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Measurement and Use of Cash by Half the World's Population

Tanai Khiaonarong and David Humphrey

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WORKING PAPER

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Monetary and Capital Markets Department

**Measurement and Use of Cash by Half the World's Population
Prepared by Tanai Khiaonarong and David Humphrey***Authorized for distribution by Tommaso Mancini Griffoli
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ABSTRACT: The use of cash for payments is not well measured. We view the value of cash withdrawn from ATMs, or as a share of all payments, as a more accurate and timely measure of cash use compared to the standard measure of currency in circulation, or as a ratio to GDP. These two measures are compared for 14 advanced and emerging market economies. When aggregated, the trend in cash use for payments is currently falling for half the world's population. Such a measure can help inform policy decisions regarding CBDC and regulatory decisions concerning access to and use of cash.

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WORKING PAPERS

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1. Introduction

The history of payments in any country is one of a particular instrument replacing another or, if failing to do so, dropping from the mix. It is no surprise that physical cash, check, and paper giro-type payments have been and are continuing to be replaced by electronic instruments in many countries, by automated clearing house and electronic giro-type transactions, along with payment cards and instant (or fast) payments (Bech and Hancock, 2020; Khiaonrong and Humphrey, 2022). All but cash payments appear to be reasonably well measured at the national level.

An improved measure of cash use for payments would provide policy makers with more accurate and timely information for assessing the performance of a country's payment system in meeting user needs and cost efficiency. If user needs are fully met with the current mix of payment instruments on offer, payment shares should be stable and indicate that, given the benefits from using different payment instruments, cost efficiency is met as well. A declining share of cash, however, suggests that neither goal is currently achieved.

This paper does three things. In Section 2, we note emerging regulatory developments associated with access to cash in some countries and acceptance of cash for payments at the point of sale. This development can be more accurately monitored. The standard way of measuring cash use is currency in circulation or currency in circulation as a ratio to GDP. The alternative suggested here is the value of cash withdrawn from a country's ATMs, or as a share of total payments (excluding large value wire or credit transfers).

In Section 3, these two measures are contrasted for 14 countries. Often, one measure is rising while the other is falling. Or, if both are moving in the same direction, one is rising or falling faster than the other. This illustrates the degree to which one measure may be more accurate and timelier than the other in measuring the use of cash for payments.

In Section 4, local currency payment values of both measures for all countries are transformed into purchasing power parity (PPP) US dollars. This allows us to assess differences in cash use for payments among economies at different levels of development using a common metric. When these PPP cash values are summed across all users in 14 countries, the trend in cash use for payments (cash withdrawn from ATMs) is shown for half the world's population. This measure of cash use per adult rose from 2005, reached a peak in 2017, but falls thereafter. This occurs in absolute terms and as a payment share. The results for the standard measure of cash use (currency in circulation) do not reach a peak and do not fall over this period. Conclusions are in Section 5 and Annex I presents some country comparisons not shown in the body of the paper.

2. Regulatory and Measurement Issues Concerning Cash Use

2.1 Access to Cash and Acceptance for Payments

The supply side of the level of currency in circulation (CIC) in a country is determined by the government, involving the central bank, the treasury (which receives seigniorage revenue), and specialized printers. The demand side of CIC concerns how the population chooses to spread currency and coin across three general activities: (1) ATM cash withdrawals that are typically used for payments that are known and legal; (2) cash used for hoarding, which are not payments and has little circulation; and (3) circulated cash used

for unknown transactions involving corruption, tax avoidance, other illegal domestic transactions, and transactions using domestic currency in another country. While ATM cash withdrawals are known, some unknown amount will include activities (2) and (3). This represents an inevitable bias when (1) is used to represent the value of cash for payments. We believe this bias is less than the bias of using all of CIC for payments and is the reason that we prefer to focus on ATM cash rather than CIC when choosing to measure the use of cash for payments.

The different uses of CIC have implications for regulatory authorities concerning banknote management and fitness, criminal use of cash, access to cash for individuals without bank accounts, bank cost of providing cash to depositors, and business costs from accepting cash. Access to cash and cash acceptance has become an issue in some countries. Here falling demand for cash for purchases has led in a few countries to reduced access to cash from banks. When cash use is very low, banks have responded by reducing their ATM networks and, in some cases, even consolidating a few of their branch offices to save costs. Outsourcing of cash services by banks to other entities has also occurred as a cost saving measure. At the same time, and for much the same reasons, some merchants have sought to reduce their costs from having to accept cash. However, as the expense of providing or accepting cash have certain fixed cost elements, significant reductions in the provision or acceptance of cash do not always lead to proportional reductions in expense.

Some examples of regulatory efforts to preserve access to and acceptance of cash for payments are noted below.¹

Netherlands. The Dutch central bank has set 3,850 ATMs as the minimum number in the country to ensure adequate access to cash services (De Nederlandsche Bank, 2020). The central bank also entered into a (non-regulatory) agreement between representatives from banks, retailers, and consumers relating to cash deposits, cash withdrawals and the acceptance of cash by retailers.

Norway. Amendments to existing financial institution regulations clarify the obligation of banks to enable customers to deposit and withdraw cash, either directly at ATMs/banks or through an arrangement with other cash service providers (Norges Bank, 2022). In addition, the government, with the support of the central bank, plans to assess the future role of cash in the event of natural disasters or situations where merchants may wish to only receive non-cash payments.

Sweden. Rules were established ensuring an “adequate” geographic coverage of ATMs along with an amendment to the Swedish Act on Payment Services obligating the six largest banks to provide certain cash services to ensure a minimum level of access to cash for consumers and companies (Sveriges Riksbank, 2021). Banks providing consumer deposit accounts are also obliged to supply places for cash withdrawals. The Swedish Post and Telecom Agency was tasked with banks’ compliance while the Swedish Financial Supervisory Authority could intervene with injunctions or penalties in cases of non-compliance.

Switzerland. Rules are in place to ensure adequate geographic coverage of ATMs for cash withdrawals.

United Kingdom. Legislation was passed to enable the widespread adoption of cash-back at the POS without a purchase as part of the Financial Services Act 2021 (HM Treasury, 2022). As well, the Financial Conduct Authority will have new authority to ensure that cash withdrawal and deposit facilities are available in all communities across the country. The UK Payment Systems Regulator also issued a Special Directive to ensure a broad geographic coverage of free-to-use ATMs (Payment Systems Regulator, 2021). As of December 2022, the Bank of England issued a consultation on its market oversight and prudential supervision of wholesale cash distribution (Bank of England, 2022).

¹ A study of access and acceptance of cash across 23 countries illustrates how countries have addressed this issue (Euro Retail Payments Board, 2021).

United States. A number of large cities have made it unlawful for retailers to refuse to accept cash for payment or from charging cash-paying customers a higher price compared to non-cash customers (Tarlin, 2021). In addition, several states have introduced pro-cash legislation to make it illegal for businesses to refuse to accept cash, and similar legislation is pending at the federal level.

If cash positions reach low levels in other countries, similar regulations, rules, or voluntary agreements among providers and acceptors of cash payments may spread. It may thus be useful to have a good indicator of cash use for payments to monitor this situation.

2.2 Two Measures of Cash Use for Payments

Currency in circulation (CIC), or the ratio of CIC to the level of domestic economic activity as indicated by GDP, has been the standard way of monitoring the use of or demand for cash. In a recent paper, Ashworth and Goodhart (2020) show that the demand for cash has fallen from its highest level of use in the late 1940s, flattened out during the 1980s, but more recently reversed course and rose steadily after the early 2000s for a selected group of countries: the Euro Area, Japan, the UK and US. More recent information on how currency in circulation to GDP has varied across a broader selection of advanced and emerging market countries is provided by Bech, et al. (2018). They find that this ratio rose for 20 out of the 25 countries they covered. The ratio only fell in 5 countries: China, Norway, Russia, South Africa, and Sweden.

Our alternative to the standard measure of cash—cash withdrawn at ATMs in a country—focuses on the use of cash for payments leaving other uses (hoarding and illegal use) aside.² When ATM cash withdrawals are expressed as a ratio to the total value of all payments in a country (excluding large value wire or credit transfers), it is conceptually similar to the standard measure of the ratio of CIC to GDP. The production of GDP includes small (retail) as well as large value (wholesale) credit transfer payments. However, wire transfers in the Euro Area and the US are more than 15 times larger than the value of all other payment instruments. Including wire transfers would distort cross-country comparisons of cash use. Unfortunately, small and large value credit transfers are not separately available in the BIS payment data we use, so both are excluded from our ratio measure.

Other measures of cash use do exist. Amromin and Chakravorti (2009) recognized that most cash is used for lower value purchases and focused on the ratio of coin and lower value currency denominations (small CIC) to GDP for 13 advanced economies. Additional countries were covered by Bech, et al. (2018) and Arango-Arango and Suarez-Ariza (2020). Use of small CIC attempts to separate the stock of cash used mostly for purchases, from cash held as a precautionary reserve, held overseas, or used to facilitate illegal activities. This benefit is similar to our use of cash withdrawn from ATMs. While small CIC actually excludes large denomination currency notes, ATMs are typically stocked with medium value denominations of currency notes that are commonly used for legal payment transactions. In this sense, the two approaches are similar.

