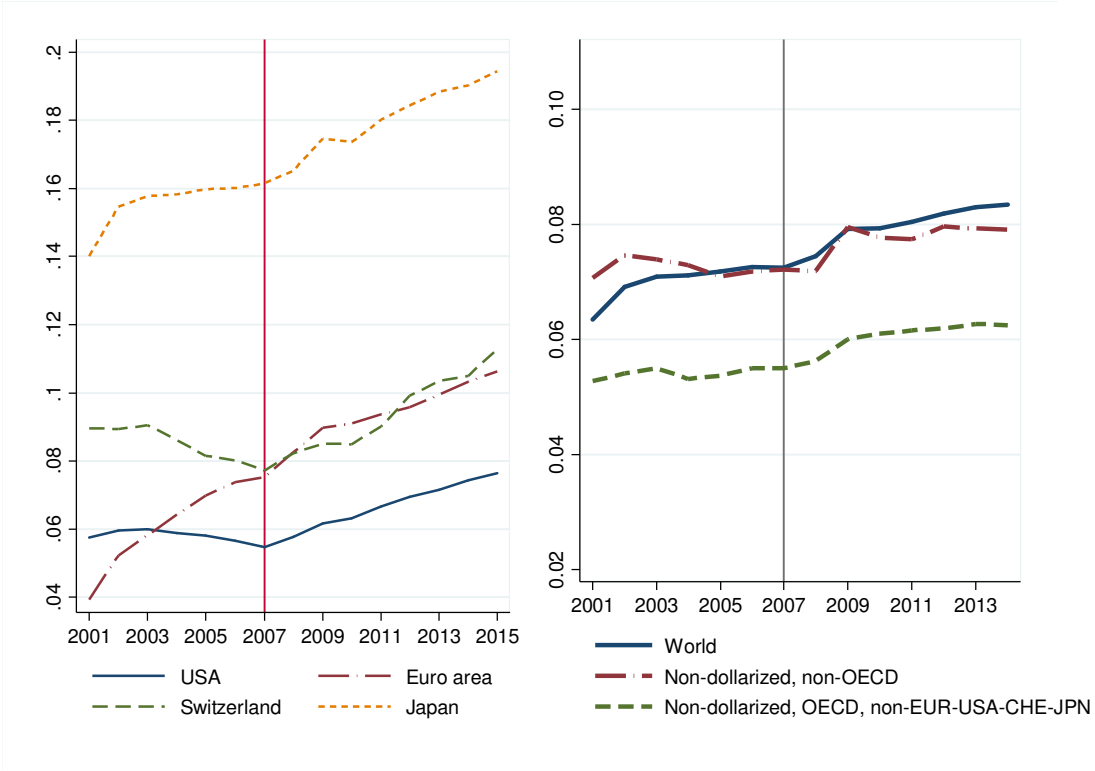
Helmut Stix - helmut.stix@oenb.at
Oesterreichische Nationalbank

Acknowledgements
The opinions are those of the authors and do not necessarily reflect the viewpoint of the Oesterreichische Nationalbank or the Eurosystem. We thank Friedrich Schneider for sharing the shadow economy indicators and Thomas Scheiber and Vincent Bignon for their generous help with historical data. Thomas Bergmair, Anna Drahonsky and Tobias Himmelbauer provided excellent research assistance. Helpful comments were received from Tobias Schmidt, Kim Huynh and participants at the following seminars: Economics Conference, Oesterreichische Nationalbank (Vienna, May 2017), 3rd International Cash Conference, Deutsche Bundesbank (Konstanz, April 2017), Fourth CEPR Economic History Symposium (Dublin, June 2016) and Cash on Trial, SUERF (November 2015).

1. Introduction

Over the past decade currency in circulation has increased sizably in the Euro area, the USA, Switzerland and Japan. Figure 1 shows that the increase started or accelerated after 2007. An increasing demand for cash is difficult to reconcile with the extant and growing use of cashless payment technologies in industrialized economies (Amromin and Chakravorti 2009; Bagnall et al. 2014). Also, the mere size of physical cash that is circulating in the hands of the public is difficult to bring into line with transaction needs: In 2014 per capita holdings were around 4000 US dollar in the Euro area (EUR) and the USA. In Switzerland (CHE) and Japan (JPN), the respective values are 9000 and 7000 US dollar (using market exchange rates).

Figure 1. Currency in circulation over nominal GDP (in %)



Note: The figures show currency in circulation to nominal GDP ratios for individual economies (left panel) as well as for country aggregates (right panel). The construction of aggregates is described in the text and are based on market USD exchange rates that are fixed at 2006. Own calculations. Variables are described in the Appendix. Data: IMF, OECD, national central banks.

It is evident that a large share of euros, US dollars and Swiss francs is circulating internationally (Bartzsch, Rösl and Seitz, 2013; Judson, 2017; Assenmacher, Seitz and

Tenhofen, 2017). Therefore it could well be that increased foreign demand conceals a declining trend in domestic demand in the issuing countries. If this interpretation is correct, one should expect a decreasing trend for currencies that do not circulate internationally. The right panel of Figure 1 shows currency in circulation for an aggregate of 76 economies that represent about 96% of World GDP. But for this "World" aggregate cash demand has been increasing as well. As the USA, EUR, JPN and CHE account for roughly 60% of this "World" aggregate, Figure 1 also shows the ratio for OECD economies, omitting the four economies that are shown in the left panel, and for non-OECD economies (in both cases, we only analyze non-dollarized economies). Again, for all sub-groups currency demand displays an upward trend over this short time period, in particular after 2008.

In light of popular claims that cash will eventually become obsolete, we consider this "return" surprising and this paper poses the question about its drivers. We move beyond the literature's typical focus on either relatively short time periods (e.g. the post-World War II period) or relatively few economies (e.g. the USA, the euro area, etc.). First, we put the increase into a longer-term perspective, assess the relative size of recent increases and study how financial crises affected cash demand. To do so, we describe the demand for currency from about 1875 to 2016 for (i) the United States, (ii) Great Britain, (iii) Germany, (iv) the Austrian-Hungarian Empire, later Austria, and (v) Switzerland. Additionally, we look at a sample of 17 countries and compare the development of currency demand in the Great Depression with developments today. Second, we analyze the development of currency from 2001 until 2014 for a sample of about 70 economies. This perspective allows us, first, to document how currency demand has evolved in a broader set of economies and, second, to econometrically study the drivers behind the recent upsurge in cash demand.

The longer-term perspective reveals that currency as a proportion of GDP, the inverse of velocity, has declined over the past 150 years – which does not occasion a surprise. However, in light of enormous technological advances in access to banking, in payment and withdrawal technologies the decline can also be interpreted as rather modest. In addition, in the second half of the 1980s, currency demand started to increase again in the USA and Germany, later the Euro area, before accelerating in a broader set of countries after 2007/08. Importantly, the acceleration in the USA, the Euro area and Switzerland is sizeable in historical comparison. The relative change since 2007 compares roughly with the sharp increases in currency demand observed in many economies during the banking crises of the 1930s.

The analysis of a large panel of 70 economies for the years 2001–2014 in turn allows us to evaluate several possible factors that could explain the apparent paradox of an increasing demand for cash. The large panel is necessary to overcome the difficulty generated by the international circulation of US dollars, euros and Swiss francs, which renders it difficult to assess whether (i) recent increases pertain to domestic or to international demand and (ii) to identify the economic factors responsible for the increase. Evidence on currencies which are not demanded internationally shows that currency ratios have increased in the majority of economies after the financial crisis of 2007/08, questioning the conjecture that foreign demand is the only force behind the observed increase in cash demand.

Other possible drivers of the increase include the decline of interest rates to historically low levels as well as increased shadow economic activities or tax evasion (Goodhart and Ashworth, 2017; Feige 2012). In order to test these conjectures we estimate a panel money demand model which relates (log) real per capita cash holdings to (log) real per capita GDP, deposit interest rates and a measure of shadow economic activities. Results show that interest rates exert a negative effect on cash demand, as predicted. Changes in the size of the shadow economy, on the other hand, are not found to have had an impact on changes in cash demand.

While the evolution of income and interest rates goes some way towards explaining the rising demand for cash, we find evidence for an unexplained upwards level shift after 2006. What are the economic reasons behind this level shift? Friedman and Schwartz (1963), when discussing currency demand in the Great Depression, stipulate that contractions affect velocity as agents hold money according to permanent income. The level shift would thus be temporary and disappear as agents gradually adjust expectations to the new, lower, level of permanent income. Using our panel setting, we study whether economic contractions or a trend decline in GDP growth rates affects currency demand and find that this factor explains some parts of the "unexplained" autonomous level shift, but again not all of it. This leads us finally to analyze the impact of banking crises on cash demand. We find (i) evidence of an increase in currency demand in economies that had a systemic banking crisis in 2008, on average, while there was (ii) no level shift in economies that have not experienced such a crisis in recent history. Given the evidence from the Great Depression, we consider this result plausible, even though no large scale banking panics were observed in the Great Recession (Goodhart and Ashworth, 2017). However, the link between banking crises and cash demand is more subtle than that, as we observe that cash demand also increased in economies that had no banking crisis in 2007 but before. We conjecture that parts of the increase in cash demand

in these economies could be the result of a generally elevated uncertainty, which raises demand for cash as an asset.

We contribute to the literature by studying the evolution of currency demand for many economies. The long-run evidence on cash circulation for selected economies is helpful for assessing recent trends. Both perspectives provide information on the determinants of money demand in times of financial innovations (Amromin and Chakravorti 2009; Bagnall et al., 2016; Fung, Huynh and Sabetti, 2014; Lippi and Secchi, 2009) and the role of cash in and after financial crises (Ramirez, 2009, Cusbert and Rohling, 2013; Assenmacher, et al., 2017). Our results highlight that cash demand is, in most economies, dominated by non-transaction demand. Another contribution of our paper is that we provide estimates of how cash demand reacts to (very) low interest rates which is difficult to identify with time series data for a single economy as periods of near-zero interest rates are rare. Schuh and Briglevics (2013) analyze cash demand in an era of low interest rates in the USA using microdata and find an interest rate elasticity that is close to the one found in this paper for a large sample of economies. Attanasio, Guiso and Jappelli (2002) and Mulligan and Sala-i-Martin (2000) provide micro-data based alternative approaches to estimate the interest rate elasticity. Moreover, we provide evidence on the impact of shadow economic activities for a broad sample of economies. Goodhart and Ashworth (2017) also compare the contemporaneous development with the Great Depression for several major currencies. In contrast to their conclusion for GBR and the USA, we argue that shadow economic activities do not seem to be at the root of increases in cash demand once more economies are included in the analysis. Policy proposals to phase out cash, or in a weaker form high denominations, are often (explicitly or implicitly) based on the contention that cash is mainly held for criminal activities or to avoid taxes (Rogoff, 2016; Sands, 2016). Our result that the shadow economy did not contribute to the observed increases and the finding that hoarding has become more important after the financial crisis of 2007/08 questions these assertions. We conclude that more research is needed to improve our understanding of why people hold cash.

2. Demand for Currency from a Long-Term Perspective

Figure 2 displays the ratio of currency in circulation (CiC) over nominal GDP from the last quarter of the 19th century to 2015 for the United States (USA), the Euro area (EUR), Austria-Hungary and Austria, Germany (DEU), Switzerland (CHE) and Great Britain (GBR).

Generating long time series involves several compromises and judgments. We would like to mention two important issues here and resort the details of the data construction and the data sources to Appendix A. First, we scale CiC by nominal GDP, while a measure of expenditures like net national product (e.g. Friedman and Schwartz 1963; Cagan 1965) would potentially be a more appropriate scale variable. The choice of GDP as a scale variable is governed by data constraints. For those periods/economies where we can compare both scale variables, we find no qualitative differences in long-run trends. Second, all series in Figure 2 include specie money. Until about the mid-1920s, countries differed sizably with respect to the circulation of gold coins which in some countries substituted for lower to medium denomination banknotes in payments and/or served as a store of wealth. The inclusion of specie money makes a substantial difference in Germany and to a lesser extent in GBR and Austria-Hungary.

In the following descriptive account we focus on large trends and neglect interesting smaller events (e.g. the banking crisis of 1907, the differences prior to World War I, etc.). We take the following main observations from Figure 2.

1) Comparing the values of 1990 with those from around 1890 informs us that cash use has declined: from 13% to 6% in DEU, from 11% in Austria-Hungary to 7% in Austria, from 9% to 3% in GBR and from 6% to 4% in the USA. For the USA, it is noteworthy that the lowest level obtained in the pre-World War II period (1927) was about the lowest value obtained in the post-World War II period (around 1980).

2) The decline in currency demand is not uniform. World War II marks the largest change; other events which affected velocity are World War I and the Great Depression (Friedman and Schwartz, 1963; Cagan, 1965; Bernanke and James, 1991).

3) Over the post-World War II period there was a secular decline in currency demand. This is the time frame that is usually analyzed in studies on the use of currency. It is evident that the focus on only the post-World War II period "biases" the picture as CiC levels were outstandingly high after the war.

4) If one is willing to accept Germany and Austria as "predecessors" of the Euro area, then it is striking that CiC over nom. GDP has always been higher in the "Euro area-Austria-Hungary-Germany" than it has been in the USA.[1]

5) Since the mid-1980s the long-run trend decline has come to a halt or even reverted: CiC has increased in the USA, in DEU and slightly in Austria. In 2014 CiC over NGDP ratios for the USA and EUR were back to levels observed at the end of the 19th century. In GBR and CHE, the increase set in a bit later and was, in comparison to the USA or DEU, less pronounced. Still, ratios in GBR and CHE are today well above the through levels observed in the late 1980s.

Figure 2 suggests some hypotheses regarding common drivers of currency demand in the long-run. The decline after World War II coincided with financial innovations that have occurred in all economies: increased availability and use of transaction accounts, broad dissemination of non-cash wage payment, increased use of payment cards and cheques and the building up of a dense network of withdrawal opportunities which allowed consumers to economize on cash balances (e.g. Krüger 2016).

The increase in CiC in the mid-1980s fits well to political/economic events (e.g. the breakdown of Communism, developments in Latin American economies) which fueled international demand for US-dollar, Deutsche mark and, confined to neighboring countries, the Austrian schilling (Porter and Judson, 1996; Seitz, 1997). In long-term perspective, the increases for the USA and EUR were substantial. In contrast, the circulation of GBP which has had no substantial international circulation continued to decline throughout the 1980s.

Finally, large shocks seem to persistently raise the use of currency: Despite the introduction of deposit insurance in the USA in 1933 and the stabilization of the banking systems in the USA, DEU and AUT the ratio remained much higher throughout the late 1930s than it had been in the pre-crisis period. WW II led to another sharp increase in the ratio. It took quite long until the ratio returned to levels observed before WW II and the 1930s banking crises.

[1] Also, from 1880 to 1990 the CiC ratio has always been lower in the USA than in Spain, Italy and France (not shown).

The increase in cash demand in the 1930s provides a potential standard of comparison for the increases that were observed after the outbreak of the 2007 crisis in the USA, EUR, CHE and, even though considerably subdued, in GBR.

Figure 3 juxtaposes the temporal evolution of the CiC over nom. GDP ratio from 2001 to 2015 (left panel) and the evolution in the Great Depression (right panel). After the US banking panics of 1931-33, the ratio more than doubled. The imposition of deposit insurance in 1933 calmed the situation, nevertheless the ratio until 1937 remained 60% higher than in the pre-crisis situation. In CHE, the ratio almost doubled and remained at that level. In AUT and DEU the ratio increased by about 20% in the 1931 banking crisis, when first the Austrian Creditanstalt and a couple of months later, the German Danat bank failed, triggering a general bank run (Schnabel 2004). Figure 4, depicting other economies in the Great Depression, shows a massive surge in currency demand in several economies (France, Belgium, Netherlands, etc.), with none of them being as large as in the USA but still in the range of CHE. GBR, which had no major bank break-down, saw its ratio increase only moderately (Bernanke and James, 1991).

In the Great Recession, ratios increased between 20% and 40% after 2007 in the US, Japan, UK, Euro area and Switzerland, thus substantially less sharply than in the USA or CHE in the Great Depression. However, there are also similarities: First, the size of the response after 2007/08 is in the range of many economies in the interwar period. Second, today as well as back then the increase seems to be persistent and is not just confined to the years characterized by banking problems.[2]

While the analysis of the time series properties of currency ratios provides valuable insights, it does not allow us to control for other possible determinants of currency demand like international circulation, changes in the interest rate or underground economic activities. In the following we will look at these factors in turn.

[2] One important way of analyzing the extent of bank panics is to look at the deposit to currency ratios which expresses the public's willingness to hold currency instead of bank deposits (Friedman and Schwartz 1963, Cagan 1965). Goodhart and Ashworth (2017) compare the evolution of D/C ratios in the Great Depression and the Great Recession for selected economies and, in line with expectations, find little evidence of banking panics in the current situation. D/C ratios are less informative for internationally circulating currencies (due to changes in foreign cash demand) and for a currency union (portfolio reallocation from domestic bank deposits towards foreign bank deposits within the currency union).

3. The Demand for Currency Today

Another way of assessing recent developments in EUR, the USA and CHE is to compare them with contemporaneous developments in other economies. We have collected data on relevant variables from around 70 economies for the period from 2001 to 2014.

3.1 Data description

Appendix B provides a description of the economies that are included in our sample and their selection. Essentially, the sample covers the largest economies in terms of their absolute economic size plus some smaller but regionally important economies that were added for breadth of geographical coverage. Overall, all included economies account for about 96% of World GDP in each year from 2001 to 2014. Henceforth, we denote this sample the "World".

Aggregating economies raises the issue of which exchange rate to apply. Since our aim is not to provide a precise estimate of World GDP or World CiC, but rather are interested in the change over time we take the pragmatic approach of employing several different exchange rates. Our preferred approach is to use USD exchange rates that are fixed as of 2006. This eliminates the impact of exchange rate movements that have occurred since 2007. However, to check robustness we have also repeated calculations with USD market rates and PPP rates. Results are unaffected, qualitatively (available in a supplement).

3.2 Demand for Currency in the "World" and in Sub-Aggregates

Figure 1 has already given a first glimpse at the currency in circulation to nom. GDP ratio for the "World" as well as for some sub-aggregates. Here, we analyze the evolution of currency and of GDP separately. Also, we study how currency demand evolved in dollarized vs. non-dollarized as well as in OECD vs. non-OECD economies.

