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WHAT EXPLAINS THE GROWING GLOBAL DEMAND FOR CASH?

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Abstract

Demand for cash is generally known to be influenced by several factors—including transaction motive used for payment, opportunity cost, precautionary motive (such as crisis period), and other motives (such as aging and demand from abroad). In recent years, cashless payment methods have increasingly become prevalent in the world through various conventional tools (such as credit cards, debit cards) and innovative convenient financial services using mobile phones and smart phones. Nevertheless, cash in circulation has been rising in many economies, especially after the global financial crisis. The rising trend is prevalent even in advanced economies, notwithstanding that the public normally has had full access to bank accounts and credit cards for a long time and other cashless payment tools in recent years. The low interest rate environment appears to have affected the rising trends. Meanwhile, emerging/developing economies continue to issue cash significantly partly because their nominal GDP growth rates have been greater than those of advanced economies. Interestingly, the People's Republic of China (PRC) experienced a decline in the ratio of cash in circulation to nominal GDP, suggesting greater access by residents to bank accounts and/or other non-bank cashless payment services. This paper first focuses on the time-series movements of cash in circulation (in terms of the amount and nominal GDP) for 22 economies for the period 2000–2018. It also investigated the movements of banknotes in circulation differentiated by denomination for six economies whose data were available. Several empirical analyses with regards to the cash demand function (controlling for the transaction motive by using the ratio of cash in circulation to nominal GDP as a dependent variable) were then conducted for the Euro Area, Japan, and the United States separately. Subsequently, an empirical analysis on cash demand covering all the 22 economies for the period 2000–2018 was performed. The paper found that the opportunity cost proxied by the central bank policy rates and age-related variable were the two most important robust determinants for cash demand. Namely, cash demand tends to grow with a decline in the policy rates and with an advancement of aging.

Keywords: money demand, monetary policy, central bank

JEL Classification: E41, E52, E58

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1. INTRODUCTION

Cash is a useful instrument for payment of goods and services and other transactions. Cash remains essential in many economies today and will likely remain relevant in the future, since cash is likely to be used often by the elderly and marginalized, low-income people. Cash becomes useful especially when natural disasters (such as earthquakes, typhoons, hurricanes) or military conflicts cause serious damage to communities and people's daily lives by generating power shortage and destruction of buildings and computer system. Thus, many central banks view that retaining some level of cash in the society could be useful, despite high cash-handling cost and prevalent cash-associated crimes.

Conceptually, cash is c*entral bank-issued money.* It is the safest, liquid payment and financial instruments for the public. Cash fulfills the following basic functions of money—that is; unit of account, means of exchange, and store of value. Cash is legal tender and an official medium of payment determined by the government through the passage of law that requires creditors to accept debt service payment in the legal tender. Cash is also used for public charges and taxes. For the public, cash remains an important means of payment, but it is increasingly being taken over by private sector-issued money, such as bank deposits and other cashless and contactless tools. Central bank-issued money consists not only of cash, but also reserve balances of financial institutions with a central bank. Generally, cash and reserve balances constitute the liability of the balance sheets of a central bank.

Factors Contributing to Demand for Cash

Cash demand of the public is generally influenced by (1) transaction motive used for payment, (2) opportunity cost, (3) precautionary motive, and (4) other motives. Transaction motive reflects demand for cash used for payments of goods and services as well as other transactions, which is likely to strengthen with an expansion in economic activities (normally proxied with nominal gross domestic product GDP). The opportunity cost for holding cash is related to the financial return arising from the close substitutes of cash, such as retail deposit rates paid by commercial banks to the public or cost of holding credit cards and bank cards (such as various fees or annual fees charged for the card membership). Generally, cash utilization tends to decline as GDP per capita increases due to greater access to bank deposits, debit cards, credit cards, and other cashless payment instruments. Moreover, the higher the opportunity cost, the lower the demand for cash becomes. As a related indicator, inflation also influences cash demand. Low inflation means that the opportunity cost of holding cash is low since the value of cash remains stable. Precautionary motive reflects demand for cash among households and firms that tends to grow at the time of financial and economic crises and/or a sharp decline in risk appetite among investors. Moreover, firms may maintain some liquidity assets in the form of cash to ensure smooth business operations even in a normal period.

Other motives include aging, tax-saving purposes, informal or illegal activities, and cash demanded from abroad. Cash is prevalent in economies with a large share of elderly population due to the habits and affinity for using cash as compared with the economies with a small share of elderly population. Some elderly people stop using credit cards after retirement. Cash demand from abroad is large for the case of the United States given that the US dollar is the most important reserve currency, invoice currency used for international trade and debt issuance, vehicle currency used for various foreign exchange transactions, as well as safe haven currency. Also, an increase in frequent foreign tourists, businesspersons, and students may raise cash demand for foreign

currencies, especially when the exchange rates are perceived to be favorable (Flannigan and Parsons 2018). Thus, demand for cash tends to grow with an expansion of economic activities, a decline in the opportunity cost, an intensification of precautionary motive, and other motives. “Cash hording” is defined as cash lying idle that is no being utilized for payments and thus could be driven by the opportunity cost, precautionary motive, and other motives.

Cash in Circulation Determined by Demand Factors

A central bank normally determines the amount of cash to be issued passively by responding to changes in demand for cash. Therefore, the amount of cash in circulation mainly reflects the demand-driven factors mentioned above—rather than supply-driven or issuer-side factors—and are thus beyond the control of a central bank. A central bank issues and circulates cash through the banking system by providing commercial banks with cash demanded by withdrawing the equivalent amount from their reserve balances with a central bank; these commercial banks then distribute the acquired cash to the public on demand through windows of bank branches and/or automated teller machines (ATMs). It should be noted that the conduct of monetary policy (such as open market operations) directly influences the amount of reserve balances, not the amount of cash, although monetary policy indirectly influences cash demand through adjustment of interest rates.

The value of cash is stable in an economy where a central bank successfully conducts monetary policy in accordance with the price stability mandate (mostly, specified at around 2% in advanced economies) and thus avoids substantially high inflation or serious deflation. Most of the public do not differentiate cash and retail deposits and view them as close substitutes partly because both are denominated in the same unit of account (i.e., legal tender) and partly because providers of retail deposits are regulated by tight banking regulations and deposits are guaranteed up to the certain amount per account holder set by the deposit guarantee system in many economies.

In recent years, cashless and contractless payments methods have increasingly become prevalent in the world through various conventional tools (such as credit cards, debit cards) and innovative convenient financial services using mobile phones and smart phones. Nevertheless, cash in circulation has been rising in many economies especially after the global financial crisis. The rising trend is prevalent, even in advanced economies notwithstanding that the public normally has had full access to bank accounts and credit cards for long periods of time and other cashless and contactless payment tools in recent years. The low interest rate environment appears to have affected the rising trends. Meanwhile, emerging/developing economies continue to issue cash partly because their nominal GDP growth rates have been greater than those of advanced economies. Interestingly, some emerging economies, such as the People’s Republic of China (PRC) have experienced a decline in the ratio of cash in circulation to nominal GDP. This may indicate that the Chinese have gained access to the bank accounts and/or other non-bank cashless payment and financial services.

The rising trends on cash in circulation might have several impacts on monetary policy as well as the economy. On the one hand, greater cash hoarding results in the erosion of the effectiveness of monetary policy through weakening the money creation process. On the other hand, greater cash issuance increases a central bank’s income through greater seigniorage. Moreover, greater cash utilization deteriorates the efficiency in the economy owing to high cash-handling costs arising from the direct fees (i.e., cost of paper and design fees to prevent counterfeiting) and indirect cost (i.e., the security and personnel cost associated with the maintenance of cash provision and payment services

by commercial banks, shops, firms, and individuals). Cash prevalence may also discourage new technology firms to enter into innovative payment and financial activities.

Therefore, it is important to investigate the recent movement on demand for cash in the world. This paper focuses on the movements of cash in circulation by investigating demand-driven factors contributing to the movements for the period 2000–2018. The paper covers 22 economies—eleven advanced (Australia, Canada, Denmark, the Euro Area, Japan, the Republic of Korea, Norway, Singapore, Sweden, the United Kingdom, and the United States), and 11 emerging/developing economies (Brazil, the PRC, India, Indonesia, Malaysia, Mexico, the Philippines, Poland, the Russian Federation, Thailand, and Turkey). The paper is composed of five sections. Section 2 focuses on the time-series movements of cash in circulation among 20 economies for the period 2000–2018. The paper also differentiates between advanced and emerging/developing economies due to the well-developed banking system in the case of former and the presence of large unbanked population in the case of latter. Section 2 also highlights the movements of banknotes in circulation differentiated by denomination in the economies whose data are available—covering Canada, the Euro Area, Japan, Republic of Korea, Poland, the United Kingdom, and the United States. Section 3 provides an empirical analysis with regards to the cash demand function for three economies—the Euro Area, Japan, and the United States—that have separately shown the rising trend and have also conducted large-scale unconventional monetary easing after the global financial crisis. Section 4 demonstrates an empirical analysis on cash demand covering all the 22 economies for the period 2000–2018. Section 5 concludes.

2. GLOBAL DEVELOPMENTS OF CASH IN CIRCULATION

This section focuses on the movements of cash demand by examining cash in circulation both as a percent of nominal GDP and in terms of the amount with regards to 22 economies for the period 2000–2018. It also focuses on the movements of the number of banknotes outstanding issued differentiated by denomination for the seven economies whose data are available. As higher-value banknotes may be more closely associated with cash hoarding, it is important to look at the movements of the highest-value banknotes to make further investigations to changes in cash demand.

2.1 Divergent Movements of Cash in Circulation in the World

There are various indicators tracing the movement of cash in circulation. For example, Kiaonarong and Humphrey (2019) used four indicators to measure the cash usage for payment: cash in circulation as a ratio of nominal GDP; difference between total consumption and the amount of all non-cash payment instruments used in consumption as a ratio of total consumption; the amount of cash withdrawn from ATMs and banks' windows as a ratio to total consumption; and the amount of all cash withdrawals as a ratio to cash plus the amount of non-cash payment instruments. This paper views cash in circulation as a ratio of nominal GDP as a preferred indicator to the three other indicators since the focus of this paper is cash demand driven not only by the transaction or payment motive, but also by the aforementioned factors (opportunity cost, precautionary motive, and other motives). The 22 economies are classified as either advanced economies and emerging/developing economies because the degree of the public's access to the banking system is likely to generate different impacts on cash demand depending on the stage of economic development. While bank accounts are widely available to the public in advanced economies, the public's access

to bank accounts remain limited in many emerging/developing economies. The gradual decline in the unbanked population in the latter economies may promote financial inclusion and encourage the public to shift transaction or settlement instruments from cash-based to cashless-based such as debit cards, credit cards, and other tools such as PayPal and Apple Pay, thereby helping to lower the ratio of cash to nominal GDP ratio. For these economies, a decline in the cash ratio may suggest higher levels of financial inclusion, strengthened financial intermediation function of the banking system, and improved monetary policy transmission mechanism. It could be also associated with greater transparency and efficiency as a result of reduced activities in the informal economy and in illegal activities. The demand for cash will be stimulated further with an increase in the ATM networks and declined charges applicable to ATM usage and cash/debit cards.

Cash Demanded by Households and Firms

Demand for cash by households and firms is determined largely by various motives as already pointed out in the previous section. Namely, most of these motives are heavily influenced by the pace of economic activities (which heavily influence the transaction motive), interest rates (that represent opportunity cost), the occurrence of economic/financing crises (that tend to strengthen precautionary motive), and other factors such as pace of aging and safe haven demand from abroad. Generally, households are the largest holders of cash among economic entities (such as households, firms, financial institutions, and governments) because of their frequent purchases of daily goods and services with low-value banknotes. Households are often sensitive to interest rates since ordinary/checking bank accounts are a close substitute for cash, as both such bank deposits and cash serve as payment tools for daily small-value transactions payments and serve to store value.