When CIC and small CIC measures were contrasted for 25 countries, more countries were found to have a falling trend in cash use with small CIC than with all CIC (Khiaonarong and Humphrey, 2021). Even so, small CIC is still a stock of currency and, like CIC, is not adjusted in a timely manner for changes in the annual turnover in the stock of cash used for purchases while cash from ATMs is a flow and does account for changes in velocity (as discussed below). The standard and small CIC measures of cash use do have the benefit of being well-recorded and available for all countries, which is why the standard measure, in particular, is commonly used.³ A measure using ATM cash withdrawals was, of course, not possible before ATMs became as commonly available as they are today. In our analysis, both cash use measures are shown per adult in a country, the primary user of cash aged 15 to 64, as opposed to per person in the total population.

² We would do this even if reliable time-series data on hoarding and illegal uses of cash were available (which is not the case).

³ A newer source of data—payment diary studies—tracks cash purchases and exchanges by a small (non-random) selection of individuals over a small number of days over a few different years. While we found only nine payment diary studies, they all suggest that younger adults tend to prefer cards over cash for transactions compared to older adults (see Kim, et al., 2020 for a US study). If this difference in preference for cash persists, the short-term trend in consumer use of cash would be expected to fall as the use of cards and other instruments continues to expand.

There are two main reasons for favoring an ATM cash withdrawal measure of cash use for payments. First, we believe that it more closely reflects the use of cash for payments than does CIC. This is similar to the way the small CIC measure is viewed to reflect more closely cash use for legal payments by excluding large value notes that are typically used for hoarding and illegal activities and are included in the stock of CIC. Focusing on cash for payments is more important than its other potential uses. Historically, cash (or something equivalent) makes transactions more efficient as it solves the “double coincidence of wants” problem associated with barter trade.

Second, the value of cash withdrawn from ATMs is a flow measure, not a stock, and thus its value is already adjusted for changes in velocity due to the substitution of cards and other payment instruments for cash over time. Outstanding stocks of CIC do change over time, but these changes (illustrated below for 14 countries) differ in their rate of change or even change in the opposite direction compared to our alternative flow measure. In addition, for two large countries (US and the Euro Area), significant portions of their currency in circulation are held and used outside their borders and this distorts the ratio of CIC to domestic GDP.⁴

A simple way of putting the velocity issue is to re-express the well-known macroeconomic relationship of money supply (M) \times velocity (V) = price level (P) \times number of transactions (T). The national money supply (M) is usually defined as equaling CIC + liquid bank and other financial institution deposits + liquid assets such as treasury and exchange bills + (in more inclusive definitions) bonds and equity when dealing with $P \times T = \text{GDP}$. Using CIC/GDP as a measure of cash use gives a rather strange measure of the implied velocity of cash circulation. With $\text{CIC} \times V = \text{GDP}$, V not only reflects the turnover of cash, but also the turnover of all other forms of payment that are included in GDP. A more reasonable expression would focus on the value of cash used for (legal) payments = $M' \times V' = P' \times T' \approx$ cash withdrawn from ATMs. The stock of currency times its velocity is a value flow and the value of ATM cash includes both an estimate of the stock of cash used for payments (M') as well as the turnover of this stock (V'). This is preferred to setting $M' \times V' = \text{small CIC} \times V' =$ value of cash used for (legal) payments as both V' and the value of cash used for (legal) payments are unknown. If we approximated the value of cash used for payments by the value of cash withdrawn from ATMs, we could compute the implied velocity V' , but then $\text{small CIC} \times V' =$ the value of ATM cash, which we have used to approximate the value of cash used for (legal) payments. To conclude, small CIC is a measure of the stock of cash (M') used to make payments while cash withdrawn from ATMs is a measure of the annual flow of cash used to make payments ($M' \times V'$).⁵

There is, however, an important drawback to using cash withdrawn from ATMs: almost no data exists on cash withdrawn from retailers offering “cash-back” at the POS and there are only a few observations on the value of cash withdrawn over the counter (OTC) at commercial banks or postal banks. Unfortunately, even these few observations are not helpful. They coningle OTC cash withdrawals by consumers to (presumably) make payments, with withdrawals by retailers to make change for cash sales. Making change is not a purchase and even if known (they aren't), it would not be included in our cash measure which focuses on purchases.⁶ CIC

⁴ Some 30% of the value of Euros and 55% of dollars are estimated to be held by other countries (Bank of France, 2020, page 8; European Central Bank, 2017; Judson, 2017). The use of cash across borders may exist for other countries as well but we have no information on this.

⁵ If one prefers to use small CIC for M' , then they also need to provide an estimate of V' to obtain the annual value of cash used to make payments. When cash is being used, $V' > 0$, but that is all we know. In contrast, the stock of cash loaded into ATMs is replenished during the year but we don't have to know either M' or V' since we approximate their result ($M' \times V'$) with the total value of cash removed from ATMs over a year. Cash removed but not spent during December of a current year should be very similar to cash spent in January that was removed in December of the prior year. Velocity is due to multiple removals of cash from ATMs plus the actions of younger adults using less cash than older adults (see payment diary studies), the continuing substitution and expanding use of cards at the POS compared to cash, the substitution of checks for cash in some emerging market countries and, historically, in advanced countries as well.

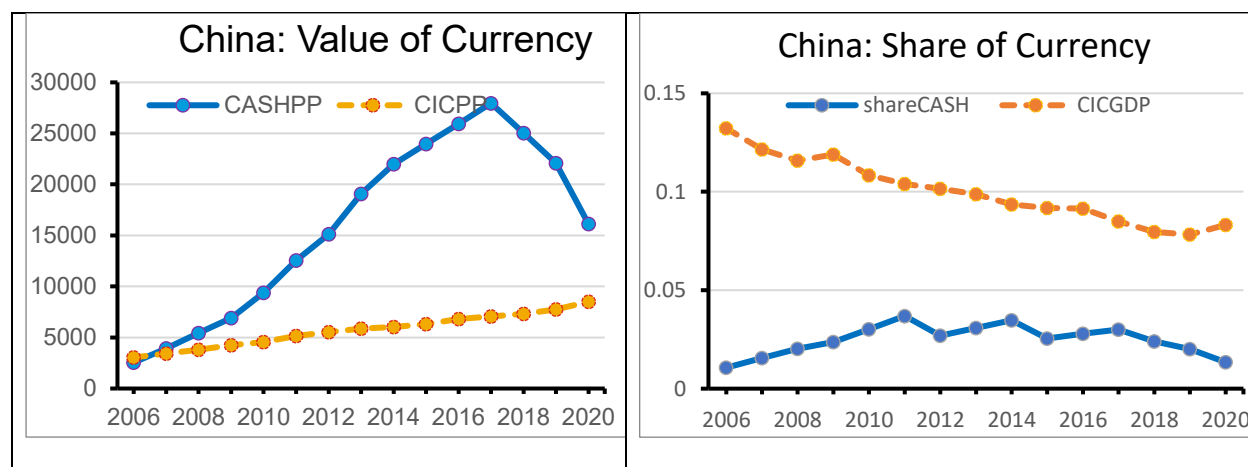
⁶ Information on OTC cash withdrawals exists for six European countries (European Central Bank, 2020). If we neglect the comingling problem and add the total OTC withdrawal to each of the six country's value of ATM cash, the share of ATM cash use for four of the six countries would rise by two percentage points (pp) or less but raise by six to seven pp for the remaining two. Retail businesses are constantly depositing medium valued notes withdrawn from ATMs and used by consumers while at the same time they are withdrawing lower value notes and coin from banks to make
(continued...)

values would include the value of cash-back at the POS and cash withdrawn over the counter at banks by consumers, as well as businesses, but it also includes cash used for hoarding, for illegal activities, as well as cash held outside the country. While neither measure is perfect, we believe that cash withdrawn from ATMs reflects better the value of cash used for payments than does CIC. And since ATM cash also reflects the change in velocity over time, it would be preferred to using the value of the stock of small CIC as its associated V is unknown.