An increase in the currency ratio can be due to either an increase in currency in circulation or a decline in the nominal GDP. Friedman and Schwartz (1963) already noted that the currency ratio might increase in a contraction because of "the tendency of holders of money to adjust their balances to their longer-term or permanent income rather than their current income" (p. 673). Therefore, the increase of the ratio could be the result of a declining GDP in the course of the global financial crisis. The right panel of Figure 5 depicts the indexed temporal evolution of CiC and nom. GDP for the World. Nominal GDP decreased

slightly from 2008 to 2009 but increased afterwards. At the same time, nominal CiC increased from 2008 to 2009. Therefore, part of the increase in the ratio from 2008 to 2009 is indeed due to a declining GDP. However, the interesting development is that CiC was increasing at a faster pace than nom. GDP throughout the entire observation period.[3]

Since a potentially sizeable share of the increase in the circulation of US dollar, euro and Swiss franc is circulating abroad, it is instructive to compare dollarized versus non-dollarized economies (Figure 6). Given the heterogeneity of non-dollarized economies, this group is further split into OECD and non-OECD members. We also look at a sub-aggregate of high income economies excluding EUR, USA and CHE because of their status as international currencies as well as JPN, which exhibits a very high currency ratio and due to its size biases the evidence. [4]

Regarding levels, the CiC over nom. GDP ratios are rather high in the dollarized (Panel A), non-dollarized OECD (Panel B) and non-dollarized, non-OECD economies (Panel C) of Figure 6, hovering between 6% and 8% after 2010 which is about the level that prevailed in GBR and AT-HU around 1910 - this compares with a ratio of below 2% in Sweden and Norway. When we restrict the sample to high income economies excluding EUR, USA, CHE and JPN, however, we obtain a ratio of less than 4% before 2007, hence more in line with what could be expected for highly developed financial systems relying very much on non-cash payment technologies. With respect to the time trend, there is a distinct difference between dollarized and non-dollarized economies. A strong upward trend in the ratio can be observed for dollarized economies before 2007. We conjecture that this increase reflects the period of "great moderation", i.e., low interest rates and increasing levels of trust in national currencies resulting in a reduction of currency substitution. With 2007, this development came to a halt. From 2007 to 2008 the ratio decreased and after 2009 it remained roughly constant and again decreased at the end of the sample period. If one presumed that unobserved overall cash demand in dollarized economies - that is domestic currency plus cash of foreign denominations - increased also in dollarized economies around 2008/09, as it did in many other non-dollarized economies, then Figure 6 visually suggests that some EUR, USD and CHF cash flowed to dollarized economies after 2007. The aggregates for non-dollarized economies, on the other hand, saw some increase in the currency ratio. For non-

[3] Figure 8 in the Appendix shows that the results are qualitatively unaffected if other exchange rates are used for aggregation.
[4] High income economies are defined as GDP per capita of more than 15,000 USD in 2012.

dollarized OECD economies (excluding the USA, EUR, CHE and JPN) the increase in the ratio after 2008 was positive but relatively small. For non-dollarized non-OECD economies the increase after 2008 is more pronounced. In all three aggregates, nominal GDP levels did not decline and the gap between GDP and currency has increased after 2009. The high-income countries excluding EUR, USA, CHE and JPN (Panel D) saw first an increase in 2009 driven by a decline in nom. GDP and after 2011 a continuously rising ratio as CiC grew at a constant rate while nominal GDP growth rates slowed.

The aggregates are influenced by large economies (e.g. CHN) and hide substantial heterogeneity across economies. Therefore, Table 1 summarizes descriptive statistics of CiC over nom. GDP ratios for individual economies. The ratio increased from 2004/5 to 2013/14 by more than 10% in 38 out of 72 economies and it decreased by more than 10% in 11 economies. In the remaining 23 economies the change was in the range from minus to plus 10%. The largest increase was 151% and the largest decrease -58%.[5] This heterogeneity applies to sub-aggregates as well. The common thread across sub-aggregates is that incidences of increases are significantly more likely than incidences of decreases, with the exception of EUR, USD and CHE. Moreover, the median increase is not negligible. Overall, the analysis of both aggregates and individual country data (i) refutes the idea that cash demand is declining, this does not hold even in the aggregate of high income economies, and (ii) shows increases after 2007 for economies which face no international demand.

To approach the issue of whether the observed increases can be accounted for by the development of income and interest rates, a simple back-of-the envelope calculation is conducted (Table 2). Specifically, we assume a simple linear money demand function where (log) real currency demand depends on (log) real GDP and interest rates. This allows us to calculate the change in real CiC that is implied by changes in real GDP and by changes in interest rates. As we treat each aggregate as an economy, we cannot estimate the money demand parameters but simply assume four plausible parameter constellations.

Table 2 summarizes the observed changes in absolute values and in percent. For the "World", we find that real CiC increased by 50% from 2004/05 to 2013/14. In contrast, real

[5] The six economies with the largest decreases are Sweden, Sri Lanka, Norway, China, Kenya and Dominican Republic (disregarding Latvia and Lithuania with their typical decline in cash circulation before the introduction of euro cash). The six economies with the largest increases are Bolivia, Iceland, Turkey, Peru, Romania and South Korea.

GDP grew by 24% and interest rates fell from 5.77 to 5.[6] If we assume an income elasticity of unity and an interest-rate semi-elasticity of -0.025 (which is in the range of estimates obtained in the literature as well as later here) then the simple currency demand model explains about 52% of the actual increase in real CiC – leaving 48% unexplained. In the second parameter constellation, money demand is assumed to be almost inelastic with respect to interest rates. Here, we find a proportion of 52% that is unexplained. If currency mainly serves as a transaction medium, its income elasticity should be lower than unity, i.e., we assume a value of 0.8. This increases the unexplained proportion to 58%. In the last case, we assume an income elasticity of 1.2, which reduces the unexplained share to 37% of the actual increase.

In the same manner, Table 2 summarizes calculations for non-dollarized and dollarized economies. It is evident that the increase for USA, EUR and CHE cannot be brought in line with money demand parameters that are conventionally considered. However, even for other OECD economies and in particular non-OECD economies we find sizeable "prediction errors" for income elasticities smaller than or equal to one – which in our view would be meaningful given the high financial development of OECD economies. We find the opposite instead: Prediction errors get smaller if income elasticities are larger than unity.[7] This suggests that demand for currency is not only driven by transaction considerations but also by a store of wealth component, at least since 2007/08.

Table 2 also reveals the relative size of country aggregates. Dollarized economies comprised less than one tenth of "World" GDP in 2013/14. Likewise, their share in CiC was about 7%. In the USA, EUR and CHE CiC grew by 742 bn USD (in real terms, applying a fixed USD exchange rate). If we use parameter constellation (a) of Table 2 as a benchmark case (income elasticity of unity) we find that 72% of this increase or 534 bn USD cannot be explained by changes in GDP and in interest rates.

[6] The relatively small reduction in interest rates can be explained by the fact that we compute an unweighted cross-economies average. Applying other aggregation methods for interest rates and/or assuming much larger interest rate reductions will not have any qualitative bearing on the following results.

[7] For completeness, we also conduct this analysis for dollarized economies although we note that these numbers are not too informative as they only show the local currency component of overall currency demand (which comprises local plus foreign denominated cash). But even in this case, we find that an income elasticity of larger than unity reduces prediction errors.

Bartzsch and Seitz (2016) show that the increase of Euro area net-shipments from 2004/05 to 2013/14 amounted to roughly 100 bn USD.[8] If one assumed the actual change in net shipments to be 120 bn and if one assumed the same figure for the USA and 15 bn for CHE[9], then one would arrive at 265 bn which makes for about half of the unexplained euro, US dollar or Swiss franc increase. This simple calculation suggests that the other half of the unpredicted increase must have been due to domestic demand in this aggregate.[10] Another interpretation is that the assumed functional relationship is wrong, either because of changing parameters over time (i.e. the interest rate elasticity) or of a scale elasticity sizably larger than unity.

4. Currency Demand Model

To gain a better understanding of the factors behind the observed increases we estimate money demand functions for individual economies. Given the difficulties in isolating the foreign demand component, we omit those economies whose currencies circulate internationally (USA, EUR, CHE, Singapore and Hong Kong) such that all estimations primarily reflect domestic demand.[11]

There are four plausible arguments that could rationalize the increase in cash demand. First, after 2007/08 interest rates decreased in the majority of economies and reached near-zero levels in some economies. Second, it has been stipulated that increases in shadow economic activities and tax evasion could be drivers of higher cash demand (Goodhart and Ashworth 2017). Third, Friedman and Schwartz (1963) argued that velocity tends to decrease in contractions because agents' demand for cash is based on permanent income rather than period income. In this line of reasoning, cash holdings could be higher relative to GDP if

[8] Figure 1 in Bartzsch and Seitz (2016) shows an increase in net shipments of approximately 95 bn EUR. This figure has been converted to real terms and to USD.

[9] The net shipment figures from the Eurosystem include shipments to cash wholesaler but does not contain cash shipments of private persons. Therefore, it is justifiable to assume higher actual shipments. However, the assumed number of 120 bn for the euro area can be seen as an upper bound. The assumption for CHE is based on the actual increase of 15 bn USD (using a constant exchange rate and in real terms). The figure for the USA is an assumption. Assuming instead that all of the increase in the USA from 2004/05 to 2013/14 (~270 bn USD) went abroad would increase the overall shipments to 405 bn USD.

[10] Judson (2017) shows that domestic demand for US dollar has contributed significantly to the increase in currency circulation since 2007. The results of Bartzsch and Uhl (2017) suggest that a substantial fraction of euro banknotes that were printed in Germany flowed to other Euro area economies.

[11] Per capita holdings were 5870 (Hong Kong) and 4540 (Singapore) US dollars in 2014. Omitting these five economies essentially means that we only include economies with per capita circulations of less than 2600 US dollars.

agents have not yet adjusted their pre-crisis estimate of permanent income to the lower income growth that occurred after 2008. Fourth, the increases could be a consequence of portfolio shifts either due to lower confidence in banks or due to increased uncertainty. This interpretation focuses on the asset (safe haven) role of cash. Note that this interpretation does not necessarily rely on the occurrence of banking panics as in the 1930s. Goodhart and Ashworth (2015), for example, analyze deposit to currency ratios and exclude banking panic as a main driver of cash increases in some major economies.

4.1 Model

We estimate the following fixed-effects currency demand model.

$$c_{it} = \alpha_i + \boldsymbol{\beta}_i' \boldsymbol{x}_{it} + u_{it} ,$$

where i denotes countries $1, \dots, N$ and t denotes years $1, \dots, T$. c_{it} denotes the natural logarithm of real per capita currency in circulation and $\boldsymbol{x}_{it}' = (x_{1it}, \dots, x_{Kit})$ is a vector of explanatory variables. The error term u_{it} is assumed, first, to be an *iid* random variable with mean 0 and variance σ_u^2 and, second, to be uncorrelated with all past, contemporaneous and future explanatory variables.

We estimate a fixed effects model for several reasons. First, we are interested in the effects that are in the sample rather than in the effects that are in the population which suggests that a fixed effects model is the preferred choice (Hsiao, 2005). Second, we analyze a very heterogeneous set of countries and we do not expect to be able to explain both the variation across time and across economies in a parsimonious model. In this sense, the fixed effects α_i control for the time-invariant differences across economies that cannot be explained either due to the lack of available data or due to a rather short observation period (as we focus only on the time from 2001 to 2014).[12]

The choice of a fixed effects model has implications on which exchange rates to apply. Our focus is on real currency and real GDP. As argued before, the preferred approach to convert real currency and real GDP from local currency to US dollar is to apply a fixed exchange rate. In a fixed effects model, the time-invariant exchange rate is controlled for by α_i and therefore we will directly use the variables expressed in local currency values.

[12] Data on the shadow economy are only available up to 2014.

The vector of explanatory variables comprises the natural logarithm of real per capita GDP, the (natural logarithm of the) deposit rate, the natural logarithm of the size of the shadow economy and year dummies for the crisis years and thereafter. These dummy variables measure the changes in the intercept relative to all pre-2007 years. Descriptions of the variables are provided in the Appendix.

The estimation of a currency demand model across such a diverse set of economies for a relatively short panel period poses severe challenges. First, imposing a uniform scale elasticity across economies is problematic as the financial development and the extent to which currency is used as a transaction medium varies greatly across economies. Some economies have a declining CiC over nom. GDP ratio which implies an income elasticity below unity while the reverse can be observed in other economies. Imposing a common scale elasticity might give rise to misspecification and autocorrelated residuals. To alleviate this concern we estimate a flexible specification where the scale elasticity is allowed to be economy specific. The downside of this approach is that the estimate of each country specific scale elasticity is based on only 14 observations. The choice one faces is thus between misspecification (a common elasticity across economies) and an imprecise estimate of the income elasticity due to a low number of observations. On balance, we consider the second option better than the first. Second, in principle this problem also applies to the interest rate (semi-)elasticity. However, our results show that that the interest rate elasticity does not vary too much across aggregates (which will be shown below) such that the imposition of a common interest rate elasticity across economies seems warranted. Third, given the large number of countries included in the sample, consistent data on some potentially important variables such as payment innovations are not available. However, the time-invariant component of these omitted variables is captured by the fixed effects, so that the omission only matters to the extent that *changes* in payment technologies have led to *changes* in money demand. In this context, the short sample period is an advantage as it alleviates this problem.

4.2 Results

Table 3 summarizes results from two specifications. Panel A models interest rates with a semi-log specification and Panel B with a log-log specification. All specifications of Table 3 exclude—in addition to EUR, USA, CHE, SGP and HGK—several economies with a heavy dependence on oil exports (see Appendix B). Moreover, we have scrutinized country-specific

point estimates of scale elasticities and have omitted six economies which display scale elasticity outside any reasonable range across various specifications.[13]

Column 1 and column 2 results refer to all 58 remaining economies. Since the income elasticity is allowed to vary across economies, we report the mean of all 58 point estimates - the mean income elasticity is 1.4 in Panel A and Panel B. Specification 2 contains year dummies which measure any changes in the post-crisis period relative to the pre-crisis period. Their inclusion reduces the mean income elasticity to roughly unity. In our view, this shows that a model without time dummies would be misspecified as, otherwise, the increases after 2006 gets mainly reflected in the scale elasticity. Columns 3 and 4 (Panel A) shows that the respective mean income elasticity is 0.77 for non-dollarized economies (column 2) and 1.29 for dollarized economies (column 3). These results concur with the extent of financial development in the former group of economies.

In all specifications of Panel A and Panel B, interest rates exert a significant negative effect on currency demand. In the semi-log model of Panel A (column 2), for example, we find an interest rate semi-elasticity of -0.02, implying an elasticity of -0.14 at an interest rate of 7%. For an interest rate of 0.5% the elasticity declines to -0.01. In the log-log model (Panel B), the interest rate elasticity is in-between these values at -0.08.

The indicator of shadow economic activities is insignificant in all specification of Table 3, implying that changes in such activities exerted, on average across economies and for this specific time period, no effect on changes in cash demand. This runs counter to results of Goodhart and Ashworth (2017) for GBR and the USA. The intuitive reason for this finding is that the shadow economic indicator is declining in many economies over the sample period, while demand for cash is increasing.[14,15]

The time dummies measure an autonomous shift in currency demand that is not captured by the evolution of real GDP, interest rates and the shadow economy. In specification 2, we

---

[13] The economies are Sweden, Norway and New Zealand (which display a downward trend in the currency to NGDP ratio) as well as Cote d'Ivoire, Algeria and Dominican Republic. For the first three economies, we presume that financial innovation drives down cash demand. As the regressions do not control for financial innovations, the regressions captures this trend by a negative scale elasticity, which is not economically meaningful.

[14] For example, it declined in 30 out of 32 OECD economies from 2003 to 2014. Although cash demand estimations omit the Euro area it should be noted that an increase of shadow economic activities in the Euro area is only found in Cyprus, Spain and Portugal. In the USA, GBR and JPN there is a slight decrease.

[15] The indicator is derived from a Multiple Indicator Multiple Causes type model (Schneider, 2015) however with the adaptation that currency in circulation is not used as an input for its calculation These indicators are widely used but have also been subject to criticism (see for example Feige (2016) and Schneider (2016).)

find that all year dummies indicate a level increase in cash demand after 2006. For the interpretation of this finding, it is important to note that the dummies measure the mean impact across economies without accounting for their relative size. Nevertheless, this result is in accordance with the visual analysis of aggregates, which accounts for the relative size of economies – the dummy variables reflect the increasing gap between currency in circulation and GDP. According to the point estimates, currency demand was on average higher by 7.5% (2008) to 12.5% (2014), in comparison to the pre-crisis period. A different temporal pattern is obtained for non-dollarized than for dollarized economies – again, being in line with the visual analysis. The point estimates of the dummies get larger over time in non-dollarized economies, whereas a decrease is found in dollarized economies. We have re-estimated all models with a common scale elasticity imposed. All results of this restricted model are qualitatively rather similar.

4.3 Non-linearities in the interest rate elasticity

In the remainder of section 4 we will look at different possible explanations why currency demand shifted upwards around 2008. Since total currency demand is unobserved in dollarized economies, we subsequently focus on non-dollarized economies. We like to assure that results are not driven by a misspecification regarding the functional form of currency demand and that this misspecification is driving the results concerning the year dummies. Specifically, we consider it necessary to more closely scrutinize how the lowering of interest rates to near-zero or in a few instances below zero has affected currency demand. The semi-log and the log-log functional form have different behavior for low interest rates. In the semi-log specification, the elasticity goes to zero as interest rates approach zero. This implies an upper bound of cash balances that agents' are willing to hold (relative to income). The log-log form, with the interest rate elasticity being independent of the level of interest rates, implies that cash demand can become arbitrarily large as interest rates approach zero. Table 4 and Table 5 summarize different specifications for non-dollarized economies for the semi-log and the log-log specification, respectively. The first column replicates the benchmark model. The second specification allows the interest rate semi-elasticity to be different after 2007 (*Deposit rate X Crisis*). The third specification allows the interest elasticity to change for interest rates below 1% (*Deposit rate <1%*). The fourth specification shows results from a model that entails separate interest (semi-)elasticities for interest rates below 1% and above 1% (*Deposit rate <= 1%*, *Deposit rate > 1%*). In this case, some caution is warranted

because of a low number of observations with interest rates below 1% to identify the respective parameter. The fifth specification contains the interest rate and its squared term (*Deposit rate squared*).

