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**The Effects of E-payment Instruments on Cash Usage:
Thailand's Recent Evidence and Policy Implications**

Rungsun Hataiseree

Payment Systems Department, Bank of Thailand

Wachirawat Banchuen

Thammasat University, Thailand

Abstract

The effects of e-payment instruments on cash use are examined for Thailand. The examination is undertaken using quarterly data from 2005-2010. The results shows that some forms of e-payment instruments like debit cards, have *negatively* affected currency in circulation, while GDP and interest rates are found to exert significant influence on currency demand as expected from the theory. The estimated coefficient of cash-card substitution of 0.15 suggests that a 10% increase in debit cards transactions would result in the reduction of demand for cash transactions of around 1.5%. However, given the low degree of debit card usage for making payments and the slow change in the payment behavior, it is unlikely that this development will have noticeable impact on the future use of cash and the implementation of monetary policy. This suggests that payments by cash continue to be strong at around 8-10% of GDP for foreseeable future. Nevertheless, given the relatively high cost of currency provision and usage, our findings of certain degree of cash-card substitution can provide positive influence on the future reduction of the country's resource costs in relation to cash usage.

Keywords: electronic payments, cash-card substitution, cost-savings, Thailand

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Contents

List of Figures

List of Tables

1. Introduction	4
2. Payment Instrument Use in Thailand and Some International Comparison	7
2.1 Payment Trends and the Use of Payment Instruments in Thailand	7
2.2 Some International Experience of Payment Instrument Use	14
3. Impact of E-payment on Cash Demand in Thailand	20
3.1 Econometric Determination of Cash Use	20
3.2 Estimation Results and the Effects of E-payments on Cash Use	22
4. Conclusions and Policy Implications	31
References	34

List of Figures

Figure 1: Cash-to-GDP Ratio: International Comparison	8
Figure 2: Distribution of Cashless Payment in Thailand	10
Figure 3: The Number and Growth Rates of EFTPOS and ATM in Thailand	12
Figure 4: Number of Payment Instruments in Thailand	13
Figure 5: Debit Card Usage: Cross-Countries Comparison	15
Figure 6: In-Store Consumer Payment Preference in the U.S.	16
Figure 7: Debit Card Transactions per Population in Thailand	17
Figure 8: The Relationship between Cash-to-GDP ratio and E-payments in Some Industrialized Countries	18
Figure 9: The Relationship between Cash-to-GDP ratio and E-payments in Thailand	19
Figure 10: Currency Holdings per Capita in Thailand	30
Figure 11: Currency in Circulation in Thailand	30

List of Tables

Table 1: The Impact of Debit Cards on Currency Demand in Thailand	24
Table 2: The Impact of Credit Cards and Cheque on Currency Demand in Thailand	27
Table 3: Transaction Value via Different Payment Channels	29

The Effects of E-payment Instruments on Cash Usage: Thailand's Recent Evidence and Policy Implications

Rungsun Hataiseree^{*}
Wachirawat Banchuen

1. Introduction

Over the past decade or so, there has been an increasing use of electronic payment (e-payment) instruments for making payments in many advanced countries. In the U.S.A., for example, the share of debit card increased significantly from around 21% in 1999 to around 37% in 2009, while the share of cash tended to record the continued decline from around 39% to around 28% during the same period. Similar experience can be seen for most European countries. As pointed out elsewhere (see, for instance, Kohler and Seitz (2004)), there has been the substantial expansion in the use of payment cards in the Euro area since the second half of the 1990s. Examples include the rapid expansion of the number of debit cards transactions in most European countries from nearly 10 transactions in 1990s to more than 20 transactions per person in 2000s. Such an increasing trend in the use of payment cards are claimed to be the driving force contributing towards the reduction of demand for currency for transaction purposes. This lies in the fact that payment cards can substitute cash payments, especially for those with small and medium-value purchases.