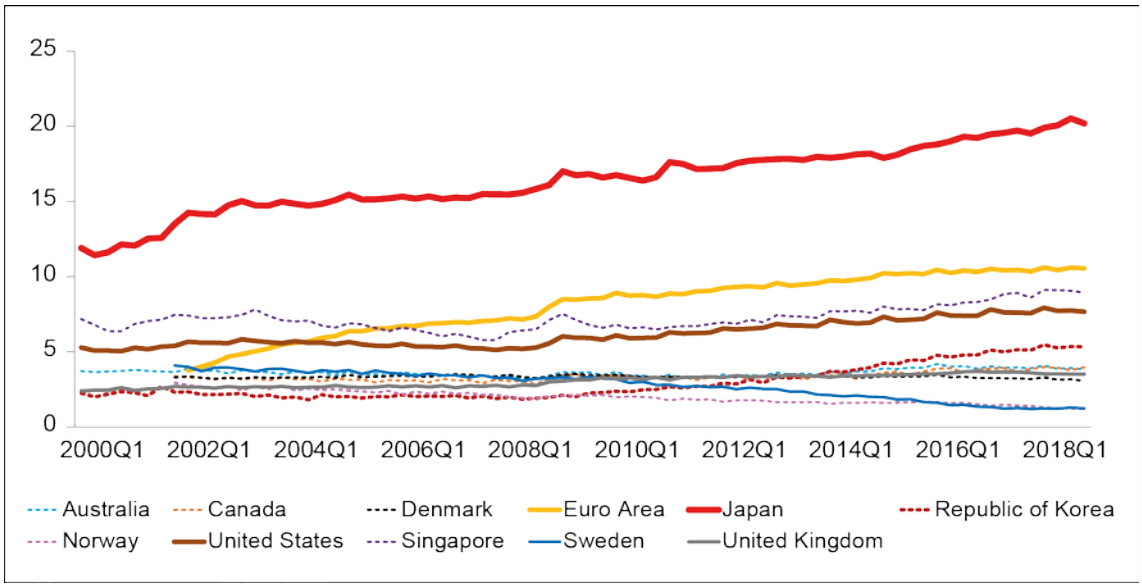
Following households, non-financial firms are generally the second largest holder of cash. They demand cash (and cash equivalents such as checking accounts) mainly due to precautionary motives because of the need to maintain the flexibility in their daily transactions and business decisions related to mergers and acquisitions (M&A) and research and development (R&D) in the face of uncertainty surrounding business conditions and capital constraint. Especially when there is information asymmetry between borrowing firms and creditors, firms with a large growth opportunity or a large external funding risk tend to maintain more liquid assets rather than using uncertain external funding (Myers and Majluf 1984). For firms, a lower interest rate promotes greater cash demand due to a decline in the opportunity cost. Nonetheless, cash holdings are likely to be dominated by households, not by firms, because households often keep cash in safety boxes due to smaller amounts of cash holdings while firms often keep money in the form of cash equivalents (i.e., bank deposits) rather than in the form of cash itself for security reasons (unless for illegal or informal activities). For example, in the case of Japan, where the data on cash holdings by types of holders are available from the flow of funds data, households' cash holdings as of the end of 2018 accounted for 80% of total outstanding cash issued, growing steadily from 53% in 2000. In contrast, the ratio of non-financial firms' holdings dropped from 37.5% to 8.6% over the period. Due to a lack of such detailed data decomposed by types of holders for other economies, this paper examines total cash in circulation without distinguishing between households and firms.

The Case of the 11 Advanced Economies

Figure 1(1) shows the amount of cash in circulation as a percentage of GDP and Figure 1(2) shows cash in circulation in terms of the index (by setting the amount in

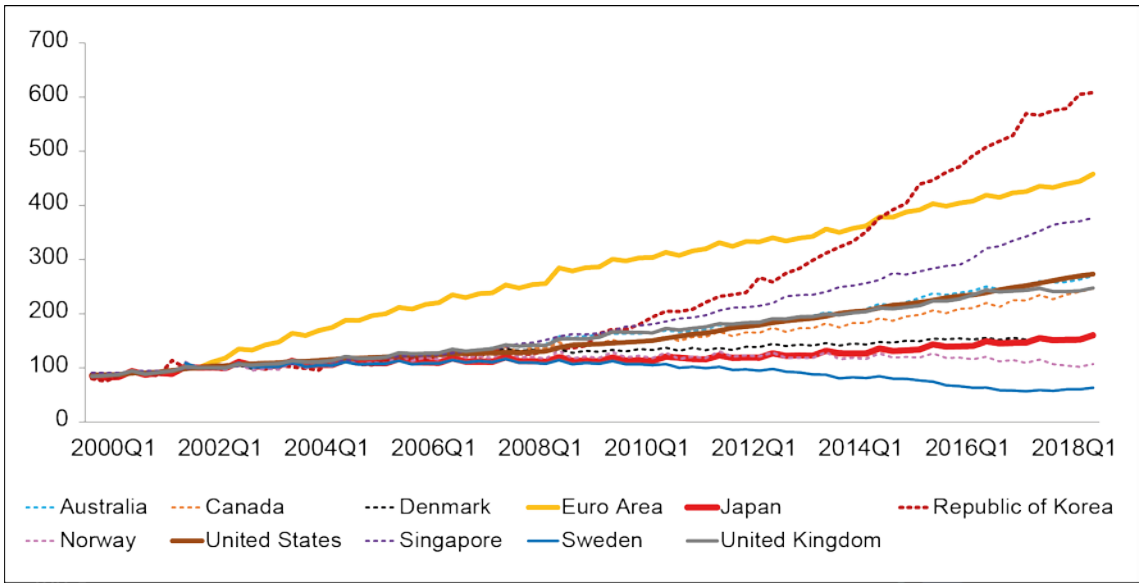
the first quarter of 2002 being equal to 100) for the period 2000–2018 regarding the 11 advanced economies. Charts in Appendix Figure 1 show the development of these two indicators for each economy. These figures indicate that the 11 economies can be classified into the following three types of economies with regards to the trend related to cash-nominal GDP ratio: (1) economies with a rising trend, (2) economies roughly with a stable or constant trend, and (3) economies with a declining trend. The economies with a rising trend include the Euro Area, Japan, the Republic of Korea, Singapore, the United Kingdom, and the United States. The rising trend strengthened in these economies especially after economic uncertainty rose as a result of the global financial crisis of 2008–2009. Greater political/economic/financial uncertainty tends to increase the precautionary demand for cash, reflecting diminished trust in the banking system. By contrast, the economies with a declining trend in the cash-nominal GDP ratio include Denmark, Norway, and Sweden, which all have a well-developed cashless and contactless payment system. The economies with a more or less stable trend include Australia and Canada. Regarding the amount of cash in circulation, all the advanced economies except Sweden and Norway experienced a rising trend, reflecting transaction motive of cash demand. The amount of cash in circulation has grown fast in the Euro Area since the early 2000s, details of which will be discussed later. Since the global financial crisis, the Republic of Korea showed a faster growth in the amount of cash in circulation. In sharp contrast, a declining trend began in Sweden from 2009 and in Norway recently from 2017.

Figure 1(1): Cash in Circulation (% of Nominal GDP) in the Advanced Economies



Source: CEIC, Bank of Canada, and Bank of England.

Figure 1(2): Amount of Cash in Circulation in the Advanced Economies (2002 Q1=100)



Source: CEIC, Bank of Canada, and Bank of England.

Among the advanced economies, it is noted that Japan's cash-nominal GDP ratio has always exceeded other economies by a wide margin and has even increased to around 20% recently, further widening the gap. Japan's high cash demand may reflect that cultural habits such as high levels of public trust in the stable government and legal tender in the face of persistently-low inflation (even though low inflation means that the Bank of Japan's policy to raise inflation to achieve the 2% price stability target is failing). In addition, a limited number of crimes associated with cash handlings and counterfeiting in Japan make it secure for the general public and particularly the elderly to depend on cash. Unwillingness to accept credit cards, debit cards, or other cashless payment instruments by some small retail stores and taxi drivers—because of high installation cost and/or card processing fees—also discourage the public from shifting to a fully cashless-based economy. In addition, Japan's long-standing mild deflation or low inflation reduced the frequency of retail price changes so that the public find it conformable to use cash. In addition, a series of monetary easing measures conducted by the Bank of Japan since the collapse of bubble in stock and real estate prices in the early 1990s reduced interest rates and lowered the opportunity cost of holding cash. The Bank of Japan has performed a series of unconventional monetary easing measures since the late 1990s, which have exerted downward pressures on short- and long-term interest rates—ranging from the zero interest rate policy in 1999–2000, to Quantitative Easing in 2001–2006, and further to Comprehensive Monetary Easing from 2010, which was then replaced in April 2013 by the Quantitative and Qualitative Monetary Easing under the New Governorship led by Haruhiko Kuroda (see Shirai 2018 for details). In addition, the intensified demand for cash in recent years might be driven by tax-saving incentives motivated as a result of various government tax-raising measures. For example, the government introduced the "My Number" system in 2015, providing all the residents with an individual identification number, which can be used for social security, tax payments, renumerations, financial investment, and other government records. Moreover, the government adopted several tax-revenue raising measures—including (a) an inheritance tax hike in January 2015 (by reducing the amount of exemption threshold); (b) an adoption of a compulsory reporting system requiring residents to submit

information on detailed foreign assets to the National Tax Authority in 2014 if exceeding 50 million yen; and (c) an adoption of a compulsory reporting system requiring individuals to submit detailed information about domestic financial/non-financial assets and debts to the National Tax Authority in 2016. The growth rate of cash in circulation has declined recently partly due to the higher penetration of cashless payment instruments, although the cash growth rates have remained above the rates of nominal GDP growth.

In the case of the Euro Area, the circulation of euro banknotes (and coins) began at the end of 2001 and those euro banknotes (and coins) became legal tender in 2002. Demand for euro banknotes appears to have increased gradually as the public gained confidence over the common currency euro as well as monetary policy conducted by the European Central Bank (ECB), as evidenced by the steady increase in the amount of euro in circulation. ECB conducted monetary easing after the global financial crisis and a series of innovative unconventional monetary easing especially from 2014—including negative interest rate policy, Targeted Long-term Refinancing operations (TLTRO I and II), and large-scale asset purchase program. The resultant declining interest rates made cash holding more attractive than before. ECB terminated the asset purchase program at the end of December 2018, announced a continuation of the reinvestment strategy to maintain the outstanding amount of asset holdings, and presented a plan to conduct the first hike on policy rates within 2019. However, economic slowdown in the region and declines in the rates of inflation and inflation expectation forced to the ECB to shift its monetary policy stance from a move toward normalization to a move toward accommodation since early 2019. ECB, thus, postponed the planned timing to raise policy rates to 2020 and made the decision to adopt the new TLTRO III in March 2019 with the effect from September 2019. Furthermore, ECB began to signal its willingness to add further monetary accommodation in the near-term to the market participants from June 2019—in one of the forthcoming Governing Council meetings by deepening the negative interest rate from the current minus 0.4% together with an adoption of the tiering system to mitigate adverse impacts on the banking system. Possible resumption of the asset purchase program has also been hinted. These series of enhanced monetary easing measures may promote further demand for cash.

The United Kingdom has also faced a moderate increase in the ratio of cash to nominal GDP ratio even though the economy is more advanced in terms of new cashless, contactless retail payment systems compared with other advanced economies. The economy had already adopted a retail Faster Payments Scheme in 2008 as a banking sector initiative to accelerate payment times between different banks' customer accounts from three working days to a few seconds. The scheme now offers a real-time payment service for the public 24 hours a day. Contactless cards and instantaneous payments thus became available from around this time. Nevertheless, cash in circulation continues to grow in the United Kingdom. The low interest rate environment generated by the Bank of England and indirectly affected by monetary easing of other major central banks appear to have contributed to greater cash demand. The first quantitative easing was announced in late 2009, expanded further in 2012, and resumed in August 2016 for a short while after the surprise 23 June 2016 Brexit referendum result. Simultaneously, the Bank of England, after having maintained the policy rate at 0.5% from 2008, decided to lower it to 0.25% in August 2016 to cope with expected economic slowdown. However, economic performance turned out better than expected and the United States was making progress with regards to monetary policy normalization so that the Bank of England began to normalize monetary policy by raising the policy rate to 0.5% in 2017 and further to 0.75% in 2018. Since early 2019, the greater concerns related to Brexit and uncertainty related to internal politics have undermined

the British economy and households' and firms' sentiments. This may increase precautionary demand for cash.