Results of the semi-log specification (Table 4) show that non-linearities in interest rate responses of cash demand do not seem to matter – no significant effect is found for the individual terms that add non-linearities; however, the main effect and the interaction effect are found to be jointly significant. The specification which allows for a separate semi-elasticity for interest rates below and above 1% shows that the elasticity is insignificantly different from zero for interest rates below 1%. This is different for the log-log specification where the elasticity changes for interest rates below 1% (Table 5): While it is -8% (specification 3) for rates above 1%, it is zero for interest rates below 1% (-8%+12%=+4%; a test shows that the sum of these point estimates is not statistically different from zero). The parameters for the interest rate elasticity and its squared term in specification 5 suggests an elasticity close to zero for interest rates around 1% and a positive elasticity for interest close to zero.

The punchline of Table 4 and Table 5 regarding the functional form is that both specifications imply an upper bound of cash balances as interest rates approach zero. In the semi-log specification this is entailed in the functional form, in the log-log specification this gets reflected in significant non-linearity terms. Regarding the selection of a suitable functional form, we prefer the semi-log specification. First, the value of the likelihood function is higher in the semi-log than in the log-log form. Second, the fact that there are just a few observations for interest rates below 1% suggests that the exact shape of the non-linearity is difficult to identify. In the semi-log form this is less of a problem as a declining elasticity is already implied by the functional form, while the predictions of the log-log form for interest rates below 1% depend more heavily on the estimated shape of the non-linearity. Therefore, we will subsequently focus on the semi-log specification (but will report results from the log-log specifications in the Appendix).

Regardless of the chosen functional form, Table 4 and Table 5 show that all year dummies remain positive and statistically significant, indicating that the autonomous increase in cash demand cannot be traced to nonlinearities that arise for low interest rates.

4.4 Structural differences across economies

The sample of economies included in the sample undoubtedly consists of very heterogeneous economies. To scrutinize how this heterogeneity affects results, Table 6 shows results for several sub-samples. Columns 1 and 2 split economies according to GDP per capita. Results show that economies with above median GDP display significant year dummies whereas this cannot be found in economies with below median GDP. In other words, all increases that were found in below median GDP economies (cf. Figure 6) can be explained by GDP and interest rates. In column 3 and 4, economies are separated according to whether interest rates decreased from 2004 to 2014. Findings suggest that autonomous increases happened in economies where interest rates declined but not in economies where interest rates increased. In columns 5 and 6, we split economies according to how often households withdraw from their accounts. This can be viewed as a direct measure of financial development and the possibility of households to economize on cash balances. With regard to the time dummies, we again find them statistically significant in economies with above median withdrawal frequencies. Finally, columns 7 and 8 split economies according to their share of migrant workers in the total work force. Migrants can be a direct source of higher cash demand (wages are often paid in cash, remittances might be sent in cash). This sub-sample analysis might also be viewed as a placebo test using a separation that is not based on GDP, financial development or interest rates. Result show that the time dummy variables are significant in both sub-samples.

The results establish that cash demand increased in wealthier economies, in financially more developed economies and in economies where interest rates were reduced. This result gives rise to the third plausible explanation that could be the driver of increases of cash demand – economic contractions. Wealthier and financially more developed economies had experienced contractions, or at least trend declines in GDP growth rates after the crisis, which also resulted in lower interest rates.

Table 7 scrutinizes this potential explanation. Specification 1 includes the dummy variable *Contraction* that takes a value of one if the growth rate of real GDP is lower than in the previous year and zero otherwise. In specification 2 and 3, dummy variables are included which are one if GDP growth is negative or smaller than 0.5%, respectively (*GDP growth < 0%*, *GDP growth < 0.5%*). Neither of these dummy variables is significant and the year dummies variables remain significant. While specifications 1 to 3 provide for a direct test of the observation of Friedman and Schwartz (1963) that velocity declines in contractions,

specification 4 provides another test. Declining GDP growth rates to which agents have not adjusted their cash balances could be drivers if agents focus on permanent income instead of period income. To test this argument, the scale variable is replaced by the moving average of GDP for the last three years (which can be viewed as a proxy of permanent income).[16] Column 4 shows that the use of "permanent" income instead of period income reduces the size of the year dummies.[17] Moreover, some year dummies turn insignificant. Specifically, a higher cash demand is found in 2007 and 2008. The effect disappears in 2009 and 2010. For 2011 to 2014 the year dummies remain significantly different from zero. Column 5 and 6 show separate regressions for economies with above median GDP and below median GDP, respectively. The findings confirm previous results that the autonomous increase is only obtained in richer economies.

4.5 Experience of banking crises and uncertainty

Keeping in mind the various challenges faced when modelling currency demand for this broad sample of economies and for this specific time period, results show that currency demand reacts in meaningful ways to interest rates. While some part of the increase in currency in circulation can thus be attributed to lower interest rates, an autonomous effect of the crisis is found. How can this finding be interpreted and what is the economic reason behind autonomous level shifts?

One suspicion is that the increase is driven by those economies that had experienced a systemic banking crisis in 2007/08. In our sample, this applies to only four economies (GBR, Denmark, Iceland and Hungary) as the sample omits the Euro area, the USA and Switzerland (Laeven and Valencia, 2012). Specifications 6 of Table 4 and Table 5 repeat the analysis but omit these four economies. The time dummy variables remain significant, although point estimates are slightly smaller. This shows that it is not the experience of a systemic banking crisis in 2007/08 that drives the finding of an autonomous increase in cash demand. However, even in the absence of a systemic banking crisis, the elevated economic and financial uncertainty might have led to portfolio shifts, increasing cash demand, leading us to the fourth plausible reason for increases in cash demand that we would like to evaluate. The ideal test for this hypothesis would be to include measures of trust in banks and/or perceived

[16] Constructing a well-derived measure of permanent income is beyond the scope of this paper.
[17] We stress that corresponding results have to be treated with caution because of a violation of the assumption that the error term is independent from contemporaneous, past and future explanatory variables.

uncertainty and to study whether these variables account for the unexplained level shift. As such data are unavailable, we conduct an indirect test by splitting the sample into groups of economies. Specifically, economies (i) that did not experience any systemic financial crisis in the post World War II period are compared with economies that (ii) either experienced a financial crisis in 2007/08 or had (iii) experienced a financial crisis before 2007/08. We analyze the latter group separately as memories of past banking crises were found to have a lasting impact on financial behavior of individuals (Malmendier and Nagel 2011, Osili and Paulson 2011, Stix 2013).[18] Therefore, one could hypothesize that cash demand increased in these economies due to an elevated sensitivity to uncertainties or to news about banking problems in other economies, even if no crisis occurred in the specific economy in 2007/08.

Figure 7 plots the accumulated prediction error of the money demand model for the period from 2008 to 2014 against the actual change in the CiC to nom. GDP ratios – a positive prediction error implies that observed cash demand is higher than predicted cash demand.[19] The largest prediction errors are found for ISL and GBR which experienced a systemic banking crisis including runs by retail depositors in 2008. A sizeable prediction error is also obtained for Hungary. This suggests that the occurrence of a banking crisis increased cash demand in these economies—which is in line with the evidence from the Great Depression. In DNK, however, which also had a banking crisis in 2008, a negative prediction error is found. Disregarding the economies that had a banking crisis in 2008 reveals a positive association between changes in currency to GDP levels and prediction errors. In other words, the model without year dummies does not adequately capture increases in currency demand. Among those economies with increases in the currency ratios and large prediction errors, many have had a financial crisis prior to 2008 but not in 2008 (Laeven and Valencia, 2012). Among economies without any record of systemic banking crisis, there is no obvious pattern between prediction errors and changes in the currency ratio.

Table 8 provides a regression-based test of Figure 7. As there are only four economies in our sample that experienced a systemic banking crisis in 2008, we cannot estimate a model but instead compare economies without any systemic banking crisis and economies that had a

[18] Osili and Paulson (2011) document that migrants to the U.S. who have lived through a systemic banking crisis in their home countries are less likely to have checking accounts in the U.S. than otherwise similar migrants who have not lived through a banking crisis. Stix (2013) shows that crisis experience increases the likelihood of households in euroized economies to hold cash instead of bank savings.

[19] Prediction errors are derived from a model that includes all economies, i.e., specification 3 of Table 4 without year dummies as we want to inquire into the reasons for the significant year dummies.

crisis before 2008 (but not in 2008). Columns 1 to 3 show regressions for economies that did not experience a systemic banking crisis in the recent history. In the first column, the scale elasticity is fixed across economies, in the second column, it is allowed to vary across economies and in the third column, we employ the moving average of GDP as the scale variable. In neither case are year dummies significant. Column 4 to 6 repeat the analysis for economies that had a systemic banking crisis prior to 2007 but not in 2007/08. In these economies all three specifications display significant time effects, even though the effects get smaller in the third specification, on average. The exercise was repeated with a log-log specification and results are rather similar, with the exception that the year dummies are insignificant in the last specification.

We think that the result that cash demand evolved in line with GDP and interest rates in economies without any financial crisis is intuitive. In contrast, substantial caution is required regarding the effect of past crises. Unless this result can be tested with appropriate data this interpretation remains speculative as unobserved variables that are correlated with the groups could drive this result.

5. Conclusion

The CiC to nom. GDP ratio has increased after 2007/08 in EUR, USA and CHE. We argue that a non-negligible part of the increase is of domestic origin. Likewise, we show that after 2007/08 increases occurred in many other economies that face no foreign demand for their currencies. If one looks at an approximate aggregate for the entire World then we also find that the CiC over nom. GDP ratio has increased.

What are the reasons for this development? We conduct panel estimations which relate (log) real per capita cash holdings to (log) real per capita GDP, deposit interest rates and a measure of shadow economic activity to test whether the increases in currency demand can be explained by these economic forces. Results show that cash demand reacts to interest rates and that the interest rate elasticity of cash demand goes to zero as interest rates approach zero. This implies that part of the increase can be assigned to the widespread decline of interest rates. Changes in shadow economic activities are not found have induced changes in cash demand. Similarly, we find little evidence that cash demand is higher than predicted by

the model if GDP growth rates slow down. Overall, our estimations leave a quantitatively significant level shift in cash demand after 2007 that needs to be explained

Delving into the likely reason for this result, we study the role of banking crisis. Foremost, no increase in the level of cash demand is found, on average, in economies without a financial crisis in the recent past. In turn, we provide evidence supporting the interpretation that increases happened, again on average, in economies which experienced a systemic banking crisis in 2008 (although this is difficult to test for just four economies). This is not surprising as the experience of the Great Depression or of other banking crises teaches us that cash serves as a safe haven asset when bank deposits are considered risky.[20]

The problem with this interpretation is that it does not provide a comprehensive explanation as only a small number of economies experienced a systemic banking crisis in 2008, while the level shift in the currency ratio is also observable in economies without systemic banking crisis in 2008. One rationalization for this finding could be memory effects – as memories of past crisis have a lasting impact on behavior of individuals, the financial crisis of 2007/08 could have induced people to hold more cash even though no banking crisis occurred. While this explanation is tempting, we stress that its relevance has yet to be demonstrated, requiring data on how trust in banks has changed over time.

Another interpretation of the result pertains to crisis and non-crisis economies. Numerous incidences of bank problems might have lowered confidence in banks and increased uncertainty, even in economies without a systemic banking crisis in 2007/08. This could have led to a situation in which bank deposits and cash were no longer seen as perfect substitutes. Friedman and Schwartz (1963) stress the general role of uncertainty for cash demand: "*The more uncertain the future, the greater the value of [the] flexibility [of cash] and hence the greater the demand for money is likely to be*" (p. 673). We conjecture that his channel, in combination with very low interest rates, might have constituted one additional important reason for the increase in cash demand in some wealthier economies after 2009. Also, this explanation does not necessarily entail a sudden or strong shift in deposit to currency ratios as would be typical for banking crises.

Notwithstanding the difficulties in testing this uncertainty channel, the argument rests on a persistent increase in uncertainty and not just a temporary surge in 2008/09. Evidence for a

[20] E.g. Brown, Evangelou and Stix (2016) present evidence about the increase in currency in circulation after banks were temporarily closed in Cyprus.

few economies can be obtained from the news-based Economic Policy Uncertainty Index (Baker, Blum and Davis, 2016) which shows a substantial increase in policy uncertainty after 2008 in many of the covered economies, i.e. GBR, Europe (an average of Germany, France, Italy and GBR), the USA, Canada, Japan and Korea. In other economies, e.g. Sweden, there was only a modest increase. In Europe, the increase in economic policy uncertainty has been persistent after 2008, in the USA, Japan and Korea it returned to pre-crisis levels around 2015. This evidence is indicative at best and more research is necessary to delve deeper into the effect of uncertainty on cash demand.

To conclude, the paper has uncovered a number of stylized facts that show that the often held assumption that cash is about to disappear is wrong – at least for the time being. Rather, currency ratios are found to have increased across a wide and diverse range of economies. When it comes to explaining the recent return to cash, the paper has provided evidence for a number of potential explanatory factors, including low interest rates and increased uncertainty. However, many questions remain open. In particular, the focus on many economies, which is key to establish the broad stylized facts on the return of cash, implies that potentially important explanatory variables are not available. Future work should include information on non-cash payments as well as on banknote denominations. A different type of study would be cross-sectional analyses which could be informative about how factors like financial development, the size of the shadow economy or cultural differences affect cross-country differences in the importance of cash. On a general note, the results in this paper confirm that transaction demand constitutes only a relatively small component of overall demand for currency which is dominated by precautionary demand, hoarding and other motives rather than by transaction motives – we think this aspect merits further attention. Given the important role of cash in the economy and recent policy debates on its abolition more research is definitely required.

References

Amromin, G. and Chakravorti, S. (2009). "Whither Loose Change? The Diminishing Demand for Small-Denomination Currency", *Journal of Money, Credit and Banking*, 41(2-3), 315–335.

Arghyrou, Michael G., Gadea, Maria-Dolores (2017). "Private Bank Deposits in the Euro-Area: The Role of Uncertainty", Paper presented at the INFINITI Conference on International Finance 2017, Valencia, June 2017.

Assenmacher, Kathrin, Seitz Franz and Tenhofen, Jörn (2017). "The use of large denomination banknotes in Switzerland", Paper presented at the 3rd International Cash Conference, Deutsche Bundesbank, April 2017.

Attanasio, Orazio P., Guiso, Luigi and Jappelli, Tullio (2002). "The Demand for Money, Financial Innovation, and the Welfare Cost of Inflation: An Analysis with Household Data", *Journal of Political Economy* 110(2), 317-351.

Bagnall, J., Bounie, D., Kosse, A., Huynh, K. P. , Schmidt, T., Schuh, S. and Stix, H. (2016). "Consumer Cash Usage and Management: A Cross-Country Comparison with Diary Survey Data", *International Journal of Central Banking* 12(4), 1-61.

Baker, Scott R., Bloom Nicholas, and Davis, Steven J. (2016). "Measuring Economic Policy Uncertainty", http://www.policyuncertainty.com/media/EPU_BBD_Mar2016.pdf (accessed April 14, 2017).

Bartzsch, N., Rösl, G. and Seitz, F. (2013). "Currency movements within and outside a currency union: The case of Germany and the euro area", *The Quarterly Review of Economics and Finance*, 53: 393-401.

Bartzsch, N. and Seitz, F. (2016). "What can biology tell us about transaction balances?", *Applied Economics Letters*, DOI: 10.1080/13504851.2016.1192269.

Bernanke, Ben and James, Harold (1991). "The Gold Standard, Deflation, and Financial Crisis in the Great Depression: An International Comparison" In R. G. Hubbard, ed., Financial Markets and Financial Crises, Chicago: University of Chicago Press.

Brown, Martin, Evangelou, Ioanna S. and Stix, Helmut (2016). "Banking Crises, Bail-ins, and Depositor Confidence: Lessons from Cyprus", mimeo.

Brown, Martin and Stix, Helmut (2015). "The Euroization of Bank Deposits in Eastern Europe". *Economic Policy* 81, 1-45.

Butschek, Franz (2011). "Österreichische Wirtschaftsgeschichte – Von der Antike bis zur Gegenwart", Böhlau Verlag: Wien, Köln, Weimar.

Cagan, Philip (1965). "The Currency Ratio", in Philip Cagan: "Determinants and Effects of Changes in the Stock of Money, 1875-1960", NBER, 118 – 150.

Cusbert, Tom and Rohling, Thomas (2013), "Currency Demand During the Global Financial Crisis: Evidence from Australia". http://dx.doi.org/10.2139/ssrn.2209604 (accessed 1 June 2016).

ECB (2013), The International Role of the Euro, European Central Bank.

Feige, Edgar L. (2012). "The myth of the "cashless society": How much of America's currency is overseas?", https://mpra.ub.uni-muenchen.de/42169/1/MPRA_paper_42169.pdf (accessed 1 June 2016).

Feige, Edgar L. (2016). "Reflections on the Meaning and Measurement of Unobserved Economies: What do we really know about the "Shadow Economy"?", *Journal of Tax Administration* 2(1), 5-41.