Thailand, among other countries, has been trying to reduce cash usage and promote the use of some form of cash substitution products such as debit card, credit card and prepaid card. The Bank of Thailand (BOT) through the guidance from the country's Payment System

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Committee (PSC) has set up many plans to extend the usage of e-payment services. A number of guidelines and initiatives have been put forward to deal with e-payment barriers, and to reduce cash usage in business sectors with high volumes of cash payments. Changing the structure of payment fees has been called for to reflect fair and appropriate rates that can promote the growing use of e-payment instruments/services. Examples in this regard include the introduction of the new structure of payment fees for different types of payment products, effective on 6 March 2006, and recent endeavors by the BOT to encourage the setting up of new payment fee structure aiming to enhance the payment efficiency and to better reflect actual costs of payment services among commercial banks.

In Thailand, evidences show that there have been significant increases in the use of e-payment channels offered by commercial banks and non-banks. Debit card (with the ATM withdrawer) is in the leading position of instrument share. It accounted for almost 39 percent of the total transactions of the cashless payments in 2006. Second importance in this regard is credit card, representing around 30 percent of the total. Noticeably, the share of debit card in the total cashless payment tended to have increased from around 32.7% in 2004 to nearly 49% in 2009. Although debit card with ATM withdrawal has experienced the largest portion, this seems to be not the case when judging in terms of the value of transactions. The share of cheque accounted for around 80% in the total value of non-cash transactions over the years 2004-2006, while debit card gained around only 5% during the same period.

Since there have been significant increases in the use of some form of e-payments, it would be interesting to assess the extent to which this sort of developments has affected both the use of cash and the demand for cash by economic agents. There are many studies which investigate the relationship between e-payments and cash usage in advanced countries (see, for example, Rinaldi (2001), Snellman *et al.* (2001), Stix (2004), Amromin and Chakravorti (2007)). But, to the best of our knowledge, little empirical studies have been carried out for the case of relatively less advanced countries like Thailand. Earlier studies by Hataiseree (2008), Hataiseree and Boonsiri (2006) and Hataiseree and Pariwat (2004a, 2004b) have provided in-depth analysis concerning the use of different types of payment instruments in Thailand. But, none of the studies has provided empirical estimation of the determinants of cash usage and the extent of substitutions of cash to e-payment instruments in Thailand.

This paper is probably the first study to provide empirical evidence about the factors influencing the cash usage in Thailand. In particular, the paper focuses on the analyzing of the effect of e-payment instruments on currency demand, using macroeconomic data spanning from 2005Q1 to 2010Q1. This sort of study is important for several reasons. First, it would explore the relationship between e-payments, like debit cards, and cash usage in Thailand. Second, it would provide empirical evidence about the impact of e-payments on currency in circulation, especially with respect to the degree of substitutions of cash to e-payment instruments in Thailand. Thus, the evidence about the effect of e-payments on currency demand obtained for Thailand may indicate the possible extent of cash-card substitutions for other countries which are in a similar state of development to Thailand. Third, it would provide empirical evidence to shed light on the extent to which the degree of cash-card substitutions has on the potential gain in resource costs for Thailand's case. As pointed out elsewhere (see, for instance, Humphrey et al. (2003)), significant shift from paper-based to electronic-based payments would give rise to an annual savings for a country of around 0.4-0.5% of GDP. Finally, it would provide empirical evidence to support the BOT's move towards the greater reliance on e-payments.

The rest of this paper is organized as follows. Section 2 presents the payment trends of different types of payment instruments in Thailand with particular emphasis on some salient features of the payment instruments used for making payments. It also briefly touches on international experience on the use of different types of payment instruments. Section 3 sets up a set of econometric models which relate currency demand to a set of key factors. These econometric models, based primarily on the Theory of Money Demand, aim to capture major influence on cash usage. We focus on the estimation of the relationship between payment cards, like debit cards, and cash usage, as this would provide useful information about the extent of cash-card substitutions in Thailand. Section 4 provides conclusions and draws some policy implications.