In the case of the United States, meanwhile, it is interesting to find that the cash-nominal GDP ratio continued to rise even after the Federal Reserve increased the federal funds rate nine times from 0–0.25% to 0.25–0.5% in December 2015 to 2.25–2.5% in December 2018 in the process of monetary policy normalization. This happened even though households are using cash less frequently than the past. According to the 2017 Diary of Consumer Payment Choice by the Federal Reserve, Kumar and O'Brien (2019) found that individuals used cash in 26% of transactions (down from 30% in 2017 and 31% in 2016), while credit cards and debit cards accounted for 23% (rose from 21% in 2017 and 18% in 2016) and 28% (rose from 26% in 2017 and 27% in 2018), respectively. Prepaid and electronic instruments remained unpopular, accounting for only 2%–3% and 10%–11% over the same period, respectively. Cash was used heavily for small-value payments (under $10) representing about 50% of payments—large-value payments representing only 10% for $50–99.99 and 6% for $100 and above. Surprisingly, the share of cash use among individuals under 25 years old was the highest (33%) of any age group, slightly higher than those aged 55 years old and above. Since early 2019, meanwhile, the Federal Reserve shifted the monetary policy stance from normalization of monetary policy to an accommodative one. First, in early 2019 the Federal Reserve abruptly stopped the interest rate normalization process (which had lasted from December 2015 to December 2018) by stressing muted inflation, declining long-term inflation expectations, and downside risks related to domestic economic growth outlook in the face of uncertainties such as US–PRC trade disputes and Brexit. The United States President Donald Trump has begun to criticize the Federal Reserve since summer 2018 for having made mistakes in 2018 by raising the federal funds rate and conducting the balance sheet run-off (so-called "quantitative tightening"). Second, the Federal Reserve advanced the timing to end the balance sheet run-off (so-called "balance sheet tightening") from the end of 2019 to the end of September 2019 in March 2019. It was further advanced to the end of July 2019—when the decision was made to cut the federal funds rate by 25 basis points from 2.25%–2.5% to 2%–2.25% for the first time since 2008. Thus, the Federal Reserve stopped shrinking the size the balance sheet earlier than originally scheduled. President Trump intensified criticism against the Federal Reserve even after the 25-basis-point policy rate cut at the end of July 2019 because the cut was only 25 basis points rather than the 50 basis points and demanded further cuts of about 100 basis point cuts in the near future. Market participants also expect further several cuts in the federal funds rate within a year because of the concerns over the inverse yield curves (the shorter-term yields such as the 3-month or the 2-year being higher than longer-term yields such as the 10-year), expected economic slowdown in the United States, and uncertainty related to the global economy. It is important to monitor whether such cuts in the policy rate will promote greater demand for cash in this economy.

In sharp contrast to Japan, the Euro Area, the United Kingdom, and the United States, Sweden exhibits a completely different pattern. Sweden progressed to become the most-advanced cashless society among the 11 advanced economies examined because of the declining trend concerning the cash-nominal GDP ratio and the amount of cash in circulation. Credit cards and a mobile-phone-based fast payment system called Swish have been widely available for some time. The pace of decline in the cash-nominal GDP ratio accelerated since 2008, which is contrary to the movements observed among other advanced economies. It should be noted that the Swedish cash-nominal GDP ratio continued to drop even after a negative interest rate policy was adopted on the repo rate in February 2015 and was deepened gradually toward

–0.5% by February 2016 and maintained the same rate until the rate was raised to –0.25% in January 2019 as part of monetary policy normalization. This indicates that a negative interest rate policy did not promote substitution from bank deposits to cash.

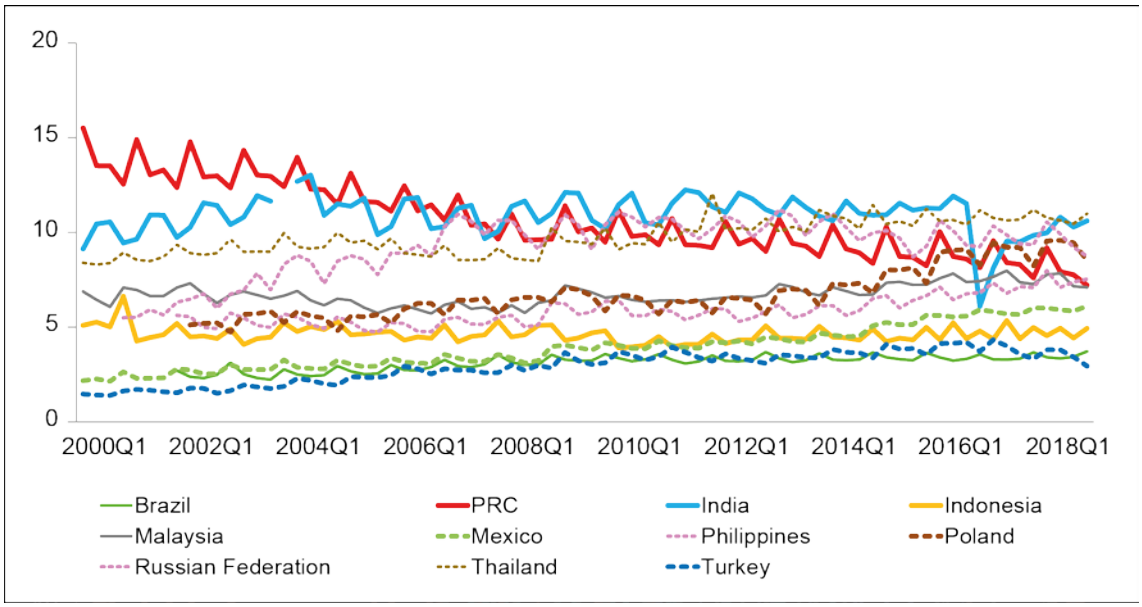
The Case of the 11 Emerging/Developing Economies

The cash-nominal GDP ratios and the amount of cash in circulation in the case of the 11 emerging economies/developing economies are shown in Figure 2(1) and 2(2), respectively. Charts in Appendix Figure 2 show developments with regards to the two indicators for each economy. While all the 11 economies recorded roughly a secular rising trend from early 2000s concerning the number of banknotes in circulation, divergent movements were observed with regards to the ratio of cash-nominal GDP ratios. The economies with a rising cash-nominal GDP ratio include the Republic of Korea, Mexico, the Philippines, Poland, and Thailand. Their rising trend prevailed from early 2000s. The economies with the declining cash-nominal GDP ratio include the PRC from early 2000s and Turkey since 2017. India experienced a sharp drop in the amount and the ratio in October–November 2016 due to the impact of the demonetization currency reform as mentioned below. Finally, the economies with the more or less stable cash-nominal GDP ratio include Brazil, Indonesia, Malaysia, and the Russian Federation.

In particular, a secular declining trend in the cash-nominal GDP ratio in the PRC is noticeable. This is likely to reflect a shift in the form of money held by the public from cash to bank deposits and/or other cashless payment tools (such as Alipay or WeChat Pay). This is in line with the deepening of the banking system and an increase in the number of depositors with commercial banks. Meanwhile, India's cash–GDP ratio remained stable until the fourth quarter of 2016, suggesting that India's cash growth is associated more or less in line with transaction demand growth. A sharp drop in the ratio in India happened temporarily in 2016 after the government abruptly implemented a currency reform that triggered a temporary shortage of banknotes in circulation. India's government banned the Rs100 and Rs500 banknotes and instead introduced a new Rs500 note for the first time and issued new Rs2,000 banknotes. This currency reform was meant to fight corruption and anti-money laundering/illegal activities, but it created severe disruptions to economic activities as a result of creating serious cash shortages. While the cash ratio recovered somewhat in the following year, it appears that the ratio has been lower than the past trend, suggesting a moderate shift from cash to bank deposits or cashless payment tools.

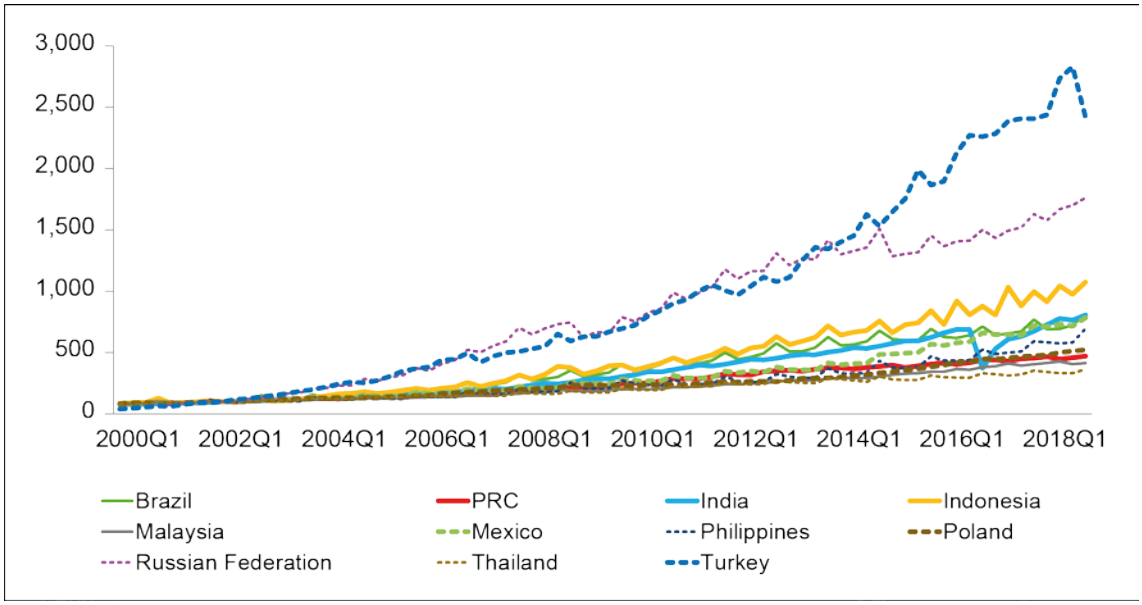
Many emerging/developing economies have increasingly reduced cash usage for payments of goods and services and other transactions in recent years. This is because payment systems are currently experiencing rapid innovation and transformation with the increasing number of technology companies and financial institutions being involved as payment providers. Many governments also encourage the use of electronic payment instruments to improve efficiency in the payment systems. Nevertheless, cash demand remained strong in many economies with the exception of the PRC.

Figure 2(1): Cash (% of Nominal GDP) in the Emerging/Developing Economies



Source: CEIC.

Figure 2(2): Amount of Cash in Circulation in the Emerging/Developing Economies (2002 Q1=100)



Source: CEIC.

2.2 Outstanding Banknotes Issued Differentiated by Denomination in Selected Economies

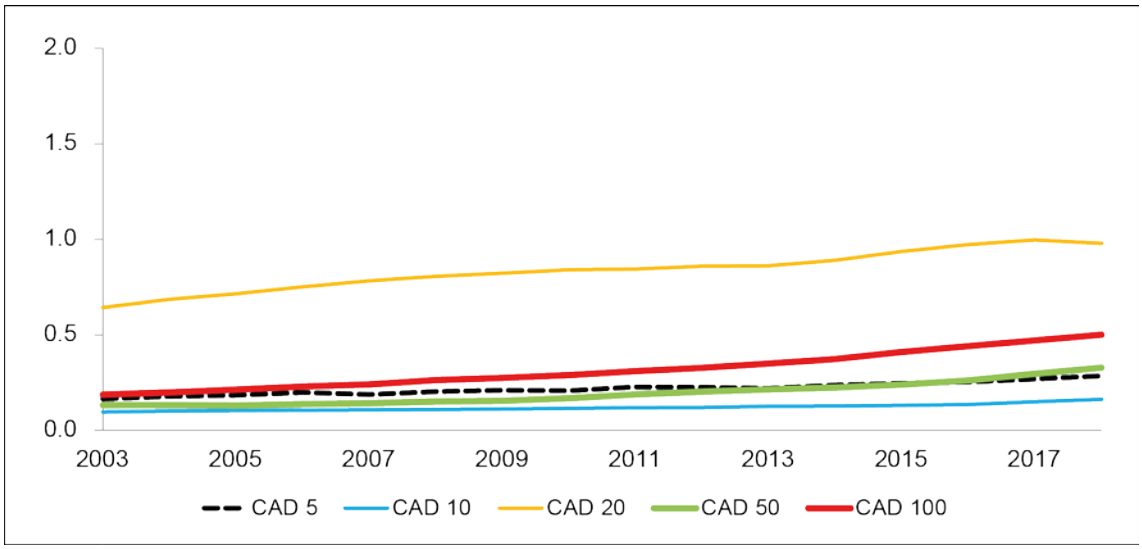
Section 2.2. also investigates the movements of cash demand further by focusing on the number of outstanding banknotes issued by size of denomination. Demand for high-denomination banknotes is likely to be associated more with cash hoarding. Such demand may have become more important during the times of the global financial crisis, since concerns about the solvency of financial institutions might have prompted depositors to withdraw their funds from commercial banks or other equivalent money market funds to increase their precautionary holdings of banknotes (Cusbert and Rohling 2013). Demand for high-denomination banknotes of international reserve currency might be increased by the increased number of foreign tourists, businesspersons, and students who frequently visit the economy under investigation. High-denomination banknotes are also preferred by the people who wish to materialize flight to safety investment. Demand for higher-denomination banknotes could be associated more negatively with changes in interest rates (Arango-Arango and Suarez-Ariza 2019). Regarding payment tools, non-cash payment tools such as credit cards are more frequently used for high-value purchases such as home electronics, furniture, expensive clothes, etc. On the other hand, low-denomination banknotes are more often used for lower-value purchases such as food and beverages. The expansion of ATM networks may increase demand for lower-denomination banknotes because of the increased frequency of trips to withdraw small numbers of banknotes.