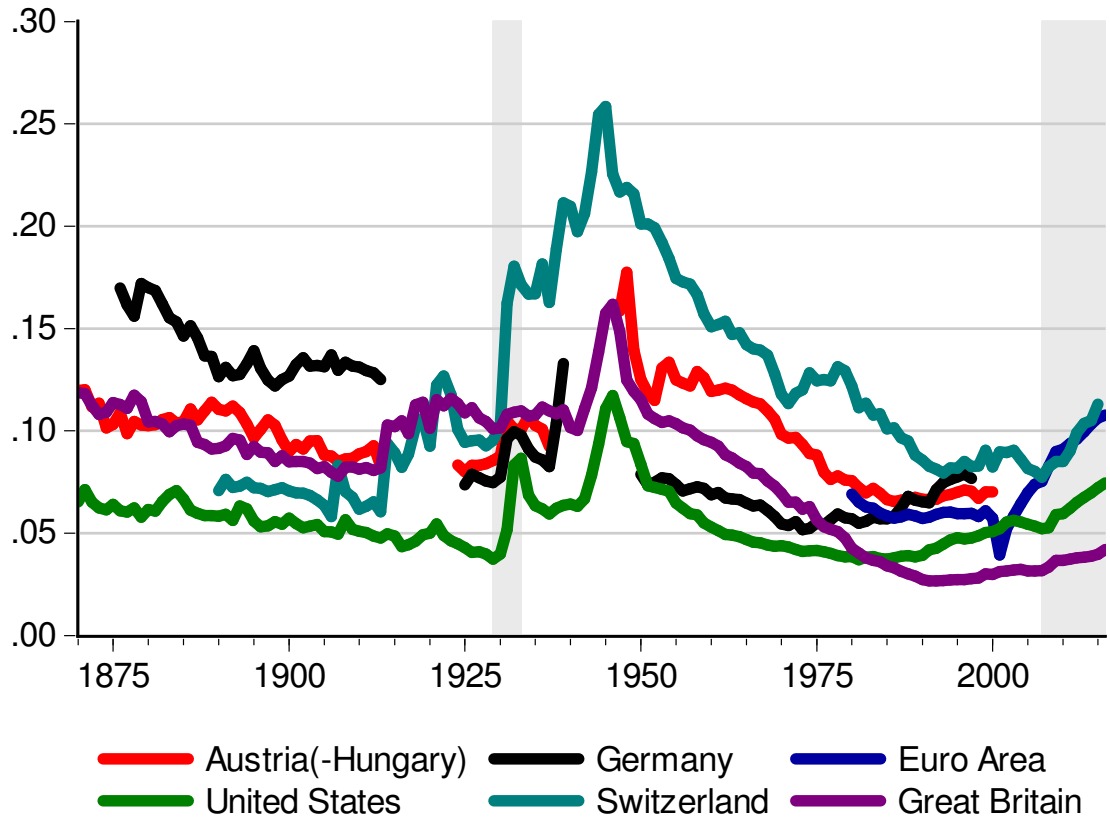
Friedman, Milton and Schwartz, Anna J. (1963). "A Monetary History of the United States, 1867–1960", Princeton: Princeton University Press for NBER.

Fung, Ben S. C., Huynh, Kim and Sabetti, Leonhard (2014). "Retail Payments Innovation and the Demand for Cash in Canada", *Journal of Financial Market Infrastructures* 3(1), 1-29.

Goodhart, Charles A.E. and Ashworth, Jonathan (2014). "Trying to Glimpse the `Grey Economy'". Vox – CEPR's Policy Portal (http://voxeu.org/article/trying-glimpse-grey-economy. Accessed Feb 10, 2016).
Goodhart, Charles A.E. and Ashworth, Jonathan (2015). "Measuring Public Panic in the Great Financial Crisis". Vox – CEPR's Policy Portal (http://voxeu.org/article/measuring-public-panic-great-financial-crisis. Accessed Feb 10, 2016).
Goodhart, Charles A.E. and Ashworth, Jonathan (2017). "The Surprising Recovery of Currency Usage", Paper presented at the 3rd International Cash Conference, Deutsche Bundesbank, April 2017.
Gordon, Robert J. (1986). "The American Business Cycle: Continuity and Change", Studies in Business Cycles (25), University of Chicago Press.
Humphrey, D. B., Pulley, L. B. and Vesala, J. M. (1996). "Cash, Paper, and Electronic Payments: A Cross-Country Analysis," *Journal of Money, Credit, and Banking* 28(4), 914–939.
Hsiao, Cheng (2005). "Analysis of Panel Data", 2nd ed., Econometric Society Monographs No. 34, Cambridge, UK: Cambridge University Press.
Jiang, Janet Hua and Shao, Enchuan (2014). "Understanding the Cash Demand Puzzle", Bank of Canada Working Paper 2014-22.
Jobst, Clemens and Kernbauer, Hans (2016). "Die Bank. Das Geld. Der Staat – Nationalbank und Währungspolitik in Österreich 1816-2016", Frankfurt am Main: Campus Verlag.
Jobst, Clemens and Stix, Helmut (2016). "Florin, crown, schilling and euro: an overview of 200 years of cash in Austria", *Monetary Policy & the Economy* Q3, 94–119.
Judson, Ruth (2017). "The Death of Cash? Not So Fast: Demand for U.S. Currency at Home and Abroad, 1990-2016", Paper presented at the 3rd International Cash Conference, Deutsche Bundesbank, April 2017.
Komlos, J. (1983). "The Diffusion of Financial Technology into the Austro-Hungarian Monarchy towards the End of the Nineteenth Century." In: Komlos, John (ed.). "Economic Development in the Habsburg Monarchy in the Nineteenth Century, Essays." New York: Columbia University Press. 137–163.
Krüger, Malte (2016). "The Spread of Branch Banking and the Demand for Cash in Post-War Germany", ROME Discussion Paper Series No. 16-09 – October 2016.
Laeven, L. and Valencia, F. (2012). "Systemic Banking Crises Database: An update". IMF Working Papers No. 12/163.
Lippi, Francesco, and Secchi, Alessandro (2009). "Technological change and the households' demand for currency." *Journal of Monetary Economics* 56(2): 222–230.
Malmendier, U. and Nagel, S. (2011). "Depression Babies: Do Macroeconomic Experiences Affect Risk Taking?", *The Quarterly Journal of Economics* 126, 373-416.
Nicoló, Gianni De, Honohan, Patrick and Ize, Alain (2005). "Dollarization of bank deposits: Causes and consequences", *Journal of Banking & Finance* 29, 1697–1727.
Osili, U.O. and Paulson, A. (2014). "Crises and Confidence: Systemic Banking Crises and Depositor Behavior", *Journal of Financial Economics* 111, 646-660.
Porter, R.D. and Judson, Ruth A. (1996). "The Location of U.S. Currency: How Much Is Abroad?", Federal Reserve Bulletin, Vol. 82 (October): 883-903.
Mulligan, Casey B. and Sala-i-Martin, Xavier (2000). "Extensive Margins and the Demand for Money at Low Interest Rates", *Journal of Political Economy* 108(5) October, 961-991.
Ramírez, Carlos D. (2009). "Bank fragility, ''money under the mattress", and long-run growth: US evidence from the ''perfect" Panic of 1893", *Journal of Banking and Finance* 33, 2185–2198.

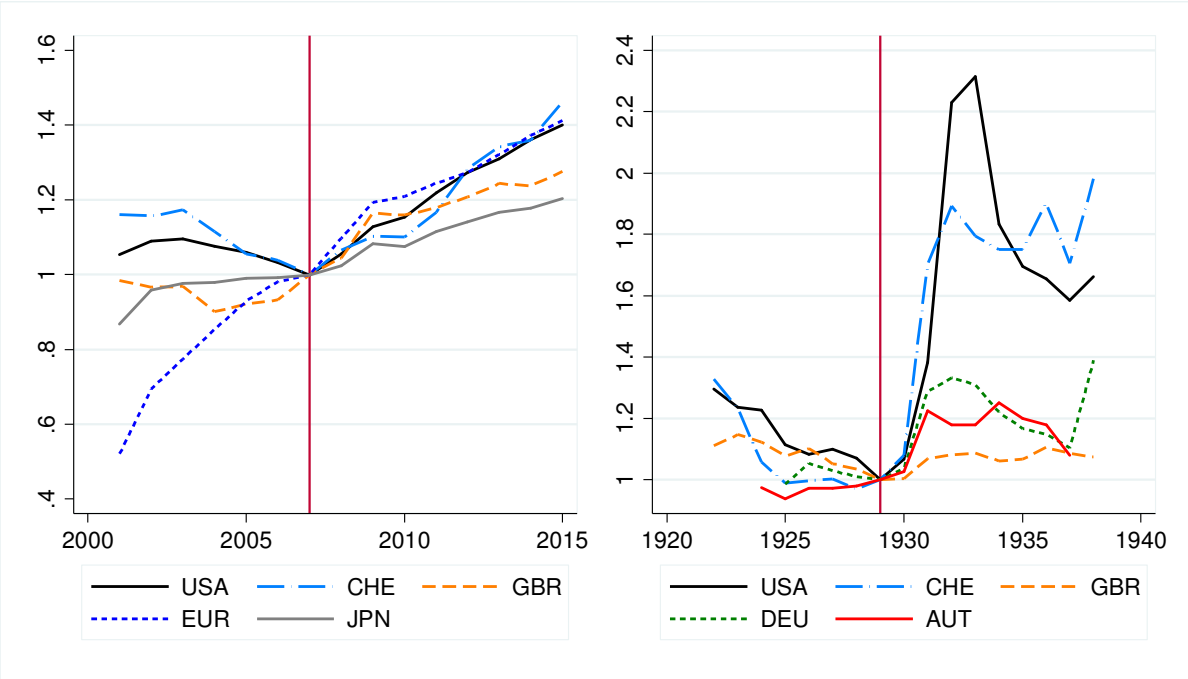
Rogoff, Kenneth S. (2016). “The Curse of Cash”, Princeton and Oxford: Princeton University Press.
Sands, Peter (2016). “Making it Harder for the Bad Guys: The Case for Eliminating High Denomination Notes”, Mossavar-Rahmani Center for Business & Government Associate Working Paper Series No 52.
Schnabel, Isabel (2004). “The German Twin Crisis of 1931”, *Journal of Economic History* 64(3), 822-871.
Schneider, Friedrich (2015). “Size and Development of the Shadow Economy of 31 European and 5 other OECD Countries from 2003 to 2015: Different Developments”, downloaded from http://www.econ.jku.at/members/Schneider/files/publications/2015/ShadEcEurope31.pdf (accessed Jan 15, 2016).
Schneider, Friedrich (2016). “Comment on Feige’s paper “Reflections on the Meaning and Measurement of Unobserved Economies: What do we really know about the “Shadow Economy”?”, *Journal of Tax Administration*, *2*(2), 82-92.
Schneider, Friedrich (2017). Unpublished data, Source: Prof. Dr. Friedrich Schneider, Department of Economics, University of Linz, A-4040 Linz / Austria.
Schneider, Friedrich, Buehn, Andreas and Montenegro, Claudio E. (2010). “Shadow Economies All over the World – New Estimates for 162 Countries from 1999 to 2007”, *International Economic Journal* 24(4), 443-461.
Schubert, A. (1991). “The Credit-Anstalt Crisis of 1931”. Cambridge, UK: Cambridge University Press.
Schuh, Scott and Briglevics, Tamas (2013), "U.S. Consumer Demand for Cash in the Era of Low Interest Rates and Electronic Payments,", FRB Boston Working Papers Series No. 13-23.
Seitz, Franz (1997). “How Many Deutschmarks are Held Abroad?”, *Intereconomics*, Vol. 32(2), March/April, S. 67-73.
Stix, Helmut (2013). “Why do People Save in Cash? Distrust, Memories of Banking Crises, Weak Institutions and Dollarization”, *Journal of Banking & Finance* 37, 4087-4106.
World Value Survey (2016). “WORLD VALUES SURVEY Wave 6 2010-2014 OFFICIAL AGGREGATE v.20150418”, World Values Survey Association (www.worldvaluessurvey.org, accessed May 13 2016).
Zipser, W. (1997). “Auf der Suche nach Stabilität. Das Zentralbankgeldangebot der österreichischen Nationalbank 1923 bis 1937”, Frankfurt: Peter Lang.

Figure 2. A Longer Term View on Currency in Circulation over Nominal GDP (in %)



Note: The shaded area marks the period from 1929 to 1933 and from 2007 to 2016. Sources of variables are described in Appendix A.

Figure 3. Comparison Great Depression and Great Recession

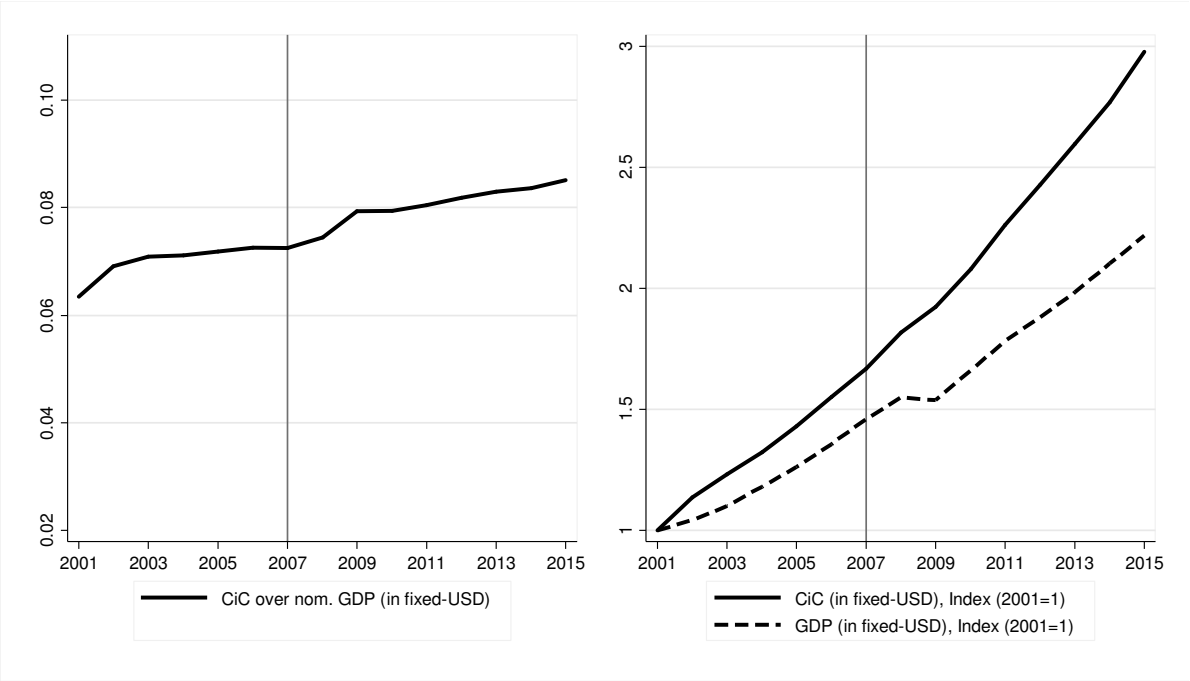


Note: The figure shows the temporal evolution of the CiC over nom. GDP ratio for the Great Recession (left panel) and the Great Depression (right panel). The ratios are indexed to one in 2007 (right panel) and 1927 (left panel). A value of 1.2 means that the CiC over nom. GDP ratio increased by 20%, relative to 2007 and 1927, respectively. Source: See Appendix.

Figure 4. Comparison Great Depression

Note: The figure shows the temporal evolution of the CiC over nom. GDP ratio for the Great Depression for various economies. For a few economies, we employ the ratio of CiC over nom. GNP. All ratios are indexed to 1927. A value of 1.2 means that the CiC over nom. GDP ratio increased by 20%, relative to 1927. Sources available from authors upon request.

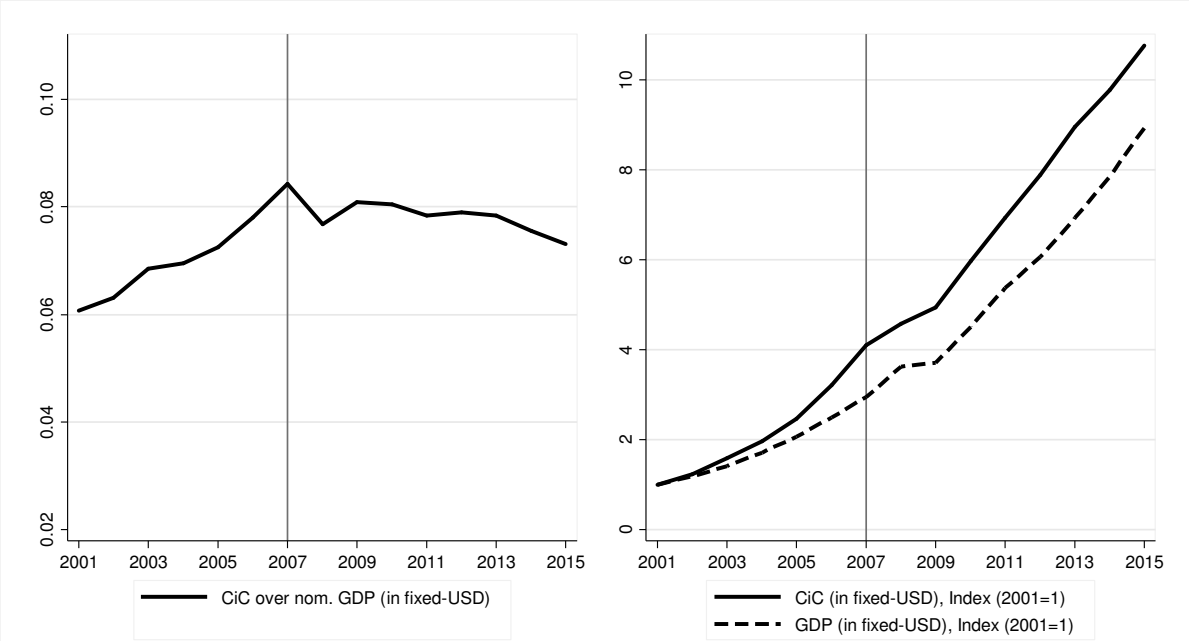
Figure 5. Currency in Circulation over Nominal GDP (in %) – "World"



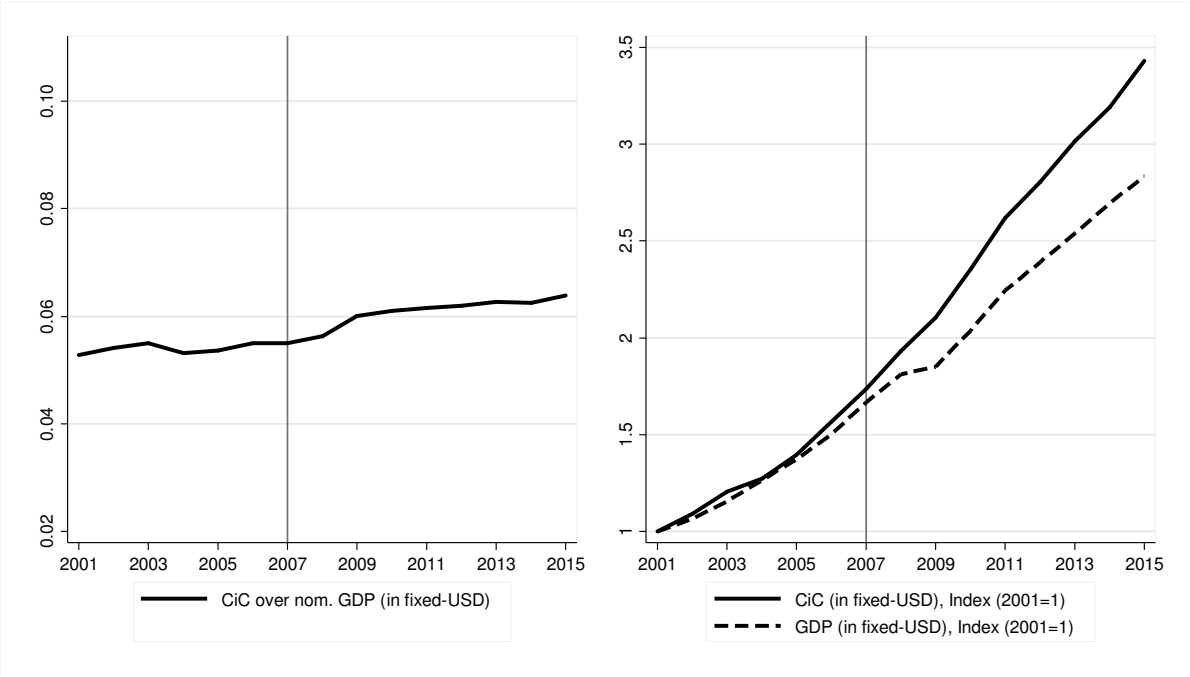
Note: The figures show the currency in circulation to nominal GDP ratios (left panel) as well as the evolution of currency in circulation and nominal GDP (right panel). All figures refer to the "World" as specified in the text. Own calculations. All aggregations are based on market USD exchange rates that are fixed at 2006. Variables are described in the Appendix. Data: IMF, OECD, national central banks.