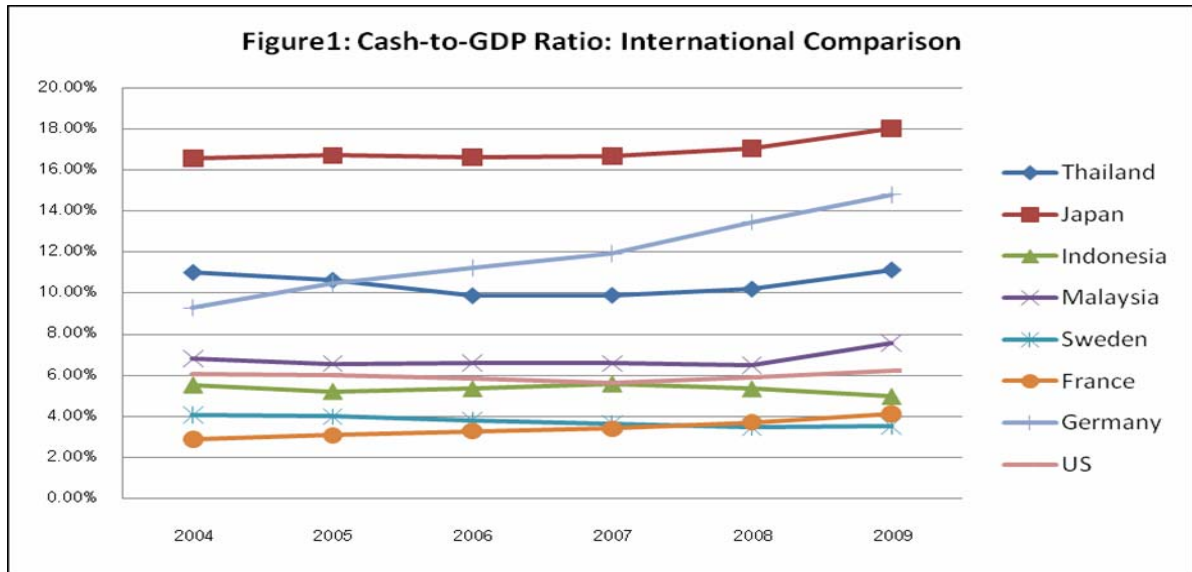
2. Payment Instrument Use in Thailand and Some International Comparison

2.1 Payment Trends and the Use of Payment Instrument in Thailand

Like in many other countries, payment systems and the use of payment instruments in Thailand have undergone significant changes for over two decades. Significant changes in this regard include the move toward the increasing reliance on the use of newly developed technologies to enable both e-commerce and e-payments. On the part of the BOT, it has over the last decade introduced the e-payment systems as the basis for financial transactions and financial settlements. The Bank has recently initiated a number of projects to create a conducive environment to foster the orderly transition to e-payment. As reflected in the Payment Systems Roadmap 2010, the Bank has set up plans to encourage the increased use of e-payments by major market participants, including in particular individual customer, businesses, government agencies. Further efforts are under way to channel and coordinate industry efforts to migrate to e-payments.

Despite these changes, Thailand has still relied extensively on the use of cash for making payments. Even with reasonably large-value transactions, many people still withdraw cash from ATM to make payments, as reflected from the recent survey by the BOT¹. ATM cards have been commonly used together with cash. It is therefore not so surprising to see such a relatively high ratio of cash to GDP. As is evident from Figure 1, the cash-to-GDP ratio, the measure of cash use in transactions, have maintained at relatively high levels of around 9-11 over the past decade or so. It had dropped to around 9% during 2006 and 2007. However, the ratio started climbing back to the same level in 2008 at around 11%.

¹ More detailed accounts of this can be seen from the recent survey report by the Payment Systems Department of the BOT. The survey is based on interviews and workshops. It covers the 3 regions where the BOT has representative offices. These comprise of Northern region, Northeast region, and Southern region.