Economies with Greater Demand for Highest-Denomination Banknotes

The consistent time-series data on the number of outstanding banknotes issued classified by denomination are available for seven economies—Canada, the Euro Area, Japan, the Republic of Korea, Poland, the United Kingdom, and the United States. Figure 3 exhibits the annual time-series developments of outstanding banknotes issued differentiated by denomination for these economies for the period 2000–2018. These seven economies can be classified into two groups: the first group with dominant largest-denomination banknotes (Japan, the Republic of Korea, and the United States) and the other group with dominant middle-denomination banknotes (Canada, the Euro Area, Poland, and the United Kingdom).

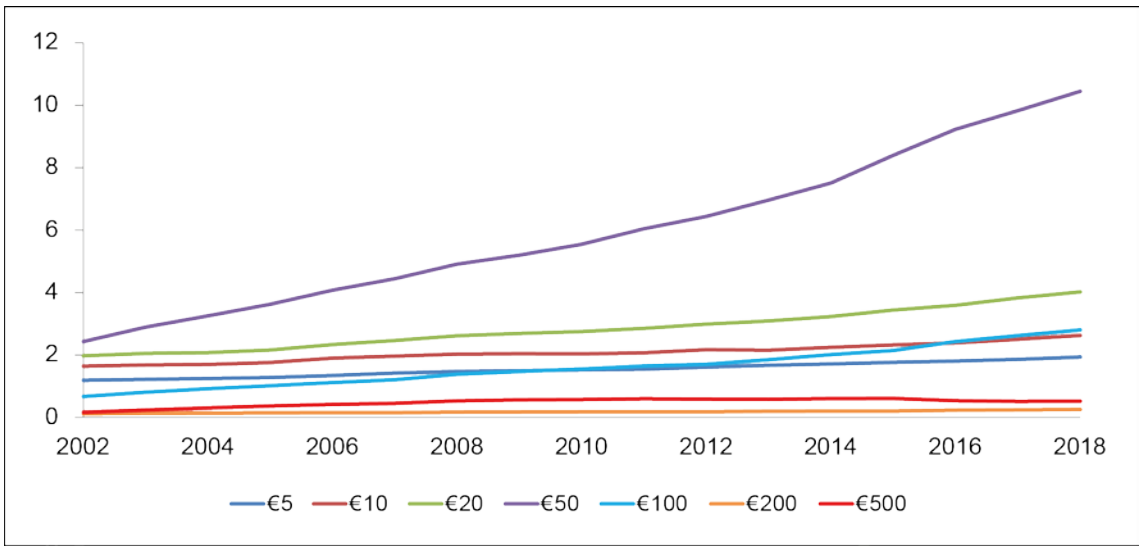
Regarding the first group, the outstanding issuance amount of the largest 10,000-yen note has always been largest over the observation period in Japan. In addition, the pace of issuance increased further since 2013 when the Bank of Japan adopted the Quantitative and Qualitative Monetary Easing. Meanwhile, the Republic of Korea began to circulate the 50,000 won in June 2009 as the largest-denomination banknote and since then the outstanding amount issued rose rapidly. The United States experienced a rapid rise in the issuance outstanding amount concerning the $100 note since the global financial crisis. In both the Republic of Korea and the United States, the amounts of the largest-denomination banknotes exceeded those of smaller-denomination banknotes recently. Consequently, the figures related to Japan, the Republic of Korea, and the United States indicate the presence of high and rising demand for cash holdings since large-denomination banknotes are best suited for this purpose.

Figure 3(1): Banknotes Issued by Denomination in Canada
(Unit: Billions)



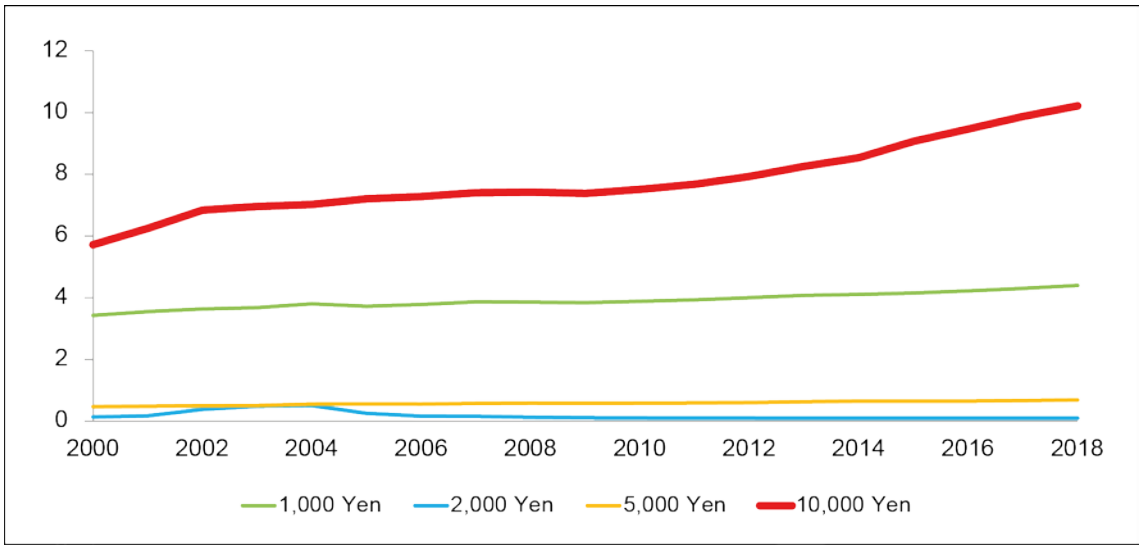
Source: CEIC.

Figure 3(2): Banknotes Issued by Denomination in the Euro Area
(Unit: Billions)



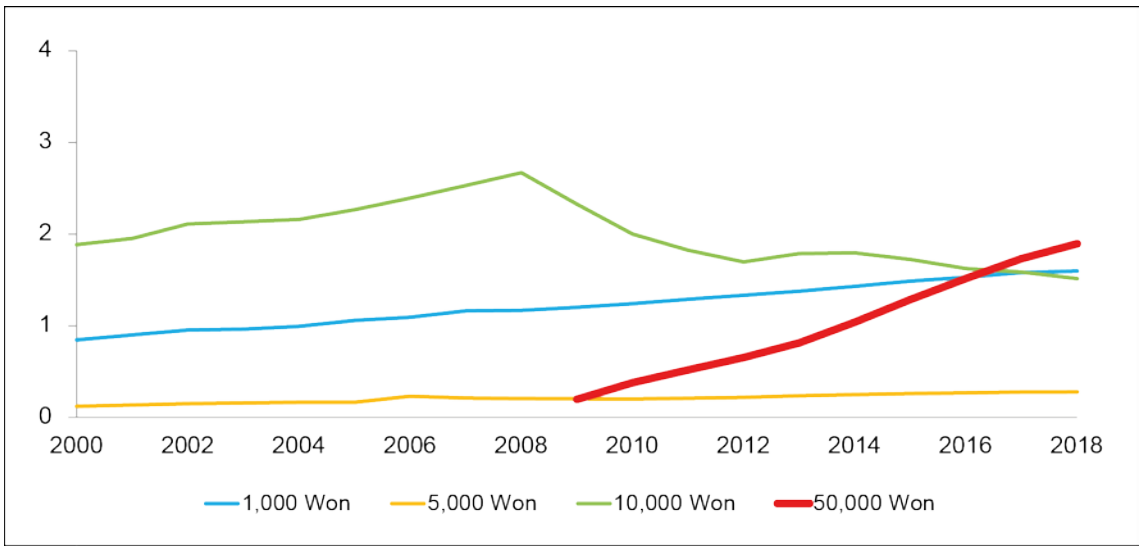
Source: CEIC.

Figure 3(3): Banknotes Issued by Denomination in Japan
(Unit: Billions)



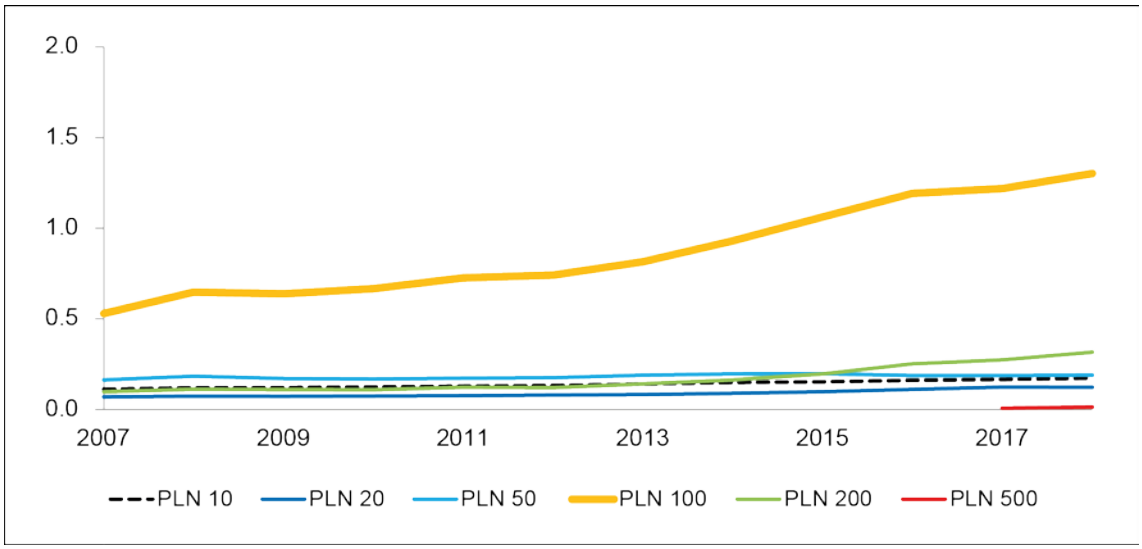
Source: CEIC.

Figure 3(4): Banknotes Issued in the Republic of Korea by Denomination
(Unit: Billions)



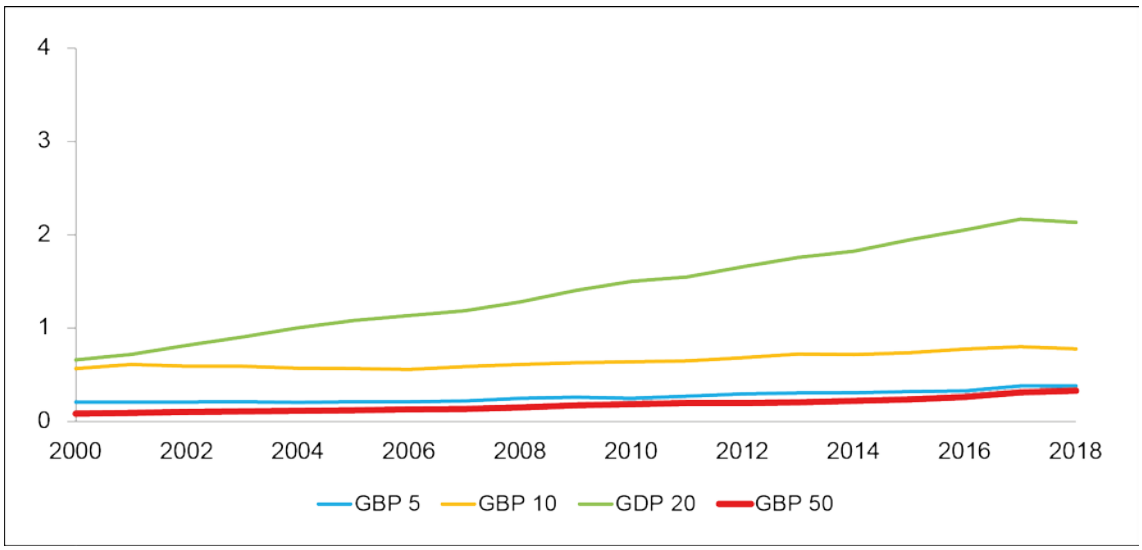
Source: CEIC.