Figure 6. Currency in Circulation over Nominal GDP (in %) for Groups of Economies

Panel A. Dollarized economies

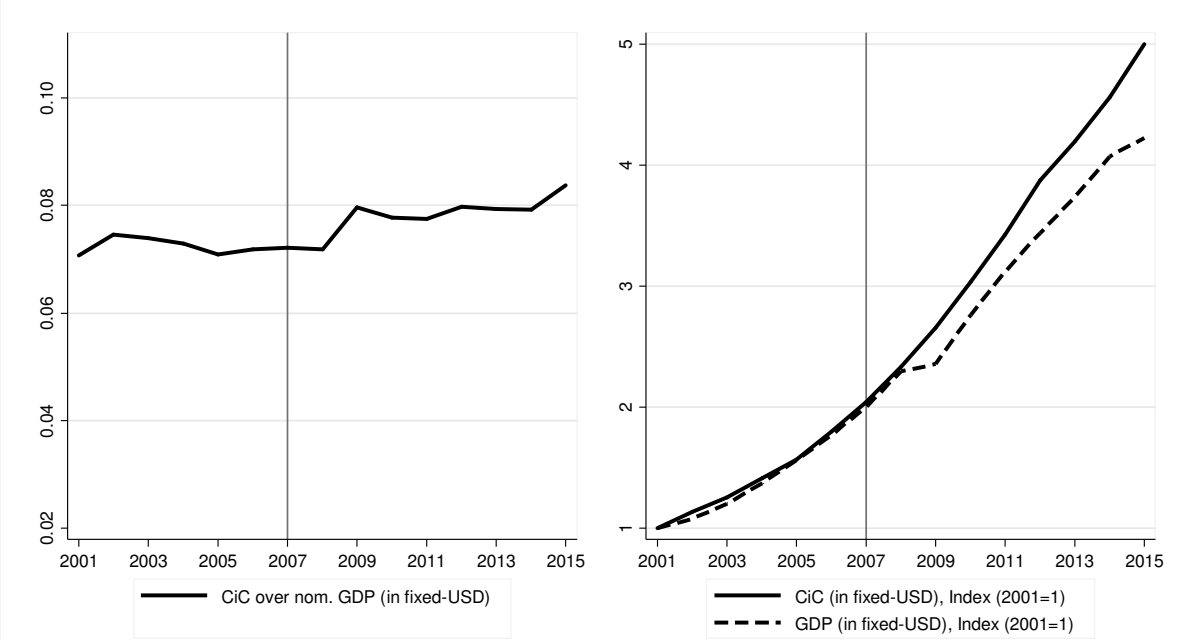


Panel B. Non-Dollarized, OECD

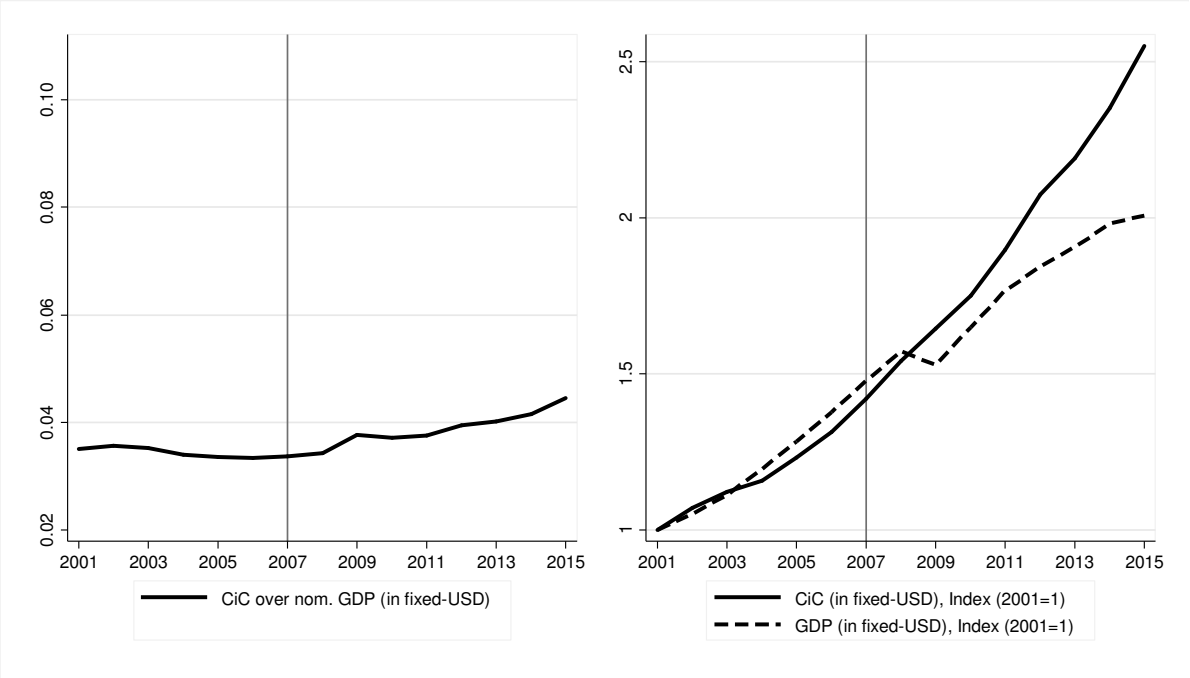


Note: See continuation.

Panel C. Non-Dollarized, non-OECD

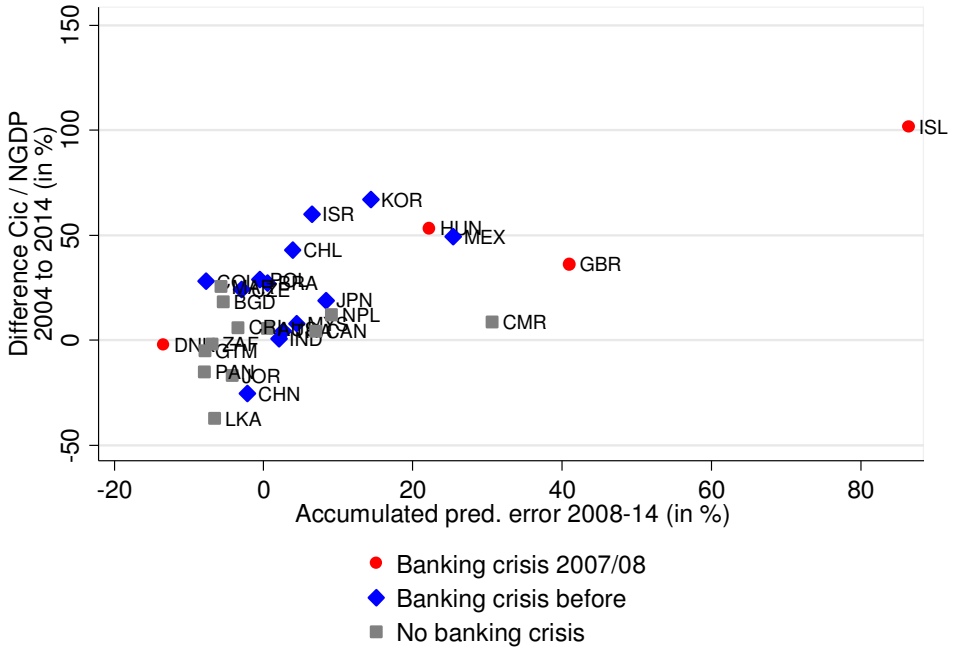


Panel D. High Income without USA, EUR, CHE and JPN



Note: The figures show the currency in circulation to nominal GDP ratios for several sub-groups of economies (left panels) and the evolution of currency in circulation and nominal GDP (right panel). USA, EUR, CHE and JPN are not included. High income economies are defined as GDP per capita of more than 15,000 USD in 2012. Own calculations. All aggregations are based on market USD exchange rates that are fixed at 2006. Data: IMF, OECD, national central banks.

Figure 7. Prediction Errors and change in CiC over nom. GDP ratios



Note: The figures show prediction errors from model (3) of Table 4 with year dummies omitted from the regression. The prediction errors are accummulated for the years 2008 to 2014. A value of 20% means that actual real per capita currency is 20% higher than predicted real per capita currency. Observations are grouped into (i) economies with a systemic banking crisis in 2008 but not before, (ii) economies with a systemic banking crisis prior to 2008 but not in 2008 and (iii) economies without any systemic banking crisis according to Laeven and Valencia (2012).

Table 1. Descriptive evidence about currency ratios

	All (="World")	Non-Dollarized				Dollarized
		Total	EUR, USA, CHE	other OECD	other non-OECD	
# economies	72	40	3	19	18	32
Change in CiC over nom. GDP ratio from 2004/05 to 2013/14 (in %)						
Min	-0.58	-0.43	0.24	-0.43	-0.37	-0.58
Max	1.51	1.02	0.51	1.02	0.54	1.51
Standard deviation	0.34	0.30	0.15	0.37	0.23	0.39
Mean	0.17	0.17	0.34	0.22	0.09	0.17
Median	0.13	0.16	0.25	0.24	0.08	0.09
p75	0.37	0.38	0.51	0.50	0.26	0.37
# economies with increase in ratio >10%	38	22	3	11	8	16
# economies with decrease in ratio >10%	11	7	0	3	4	8

Note: The table shows descriptive statistics about the change in the currency in circulation over nominal GDP ratios. The descriptive statistics refer to the percent changes in the ratio from 2004/05 to 2013/14. "#of economies with increase (decrease) of ratio" refers to changes in the ratio that are larger (smaller) than plus (minus) 10%. Oil-producing economies have been omitted.

Table 2. Aggregate currency demand before and after the crisis

			Total	EUR, USA, CHE	other OECD	other non-OECD	
Real GDP - in bn fixed USD	2004/05	46,100	43,000	24,400	15,400	3,247	3,095
	2013/14	57,100	52,400	26,600	20,700	5,104	4,711
	Change in %	24%	22%	9%	34%	57%	52%
Deposit rate	2004/05	5.77	4.84	1.78	4.45	5.63	6.95
	2013/14	5.00	3.42	0.12	2.56	4.67	7.01
	Change (in perc. points)	-0.77	-1.42	-1.66	-1.89	-0.96	0.06
Real CiC - in bn fixed USD	2004/05	3,269	3,048	1,528	1,291	229	221
	2013/14	4,918	4,557	2,270	1,866	421	361
	Change (bn USD)	1,649	1,509	742	575	192	140
	Change in %	50%	50%	49%	45%	84%	63%
(a) Income elasticity = 1, interest rate semi-elasticity -0.025							
unexplained increase / actual increase in CiC (%)		48%	47%	72%	8%	27%	18%
(b) Income elasticity = 1, interest rate semi-elasticity -0.005							
unexplained increase / actual increase in CiC (%)		52%	54%	80%	20%	31%	18%
(c) Income elasticity = 0.8, interest rate semi-elasticity -0.025							
unexplained increase / actual increase in CiC (%)		58%	57%	76%	26%	44%	37%
(d) Income elasticity = 1.2, interest rate semi-elasticity -0.025							
unexplained increase / actual increase in CiC (%)		37%	37%	68%	-11%	9%	-3%

Note: The summarizes the temporal evolution of real GDP, deposit rates and real currency in circulation (CiC) from 2004/05 to 2013/14 for all economies (column 1) and several sub-aggregates. We employing a simple money demand framework, in which real CiC is modelled as a function of real GDP and interest rates, to predict the increase in CiC that is implied by the changes in rel GDP and interest rates. The percentage share of the observed increase in real CiC that cannot be explained by this simple model is summarized in the lower part of the table.

Table 3. Panel Estimation Results

Panel A. Semi-log specification	All	All	Non-Dollarized	Dollarized
	(1)	(2)	(3)	(4)
Deposit rate	-0.020***	-0.020***	-0.025***	-0.016***
	(0.005)	(0.005)	(0.006)	(0.005)
Ln Share shadow ecnmy	-0.025	-0.048	-0.055	0.004
	(0.100)	(0.113)	(0.159)	(0.161)
2007		0.081***	0.056**	0.103***
		(0.018)	(0.022)	(0.027)
2008		0.075***	0.089**	0.051
		(0.026)	(0.036)	(0.036)
2009		0.099***	0.088***	0.087**
		(0.027)	(0.030)	(0.041)
2010		0.093***	0.087**	0.076*
		(0.032)	(0.041)	(0.042)
2011		0.091**	0.116**	0.041
		(0.035)	(0.045)	(0.045)
2012		0.117***	0.134**	0.072
		(0.039)	(0.050)	(0.052)
2013		0.111**	0.138**	0.051
		(0.043)	(0.055)	(0.056)
2014		0.121**	0.165***	0.036
		(0.049)	(0.058)	(0.069)
Mean income elasticity	1.40	1.01	0.77	1.29
R2-within	0.89	0.90	0.90	0.91
R2-between	0.14	0.07	0.25	0.00
R2-overall	0.14	0.07	0.25	0.00
log-L	832.6	869.8	527.2	383.7
N	787	787	401	386
N-economies	58	58	29	29
Implied interest rate elasticities:				
Interest rate elasticity at mean r	-0.125	-0.124	-0.130	-0.119
Interest rate elasticity at r=7%	-0.138	-0.137	-0.174	-0.110
Interest rate elasticity at r=3%	-0.059	-0.059	-0.075	-0.047
Interest rate elasticity at r=0.5%	-0.010	-0.010	-0.012	-0.008

Note: See continuation..

Table 3. Panel Estimation Results **(cont'd)**

Panel B. Log-log specification	All	All	Non-Dollarized	Dollarized
	(1)	(2)	(3)	(4)
Ln Deposit rate	-0.089***	-0.084***	-0.040*	-0.116***
	(0.022)	(0.022)	(0.021)	(0.038)
Ln Share shadow ecnmy	-0.025	-0.048	-0.038	0.015
	(0.103)	(0.117)	(0.164)	(0.163)
2007		0.078***	0.050**	0.106***
		(0.019)	(0.023)	(0.028)
2008		0.063**	0.073**	0.052
		(0.026)	(0.035)	(0.037)
2009		0.086***	0.101**	0.085**
		(0.028)	(0.037)	(0.040)
2010		0.081**	0.108*	0.07
		(0.035)	(0.054)	(0.042)
2011		0.077*	0.131**	0.038
		(0.039)	(0.058)	(0.045)
2012		0.094**	0.147**	0.064
		(0.043)	(0.064)	(0.051)
2013		0.082*	0.149**	0.039
		(0.048)	(0.070)	(0.056)
2014		0.084	0.177**	0.017
		(0.053)	(0.074)	(0.067)
Mean income elasticity	1.43	1.13	0.88	1.32
R2-within	0.88	0.89	0.88	0.91
R2-between	0.17	0.13	0.32	0.01
R2-overall	0.17	0.13	0.32	0.01
log-L	810.64	837.42	492.02	381.62
N	787	787	401	386
N-economies	58	58	29	29

Note: The table shows fixed-effects panel estimation results (2001-2014). The dependent variable is the natural logarithm of real currency in circulation. Panel A contains the the level of the interest rate and Panel B the natural logarithm of interest rates as the independent variable. The estimates for the scale variable (Ln Real GDP), which are allowed to vary across economies, are not shown. Mean income elasticity refers to the sample mean of respective point estimates. Panel A shows the implied interest rate elasticities for various interest rates. All specifications exclude the Euro area, the US, Switzerland, Hong Kong and Singapore. Robust standard errors adjusted for clustering at the economy level are in parentheses. *** (**) [*] denotes significance at the 1% (5%) [10%] level.