3. Differences in Cash Use Across 14 Countries

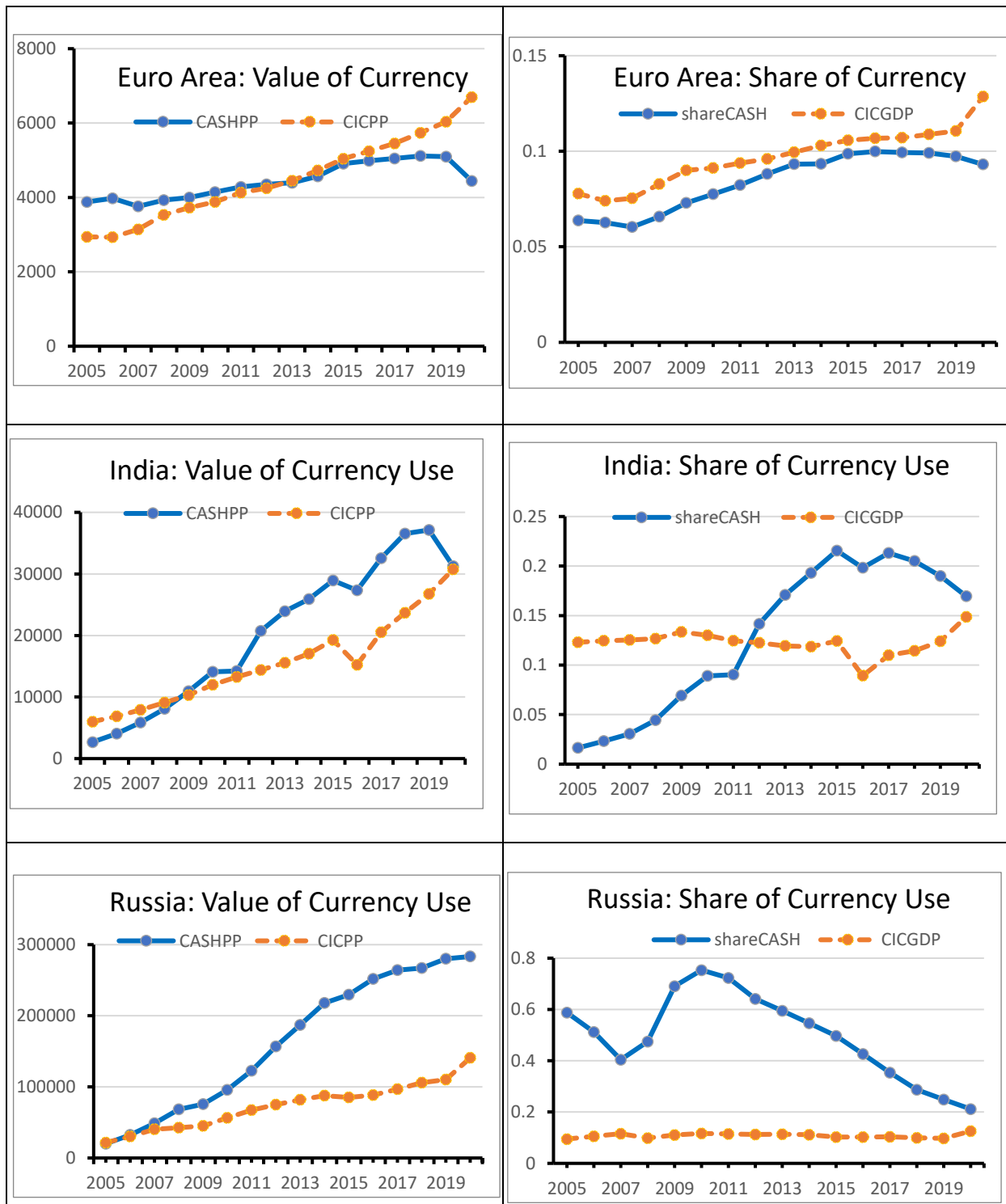
The graphs on the left-hand side of Figure 1 show the value of CIC per adult and ATM cash per adult for five of our largest countries: China, Euro Area, India, Russia, and the US. This reflects different measures of the trend in the level of cash use in a country over 2005-2020. The values are in local currency and, for our purposes, we treat the Euro Area as a single country. The corresponding CIC/GDP and ATM cash payment share measures are shown on the right-hand side. These are relative measures and are more comparable across countries. The standard measure of cash use is the stock of CIC relative to the flow of total domestic economic activity (GDP) while our alternative measure is the share of the flow of ATM cash relative to the flow of other domestic payments in a country.⁷ Similar figures for nine other countries are shown in the Annex I.

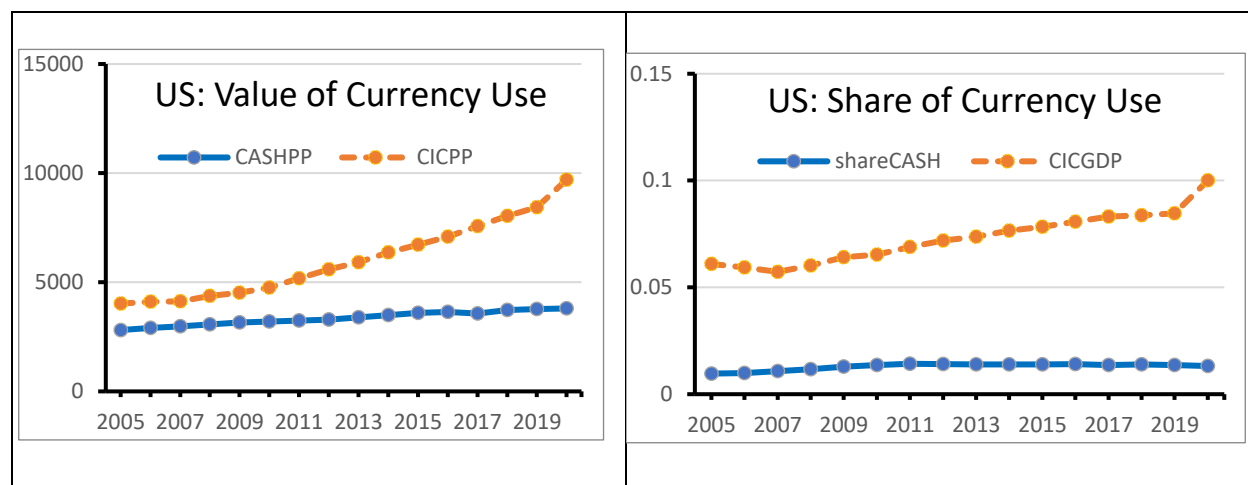
Figure 1. Value and Share of Currency Per Adult for China, Euro Area, India, Russia, and the United States, 2005-2020



change. The main reason banks adopted ATMs was to reduce the cost of supplying cash to consumer depositors at their branch offices. If this had turned out to be unsuccessful, we would not be seeing large networks of ATMs today. Thus we expect that the majority of cash withdrawn OTC at banks is for business use in making change.

⁷ Domestic payments are the sum of the value of ATM cash, all cards, instant payments, as well as checks and direct debits. Large value wire or credit transfers are excluded as they differ markedly across countries and, if included, would make our comparison less informative. Our data sources do not distinguish between large versus smaller value credit transfers, although instant payments represent smaller value credit transfers.





Source: Authors' calculations.

3.1 Value of Currency Use Per Adult

In the graph showing the local Value of Currency Use per adult in China, we see that ATM cash per adult (CASHPP, solid line) had a 98% rise in nominal terms from 2005 to when it reached a peak in 2017. This was associated with rapid internal output, domestic consumption, and overall payment growth in China. After the peak, and relative to the base period 2005, use of ATM cash fell by 42% over the next three years to 2020.

In contrast, CIC in China (CICPP, dashed line) rose by 32% up to 2017 but then continued to rise by an additional 47% (relative to 2005). Thus, the CIC measure did not account for most of the rise in cash use and turnover that occurred during 2005-2017 and it missed the reduction in use over 2017-2020 when ATM cash was falling but CIC was still rising. The main inconsistency here is that ATM cash is falling while CIC is rising (Problem 1).

We see a less dramatic pattern in the graphs for the Euro Area and US. Here CIC is rising while ATM cash is relatively stable, rather than falling for more than one year toward the end of our sample (Problem 2). Lastly, for India and Russia, ATM cash is rising faster than CIC at different points in time while the reverse occurs for the US and (less so) for the Euro Area (Problem 3).⁸ Graphs for the other nine countries are shown in the Annex I.

These inconsistencies for all 14 countries are shown in Table 1. Each inconsistency involves a different trend between our two measures of the level of cash use in a country. The most serious concerns trends moving in opposite directions: one rising while the other is falling at certain points over time and that this occurs for more than just one year (Problem 1). This applies to China and Australia.⁹

Less serious, but still misleading in terms of the direction of the trend, is where one trend is either rising or falling while the other is relatively stable (Problem 2). As seen in the table, this seems to affect five countries for some time periods. Finally, and the most frequent problem, is when both trends are generally rising or falling together, but the slope of the trend differs. Here one trend rises or falls faster than the other, reflecting a different rate of change in cash use over time (Problem 3). This affects seven countries. All three problems involve misleading information. The question then is, which measure likely best reflects the true situation in terms of cash use for payments in a country? For us, this would be ATM cash since it includes the turnover or velocity of cash use while CIC does not but includes non-payment activity (hoarding) and illegal payment activity (the extent of which is largely unknown).

⁸ The reversal for the US and Euro Area is likely due to having a significant portion of CIC held and used outside their borders.

⁹ Australia collects additional data for their case use, including the value of debit card "cash out" purchases, credit card cash advances, cash depot utilization, and consumer survey data.