Figure 3(5): Banknotes Issued by Denomination in Poland
(Unit: Billions)



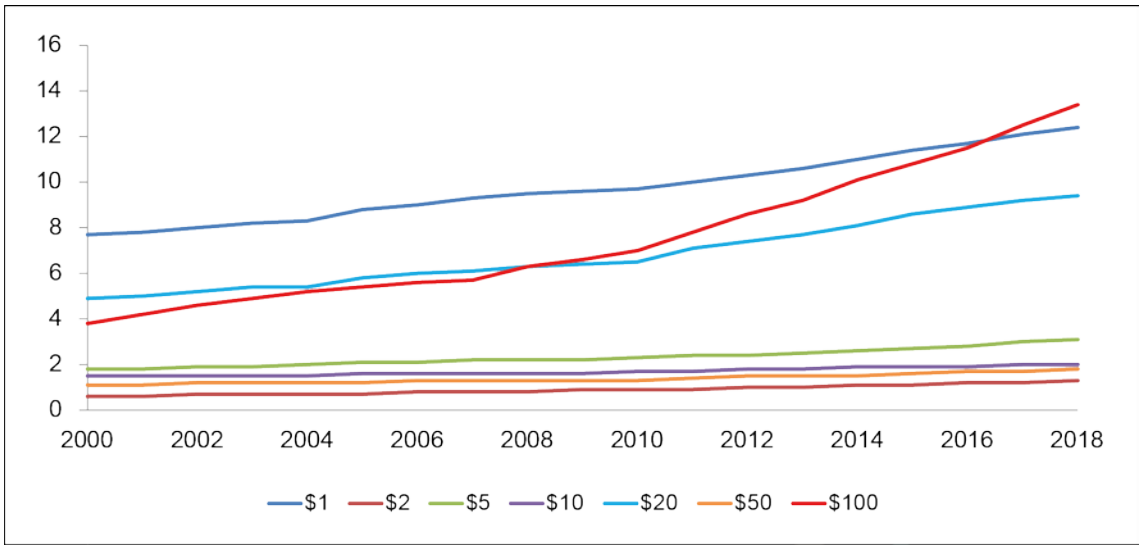
Source: CEIC.

Figure 3(6): Banknotes Issued by Denomination in the United Kingdom
(Unit: Billions)



Source: CEIC.

Figure 3(7): Banknotes Issued in the United States by Denomination
(Unit: Billions)



Source: CEIC.

In the case of Japan, the dominant issuance amount of the 10,000-yen note could be attributed to the increase in cash hoarding driven by downward pressures in interest rates (and low rate of inflation even after massive monetary easing) as well as intensified tax-saving motives mentioned earlier. Otani and Suzuki (2008) estimated cash hoarding by choosing 1995 as the base year, assuming that transaction motive was present, but no cash hoarding was present, thus regarding the difference between the total 10,000-yen banknotes in circulation and that of the base year as the estimated amount of cash hoarding. Fujiki and Nakashima (2019) assumed that cash hording took place only in the form of the 10,000-yen banknote and thus estimated cash hoarding from the difference between all the units of 10,000-yen issued and the estimated transaction motive proxied by the movement of the 1,000-yen banknote (major note used in daily transactions). The paper concluded that about 40% of banknotes in circulation were attributed to cash hoardings, provided that the hoarding of 10,000-yen banknotes began in 1995.

Regarding the United States, the rapidly rising trend of the US$100-note issuance especially after the global financial crisis is noted. The amount of the US$100 note issue exceeded that of the US$20 note and all other denominates except the US$1 note (the most frequently used note in daily transactions) in 2009 and finally exceeded even the amount of the $1 note in 2017. There has been no sign of reversal of these trends. According to the aforementioned 2017 Diary of Consumer Payment Choice (DCPC) conducted by the Federal Reserve, Greene and Stavins (2018) found that the average value of a cash transaction was only $23, compared with $109 for the average non-cash transaction (and $83 for all transactions). From the same database, Kumar, Maktabi, and O'Brien (2018) pointed out that cash represented 55% of transactions under $10. This suggests that consumers evaluated cash highly for being low cost and easy to use. Cash is also an important payment option for low-income households because of the difficulty to obtain credit cards or the high annual charges associated with credit cards. The paper found that households that earned less than $25,000 a year used cash for 43% of their payments.

Several studies pointed out that the rising trend of US$100 issuance is attributable not to only domestic demand but also to foreign demand, which regards the US dollar as a safe haven currency, especially from emerging/developing economies with unstable financial systems and weak macroeconomic fundamentals (Haasl, Schulhofer-Wohl, and Paulson 2018; Judson 2017). High demand for the banknotes from abroad is unique to the case of the US dollar, given the dominant status of the US dollar in various cross-border trade, financial, and other transactions. Foreign holdings of the US dollar banknotes take place through immigrants or tourists' or other cash flows especially from the United States to Mexico, as well as other commercial banking and non-banking cross-border cash transfer channels. Judson (2017) found that foreign demand for the US dollar has increased from the 1990s to early 2000s—a period that coincided with external uncertainties (such as the fall of the Berlin Wall, the collapse of the Soviet Union, and several economic and political crises in Latin America). After such demand stabilized, the global financial crisis has given rise to renewed demand for US dollar banknotes and rising demand continues until the present. Judson (2017) also estimated that such foreign demand has accounted for more than 60% of all US dollar banknotes and nearly 80% of $100 banknotes.

Economies with Greater Demand for Middle-Value Banknotes

As for the second group, the outstanding amount issued over medium-denomination banknotes have dominated that of other larger-denomination and small-denomination banknotes. This is because the public use cash only for lower-value transactions and use credit cards or other cashless payment tools for higher-value transactions. For example, Canada has used the 20 Canadian dollar banknotes dominantly over the period and the gap between it and the largest-denomination (100 Canadian dollar) banknotes has remained large. The Euro Area was dominated by the €50 banknote, followed by the €20 banknote so that the outstanding amounts issued of the €500 banknote, the €200 banknote, and the €100 banknote remained small. In Poland, the value of outstanding issued 100 Poland zloty banknote has been dominant and has widened the gap with that of the 500 and the 200 Poland zloty banknotes. In the United Kingdom, the outstanding amount issued on the £100 banknote has remained dominant and the gaps with the larger-denomination £500 banknote and £200 banknote have expanded over time.

In the case of the Euro Area, the outstanding amount issued on the €500 note issued was never large as compared to other smaller-denomination banknotes such as the €50 and the €20 banknotes despite the adoption of various unconventional monetary easing tools including the large-scale asset purchase program and the negative interest rate policy. This could be may be related to the fact that the residents in the Euro Area maintained smaller-denomination banknotes for daily transactions and did not increase precautionary demand for cash. The ECB conducted a survey in 2016 to analyze the use of cash, cards, and other payment instruments used at points of sale (POS) by Euro Area households (Esselink and Hernández 2017). The survey results indicated that nearly two-thirds of the transactions were below €15. Moreover, two-thirds of all transactions took place in shops for purchases of day-to-day items, as well as in restaurants, bars, and cafés. On the other hand, only 8% of all transactions were above €50, and only 14% were made in shops for durable goods or in petrol stations. The report stated that access to payment cards could not be a major factor in explaining the payment behavior due to there being high access on average in the region; nevertheless, a negative relationship appeared to exist between card acceptance and cash usage. The limited usage of the €500 note indicates that the adverse impact of the ECB's decision in 2016 to stop printing the €500 note from the end

of April 2019 (although continuing to circulate in the economy as legal tender) had limited impact on the economy.

3. EMPIRICAL ANALYSIS ON CASH DEMAND IN THE EURO AREA, JAPAN, AND THE UNITED STATES

This section focuses on the cash demand function of the three largest advanced economies in the world—the Euro Area, Japan, and the United States—which adopted massive unconventional monetary easing after the global financial crisis that contributed to the global low interest rate environment. Cash tends to rise as economic activities (proxied by nominal GDP) grow, mainly reflecting transaction motive. Therefore, this paper uses cash in circulation as a share of nominal GDP as an independent variable in order to examine the trend, excluding the direct impact coming from greater economic activities. In other words, the paper focuses on cash demand that cannot be explained by the transaction motive—such as opportunity cost, precautionary motive, and other motives in the three economies. One of the precautionary motives on which this paper will focus is the presence of uncertainty, which is often enhanced by the economic and financial crisis and resultant turbulence in the financial and capital markets, such as the case of early 2000s dotcom crash and the global financial crisis of 2007–2009. Other motives this paper will highlight is aging, which might exert the positive contribution to cash demand because the elderly may prefer using familiar cash payment tools, have limited access to new credit cards due to their retirement status, or find it difficult to learn new digital instruments. The relative use of cash is expected to decrease eventually and over time due to the effect of generation replacement; however, it will take some time to see this effect in many economies. Based on Spain's microdata, for example, Alonso et al. (2018) demonstrated that the age was a clear determinant in the use of cards as a payment method compared to cash. Namely, the population aged 60 years old and above used 33% more cash than the overall average (in terms of the value of transactions) while the population aged below 30 years old used 44% less cash than the overall average.

This section will estimate the following time-series equation that shows the relationship between cash demand and their potential determinants:

$$CASH_{i,t} = \alpha + \beta_1 INTEREST_{i,t} + \beta_2 AGE_{i,t} + \beta_3 CRISIS_{i,t} + \varepsilon_{i,t} \quad (1)$$

where CASH refers to cash in circulation as a ratio of nominal GDP as already mentioned. This paper uses *i* for country index, while index *t* refers to time period (quarterly). The constant term α reflects a country's specific features that prevailed persistently such as the cultural factors, prevalence of trust, frequency of cash-related crimes, payment habits, and public safety, all of which influence an economy's level of the cash-nominal GDP ratio. Independent variables include proxies for the opportunity cost, the precautionary motive, and other motives. $\varepsilon_{i,t}$ refers to the error term for the respective country, which captures other factors besides the independent variables that affect the dependent variable.

Among independent variables, INTEREST represents the opportunity cost or the forgone interest of holding cash and is proxied by the central bank policy rate. The 10-year yield (10-YEAR) is used interchangeably because some central banks faced the zero lower bound or effective lower bound after having lowered the policy rates and thus pay more attention to the longer-term yields to generate monetary accommodation. The signs of INTEREST and 10-YEAR parameters are expected to be

negative. The precautionary motive is represented by CRISIS, which is a dummy variable to capture macroeconomic turbulences. The variable is set equal to one during the IT bubble burst in early 2000 (from the second quarter of 2000 to the third quarter of 2001) and the global financial crisis (from the second quarter of 2007 to the first quarter of 2009), and zero otherwise. This study attempted to use an alternative variable for the precautionary motive, which is the volatility index of stock markets (VOLAT)—namely, VIX (the Chicago Board Options Exchange Volatility Index which measures the stock market's expectation of volatility implied by S&P500 index options for the United States), similar Euro Stoxx 50 volatility index for the Euro Area, and similar Nikkei-255 volatility index for Japan. Regarding other motives, this paper uses AGE as the age-related variable which is proxied by the ratio of population aged equal or greater than 65 years old. Life expectancy (LIFE) was used interchangeably with AGE. The logarithmic form is used for LIFE to enable measuring the impact of its change on the dependent variable in a percentage term. The signs of AGE and log (LIFE) parameters are expected to be positive.

Besides examining equation (1), this section also examines the impact of country-specific variables on cash in circulation: nominal effective exchange rate for the case of the United States (NEER_US), and negative deposit interest rates in the case of Euro Area and Japan (proxied by dummy variable called NEG_INT).

NEER_US variable is used as a proxy for measuring demand for the US dollar from abroad which may rise from emerging/developing economies during a crisis or period of economic turbulence or amplified global uncertainty, as already pointed out in Section 2. An increase in NEER_US means an appreciation of the US dollar against major trade partners. Demand for the US dollar from abroad may rise especially when the US dollar is stronger, since a strength of the US dollar is often associated with a decline in risk appetite among global investors driven by greater global economic uncertainty. The sign of the NEER_US parameter is expected to be positive.