Table 4. Non-Linearities in Interest Rate Elasticities – Semi-log

	Non-Dollarized					Non-Dollarized, no banking crisis in 2007/08
	(1)	(2)	(3)	(4)	(5)	(6)
Deposit rate	-0.025***	-0.028***	-0.026***		-0.013	-0.017***
	(0.006)	(0.009)	(0.007)		(0.011)	(0.003)
Ln Share shadow ecnmy	-0.055	-0.089	-0.056	-0.056	-0.079	-0.089
	(0.159)	(0.162)	(0.160)	(0.160)	(0.158)	(0.119)
Deposit rate X Crisis		0.009				
		(0.009)				
Deposit rate <1%			-0.052			-0.006
			(0.052)			(0.022)
Deposit rate <=1%				-0.059		
				(0.051)		
Deposit rate >1%				-0.025***		
				(0.007)		
Deposit rate squared					-0.001	
					(0.001)	
2007	0.056**	0.064**	0.060**	0.059**	0.056**	0.043**
	(0.022)	(0.025)	(0.023)	(0.023)	(0.022)	(0.019)
2008	0.089**	0.040	0.094**	0.092**	0.091**	0.059**
	(0.036)	(0.042)	(0.038)	(0.038)	(0.037)	(0.026)
2009	0.088***	0.051	0.094***	0.092***	0.097***	0.075***
	(0.030)	(0.036)	(0.033)	(0.032)	(0.034)	(0.025)
2010	0.087**	0.055	0.093**	0.090**	0.097**	0.061**
	(0.041)	(0.034)	(0.044)	(0.043)	(0.047)	(0.029)
2011	0.116**	0.082**	0.122**	0.119**	0.125**	0.082**
	(0.045)	(0.037)	(0.048)	(0.047)	(0.050)	(0.033)
2012	0.134**	0.101**	0.144**	0.140**	0.144**	0.099**
	(0.050)	(0.041)	(0.055)	(0.054)	(0.055)	(0.040)
2013	0.138**	0.109**	0.145**	0.142**	0.151**	0.103**
	(0.055)	(0.046)	(0.058)	(0.058)	(0.062)	(0.045)
2014	0.165***	0.138***	0.174***	0.170***	0.180**	0.130**
	(0.058)	(0.050)	(0.062)	(0.061)	(0.066)	(0.051)
Mean income elasticity	0.77	0.70	0.74	0.75	0.72	0.85
R2-within	0.90	0.90	0.90	0.90	0.90	0.93
R2-between	0.25	0.25	0.24	0.25	0.24	0.30
R2-overall	0.25	0.25	0.24	0.25	0.24	0.30
log-L	527.2	531.5	528.6	527.9	530.0	527.0
N	401	401	401	401	401	345
N-economies	29	29	29	29	29	25

Note: The table shows fixed-effects panel estimation results (2001-2014). The dependent variable is the natural logarithm of real currency in circulation The estimates for the scale variable (Ln Real GDP), which are allowed to vary across economies, are not shown. Mean income elasticity refers to the sample mean of respective point estimates. All specifications exclude the Euro area, the US, Switzerland, Hong Kong and Singapore. Robust standard errors adjusted for clustering at the economy level are in parentheses. *** (**) [*] denotes significance at the 1% (5%) [10%] level.

Table 5. Non-Linearities in Interest Rate Elasticities – Log-log

	Non-Dollarized				Non-Dollarized, no banking crisis in 2007/08	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Deposit rate	-0.040*	-0.062	-0.081***		-0.016	-0.074***
	(0.021)	(0.039)	(0.021)		(0.029)	(0.019)
Ln Share shadow ecnmy	-0.038	-0.070	-0.057	-0.057	-0.062	-0.066
	(0.164)	(0.169)	(0.158)	(0.158)	(0.155)	(0.120)
Ln Deposit rate X Crisis		0.040				
		(0.049)				
Ln Deposit rate <1%			0.128**			0.079***
			(0.052)			(0.023)
Ln Deposit rate <=1%				0.047		
				(0.045)		
Ln Deposit rate >1%				-0.081***		
				(0.021)		
Ln Deposit rate squared					-0.031**	
					(0.014)	
2007	0.050**	0.062**	0.050**	0.050**	0.052**	0.039*
	(0.023)	(0.028)	(0.022)	(0.022)	(0.021)	(0.019)
2008	0.073**	0.019	0.074**	0.074**	0.080**	0.050*
	(0.035)	(0.062)	(0.034)	(0.034)	(0.034)	(0.026)
2009	0.101**	0.059	0.085**	0.085**	0.083**	0.063**
	(0.037)	(0.055)	(0.034)	(0.034)	(0.031)	(0.025)
2010	0.108*	0.069	0.092*	0.092*	0.087*	0.051
	(0.054)	(0.053)	(0.050)	(0.050)	(0.046)	(0.030)
2011	0.131**	0.090	0.118**	0.118**	0.115**	0.072**
	(0.058)	(0.056)	(0.055)	(0.055)	(0.049)	(0.035)
2012	0.147**	0.108*	0.136**	0.136**	0.135**	0.087**
	(0.064)	(0.059)	(0.060)	(0.060)	(0.056)	(0.041)
2013	0.149**	0.115*	0.144**	0.144**	0.142**	0.088*
	(0.070)	(0.063)	(0.066)	(0.066)	(0.062)	(0.047)
2014	0.177**	0.145**	0.171**	0.171**	0.170**	0.113**
	(0.074)	(0.066)	(0.070)	(0.070)	(0.066)	(0.052)
Mean income elasticity	0.88	0.81	0.81	0.81	0.74	0.93
R2-within	0.88	0.88	0.89	0.89	0.89	0.93
R2-between	0.32	0.33	0.20	0.20	0.11	0.31
R2-overall	0.32	0.33	0.20	0.20	0.11	0.31
log-L	492.0	497.3	503.2	503.2	515.5	522.0
N	401	401	401	401	401	345
N-economies	29	29	29	29	29	25

Note: The table shows fixed-effects panel estimation results (2001-2014). The dependent variable is the natural logarithm of real currency in circulation The estimates for the scale variable (Ln Real GDP), which are allowed to vary across economies, are not shown. Mean income elasticity refers to the sample mean of respective point estimates. All specifications exclude the Euro area, the US, Switzerland, Hong Kong and Singapore. Robust standard errors adjusted for clustering at the economy level are in parentheses. *** (**) [*] denotes significance at the 1% (5%) [10%] level.

Table 6. Results for sub-samples – Semi-log

	Above median GDP	Below median GDP	Interest rate decline	Interest rate increase	Above median withdrawal frequency	Below median withdrawal frequency	Above median share migrants	Below median share migrants
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Deposit rate	-0.024**	-0.017***	-0.028***	-0.013*	-0.015***	-0.019***	-0.025**	-0.020***
	(0.010)	(0.004)	(0.007)	(0.006)	(0.004)	(0.005)	(0.011)	(0.005)
Deposit rate <1%	-0.078		-0.081	-0.021	0.005		-0.107	-0.071**
	(0.062)		(0.068)	(0.033)	(0.023)		(0.092)	(0.025)
Ln Share shadow ecnmy	0.234	-0.081	0.042	-0.105	0.183	-0.045	0.119	0.044
	(0.320)	(0.113)	(0.211)	(0.212)	(0.190)	(0.146)	(0.256)	(0.142)
2007	0.046	0.036	0.072**	0.017	0.017	0.070**	0.045	0.092**
	(0.029)	(0.032)	(0.027)	(0.018)	(0.028)	(0.032)	(0.031)	(0.028)
2008	0.123**	0.016	0.126**	0.012	0.051	0.071	0.085	0.102**
	(0.055)	(0.040)	(0.047)	(0.026)	(0.035)	(0.045)	(0.057)	(0.042)
2009	0.108***	0.027	0.102**	0.056	0.063**	0.081	0.079*	0.105**
	(0.036)	(0.040)	(0.041)	(0.032)	(0.022)	(0.048)	(0.043)	(0.039)
2010	0.118*	0.009	0.109*	0.034	0.049	0.070	0.101	0.119**
	(0.056)	(0.046)	(0.057)	(0.030)	(0.031)	(0.052)	(0.068)	(0.039)
2011	0.158**	0.020	0.143**	0.050	0.087**	0.085	0.147*	0.130**
	(0.057)	(0.052)	(0.058)	(0.043)	(0.038)	(0.060)	(0.070)	(0.047)
2012	0.191***	0.017	0.173**	0.046	0.101**	0.106	0.191**	0.138**
	(0.064)	(0.059)	(0.064)	(0.054)	(0.040)	(0.072)	(0.082)	(0.054)
2013	0.197***	-0.005	0.164**	0.050	0.118**	0.096	0.182**	0.135*
	(0.065)	(0.061)	(0.068)	(0.056)	(0.049)	(0.082)	(0.084)	(0.065)
2014	0.241***	0.012	0.216***	0.051	0.152**	0.125	0.227**	0.145
	(0.064)	(0.064)	(0.074)	(0.063)	(0.057)	(0.088)	(0.085)	(0.079)
Mean income elasticity	1.04	0.99	0.65	1.08	1.22	0.72	0.74	0.83
R2-within	0.88	0.95	0.88	0.94	0.92	0.93	0.85	0.96
R2-between	0.42	0.24	0.14	0.80	0.52	0.19	0.27	0.39
R2-overall	0.42	0.24	0.14	0.80	0.52	0.20	0.27	0.39
log-L	252.8	315.8	305.9	248.9	299.1	291.6	227.6	210.5
N	210	191	251	150	196	191	195	126
N-economies	15	14	18	11	14	14	14	9

Note: The table shows fixed-effects panel estimation results (2001-2014) for non-dollarized economies. The dependent variable is the natural logarithm of real currency in circulation. Columns 1 and 2 compare economies with above and below median GDP (as of 2005). Columns 3 and 4 compare economies with a decrease and an increase of interest rates from 2003/04 to 2013/04. Columns 5 and 6 compare economies with above and below median monthly withdrawal frequencies. Columns 7 and 8 compare economies with above and below median number of people born in a country other than that in which they live. The estimates for the scale variable (Ln Real GDP), which are allowed to vary across economies, are not shown. Mean income elasticity refers to the sample mean of respective point estimates. All specifications exclude the Euro area, the US, Switzerland, Hong Kong and Singapore. Robust standard errors adjusted for clustering at the economy level are in parentheses. *** (**) [*] denotes significance at the 1% (5%) [10%] level. Variables are defined in the Appendix.

Table 7. The role of contractions – Semi-log

	Scale variable Ln GDP			Scale variable Ln GDP (moving avg)		
	All	All	All	All	Above median GDP	Below median GDP
	(1)	(2)	(3)	(4)	(5)	(6)
Deposit rate	-0.026***	-0.026***	-0.026***	-0.025***	-0.025***	-0.018***
	(0.007)	(0.007)	(0.007)	(0.005)	(0.007)	(0.004)
Deposit rate <1%	-0.053	-0.055	-0.051	-0.053	-0.062	
	(0.053)	(0.056)	(0.051)	(0.041)	(0.042)	
Ln Share shadow ecnmy	-0.057	-0.055	-0.072	-0.192	-0.010	-0.190
	(0.160)	(0.161)	(0.156)	(0.134)	(0.226)	(0.145)
Contraction	0.002					
	(0.008)					
GDP growth <0%		0.017				
		(0.025)				
GDP growth <0.5%			0.014			
			(0.016)			
2007	0.061**	0.060**	0.060**	0.063***	0.041	0.049
	(0.023)	(0.023)	(0.023)	(0.019)	(0.024)	(0.039)
2008	0.093**	0.092**	0.088**	0.079**	0.090*	0.015
	(0.038)	(0.037)	(0.035)	(0.032)	(0.046)	(0.057)
2009	0.093***	0.085***	0.087***	0.055	0.034	0.007
	(0.032)	(0.031)	(0.031)	(0.034)	(0.043)	(0.067)
2010	0.094**	0.091**	0.088**	0.058	0.052	-0.009
	(0.045)	(0.042)	(0.042)	(0.039)	(0.049)	(0.076)
2011	0.122**	0.120**	0.115**	0.089**	0.100*	-0.003
	(0.048)	(0.047)	(0.044)	(0.043)	(0.051)	(0.083)
2012	0.144**	0.142**	0.136**	0.113**	0.134**	-0.001
	(0.055)	(0.053)	(0.050)	(0.048)	(0.056)	(0.094)
2013	0.145**	0.143**	0.135**	0.112*	0.141*	-0.029
	(0.058)	(0.057)	(0.054)	(0.056)	(0.066)	(0.104)
2014	0.174***	0.172***	0.162***	0.132**	0.171**	-0.020
	(0.062)	(0.061)	(0.057)	(0.060)	(0.068)	(0.109)
Mean income elasticity	0.74	0.75	0.77	0.79	1.06	1.09
R2-within	0.90	0.90	0.90	0.91	0.91	0.93
R2-between	0.24	0.25	0.25	0.18	0.31	0.20
R2-overall	0.24	0.25	0.25	0.18	0.31	0.21
log-L	528.7	529.1	529.6	558.9	284.6	295.2
N	401	401	401	401	210	191
N-economies	29	29	29	29	15	14

Note: The table shows fixed-effects panel estimation results (2001-2014) for non-dollarized economies. The dependent variable is the natural logarithm of real currency in circulation. Columns 1 to 4 refer to all non-dollarized economies. Columns 5 and 6 to above and below median GDP economies. The scale variable is ln GDP in columns 1 to 3 and the 3 year moving average of ln GDP in columns 4 to 6. The estimates for the scale variables which are allowed to vary across economies are not shown. Mean income elasticity refers to the sample mean of respective point estimates. All specifications exclude the Euro area, the US, Switzerland, Hong Kong and Singapore. Robust standard errors adjusted for clustering at the economy level are in parentheses. *** (**) [*] denotes significance at the 1% (5%) [10%] level. Variables are defined in the Appendix.

Table 8. Crisis experience

	Economies without systemic banking crises			Economies with systemic banking crises before 2007 but not in 2007/08		
	Scale variable Ln GDP fix	Scale variable Ln GDP variable	Scale variable: Ln GDP (moving avg) variabel	Scale variable Ln GDP fix	Scale variable Ln GDP variable	Scale variable: Ln GDP (moving avg) variabel
	(1)	(2)	(3)	(4)	(5)	(6)
Ln GDP per capita LC	0.739**			0.492***		
	(0.251)			(0.111)		
Deposit rate	-0.006	-0.018***	-0.018***	-0.023***	-0.015***	-0.019***
	(0.010)	(0.003)	(0.005)	(0.005)	(0.004)	(0.004)
Deposit rate <1%	0.023	0.007	-0.011	-0.036	-0.003	-0.055***
	(0.045)	(0.042)	(0.031)	(0.054)	(0.021)	(0.016)
Ln Share shadow ecnmy	-0.460*	-0.128	-0.225	-0.369***	0.162	-0.106
	(0.243)	(0.120)	(0.166)	(0.112)	(0.152)	(0.187)
Contraction	0.001	-0.001	-0.002	-0.005	-0.008	-0.012**
	(0.011)	(0.010)	(0.010)	(0.008)	(0.005)	(0.005)
2007	0.034	0.047	0.066*	0.089***	0.030	0.038*
	(0.029)	(0.034)	(0.037)	(0.021)	(0.021)	(0.020)
2008	0.013	0.024	0.040	0.151***	0.088***	0.076**
	(0.034)	(0.042)	(0.051)	(0.030)	(0.029)	(0.030)
2009	0.047	0.024	0.029	0.172***	0.114***	0.061
	(0.039)	(0.039)	(0.060)	(0.025)	(0.026)	(0.036)
2010	0.032	0.006	0.014	0.165***	0.100***	0.055
	(0.035)	(0.048)	(0.070)	(0.034)	(0.029)	(0.040)
2011	0.020	0.014	0.021	0.211***	0.143***	0.103**
	(0.031)	(0.047)	(0.068)	(0.041)	(0.033)	(0.045)
2012	0.020	0.025	0.034	0.244***	0.160***	0.126**
	(0.037)	(0.055)	(0.076)	(0.053)	(0.045)	(0.054)
2013	0.013	0.005	0.017	0.275***	0.180***	0.129*
	(0.036)	(0.056)	(0.084)	(0.061)	(0.053)	(0.069)
2014	0.033	0.031	0.035	0.305***	0.212***	0.151*
	(0.045)	(0.056)	(0.085)	(0.068)	(0.062)	(0.082)
Mean income elasticity		0.77	0.69		1.18	1.22
R2-within	0.72	0.91	0.89	0.91	0.95	0.95
R2-between	0.82	0.01	0.00	0.97	0.48	0.35
R2-overall	0.83	0.01	0.00	0.96	0.48	0.35
log-L	175.6	267.6	251.9	227.8	284.8	271.9
N	163	163	163	182	182	182
N-economies	12	12	12	13	13	13

Note: The table shows fixed-effects panel estimation results (2001-2014) for non-dollarized economies. The dependent variable is the natural logarithm of real currency in circulation. Columns 1 to 3 refer to economies that did not experience a systemic banking crisis in the recent past (Laeven and Valencia, 2012). Columns 4 to 6 refer to economies that experienced a systemic banking crisis before 2007 but not in 2007/08. The scale variable is ln GDP in columns 1, 2, 4, 5 and the 3 year moving average of ln GDP in columns 3 and 6. The estimates for the scale variables which are allowed to vary across economies are not shown. Mean income elasticity refers to the sample mean of respective point estimates. All specifications exclude the Euro area, the US, Switzerland, Hong Kong and Singapore. Robust standard errors adjusted for clustering at the economy level are in parentheses. *** (**) [*] denotes significance at the 1% (5%) [10%] level. Variables are defined in the Appendix.

Appendix A.

Sources for Long Time Series

a. *Currency in circulation (CiC)*

USA

1867-1958: Friedman/Schwartz (1963), Table A-1, p 704ff, Column 1, Currency held by the public
1959-2014: Haver, Federal Reserve Board, Money Supply; Currency S111FMC@G10

AT-HU and AUT

1863-1913: OeNB CiC (Umlauf von Banknoten und Staatsnoten), Source: Jobst and Stix (2016).
1924-1937: OeNB CiC (Banknotenumlauf), Source: Jobst and Stix (2016).
1959-2001: International Financial Statistics (IFS) line 153 122“34A_N“J.

Euro area

ECB Statistical Data Warehouse (http://sdw.ecb.europa.eu/), Series BSI.M.U2.N.C.L10.X.1.Z5.0000.Z01.E: Euro area (changing composition), Outstanding amounts at the end of the period (stocks), Eurosystem reporting sector - Currency in circulation, All currencies combined - World not allocated (geographically) counterpart, Unspecified counterpart sector sector, denominated in Euro, data Neither seasonally nor working day adjusted. This series is only available back until 1997. Values from 1980 to 1996 were constructed using annual growth rates of series BSI.M.U2.Y.V.L10.X.1.U2.2300.Z01.E (Euro area (changing composition), Outstanding amounts at the end of the period (stocks), MFIs, central government and post office giro institutions reporting sector - Currency in circulation).