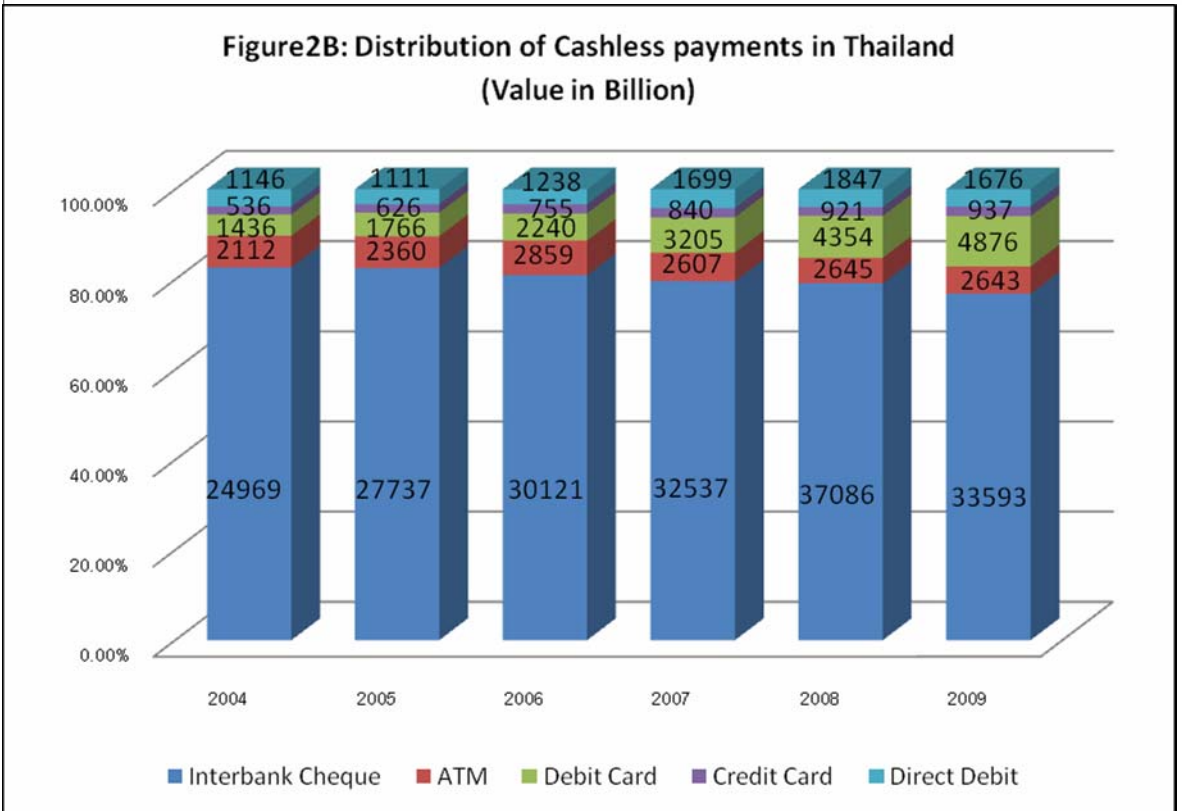
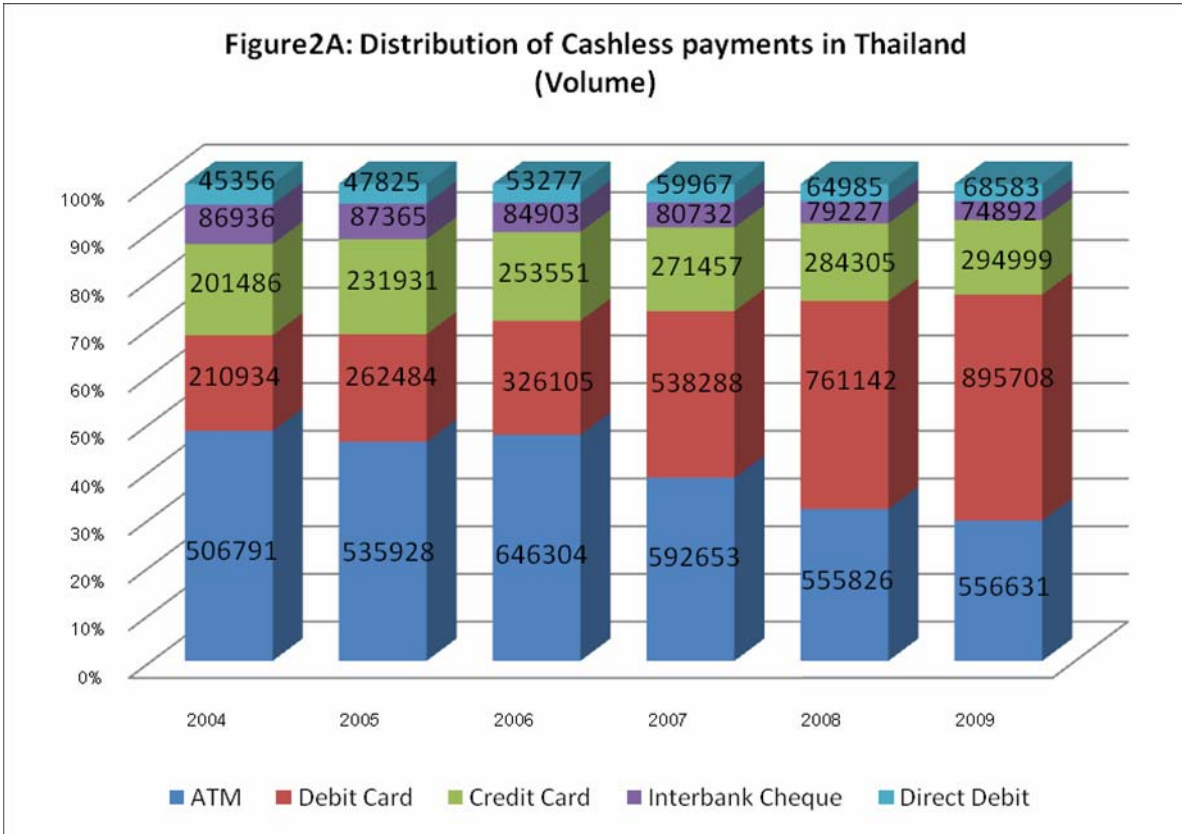
Source: Authors' own calculation based on Bank of Thailand database