With respect to NEG_INT for the case of Euro Area and Japan, the value of the NEG_INT is set to one for period when the deposit interest rate in the respective country is negative, and zero otherwise The ECB announced a negative rate on the deposit facility rate at -0.1% in June 2014 and deepened the rate gradually toward –0.4% by March 2016. After having been preparing and announcing for a first-rate hike (scheduled around the fall of 2019) from 2018, the ECB changed the stance of monetary policy in 2019 due to concerns over low inflation and low inflation expectations. ECB adopted a package of monetary easing in September 2019 by deepening the deposit facility rate further to –0.5% together with a restart of the asset purchase program with effect from November 2019. Meanwhile the Bank of Japan announced an adoption of a negative interest rate of –0.1% on a small portion of their excess reserves with the Bank in January 2016. The negative interest rate on excess reserves is expected to increase cash in circulation, as households may be encouraged to hold cash rather than placing their money in banks. Therefore, the sign of NEG_INT parameter is expected to be positive.

Table 1 shows the regression results of the time-series final estimation models. Model (1) pairs the INTEREST and AGE variables, while Model (2) pairs INTEREST and log (LIFE). Models (3) and (4) are for the Euro Area only, where the former pairs the 10-YEAR and AGE while the latter pairs the 10-YEAR and log (LIFE). Model (5) is prepared specifically for the United States where it pairs INTEREST, AGE, and NEER variables. The paper added the autoregression term AR (1) in all the estimation models due to the presence of autocorrelation problem. Table 1 does not display the results of models that include 10-YEAR for Japan and the United States, CRISIS, VOLAT, and NEG_INT, as these variables were not statistically significant.

Table 1: Regression Results
(Prob t-statistics in bracket)

Model (1)

	Constant	INTEREST (%)	AGE (%)	AR (1)	R^2	Adjusted R^2	Prob (F-stats.)	Durbin-Watson Stats.
Euro Area	–6.2114** (0.0890)	–0.3166* (0.0000)	0.7496* (0.0002)	0.9947* (0.0000)	*0.9948*	*0.9945*	*0.0000**	*1.8771*
Japan	9.1323* (0.0092)	–1.2409* *(lag 1)* (0.0015)	0.3272* (0.0017)	0.9927* (0.0000)	*0.9851*	*0.9842*	*0.0000**	*1.8037*
United States	–2.7772* (0.0000)	–0.0781* (0.0004)	0.6822* (0.0000)	0.6497* (0.0000)	*0.9840*	*0.9830*	*0.0000**	*2.1380*

Model (2)

	Constant	INTEREST (%)	Log (LIFE)	AR (1)	R^2	Adjusted R^2	Prob (F-stats.)	Durbin-Watson Stats.
Euro Area	–143.0819* (0.0000)	–0.3136* (0.0000)	34.4662* (0.0071)	0.9968* (0.0000)	*0.9936*	*0.9932*	*0.0000**	*1.8050*
Japan (with constant)	22.6300 (0.8269)	–1.4198* *(lag 1)* (0.0001)	–1.4852 (0.9498)	0.9973* (0.0000)	*0.9818*	*0.9807*	*0.0000**	*1.5407*
Japan (without constant)	–	–1.4008* *(lag 1)* (0.0001)	3.6344* (0.0000)	0.9971* (0.0000)	*0.9817*	*0.9809*	–	*1.5629*
United States	–201.6661* (0.0029)	–0.0709 (0.2160)	47.7892* (0.0021)	0.9655* (0.0000)	*0.9612*	*0.9589*	*0.0000**	*2.3138*

Model (3)

	Constant	10-YEAR (%)	AGE (%)	AR (1)	R^2	Adjusted R^2	Prob (F-stats.)	Durbin-Watson Stats.
Euro Area (with constant)	–5.4670 (0.2037)	–0.1607* (0.0011)	0.7063* (0.0018)	0.9946* (0.0000)	*0.9933*	*0.9929*	*0.0000**	*1.8044*
Euro Area (without constant)	–	–0.1659* (0.0005)	0.5642* (0.0060)	0.9989* (0.0000)	*0.9933*	*0.9929*	–	*1.8216*

Model (4)

	Constant	10-YEAR (%)	Log (LIFE)	AR (1)	R^2	Adjusted R^2	Prob (F-stats.)	Durbin-Watson Stats.
Euro Area	–27.4449* (0.0123)	–0.1992* (0.0003)	0.4433* (0.0015)	0.9963* (0.0000)	*0.9925*	*0.9920*	*0.0000**	*1.6878*

Model (5)

	Constant	INTEREST (%)	AGE (%)	NEER	AR (1)	R^2	Adjusted R^2	Prob (F-stats.)	Durbin-Watson Stats.
United States	–3.1531* (0.0000)	–0.0874* (0.0000)	0.6651* (0.0000)	0.0056* (0.0334)	0.6090* (0.0000)	*0.9847*	*0.9836*	*0.0000**	*2.1318*

* = significant at 5% significance level; ** = significant at 10% significance level.

Source: Authors' calculations.

Regarding the opportunity cost, INTEREST was statistically significant for the three economies in most of the estimation models adopted in this paper. In the case of Japan, one-period lag for INTEREST was used as it showed statistical significance only when using the lag. Meanwhile, the 10-year yield was statistically significant for the Euro Area, but not statistically significant in the case of Japan and the United States. This may imply that the central bank policy rate is affecting cash demand in the three economies mainly through shorter-term interest rates rather than longer-term interest rates often set based on the benchmark government bond yields.

As for the precautionary motive, CRISIS and VOLAT were not statistically significant for the three economies. Thus, the precautionary motive was not a major factor affecting demand for cash in the Euro Area, Japan, and the United States. Regarding other variables, the AGE and log (LIFE) variables were statistically significant in the most of estimation models, both with positive signs as expected. These findings confirm that the age-related factors have a positive contribution to demand for cash.

The NEER_US was statistically significant for the case of United States and the parameter sign was positive as expected, but the value of its parameter was rather too small. NEG_INT was not statistically significant for both Euro Area and Japan. This implies that the negative interest rate policy did not significantly affect demand for cash in the Euro Area and Japan, contrary to the widely-shared view. This may reflect that the policy rate was a dominant opportunity cost factor contributing to cash demand.

Results from Model (1) exhibited that absolute value of INTEREST parameter was largest in Japan (–1.2), followed by the Euro Area (–0.3) and the United States (–0.08). In the case of Japan, the negative relationship indicates that a decline in the central bank policy rate by 1 percentage point has raised the ratio of cash in circulation to nominal GDP by more than 1 percentage point. Japan's high sensitivity of cash demand to the change in the central bank policy rate reflect that cash and retail bank deposits have become a closer substitute. Households have increased both cash and bank deposits over the period 2000–2018 not only in terms of the value, but also relative to nominal GDP. In addition, households increased cash holdings faster than bank deposits, as evidenced by an increase in the ratio of cash to total financial assets from about 2% in early 2000s to about 5% in 2018 and a decline in the ratio of bank deposits to total assets from about 51% in early 2000s to about 48% in 2018. By contrast, the United States were least sensitive to changes in the central bank policy rate. Regarding the AGE variable, the parameters were statistically significant and positive for the three economies. The size of the parameters was largest in the Euro Area (0.75), followed by the United States (0.7) and Japan (0.3).

Results from Model (2) were in line with the results from Model (1). The constant term was not significant for Japan in Model (2), hence, it was excluded from the final model. In the final model, Japan had the largest absolute value with regards to the parameter of INTEREST (–1.4), followed by the Euro Area (–0.3). INTEREST was not significant for the United States in Model (2); it was statistically significant in Model (1) but the parameter value was rather small. The log (LIFE) variable was significant and positive for the three economies in the final version of Model (2), as expected.

As shown by the results of Models (3) and (4), the 10-YEAR variable was statistically significant in the case of Euro Area. The final version of Model (3) does not include the constant term as it is not statistically significant. The 10-YEAR variable was statistically significant and negative (-0.2), while the AGE variable was significant and positive (0.6)—both parameter signs were as expected. Results from Model (4) are consistent with Model (3), where the 10-YEAR and log (LIFE) were significant and both parameter signs were as expected (–0.2 for the 10-YEAR and 0.4 for the log (LIFE)). In brief, results

from Model (3) and (4) show that the rise in the yield of government bond would reduce cash demand, while the increase in the proportion of the elderly to total population and the extension of life expectancy would increase demand for cash.

Results from Model (5) show that INTEREST, AGE, and NEER variables were statistically significant in the case of the United States, where the parameter signs for these variables were as expected. Having said that, the size of parameter NEER_US (0.006) was rather too small—if not negligible. This finding implies that foreign demand for the US dollar only marginally affected cash demand in the United States once taking into account other motives.

4. EMPIRICAL ANALYSIS COVERING ADVANCED AND EMERGING/DEVELOPING ECONOMIES

Section 4 develops several econometric models and conducts pooled-data regressions for the 22 economies based on the following generic equation:

$$CASH_{i,t} = \alpha + \beta_1 INTEREST_{i,t} + \beta_2 AGE_{i,t} + \beta_3 CRISIS_{i,t} + \varepsilon_{i,t}$$

As was the case in Section 3, this section uses cash in circulation to nominal GDP ratio for CASH as a dependent variable. Among independent variables, the central bank policy interest rate (INTEREST) or the yield of the benchmark 10-year yield (10-YEAR) is used to capture the opportunity cost. As for the precautionary motive, crisis dummy variable (CRISIS) is adopted, where the value setting of this variable is the same as in Section 3. The stock market volatility index is not used in the pooled-data model due to the lack of relevant data for many sample economies. As age-related factors, AGE is used interchangeably with log (LIFE). The term *i* refers to country index, while *t* refers to time index. $\varepsilon_{i,t}$ refers to the error term for the respective economy. The signs of parameters in the model are expected to be negative for INTEREST and 10-YEAR and positive for AGE, log (LIFE), and CRISIS. The Hausman test is conducted to select the appropriate form (between the random-effect or fixed-effect) for each model.

Table 2 shows the results of the models with relatively good performance: Model (1), with INTEREST and AGE as independent variables; Model (2), with INTEREST and log (LIFE) as independent variables; and Model (3), with 10-YEAR and log (LIFE) as independent variables. Table 2 does not display models that incorporate the CRISIS variable, as it was not statistically significant in the models; this implies that crisis was not a major determinant for cash hoarding once covering the 22 economies in the sample.

Results from Model (1) exhibited that INTEREST and AGE were statistically significant, with a negative sign on INTEREST and a positive sign on AGE. These signs are in line with the hypotheses. This suggests that for the 22 economies combined, the central bank policy rate hike reduced demand for cash, while an increase in the ratio of elderly population increased demand for cash—similar to the results shown in Section 3. Both INTEREST and log (LIFE) were statistically significant in Model (2). The parameter sign for INTEREST was negative, while positive for log (LIFE)—in line with the hypotheses. Similar to Model (1), demand for cash increased when life expectancy rose, but it fell when the policy rates increased. As proxy for opportunity cost, 10-YEAR was less robust than INTEREST as a regressor in the pooled-data models. Results from Model (3) showed that the 10-YEAR and log (LIFE) variables were statistically significant, with a negative sign for 10-YEAR and positive for log (LIFE). Nonetheless, in the model

using 10-YEAR and AGE as independent variables, it turned out that 10-YEAR was not statistically significant, while AGE remained statistically significant.