GBR

1870-2015: Hill et al. (2015) Notes and coins in circulation – spliced series.

DEU

1876–1975: Deutsche Bundesbank (1976)
1976–1997: Deutsche Bundesbank (1998).

CHE

1880-1993: Mitchell (2003).
1994-2015: IFS line 14a (Currency in circulation).

b. Nominal GDP

USA

1875-1928: constructed using GDP level from 1929 (see below) and GNP growth rates from Gordon (1986, Appendix B) (http://www.nber.org/data/abc/, accessed 17 April 2014).
1929-2014: Bureau of Economic Analysis Last Revised on: March 27, 2014 (http://www.bea.gov/national/index.htm#gdp, accessed April 17 2014)

AT-HU and AUT

1870-1937: Jobst and Scheiber (2014) and the sources cited therein.
1946-2014: Volkswirtschaftliche Datenbank (AUT;VDBHZBIPNOM-EUR;1946;A;Z5).

EUR

New Cronos Database, Gross Domestic Product at Market Prices, Euro area in changing composition (EA11-2000, EA12-2006, EA13-2007, EA15-2008, EA16-2010, EA17-2013, EA18) Series AMQ_GDP_C.S_ADJ.SWDA.UNIT.MIO_EUR.INDIC_NA.B1GM.GEO.EA.

GBR

1870–2015: Hill et al. (2015) Composite estimate of nominal GDP at market prices £mn - no break-adjustment for Ireland.

DEU

1876–1975: Deutsche Bundesbank (1976)
1976–1997: Deutsche Bundesbank (1998).

CHE

1861-1993: Halbeisen and Müller (2012).
1994-2015: IFS line 99b (Gross Domestic Product SA).

References for Data Sources:

Anderson, R.G. (2003). Some Tables of Historical U.S. Currency and Monetary Aggregates Data, Working Paper 2003-006A, Federal Reserve Bank of St. Louis.
Deutsche Bundesbank (1976). Deutsches Geld- und Bankwesen in Zahlen. 1876–1975. Frankfurt: Knapp.
Deutsche Bundesbank (1998). 50 Jahre Deutsche Mark. Monetäre Statistiken von 1948 bis 1997. CD-ROM. Munich: Beck.
Friedman, M. and A. J. Schwartz (1963). A Monetary History of the United States, 1867–1960. Princeton University Press for NBER.
Gordon, R. J. (1986). National Bureau of Economic Research Studies in Business Cycles Volume 25, University of Chicago Press.

Halbeisen, P. and Müller, M. (2012). Wirtschaftsgeschichte der Schweiz im 20. Jahrhundert, Basel: Schwabe, http://www.fsw.uzh.ch/hstat/nls_rev/overview.php (accessed June 13 2017).
Hills, S, Thomas, R and Dimsdale, N (2015) "Three Centuries of Data - Version 2.2", Bank of England.
Jobst, C. and Stix, H. (2016). "Florin, crown, schilling and euro: an overview of 200 years of cash in Austria", *Monetary Policy & the Economy* Q3, 94–119.
Mitchell, Brian R. (2003). International historical statistics - Europe: 1750 – 2000, 5th edition. Basingstoke: Palgrave Macmillan.
OeNB (1990–2004). Statistisches Monatsheft. Oesterreichische Nationalbank, Vienna.
US Bureau of the Census (1975), Bicentennial Edition, Washington, D.C.

Appendix B. Panel Data for 2001 to 2014

The countries were selected as follows: We select the 80 largest economies of the world in terms of 2010 GNI in PPP-USD (the euro area with 19 Member States is counted as one economy). From this list we delete several economies (i) due to missing data, (ii) crisis or war, (iii) because they are officially dollarized (Cuba, Sudan, Tunisia, Yemen, Afghanistan, Libya, Ecuador, Puerto Rico, Panama). Then we add (1) all European & Central Asian economies that have not been included yet (except those for which data are unavailable – Uzbekistan, Turkmenistan, Kosovo, Montenegro) and (2) the 15 richest Latin American & Caribbean economies (if not already included before) and (3) the 10 richest African economies (again if not already included before). This sample comprises 85 economies or 101 countries (if each euro area member is counted separately).

We separate the sample into non-dollarized and dollarized economies. Dollarized economies are defined from Nicoló, Honohan and Ize (2006). The group of non-dollarized economies is further separated into (i) OECD economies and (ii) non-OECD economies.

The data comprise the following economies (ranked by their 2010 value of GDP per capita in PPP-USD).

Non-dollarized OECD economies (22 economies): Norway (NOR), Switzerland (CHE), United States (USA), Denmark (DNK), Sweden (SWE), Australia (AUS), Canada (CAN), Iceland (ISL), United Kingdom (GBR), Euro area (EUR), Japan (JPN), New Zealand (NZL), South Korea (KOR), Israel (ISR), Czech Republic (CZE), Hungary (HUN), Poland (POL), Chile (CHL), Mexico (MEX), South Africa (ZAF), Colombia (COL), China (CHN).

Non-dollarized non-OECD economies (23 economies): Qatar (QAT), Kuweit (KWT), Singapore (SGP), Oman (OMN), Hong Kong (HKG), Saudi Arabia (SAU), Malaysia (MYS), Venezuela (VEN), Brazil (BRA), Thailand (THA), Algeria (DZA), Costa Rica (CRI), Jordan (JOR), Dominican Republic (DOM), Sri Lanka (LKA), Guatemala (GTM), Morocco (MAR), India (IND), Cote d'Ivoire (CIV), Cameroon (CMR), Bangladesh (BGD), Nepal (NPL), Ethiopia (ETH).

Dollarized economies (40 economies): Russia (RUS), Croatia (HRV), Kazakhstan (KAZ), Romania (ROU), Turkey (TUR), Uruguay (URY), Lebanon (LBN), Azerbaijan (AZE), Belarus (BLR), Bulgaria (BGR), Serbia (SRB), Macedonia (MKD), Egypt (EGY), Peru (PER), Albania (ALB), Bosnia and Herzegovina (BIH), Indonesia (IDN), Ukraine (UKR), Angola (AGO), Paraguay (PRY), Armenia (ARM), Georgia (GEO), Philippines (PHL), Bolivia (BOL), Nigeria (NGA), Vietnam (VNM), Pakistan (PAK), Moldova (MDA), Ghana (GHA), Kyrgyzstan (KGZ), Tajikistan (TJK), Kenya (KEN), Tanzania (TZA), Uganda (UGA). The following six economies are included in the sample, however no PPP rates are available: Argentina (ARG), Lithuania (LTU), Estonia (EST), Slovak Republic (SVK), Latvia (LVA), Slovenia (SVN).

For all aggregations and descriptive statistics we use the broadest set of economies for which we have data (on GDP, CiC and exchange rates). For the estimations, several other restrictions apply which reduce the sample size: (i) we exclude the following oil producing economies: Angola, Azerbaijan, Kazakhstan, Kuwait, Nigeria, Oman, Qatar, Saudi Arabia, Venezuela. (ii) Moreover, we include only economies where currency in circulation is recorded for 2008 (which excludes those economies which joined the euro between 2001 and

2008) and (iii) we exclude all observations with short-term interest rates above or equal to 25% and (iv) economies with missing information on some explanatory variables. The final estimation sample comprises 64 economies, of which we eliminate six economies. This gives the final estimation sample (cf. footnote 5).

Variable Description (Data 2001 -2014):

"Currency in circulation": Currency in circulation includes paper currency and coin held both by the public and in the vaults of depository institutions. For several countries only "currency outside banks" is available. Source: For the majority of economies, International Financial Statistics line 14. For few economies, national Central Banks. "Real Currency in circulation" constructed using "GDP deflator".

"Gross Domestic Product": Series in current prices and local currency units taken from International Financial Statistics (line 99B). Conversion to USD and PPP-USD using "Exchange rate per USD" and "PPP conversion rate". "Real GDP" constructed using "GDP deflator". In some estimations, the three year moving average is employed instead of period GDP.

"GDP deflator": From World Bank (World Development Indicators), NY.GDP.DEFL.ZS. As the base year of the World Bank GDP deflator varies by country, each individual series was rebased to 2006.

"Deposit rate": Series taken from World Bank (World Development Indicators): "Deposit interest rate is the rate paid by commercial or similar banks for demand, time, or savings deposits. The terms and conditions attached to these rates differ by country, however, limiting their comparability" (FR.INR.DPST). For OECD economies, we use the series short term interest rate (STINT) [OECD (2016), Short-term interest rates (indicator). doi: 10.1787/2cc37d77-en (Accessed on 06 April 2016)]. For EUR we use the ECBs series MIR.M.U2.B.L23.D.R.A.2250.EUR.N (Deposits redeemable at notice, up to 3 months period of notice, New business coverage, Households and non-profit institutions serving households.

"Exchange rate per USD": Official exchange rate. Source: International Financial Statistics, line _AF.

"PPP conversion rate": From World Bank (World Development Indicators), PA.NUS.PPPC.RF. "Purchasing power parity conversion factor is the number of units of a country's currency required to buy the same amounts of goods and services in the domestic market as U.S. dollar would buy in the United States. This conversion factor is for GDP. For most economies PPP figures are extrapolated from the 2011 International Comparison Program (ICP) benchmark estimates or imputed using a statistical model based on the 2011 ICP". For the Euro area, the PPP rate is calculated from the ECB's Statistical Data Warehouse series ESA.A.I7.N.0000.B1QPPS.1000.TTTT.X.S.A.

"Inflation rate": Inflation rate, consumer prices. From World Bank (World Development Indicators), FP.CPI.TOTL.ZG.

"Population": From World Bank (World Development Indicators) SP.POP.TOTL.

"Systemic banking crisis": Information about the occurrence of systemic banking crises is from Laeven, L. and Valencia, F. (2012). "Systemic banking crises database: An update". IMF Working Papers No. 12/163.

"Shadow economy": Estimate of the size of the shadow economy in percent of official GDP. Data from Schneider (2017). The indictor is based on a MIMIC tye model (Schneider, 2015) however with the adaptation that currency in circulation is not used as an input for its calculation. The concept of shadow economy that is employed here includes "all market-based legal production of goods and services that are deliberately concealed from public authorities to avoid payment of income, value added or other taxes; to avoid payment of social security contributions; having to meet certain legal labour market standards, such as minimum wages, maximum working hours, safety standards, etc; and complying with certain administrative procedures, such as completing statistical questionnaires or administrative forms" (Schneider, Buehn and Montenegro, 2015, p. 444).

The following variables are used to separate groups of economies:

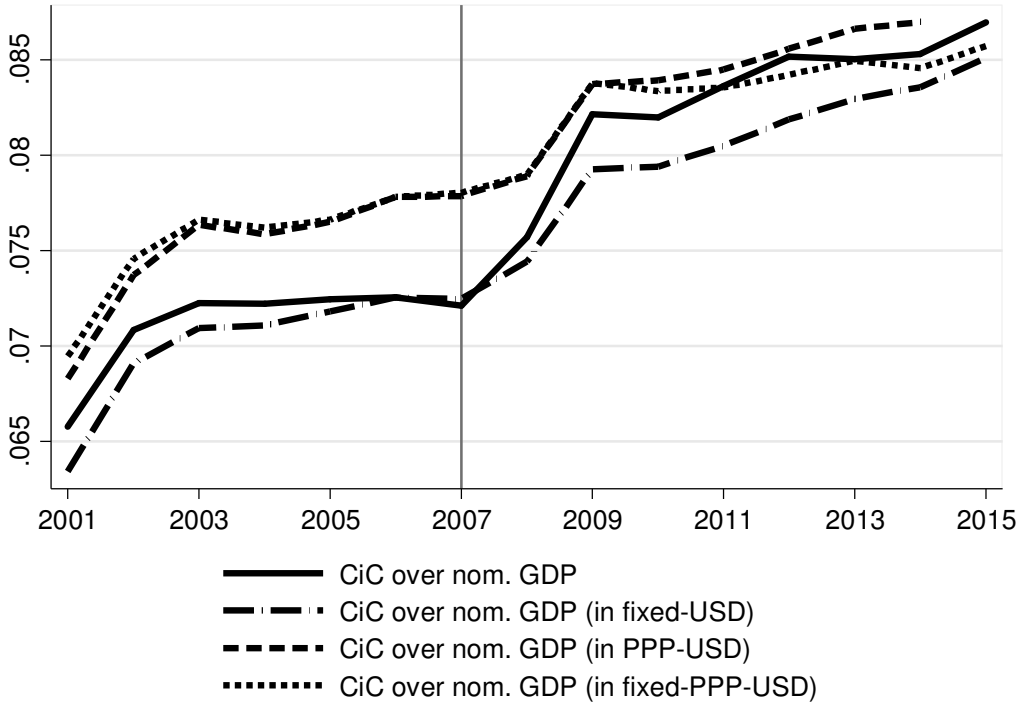
"Above/below median GDP": Economies are grouped according to the median of the 2005 value of per capita GDP (in US dollars).

"Above/below median withdrawal frequency": Economies are grouped according to the median number of withdrawals from accounts per country ("In a typical month, about how many times is money taken out of your personal account(s)? This includes cash withdrawals, electronic payments or purchases, checks, or any other time money is removed from your account(s) by yourself or others"). Respondents without an account were assigned a value of zero. The respective results refer to the year 2011. Source: World Bank FINDEX database.

"Above/below median migrants": Economies are grouped according to the median of the 2012 value of international migrant stock. This variable refers to the number of people born in a country other than that in which they live, which also includes refugees. Source: World Bank (SM.POP.TOTL.ZS).

Appendix C. Additional Figures

Figure 8. "World" currency in circulation over nominal GDP (in %) – Different exchange rates

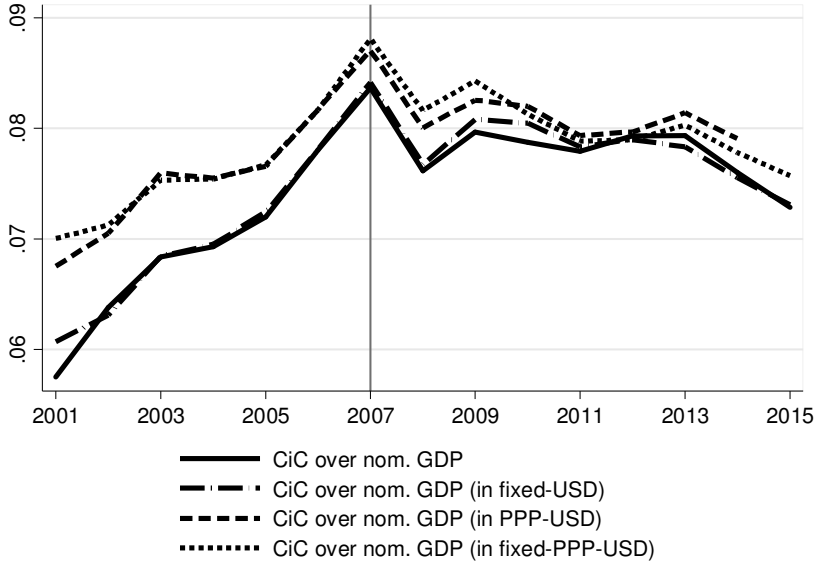


Note: The figure shows the ratio of currency over nominal GDP for all economies ("World") for several exchange rates. To analyze whether the exchange rate that is used in the aggregation across economies, only those ecoomies are included in the calculation for which all required variables are oberved over the entire period. For this reason the figure may deviate from Figure 5. Variables are described in the Appendix.

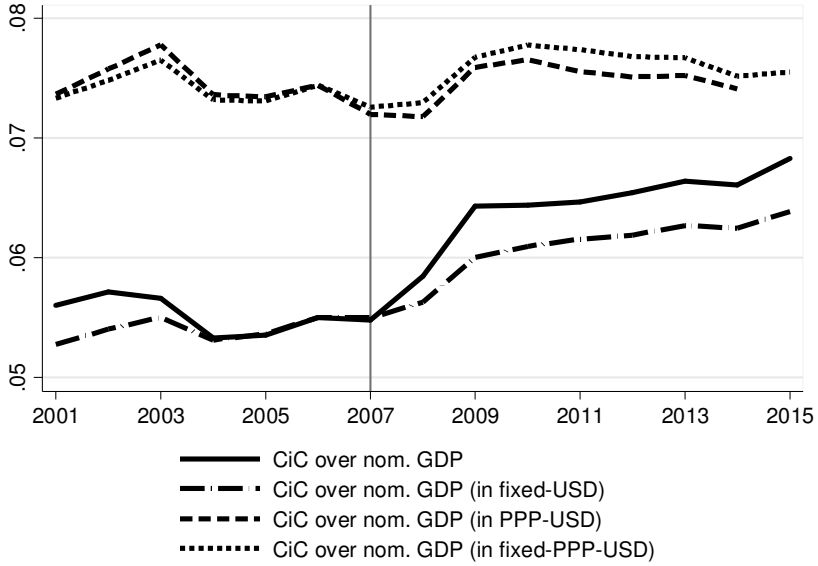
Supplement (not for publication)

Figure S1. Currency in Circulation over Nominal GDP (in %) for Groups of Economies - Different exchange rates

Panel A. Dollarized economies

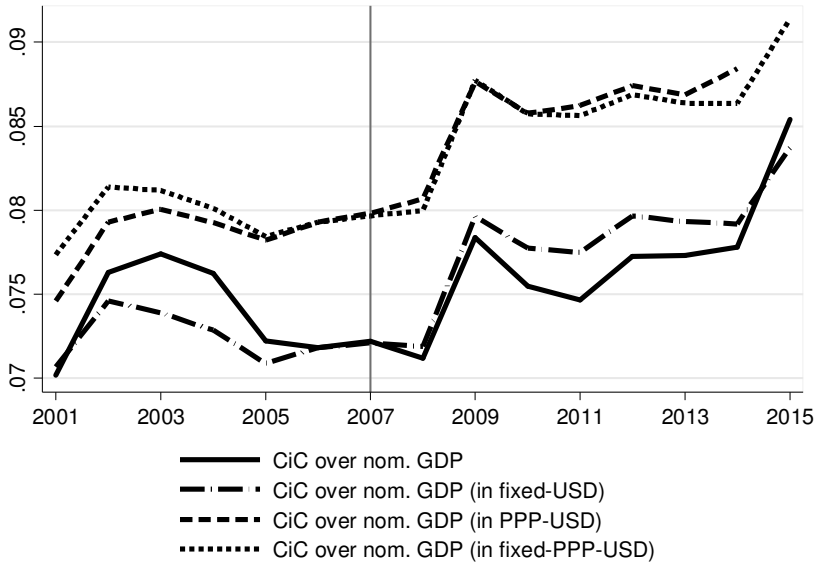


Panel B. Non-Dollarized, OECD (without JPN)

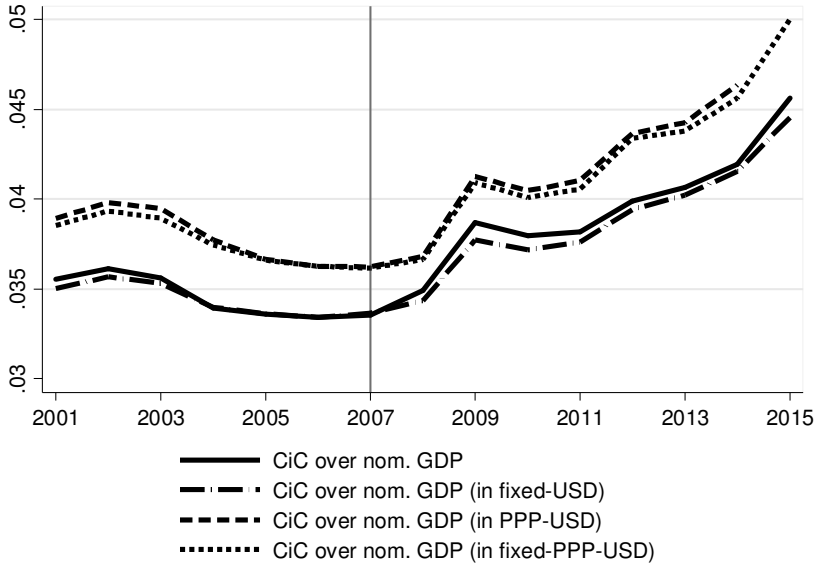


Note: See continuation.