Table 1. Inconsistencies Between CIC and ATM Cash

Problem 1: One level measure is rising; the other is falling:
Australia, China

Problem 2: One level measure is rising or falling, the other is relatively stable:
Euro Area, Norway, Singapore, UK, US

Problem 3: One level measure rising or falling faster than the other one:
India, Indonesia, Malaysia, Mexico, Russia, Sweden, Thailand

Source: Authors' calculations.

3.2 Share of Currency Use Per Adult

While ATM cash is our choice to measure cash use for payments, to determine whether it is “high” or “low”, it is helpful to have a numeraire. The solution is to express the level of cash use relative to an indicator of total income, or GDP, or the value of payments in a country. The information one wants here is in the trend, not so much in the level of a computed ratio or payment share.

Two things determine the trend in the relative use of cash. The first is already shown in the (left hand side) graphs in Figure 1 dealing with changes in the value of CIC or ATM cash by themselves. The second is not shown and deals with changes in the denominator—GDP or the value of payments. If these rise (or fall) more rapidly than CIC or ATM cash, then the resulting trends will tend to correspondingly fall (or rise). Thus trends in the first set of graphs discussed above can differ somewhat from the relative measures shown in the second set of (right hand side) graphs titled Share of Currency Use.

Importantly, the set of problems identified in Table 1 can be attenuated, but not usually eliminated. Returning to the example of China, the large initial rise and then fall of CASHPP, is mirrored, but less obvious, in the graph to its right showing China's share of currency use. Both CASHPP and shareCASH, the solid lines in both graphs, are shaped like an inverted U. In the first graph, the peak in CASHPP occurs in 2017. In the second, the peak in use occurs in 2011. This is because, although CASHPP was rising at that time, the value of other payments was rising more rapidly, leading to a decline in the trend of shareCASH starting in 2011, rather than later. In a similar manner, the dashed line in the first graph shows the slow rise in CICPP over 2005 to 2020 but the dashed line in the second graph, reflecting the relative measure of CIC/GDP, is seen to constantly fall. This is due to GDP consistently rising more rapidly than CIC. Problem 1 is still evident here since over some time periods one trend is rising while the other is falling.¹⁰

¹⁰ Comparing CIC per adult to the ratio CIC/GDP is appropriate since CIC per adult, divided by GDP per adult equals CIC/GDP. The same holds for the other relative measure.

Table 2. Inconsistencies Between CIC/GDP and ATM Cash/Payment Value

Problem 1: One relative measure is rising; the other is falling:

Australia, China

Problem 2: One measure is rising or falling, the other is relatively stable:

Euro Area, India, Indonesia, Malaysia, Norway, Russia, Singapore, UK, US

Problem 3: One measure rising or falling faster than other one:

Mexico, Sweden

Thailand (basically parallel, no problem)

Source: Authors' calculations.

The three types of inconsistencies identified in Table 1 for value of currency use are shown for share of currency use in Table 2. Problem 1, where one share measure is rising while the other is falling, still pertains to Australia and China but is less extreme. It now includes the effect of the growth in the two denominators—GDP and payments in a country—which often exceeds the growth of the numerator CIC or ATM cash. This results in India, Indonesia, Malaysia, and Russia moving from Problem 3 in Table 1 to Problem 2 and Thailand, formally in Problem 3, not having a problem at all in Table 2. While the incidence of the various inconsistencies between Tables 1 and 2 is changed somewhat, the conclusion is that whether CIC or ATM cash are viewed individually or relatively, they do not provide the same information about the trend in cash use.

4. Comparing Shares of Currency Use Per Adult Across Countries

Figure 2 shows those countries that, at some point, had a cash share of 12% or higher while Figure 3 shows countries with lower shares during 2005 to 2020. In Figure 2, Indonesia and Russia have very high cash shares, reaching over 70% at their highest point. They then fall rapidly to 40% and 20%, respectively, by 2020. The shares for Sweden and Norway start at 24% and 13% in 2005, consistently fall over the period, and each end up almost at the same level in 2020 with shares of 4% and 3%, respectively. Mexico was the only country where the cash share rose continuously for the whole period. The shares for Malaysia and India also rose initially but then level off or fell slightly. By 2020 their respective shares are 15% and 17%.

Figure 3 includes countries that have initial cash shares lower than either Sweden or Norway but also fall much less over the period. The initial dispersion in 2005 of the 6 countries ranges from 10 percentage points (11% for Thailand to only 1% for China and the US) and falls only slightly to 8 percentage points (pp) by 2020 (9% for the Euro area, still 1% for China and the US). For Australia, China, and the US, the change in their shares between 2005 and 2020 were so small that their beginning and ending values can be considered almost equal.

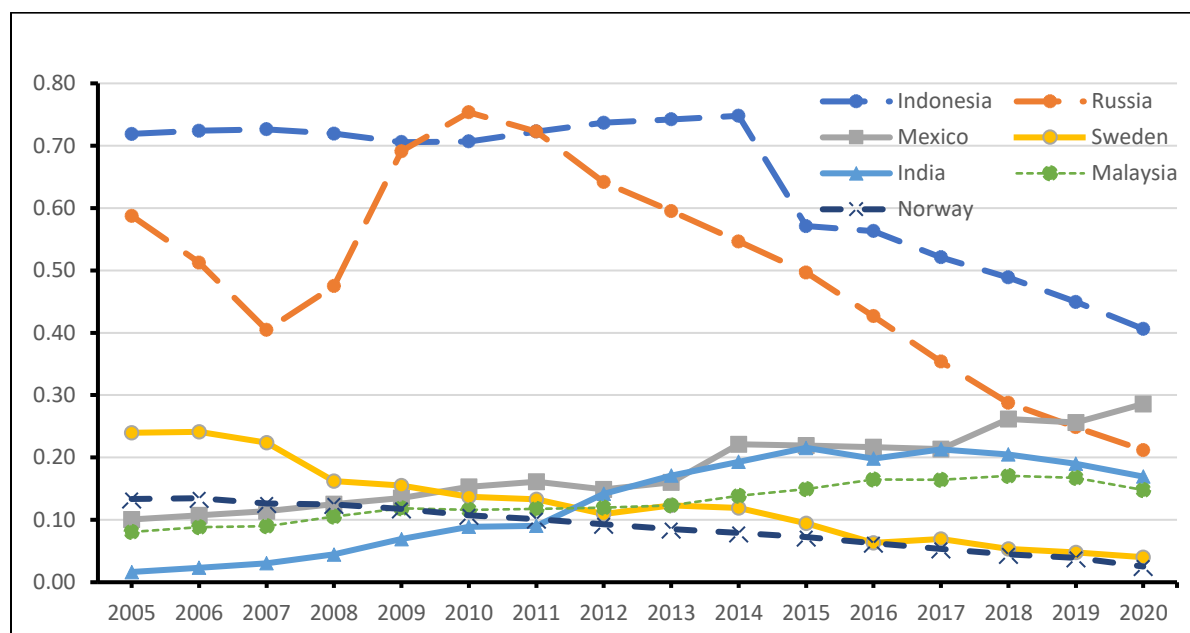
The values noted above, along with additional information, are shown in Table 3. To make the important information in Column 5 clearer, the countries have been ranked according to the size of the reduction they experienced after their ATM cash share reached a peak sometime during 2005-2020. But first, we cover in more detail what the change in their cash shares were over the whole period.

The initial and ending ATM cash shares are shown in Columns 1 and 2 while Column 3 shows the changes over the 16-year period. Eight of the 14 countries experienced a decline over the period. This was greatest for Russia (-38 pp), Indonesia (-31 pp), Sweden (-19 pp), and Norway (-11 pp). The reductions for the UK, Thailand, Singapore, and Australia were much smaller, ranging from -3.3 pp to -0.4 pp. Positive changes in cash shares occurred for Mexico, India, Malaysia, Euro Area, and US, but were very small for the last two countries.

The year that a country's cash share peaked is shown in Column 4, along with the value of the share at the peak. Thailand reached a peak in the first year of the sample so the subsequent change in its share covers 15 years in Column 5. In contrast, Mexico reached its highest value in the last year so, strictly speaking, there is no peak at present. As seen in Column 5, the decline after the peak was greatest for Russia, Indonesia, Sweden and Norway, the same result for these four countries is seen for the whole period in Column 3. For the nine other countries--India, Thailand, UK, China, Malaysia, Australia, Euro Area, Singapore, and US—the post peak share reduction only ranged between -5 pp to -0.