Table 2: Pooled-Data Regression Results for the 22 Economies
(Probability of t-statistics in bracket)

MODEL 1		**MODEL 2**		**MODEL 3**	
Constant	1.7877* (0.0346)	Constant	–64.4437* (0.0000)	Constant	–72.7090* (0.0000)
INTEREST (%)	–0.0162* (0.0000)	INTEREST (%)	–0.0122* (0.0000)	10-YEAR (%)	–0.0652* (0.0000)
AGE (%)	0.3811* (0.0000)	Log (LIFE)	17.2276* (0.0000)	Log (LIFE)	18.2785* (0.0000)
Random Effects Coefficients (Cross)		**Fixed Effects Coefficients (Cross)**		**Fixed Effects Coefficients (Cross)**	
_Australia	–3.9408	_Australia	–3.5006	_Australia	–3.7631
_Canada	–4.8990	_Canada	–3.7581	_Canada	–4.0857
_Denmark	–0.6594	_Denmark	–3.3173	_Denmark	–3.6377
_Euro Area	6.1656	_Euro Area	1.0526	_Euro Area	0.6967
_Japan	–2.8132	_Japan	8.7332	_Japan	8.2646
_Korea	–5.6550	_Korea	–3.9400	_Korea	–4.2019
_Norway	1.8051	_Norway	–5.0321	_Norway	–5.7552
_Singapore	–6.0034	_Singapore	0.0783	_Singapore	–0.4282
_Sweden	–5.1291	_Sweden	–4.2778	_Sweden	–5.1914
_Utd. Kingdom	–0.6614	_Utd. Kingdom	–3.7920	_Utd. Kingdom	–4.0926
_United States	–1.0866	_United States	–0.3497	_United States	–0.6184
_Brazil	5.6836	_Brazil	–2.1657	_Brazil	–1.9685
_PRC	7.2645	_PRC	5.1633	_PRC	3.6757
_India	0.9613	_India	7.4676	_India	7.5922
_Indonesia	2.9679	_Indonesia	0.3533	_Indonesia	0.7204
_Malaysia	0.5760	_Malaysia	1.0694	_Malaysia	0.9763
_Mexico	2.5939	_Mexico	–1.5151	_Mexico	–1.3618
_Philippines	–0.3385	_Philippines	1.6567	_Philippines	1.7516
_Poland	3.1243	_Poland	0.6448	_Poland	0.4499
_Russian Fed.	4.6195	_Russian Fed.	5.3306	_Russian Fed.	5.5561
_Thailand	–1.2731	_Thailand	4.3703	_Thailand	4.1772
_Turkey	–1.0866	_Turkey	–2.2893	_Turkey	–1.9811
Weighted Statistics					
R-squared	*0.2855*	*R-squared*	*0.9515*	*R-squared*	*0.9618*
Adj. R-squared	*0.2845*	*Adj. R-squared*	*0.9506*	*Adj. R-squared*	*0.9611*
Prob (F-stats.)	*0.0000**	*Prob (F-stats.)*	*0.0000**	*Prob (F-stats.)*	*0.0000**

* = significant at 5% significance level.

Source: Authors' calculations.

5. CONCLUSIONS

This paper focused on the movements of cash in circulation by investigating demand-driven factors contributing to the movements for the period 2000–2018. It focused on the time-series movements of cash in circulation (both in terms of the amount and nominal GDP) among 20 economies for the period 2000–2018. The results of the analysis can be summarized as follows:

- Among the 11 advanced economies with regards to the trend related to cash-nominal GDP ratio, there were economies with a rising trend (the Euro Area, Japan, the Republic of Korea, Singapore, the United Kingdom, and the United States), economies roughly with a stable or constant trend (Australia and Canada), and economies with a declining trend (Denmark, Norway, and Sweden). Regarding the economies with a rising trend, the rising pace accelerated especially after the economic uncertainty rose as a result of the global financial crisis of 2008–2009. As for the amount of cash in circulation, all the economies except Sweden from 2009 and Norway from 2017 showed a secular rising trend. In particular, Japan's substantially high and rising cash-nominal GDP ratio is noticeable, perhaps reflecting the public's trust in the stable government and legal tender in the face of persistently-low inflation a limited number of crimes associated with cash handlings and counterfeiting; it also has the highest proportion of the elderly in total population.
- As for the 11 emerging/developing economies, all the economies recorded the secular rising trend from early 2000s concerning the amount of cash in circulation. Some divergent movements were observed with regards to the ratio of cash-nominal GDP ratios. The economies with the rising cash-nominal GDP ratio included the Republic of Korea, Mexico, the Philippines, Poland, and Thailand—all growing from early 2000s. Meanwhile, the economies with the declining cash-nominal GDP ratio included the PRC from early 2000s and Turkey since 2017. India experienced a sharp drop in the amount and the ratio in October–November 2016 due to the impact of the demonetization currency reform. Finally, the economies with a more or less stable cash-nominal GDP ratio included Brazil, Indonesia, Malaysia, and the Russian Federation.
- With regards to the seven economies where data on banknotes in circulation differentiated by denomination are available, the economies were found to be classified into two groups: economies with dominant highest-denomination banknotes (Japan, the Republic of Korea, and the United States) and economies with lower-denomination banknotes (Canada, the Euro Area, Poland, and the United Kingdom). The former group may indicate the presence of high and rising demand for cash hoarding since high-denomination banknotes are best suited for this purpose. In addition, the rising trend of the highest denomination, US$100, could be attributable not to only domestic demand-driven factors but also to foreign demand that regards the US dollar as a safe haven currency. As for the second group, the outstanding amount issued over medium-denomination banknotes have dominated that of other higher-denomination and lower-denomination banknotes. This is because the public use cash only for lower-value transactions and use credit cards or other cashless payment tools for higher-value transactions.
- The paper subsequently conducted an empirical analysis first with regards to the Euro Area, Japan, and the United States separately in various regression models. Using the ratio of cash in circulation to nominal GDP as a dependent variable, this paper used various variables as proxies for the opportunity cost (interest rate), the precautionary motive (triggered by economic/financial crises) and other motives (aging and demand from abroad). Regarding the opportunity cost, the central bank policy rate was the most robust variable in the three economies, as it was statistically significant in most of the estimation models adopted. The 10-year yield was used as a variable alternative to the policy rate but was found statistically significant only for the Euro Area. This may imply that the central bank policy rate is affecting cash demand in the three economies mainly through

shorter-term interest rates rather than longer-term interest rates. The other statistically significant variable was the age-related factors. As a proxy for foreign demand for the US dollar from abroad, the paper used the nominal effective exchange rate of the US dollar. The variable was statistically significant, but the value of its parameter was rather too small. The precautionary motive proxied by the crisis dummy variable or the stock market volatility index was not statistically significant for the three economies. The econometric analysis was then conducted for pooled-data regressions covering the 22 economies with the similar equation. As was the case of the previous results, the central policy rate and age-related factor remained the most important determinant for demand for cash in these economies.

This paper found that the low interest rate environment generated by massive monetary easing contributed to increasing demand for cash not only in advanced economies, but in emerging/developing economies. The inertia continued in the United States even after the normalization of monetary policy was conducted from December 2015 to December 2018. Age-related factors were also found to be important contributor to higher cash demand. As a future topic, it will be interesting to examine whether demand for cash will decline if stable crypto assets such as Facebook's Libra— which will stabilize the value against the basket of reputable, fiat currencies such as the US dollar— become widely used in the world.

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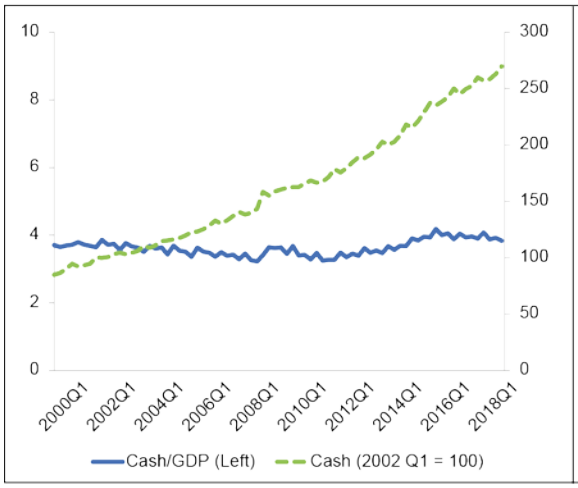
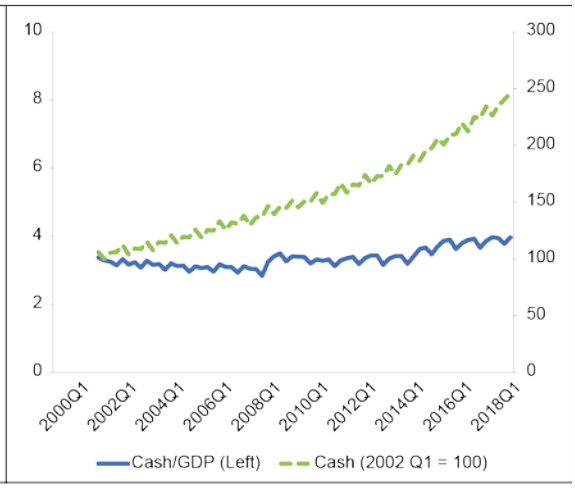
APPENDIX

Appendix Figure A1: Cash in Circulation in the Advanced Economies
(% of Nominal GDP, 2002 Q2=100)

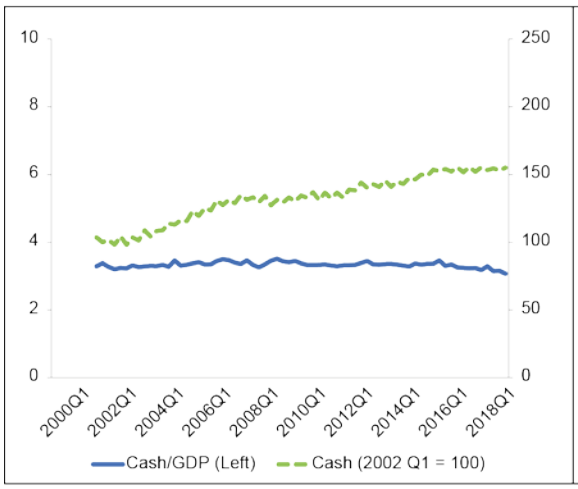
(1) Australia



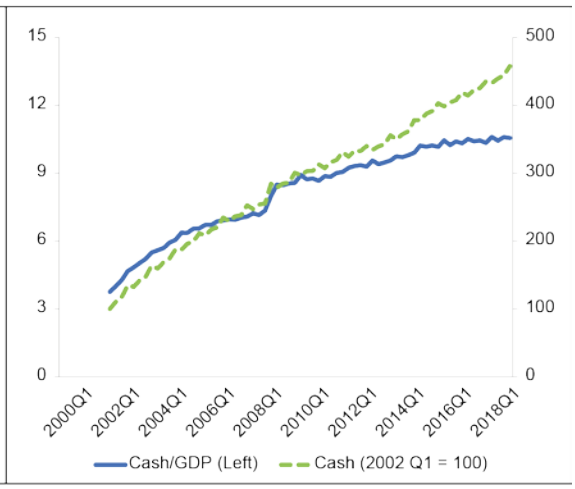
(2) Canada



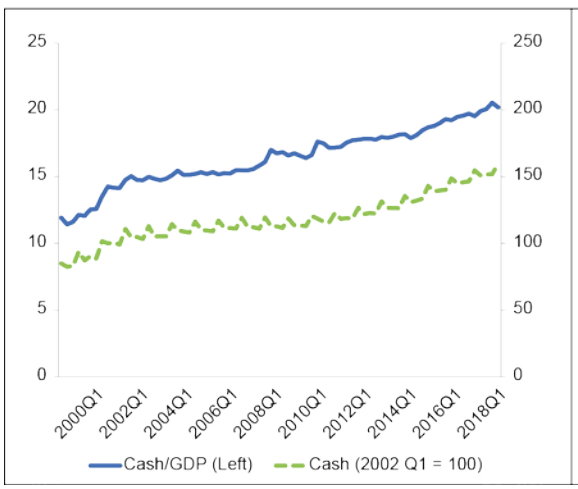
(3) Denmark



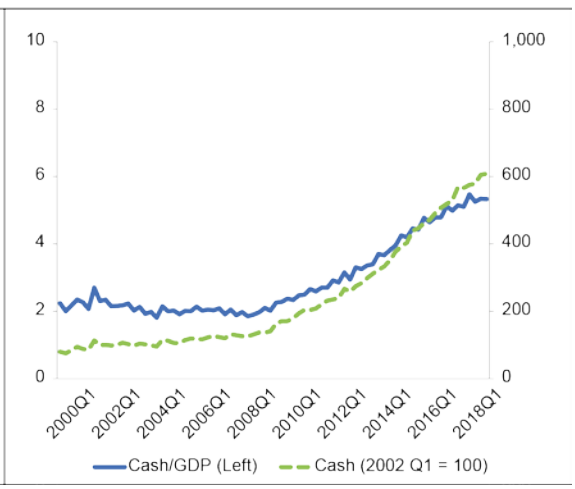
(4) Euro Area



(5) Japan



(6) Republic of Korea



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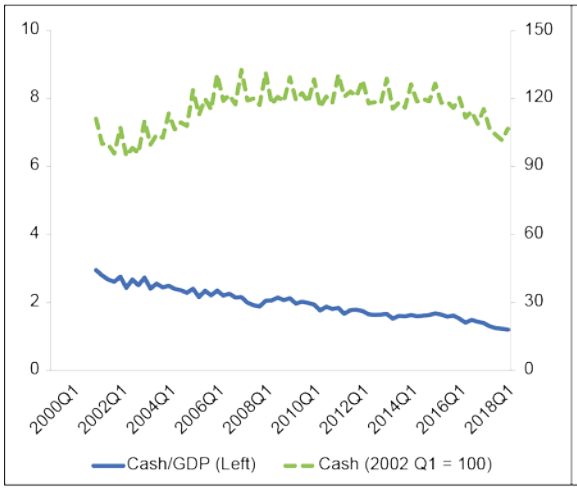
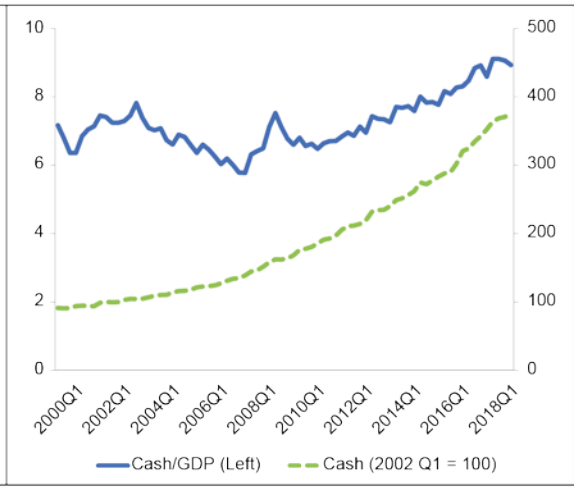
Appendix Figure A1 *continued*