Panel C. Non-Dollarized, non-OECD

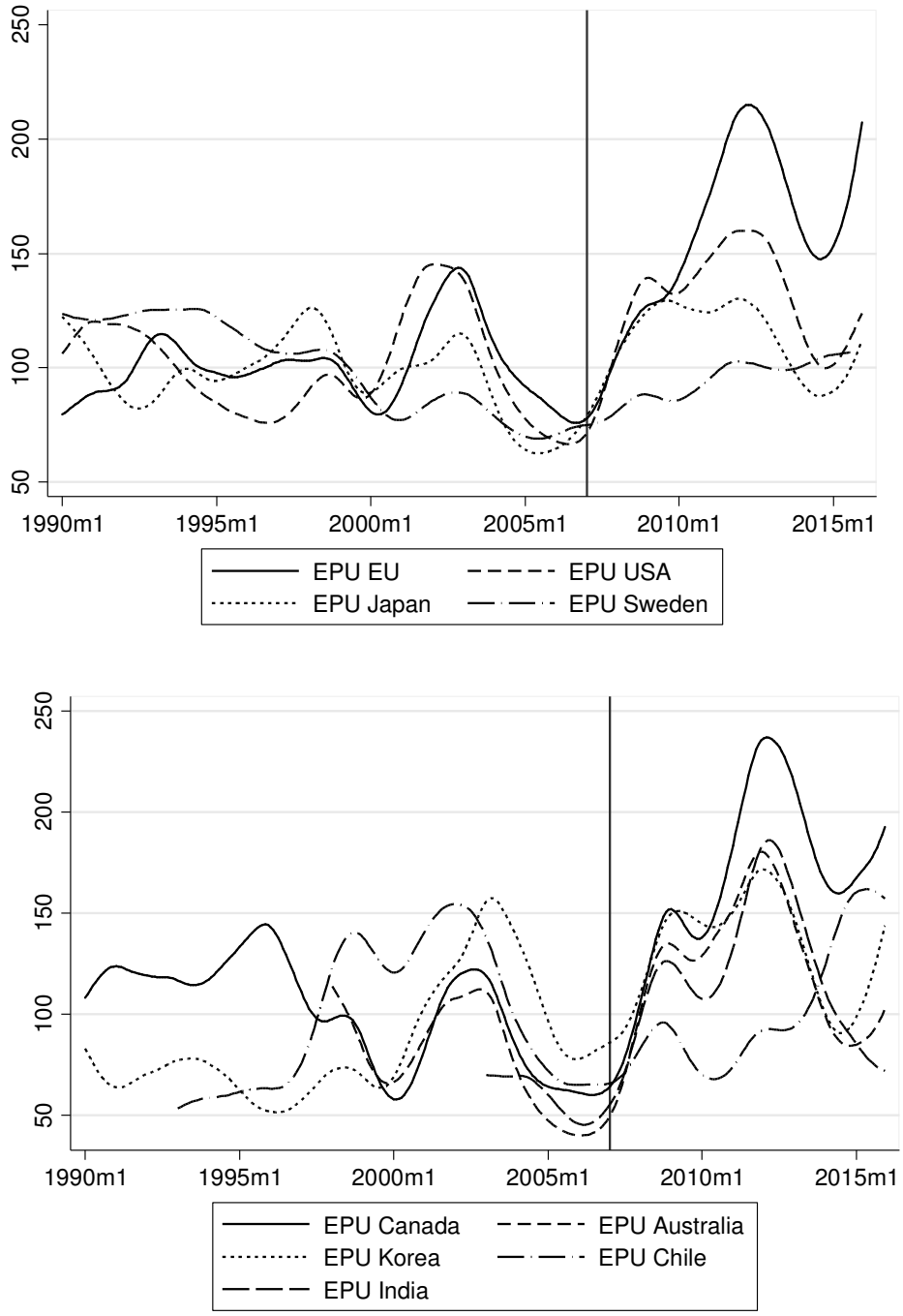


Panel D. High Income without USA, EUR, CHE and JPN



Note: The figure shows the ratio of currency over nominal GDP for all economies ("World") for several exchange rates. To analyze whether the exchange rate that is used in the aggregation across economies, only those ecoomies are included in the calculation for which all required variables are oberved over the entire period. For this reason the figure may deviate from Figure 6. Variables are described in the Appendix.

Figure S2. Economic Policy Uncertainty



Note: The figure shows news-based economic policy uncertainty indices. The original monthly series was HP filtered. Source for most economies: Baker Scott R., Bloom Nicholas and Davis, Steven J. "Measuring Economic Policy Uncertainty". Sweden: Armelious Hanna, Hull Isaiah and Stenbacka Köhler Hanna, "The Timing of Uncertainty Shocks in a Small Open Economy," Sveriges Riksbank Working Paper 334, December 2016. All series from www.PolicyUncertainty.com (accessed April 2017).

.

Table 6S. Results for sub-samples – Log-log

	Above median GDP	Below median GDP	Interest rate decline	Interest rate increase	Above median withdrawal frequency	Below median withdrawal frequency	Above median share migrants	Below median share migrants
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln Deposit rate	-0.034	-0.087***	-0.096***	-0.044	-0.057**	-0.085**	-0.040*	-0.138**
	(0.028)	(0.025)	(0.027)	(0.025)	(0.026)	(0.037)	(0.021)	(0.047)
Ln Deposit rate <1%	0.094*		0.271***	0.047	0.093**		0.233**	0.118**
	(0.052)		(0.089)	(0.027)	(0.035)		(0.093)	(0.043)
Ln Share shadow ecnmy	0.230	-0.066	-0.026	-0.103	0.207	-0.050	-0.046	0.133
	(0.288)	(0.123)	(0.215)	(0.210)	(0.190)	(0.153)	(0.264)	(0.160)
2007	0.024	0.036	0.073***	0.011	0.014	0.066*	0.045	0.095***
	(0.027)	(0.033)	(0.025)	(0.016)	(0.027)	(0.033)	(0.028)	(0.027)
2008	0.084*	0.011	0.116**	0.002	0.043	0.063	0.076	0.102**
	(0.044)	(0.041)	(0.041)	(0.026)	(0.033)	(0.046)	(0.046)	(0.040)
2009	0.112**	0.020	0.112**	0.046	0.053**	0.075	0.108*	0.098**
	(0.040)	(0.039)	(0.047)	(0.033)	(0.020)	(0.050)	(0.055)	(0.036)
2010	0.133*	0.005	0.122	0.029	0.038	0.072	0.141	0.113**
	(0.069)	(0.045)	(0.071)	(0.032)	(0.031)	(0.054)	(0.089)	(0.034)
2011	0.171**	0.015	0.148*	0.045	0.077*	0.084	0.181*	0.128**
	(0.071)	(0.051)	(0.071)	(0.044)	(0.037)	(0.063)	(0.088)	(0.044)
2012	0.201**	0.012	0.179**	0.037	0.095**	0.100	0.225**	0.136**
	(0.075)	(0.060)	(0.076)	(0.055)	(0.040)	(0.075)	(0.095)	(0.049)
2013	0.235**	-0.013	0.200**	0.040	0.117**	0.090	0.271**	0.131*
	(0.081)	(0.061)	(0.090)	(0.058)	(0.052)	(0.085)	(0.112)	(0.059)
2014	0.281***	0.001	0.247**	0.045	0.149**	0.120	0.312**	0.136*
	(0.081)	(0.062)	(0.095)	(0.064)	(0.061)	(0.090)	(0.112)	(0.070)
Mean income elasticity	1.02	1.06	0.65	1.11	1.25	0.76	0.56	0.93
R2-within	0.86	0.95	0.87	0.94	0.92	0.93	0.84	0.95
R2-between	0.23	0.22	0.13	0.79	0.42	0.23	0.34	0.36
R2-overall	0.23	0.22	0.13	0.80	0.41	0.23	0.34	0.36
log-L	238.8	314.5	291.7	247.0	298.5	288.3	222.3	209.8
N	210	191	251	150	196	191	195	126
N-economies	15	14	18	11	14	14	14	9

Note: The table shows fixed-effects panel estimation results (2001-2014) for non-dollarized economies. The dependent variable is the natural logarithm of real currency in circulation. Columns 1 and 2 compare economies with above and below median GDP (as of 2005). Columns 3 and 4 compare economies with a decrease and an increase of interest rates from 2003/04 to 2013/04. Columns 5 and 6 compare economies with above and below median monthly withdrawal frequencies. Columns 7 and 8 compare economies with above and below median number of people born in a country other than that in which they live. The estimates for the scale variable (Ln Real GDP), which are allowed to vary across economies, are not shown. Mean income elasticity refers to the sample mean of respective point estimates. All specifications exclude the Euro area, the US, Switzerland, Hong Kong and Singapore. Robust standard errors adjusted for clustering at the economy level are in parentheses. *** (**) [*] denotes significance at the 1% (5%) [10%] level. Variables are defined in the Appendix.

Table 7S. The role of contractions – Log-log

	Scale variable Ln GDP			Scale variable Ln GDP (moving avg)		
	All	All	All	All	Above median GDP	Below median GDP
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Deposit rate	-0.080***	-0.081***	-0.082***	-0.086***	-0.054	-0.086***
	(0.021)	(0.021)	(0.021)	(0.023)	(0.032)	(0.028)
Ln Deposit rate <1%	0.127**	0.126**	0.129**	0.133*	0.132	
	(0.053)	(0.051)	(0.053)	(0.071)	(0.076)	
Ln Share shadow ecnmy	-0.057	-0.056	-0.065	-0.204	-0.079	-0.172
	(0.159)	(0.159)	(0.156)	(0.139)	(0.214)	(0.158)
Contraction	-0.004					
	(0.006)					
GDP growth <0%		0.009				
		(0.021)				
GDP growth <0.5%			0.007			
			(0.013)			
2007	0.050**	0.050**	0.050**	0.057***	0.027	0.050
	(0.021)	(0.021)	(0.021)	(0.019)	(0.025)	(0.040)
2008	0.075**	0.072**	0.070**	0.063*	0.064	0.009
	(0.034)	(0.033)	(0.032)	(0.031)	(0.042)	(0.057)
2009	0.087**	0.080**	0.081**	0.047	0.046	-0.003
	(0.034)	(0.030)	(0.032)	(0.035)	(0.039)	(0.067)
2010	0.090*	0.090*	0.089*	0.057	0.071	-0.014
	(0.050)	(0.049)	(0.048)	(0.044)	(0.053)	(0.075)
2011	0.118**	0.116**	0.114**	0.086*	0.116*	-0.011
	(0.055)	(0.053)	(0.051)	(0.049)	(0.057)	(0.083)
2012	0.137**	0.134**	0.132**	0.106*	0.147**	-0.010
	(0.061)	(0.058)	(0.057)	(0.056)	(0.064)	(0.094)
2013	0.144**	0.142**	0.139**	0.112	0.184**	-0.041
	(0.067)	(0.064)	(0.062)	(0.067)	(0.076)	(0.104)
2014	0.172**	0.170**	0.165**	0.132*	0.216**	-0.035
	(0.070)	(0.068)	(0.065)	(0.071)	(0.079)	(0.107)
Mean income elasticity	0.80	0.81	0.82	0.81	0.86	1.18
R2-within	0.89	0.89	0.89	0.90	0.89	0.93
R2-between	0.20	0.21	0.21	0.12	0.08	0.19
R2-overall	0.20	0.21	0.21	0.12	0.08	0.20
log-L	503.3	503.3	503.4	530.9	267.2	292.8
N	401	401	401	401	210	191
N-economies	29	29	29	29	15	14

Note: The table shows fixed-effects panel estimation results (2001-2014) for non-dollarized economies. The dependent variable is the natural logarithm of real currency in circulation. Columns 1 to 4 refer to all non-dollarized economies. Columns 5 and 6 to above and below median GDP economies. The scale variable is ln GDP in columsn 1 to 3 and the 3 year moving average of ln GDP in columns 4 to 6. The estimates for the scale variables which are allowed to vary across economies are not shown. Mean income elasticity refers to the sample mean of respective point estimates. All specifications exclude the Euro area, the US, Switzerland, Hong Kong and Singapore. Robust standard errors adjusted for clustering at the economy level are in parentheses. *** (**) [*] denotes significance at the 1% (5%) [10%] level. Variables are defined in the Appendix.

Table 9S. Crisis experience – Log-log specification

	Economies without systemic banking crises			Economies with systemic banking crises before 2007 but not in 2007/08		
	Scale variable Ln GDP fix	Scale variable Ln GDP variable	Scale variable: Ln GDP (moving avg) variabel	Scale variable Ln GDP fix	Scale variable Ln GDP variable	Scale variable: Ln GDP (moving avg) variabel
	(1)	(2)	(3)	(4)	(5)	(6)
Ln GDP per capita LC	0.752**			0.566***		
	(0.247)			(0.133)		
Ln Deposit rate	-0.051	-0.091***	-0.096***	-0.131***	-0.061**	-0.067**
	(0.042)	(0.022)	(0.025)	(0.041)	(0.026)	(0.029)
Ln Deposit rate <1%	0.093	0.227	0.244**	0.127**	0.067**	0.059
	(0.197)	(0.135)	(0.098)	(0.045)	(0.029)	(0.056)
Ln Share shadow ecnmy	-0.459*	-0.141	-0.239	-0.208	0.218	-0.044
	(0.241)	(0.117)	(0.155)	(0.140)	(0.159)	(0.229)
Contraction	0.000	-0.003	-0.005	-0.007	-0.010*	-0.016***
	(0.011)	(0.009)	(0.010)	(0.008)	(0.006)	(0.005)
2007	0.035	0.044	0.063	0.099***	0.027	0.033
	(0.029)	(0.034)	(0.036)	(0.024)	(0.020)	(0.021)
2008	0.011	0.018	0.031	0.160***	0.080**	0.064*
	(0.033)	(0.042)	(0.051)	(0.032)	(0.029)	(0.034)
2009	0.043	0.020	0.021	0.148***	0.104***	0.045
	(0.039)	(0.038)	(0.059)	(0.028)	(0.029)	(0.044)
2010	0.027	0.003	0.005	0.151***	0.091**	0.043
	(0.035)	(0.046)	(0.068)	(0.039)	(0.033)	(0.051)
2011	0.010	0.004	0.004	0.217***	0.136***	0.094
	(0.031)	(0.045)	(0.068)	(0.045)	(0.037)	(0.058)
2012	0.009	0.012	0.014	0.246***	0.152***	0.110
	(0.037)	(0.054)	(0.075)	(0.057)	(0.047)	(0.070)
2013	0.001	-0.009	-0.005	0.270***	0.170**	0.111
	(0.036)	(0.055)	(0.084)	(0.064)	(0.057)	(0.091)
2014	0.020	0.019	0.014	0.294***	0.198**	0.126
	(0.045)	(0.052)	(0.083)	(0.068)	(0.067)	(0.108)
Mean income elasticity		0.78	0.74		1.29	1.38
R2-within	0.72	0.91	0.89	0.91	0.95	0.94
R2-between	0.82	0.03	0.01	0.97	0.46	0.32
R2-overall	0.83	0.03	0.01	0.97	0.45	0.32
log-L	176.8	267.9	252.6	225.5	280.8	263.4
N	163	163	163	182	182	182
N-economies	12	12	12	13	13	13

Note: The table shows fixed-effects panel estimation results (2001-2014) for non-dollarized economies. The dependent variable is the natural logarithm of real currency in circulation. Columns 1 to 3 refer to economies that did not experience a systemic banking crisis in the recent past (Laeven and Valencia, 2012). Columns 4 to 6 refer to economies that experienced a systemic banking crisis before 2007 but not in 2007/08. The scale variable is ln GDP in columns 1, 2, 4, 5 and the 3 year moving average of ln GDP in columns 3 and 6. The estimates for the scale variables which are allowed to vary across economies are not shown. Mean income elasticity refers to the sample mean of respective point estimates. All specifications exclude the Euro area, the US, Switzerland, Hong Kong and Singapore. Robust standard errors adjusted for clustering at the economy level are in parentheses. *** (**) [*] denotes significance at the 1% (5%) [10%] level. Variables are defined in the Appendix.