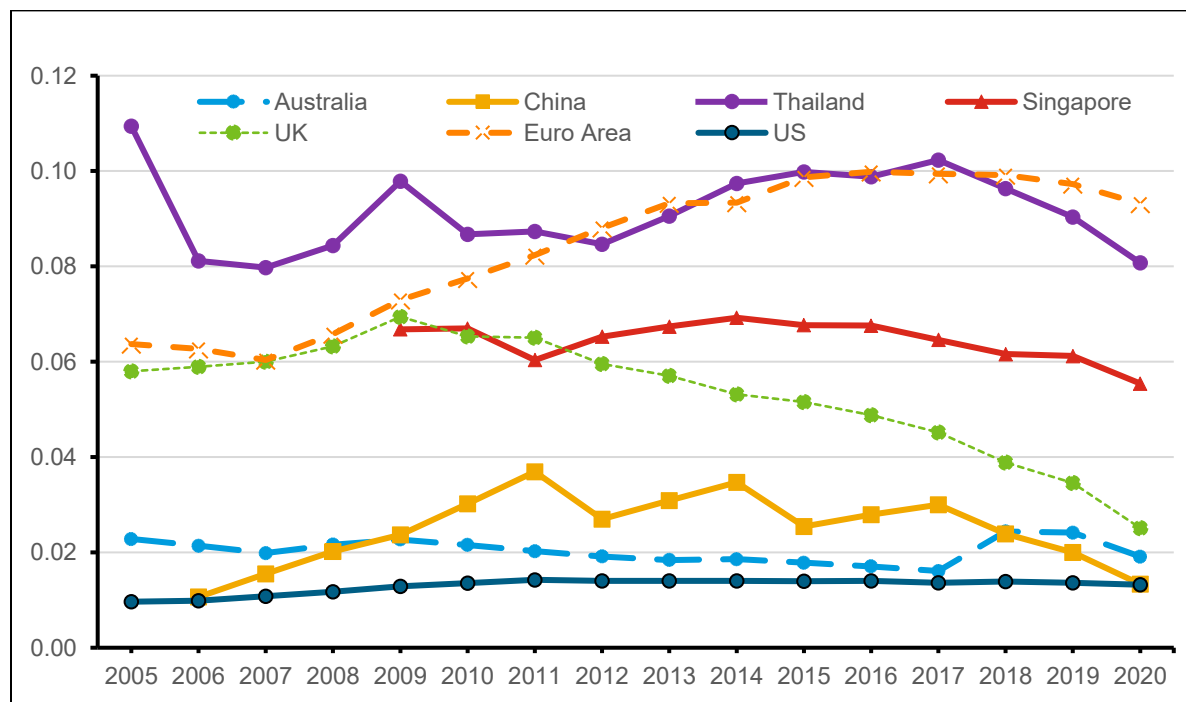
As can be determined in Figure 2 (and also by comparing Column 4 with 5 in Table 3), there is a difference in how fast the use of ATM cash falls after reaching a peak. If the share was high when the peak was reached, as occurs for Russia when its peak was 75%, the following decline is also high, at -54 pp. China's peak share was low at 4% and its post-peak decline of -2 pp is also low. This would correspond to an inverse logistic curve where cash is falling at a decreasing rate.

Figure 2. Share of ATM Cash in Payments



Source: Authors' calculations.

Figure 3. Share of ATM Cash in Payments (continued)



Source: Authors' calculations.

Table 3. Trends in the Share of ATM Cash Per Adult in Payments

Country	Pct. Share in 2005 (1)	Pct. Share in 2020 (2)	pp change (3)	Peak Year (& Share) (4)	pp Decline Since Peak (5)
Russia	59%	21%	-38	2010 (75%)	-54
Indonesia	72	41	-31	2014 (75)	-34
Sweden	24	4.6	-19	2006 (24)	-20
Norway	13	2.5	-11	2006 (13)	-11
India	1.6	17	15	2015 (22)	-5
Thailand	11	8.1	-2.8	2005 (11)	-3
UK	5.8	2.5	-3.3	2009 (7)	-4
China	1.1	1.3	0.2	2011 (4)	-2
Malaysia	8.1	15	6.7	2018 (17)	-2
Australia	2.3	1.9	-0.4	2018 (2)	-1
Euro Area	6.4	9.3	2.9	2016 (10)	-1
Singapore	6.7	5.5	-1.2	2014 (7)	-1
US	1.0	1.3	0.3	2011 (1)	-0
Mexico	10	27	19	2020 (29)	0

Notes: pp = percentage points; all data are rounded; data starts in 2009 for Singapore, 2006 for China.
Source: Authors' calculations.

4.1 Cash Use in Advanced and Emerging Economies

Our sample contains both advanced and emerging market economies. A common presumption is that adults in advanced countries use less cash because they have adopted and use cash substitutes (checks, electronic payments, cards, and fast payments) while individuals in emerging economies use more cash because of lower incomes and availability of fewer cash substitutes.

Table 4 shows the average use of ATM cash across countries annually, weekly, and daily in US dollars in 2020. Local currency values of ATM cash use in total are shown in Figure 1 (solid lines) and is re-expressed as US purchasing power parity (PPP) adjusted values of cash use per adult in each country. The seven countries where adults use the most cash are in the top group in Table 4 while those using the smallest value of cash are in the bottom group.¹¹ Both groups seem to contain a mixture of emerging and advanced economies suggesting that more than income level and the relative availability of cash substitutes is involved in determining the use of ATM cash for payments, perhaps relative ATM availability and institutional or cultural differences across countries.

¹¹ The annual values look to be high because, as individuals, we do not withdraw cash on an annual basis. Similarly, the daily values seem low unless one commonly uses cash on a daily basis. The weekly or bi-weekly values should look more reasonable as this is how most adults tend to monitor their cash use.

Table 4. Average ATM Cash Use Per Adult in 2020 (US dollars, PPP).

Country	Annual	Weekly	Daily
Singapore	\$13,790	\$265	\$38
Russia	11,568	222	32
Malaysia	10,712	206	29
Thailand	10,603	204	29
Euro Area	6,300	121	17
Mexico	4,805	92	13
Australia	4,299	83	12
China	3,859	74	11
US	3,801	73	10
UK	3,798	73	10
Indonesia	3,458	67	9
Sweden	1,459	28	4
India	1,421	27	4
Norway	1,042	20	3
Total	80,915	3,112	222

Source: Authors' calculations.

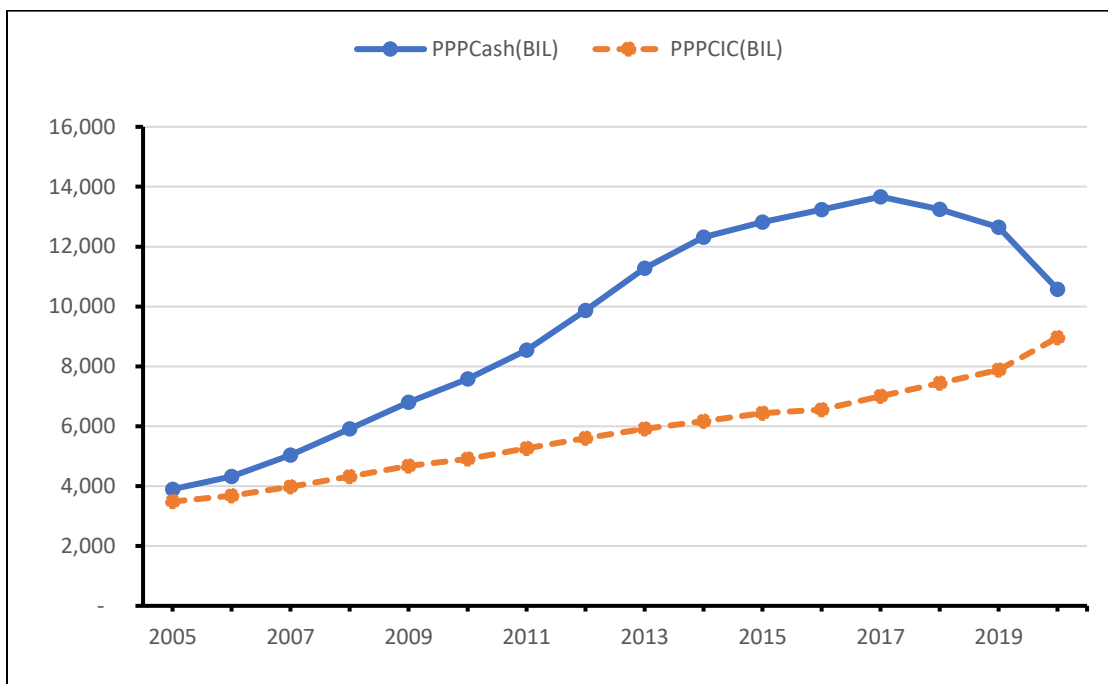
4.2 Aggregate Use of Cash for Half the World's Population

Our sample covers 14 countries who collectively account for 53% of the world's population and two-thirds of world GDP. Figure 4 shows the sum of the purchasing power parity values (in US dollars) of the annual value of ATM cash per adult across all countries (PPPCash) and the corresponding PPP value of currency in circulation per adult (PPPCIC).¹² The same problems seen earlier for individual countries (China in particular) are also seen reflected in the aggregated data. That is, ATM cash rises faster than CIC, reaches a peak toward the end of the period, and then starts to fall while CIC is still rising. Relying on one or the other will give different information regarding the slope, level, and direction of the change in the trend in cash use for payments.

Figure 5 shows the PPP adjusted value of the share of ATM cash in payments (PPPCASHshare) for all countries as well as the share of CIC relative to GDP. As noted earlier when similar currency share graphs were shown in Figure 1, the fact that the shares differ from the levels is only due to the choice of the denominator (payments in a country versus GDP). Thus the important result lies in the trend—a rather stable trend in the ratio of CIC/GDP while the share of ATM cash is first rising, reaches a peak, and then falls toward the end of the period.