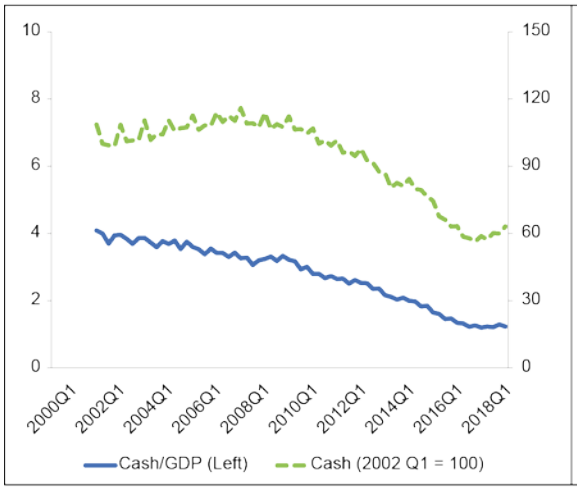
(7) Norway



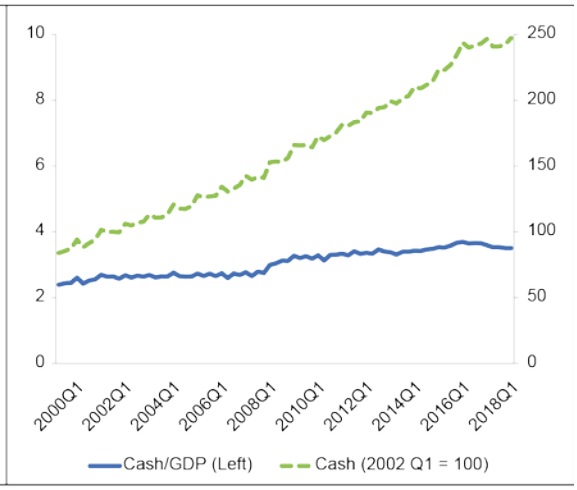
(8) Singapore



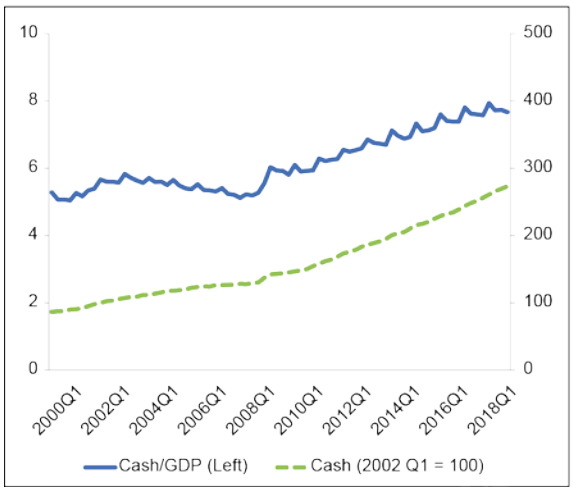
(9) Sweden



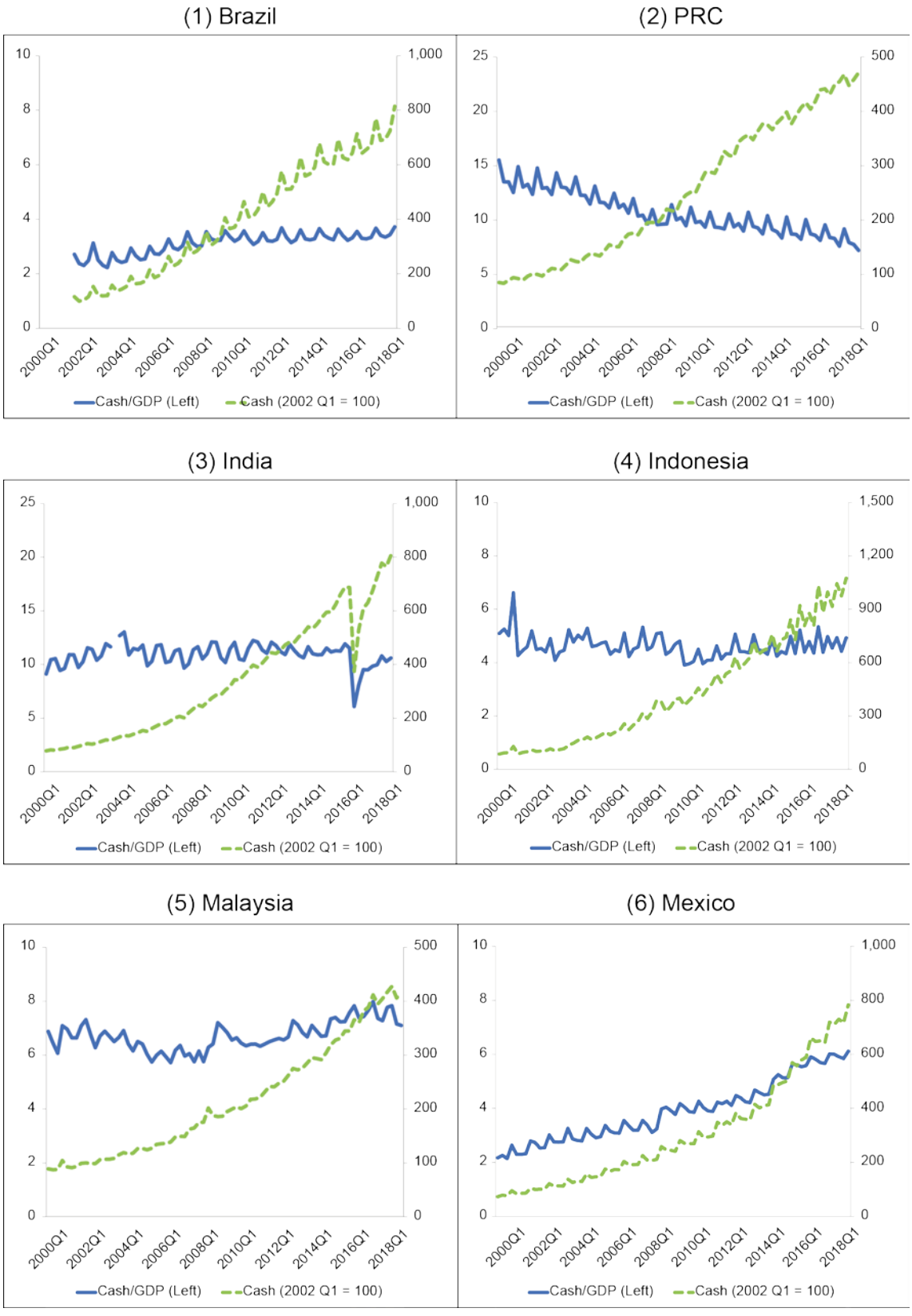
(10) United Kingdom



(11) United States



Appendix Figure A2: Cash in Circulation in the Emerging/Developing Economies
(% of Nominal GDP, 2002 Q2=100)



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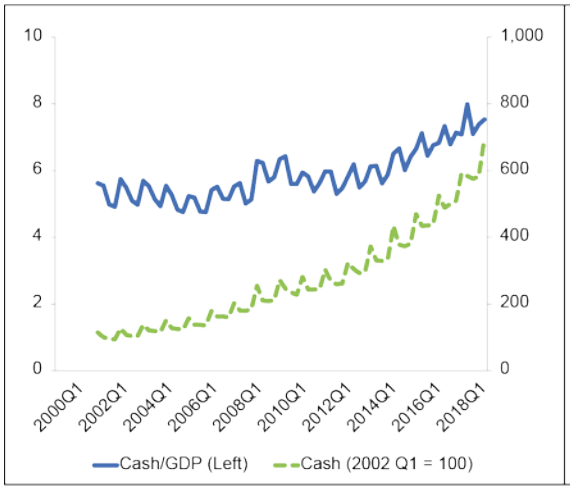
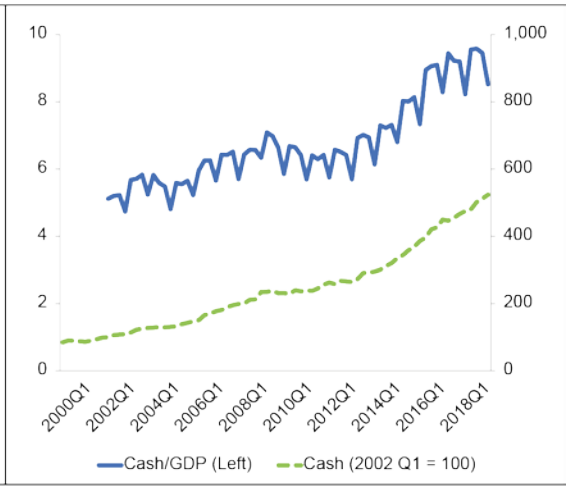
Appendix Figure A2 *continued*

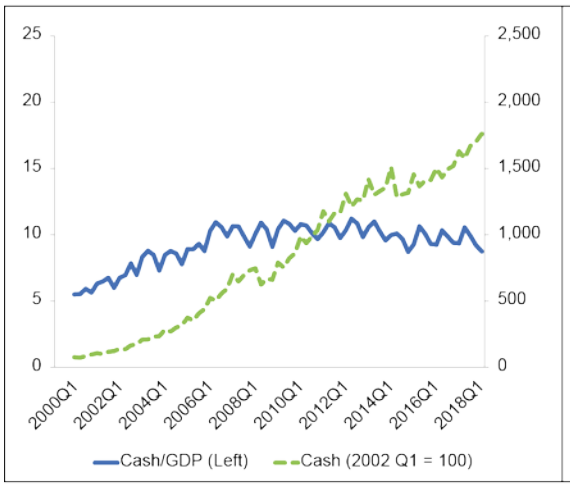
(7) Philippines



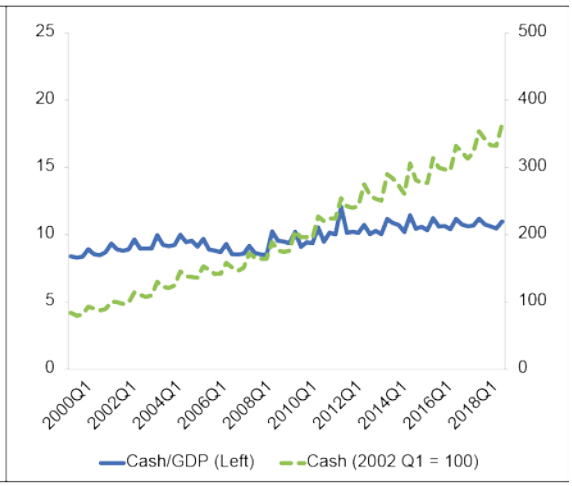
(8) Poland



(9) Russian Federation



(10) Thailand



(11) Turkey