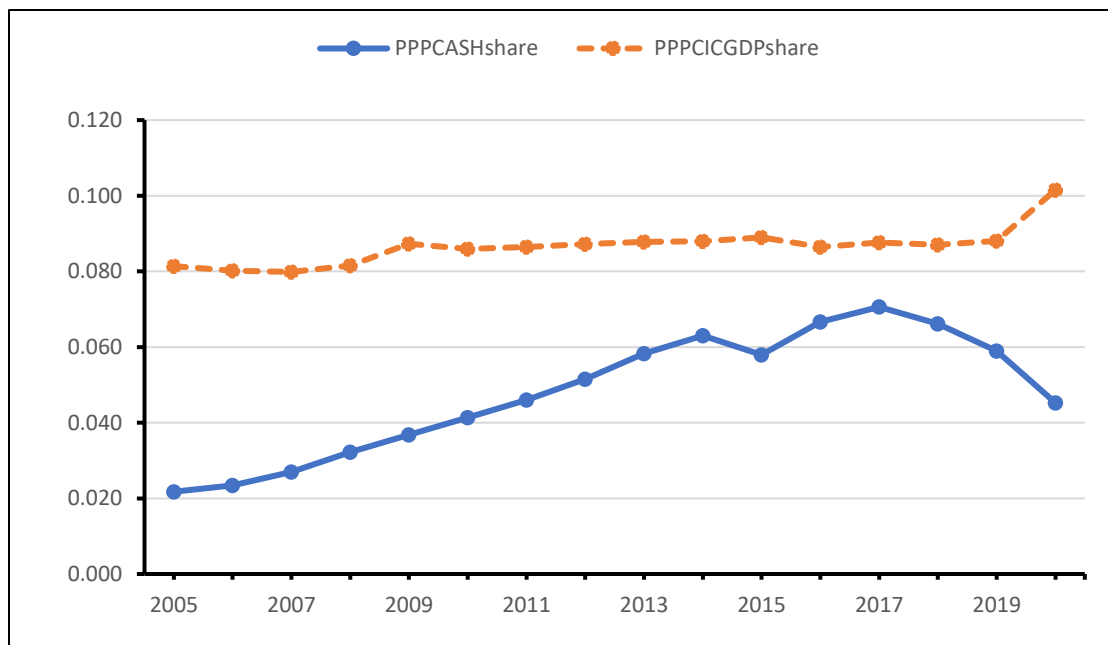
¹² Figures 4 and 5 were determined in the same way as the graphs in Figure 1 except that the values shown are determined by sums of US PPP dollar values rather than in local currency. Importantly, the sum of values across all 14 countries together—whether ATM cash, CIC, number of adults, total payments, or GDP—are obtained before any division of a numerator by a denominator occurs to form the graphs.

Figure 4. Aggregate Currency Value



Source: Authors' calculations.

Figure 5. Aggregate Currency Share



Source: Authors' calculations.

5. Conclusion

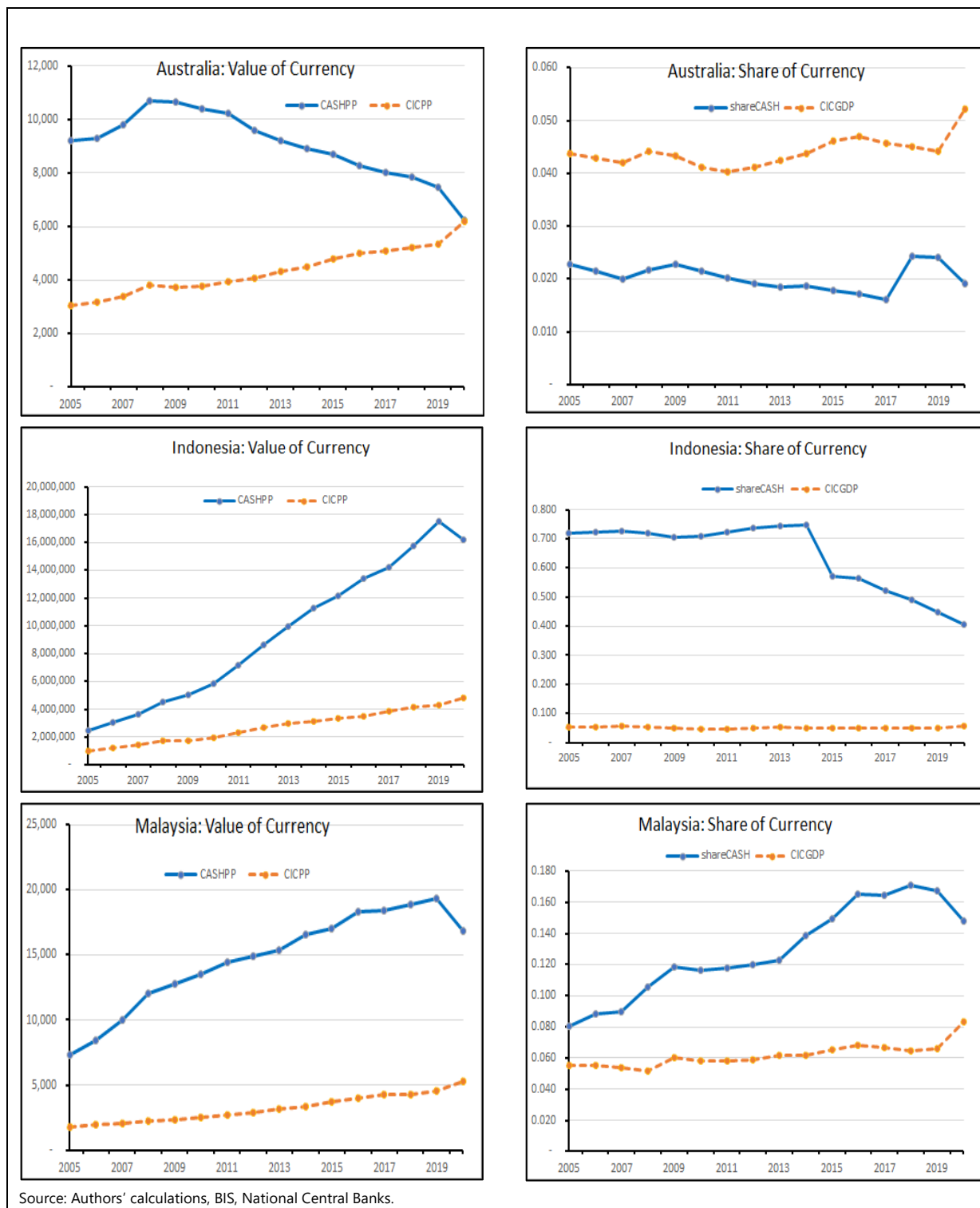
We contrast the current standard way of assessing cash use in a country—the value of currency in circulation (CIC), and also CIC as a ratio to GDP—to an alternative we believe to be more accurate and timelier to monitor the use of cash for payments. This alternative is the value of cash withdrawn from ATMs, and also as a ratio to the total value of payments in a country (excluding large value credit transfers). All of these indicators are measured per adult to control for demographic differences across countries. We wish to exclude the use of cash for hoarding or for illegal use. These uses are less important for an economy than using cash for payments. The original purpose of cash, or more properly its earlier equivalent, was to solve a major problem with barter transactions.

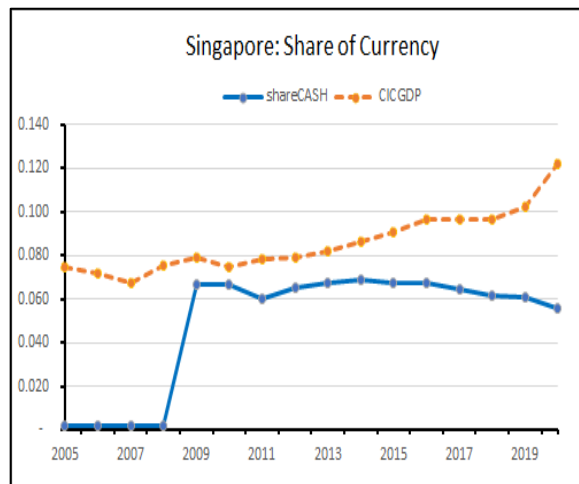
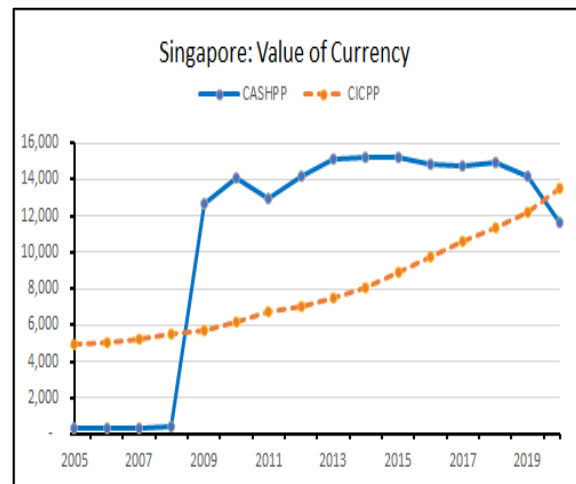
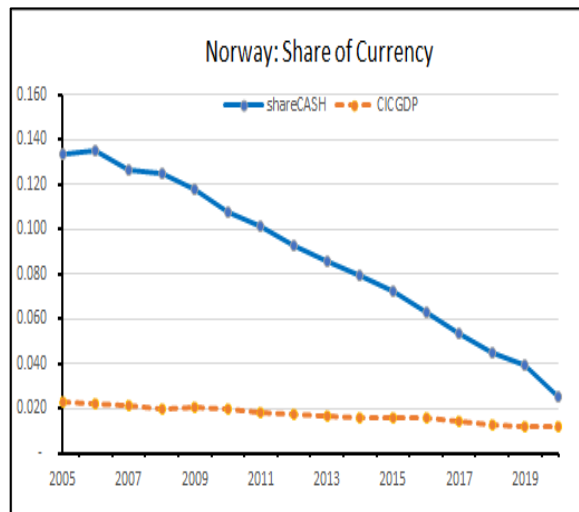
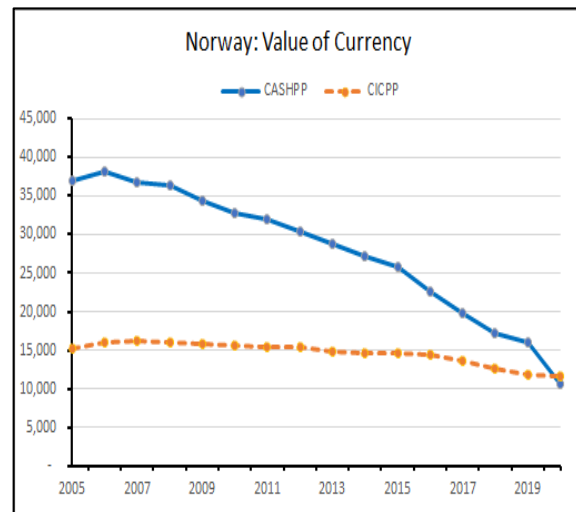
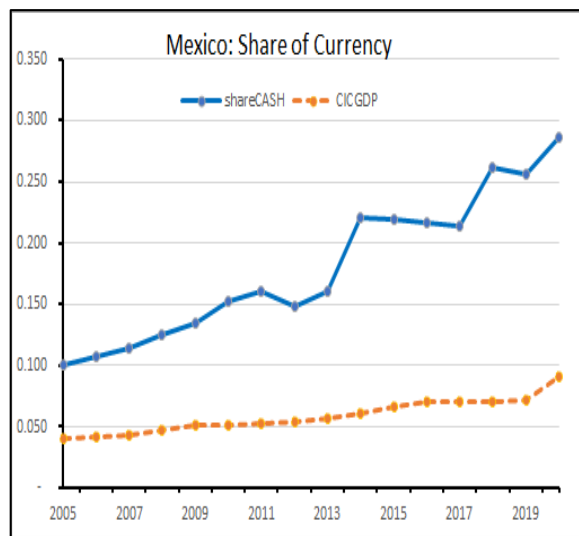
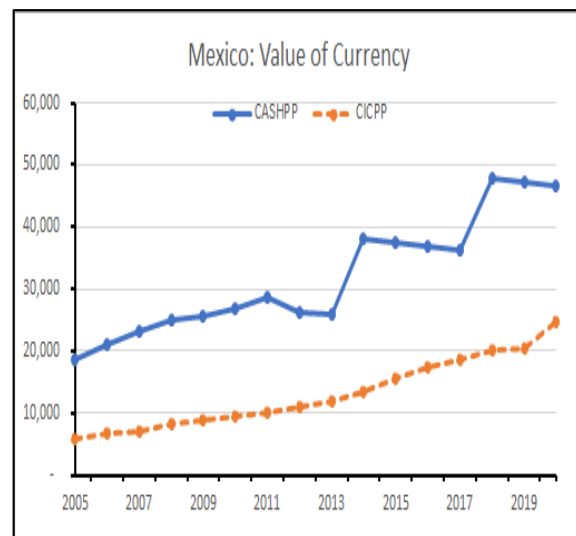
Measured as a level, or relative to GDP or total payments, the standard measure and our alternative indicator give conflicting information on the use of cash for payments. We see different magnitudes of these two measures at the same point in time, different slopes for the rising (or downward) trends they both may have at the same time, and also on some occasions even a different direction in the trend—one rising, the other falling. This occurs in different countries, at different time periods, but is important enough to be obvious when the data for all countries are expressed in US dollars and aggregated across countries. The main reason for this divergence lies in the fact that CIC includes cash used for payments, hoarding, and illegal use while ATM cash is focused much more on the use of cash for payments alone. As well, the stock of CIC is not adjusted for the turnover of cash for payments while ATM cash already includes it. As we show in the paper, cash is still strongly used for payments in some countries, but in most it has reached a peak and, overall, is starting to fall using the ATM cash measure—either in levels or as a share of payments.

The 14 countries in our sample account for half of the world's population and two-thirds of its GDP. Using our preferred measure, the value of cash withdrawn from ATMs, four countries with the highest cash shares in 2005 (ranging from 13 to 72%) experienced the largest reductions in cash use by 2020 (falling between 11 to 54 pp) over our 16-year period. Half of our countries already have low cash shares of 5.5% or less. Considering the largest and smallest users of cash together, when cash shares are high, share reductions are large. And when shares are small, reductions are also small. The pattern of cash reduction, when falling, follows an inverse logistic curve and thus seems to fall at a decreasing rate. In this regard, all but two of our 14 countries have reached a peak in their cash use toward the middle or end of our sample period (2005-2020) and are currently experiencing a downward trend.

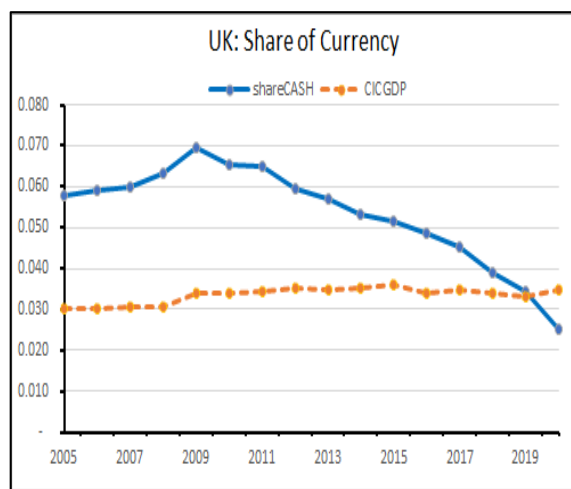
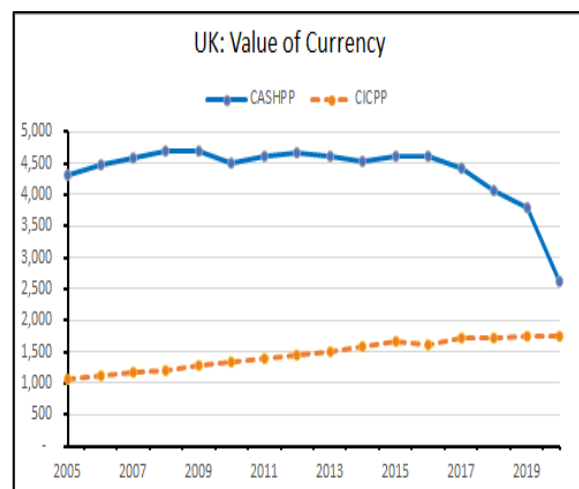
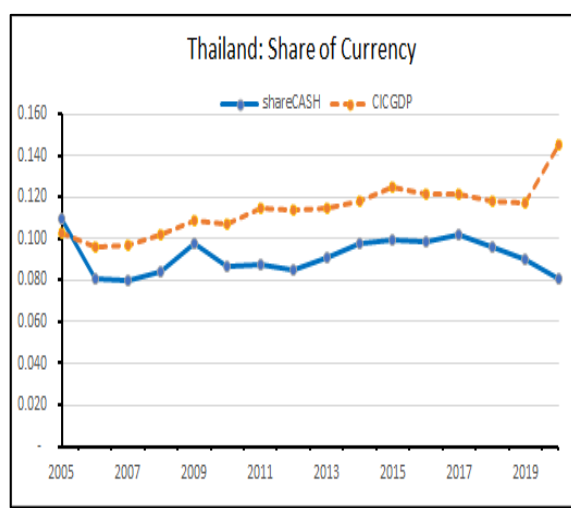
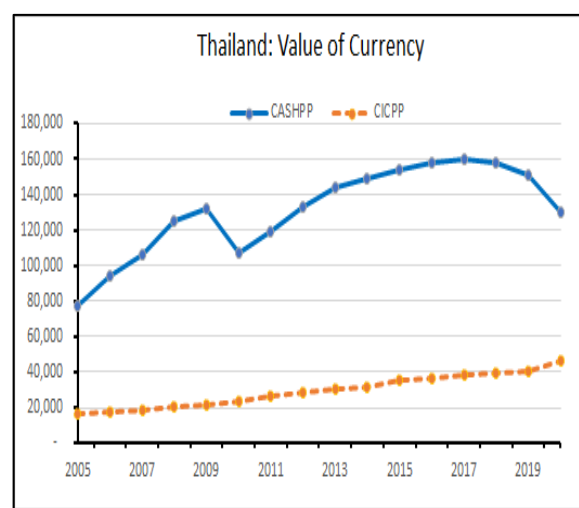
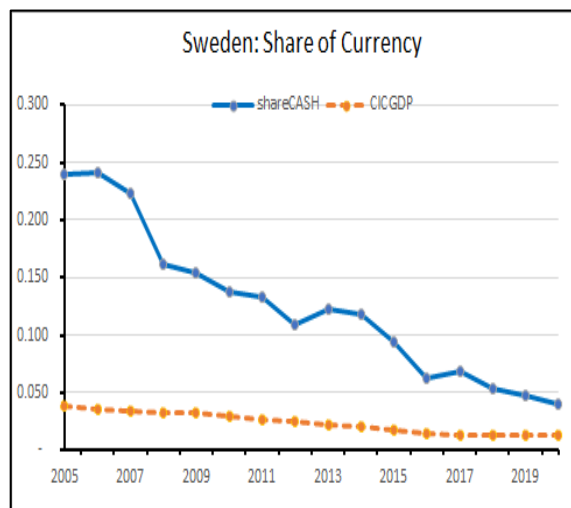
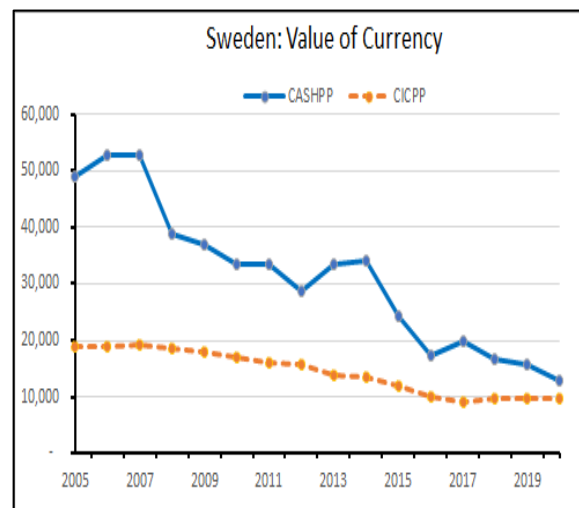
Neither measure of cash use is perfect. CIC includes hoarding and illegal use (which we do not want) and excludes timely changes in velocity. ATM cash includes velocity and, like another indicator of cash use which excludes high value currency notes thought to be used mostly for hoarding and illegal activities (small CIC), is focused on payments as ATMs are usually stocked with currency reflecting medium denominations—not the highest denominations. For us, the balance favors the ATM cash measure of cash use for payments. This measure may be preferred when policy makers are faced with decisions concerning CBDC and, where cash use is already very low, establishing regulations to ensure access to cash and assuring it can continue to be used for transactions with merchants.

Annex I. Value and Share of Currency in Other Selected Countries, 2005-2020





Source: Authors' calculations, BIS, National Central Banks.



Source: Authors' calculations, BIS, National Central Banks, UK FPS

Annex II. Data Sources

The data used in the study were collected from public sources, including from the Bank for International Settlements (BIS), European Central Bank (ECB), International Monetary Fund (*International Financial Statistics*), World Bank (*World Development Indicators*), national central banks. Domestic payments were calculated by the sum of the value of ATM cash withdrawals, all card payments (including credit, debit, and e-money functions), fast payments, checks, and direct debits. Large value wire or credit transfers are excluded.

Country	Data Sources and Notes
Australia	BIS statistics on payments and financial market infrastructures
China	BIS statistics on payments and financial market infrastructures
Euro Area	<p>BIS statistics on payments and financial market infrastructures for currency and coins in circulation</p> <p>ECB statistical warehouse for payment statistics</p> <p>Notes. Statistics are based on the Euro Area (with changing composition). For credit transfers, direct debits, and checks, all transactions are sent. Cash withdrawal transactions are based on cards issued by resident payment service providers (PSPs) via customer terminals provided by resident PSPs. Card transactions at point-of-sale, except e-money transactions, are issued by resident PSPs via customer terminals provided by resident PSPs. E-money payment transactions are based on cards issued by resident PSPs via customer terminals provided by resident PSPs. GDP for Euro Area (Member States and Institutions of the Euro Area) are at market prices and collected from the ECB Statistical Data Warehouse. GDP for Euro Area (at market prices) reported by the ECB are similar to figures reported for the Euro Area (at current prices) by the BIS.</p>
India	BIS statistics on payments and financial market infrastructures
Indonesia	<p>BIS statistics on payments and financial market infrastructures</p> <p>Central Bank of Indonesia, payment system and financial market infrastructure statistics</p> <p>Direct debits were introduced in 2017 and operated by the ACH. Check data before 2009 is not available. E-money includes the total value of chip-based e-money and server-based e-money issued by commercial banks and non-bank fintech firms. Fast payments consist of credit transfers through ATMs and online banking (internet and mobile) reported by four domestic switches and global principals (VISA, Mastercard, CUP, JCB). Individual credit transfers processed through BI-RTGS are excluded. Data before 2015 is not available. For fast payments, data includes the value of interbank transfers below Rp100 million per transaction sent through ATMs, mobile banking and internet banking. Funds transfer amounts exceeding Rp100 million is legally recognized as large value.</p>
Malaysia	Central Bank of Malaysia, payment statistics

	Check payments are based on clearance through eSPICK. Value of fast payments are based on instant credit transfers, which include Duit Now transactions from December 2018.
Mexico	BIS statistics on payments and financial market infrastructures Fast payments refer to low value payments which are less than MXP 8,000 per transaction from the SPEI payment system and obtained from the Central Bank of Mexico.
Norway	Central Bank of Norway, financial infrastructure report , various issues Card transaction include the use of Norwegian cards for debit, billing, credit, and e-money functions. ATM cash withdrawals includes the use of Norwegian cards at Norwegian terminals. E-money includes the use of Norwegian cards. Fast payments refers to instant payments.
Russia	BIS statistics on payments and financial market infrastructures
Singapore	BIS statistics on payments and financial market infrastructures ATM cash withdrawals did not include in-house ATM data pre-2009. A large spike in ATM cash withdrawals is therefore evident from 2009.
Sweden	BIS statistics on payments and financial market infrastructures
Thailand	Bank of Thailand, payment systems annual report , various issues Card and e-money payments includes the following. For debit cards from 2010, domestic and overseas spending of Thai debit cards via EFTPOS and the Internet. Since 2015, data includes domestic spending of foreign debit card via EFTPOS and the Internet. For credit cards from 2010, domestic and overseas spending of Thai credit cards and domestic spending of foreign credit cards via EFTPOS and the Internet. For e-money from 2010, data includes banks and non-banks which operate electronic payment service businesses and excludes top-up cards. For 2005 to 2009, figures were collected from the Bank of Thailand's Annual Payment Systems Report 2010 (page 80, table 7). ATM cash withdrawals are based on ATM cards and debit cards. For ATM cash withdrawals through debit cards, transactions include cash withdrawals, purchasing of goods and services via other non-EFTPOS channels, deposits, and funds transfer. Publicly available statistics provide a breakdown of debit card transactions into purchasing purposes via EFTPOS and for other purposes (including cash withdrawals). Checks include in-house and interbank checks. Some financial institutions report in-house clearing in Bangkok and the metropolitan areas only. Check data from Special Financial Institutions were included from 2019. E-money payments include data from banks and non-bank which operate electronic payment service business and excludes top-up cards. Fast payments refers to PromptPay services, which use identification numbers such as mobile phone numbers, national identity numbers, corporate tax numbers, e-Wallet numbers, and traditional banking account numbers.
United Kingdom	BIS statistics on payments and financial market infrastructures Pay.UK, payment statistics

	<p>“Single immediate payments” refer to fast payments conducted through the UK Faster Payments Service. In 2012, a new regulation was introduced in the UK for payments to reach the payee’s account no later than the day after the payer’s account is debited. This resulted in the migration of remaining bill payments and standing orders to payments processed by the Faster Payments Service. For this paper, fast payments figures include: 1) single immediate payments 2) standing order payments, 3) forward dated payments and 4) return payments. Total cash withdrawals are used as a substitute of value of ATM cash withdrawals, which is not available.</p>
United States	<p>BIS statistics on payments and financial market infrastructures</p> <p>Notes. The US Federal Reserve revised estimates for direct debits from 2013-2019 for consistency with the Federal Reserve Payment Study.</p>

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