Thailand's cash-to-GDP ratio tends to be reasonably high when compared with some advanced countries such as the United States, United Kingdom and Sweden. As showed in Figure 1, the cash-to GDP ratios of these countries are in the range of 3-5% over the years 2004-2009. However, this tends to be not the case for Japan where the cash-to-GDP ratio has continued to stay at a relatively high level during the same period. This could stem from the influence of national culture. Generally speaking, the level of cash usage in Thailand seems to be not too different from its peer group countries such as Malaysia and Indonesia. Distinctive differences of cash-to-GDP ratio between developing countries and developed world suggest that there are rooms for developing countries to improve payment system through the reform in payment intermediaries.

Overtime, cash usage in Thailand has been replaced in many types of transactions by the increased use of many cashless payment instruments, though the rate of replacement tends to be slower when compared with those in advanced countries.² Chief among these include, for example, (i) credit cards, (ii) debit cards, (iii) e-money, and (iv) payment channels related to interbank cheque and direct debit. As portrayed in Figure 2a, debit card (with the ATM withdrawer) has the leading position of instrument share. It accounted for almost 47% of the total transactions of the cashless payments in 2009. Second importance in this regard is ATM card, representing around 30% of the total. Noticeably, the share of debit card in the total cashless payment tended to have increased from around 20% in 2004 to nearly 47% in 2009 while the share of ATM card has dropped from 48% in 2004 to 30% in 2009. The rise in the debit card share appeared to come up with the expense from certain types of payment instruments, especially ATM card and credit card reducing from 48% to 29%.

² Cash usage, as it can be argued, could be constrained by using electronic payment instruments as a substitute. Those electronic instruments include debit card, credit card, ATM card, and electronic transfer. The replacement can be done in *two* dimensions. One is related to “Money Receiving”. Business can make payment of goods and services using e-payment instruments such as debit card or credit card. Merchants will not receive money directly from customers but will be paid by money transfer from acquiring banks within one business day. Acquiring cards instead of cash could eliminate some cost of cash management especially for retailers who receive large amount of money. Despite Merchant Discount Rate (MDR) required to be paid to acquirer, it still benefits merchants since the cost of counting banknotes and bringing cash to deposit provider can be reduced as well as there is less possibility of operational error and smaller damage fraud. Another use of electronic card is that card holder can do transaction ‘cash out’ which allow them to ask for cash at point of sale. This reduces amount of cash held in stores and provides convenient to card holders.

The other concerns “Money Payment”. Salaries and fees paid to employees, business partners, or suppliers can be made by electronic transaction. Company can directly transfer money from its own account to receivers’ account. This reduces cost from withdrawals and transferring huge amount of money. Furthermore, the electronic transfer can be done using less time as payer can use bulk payment. Electronic transferring also reduces expenditure of papers related to transaction and cost from printing document such as receipts and bills.



Source: Calculated from International Financial Statistics, various issues

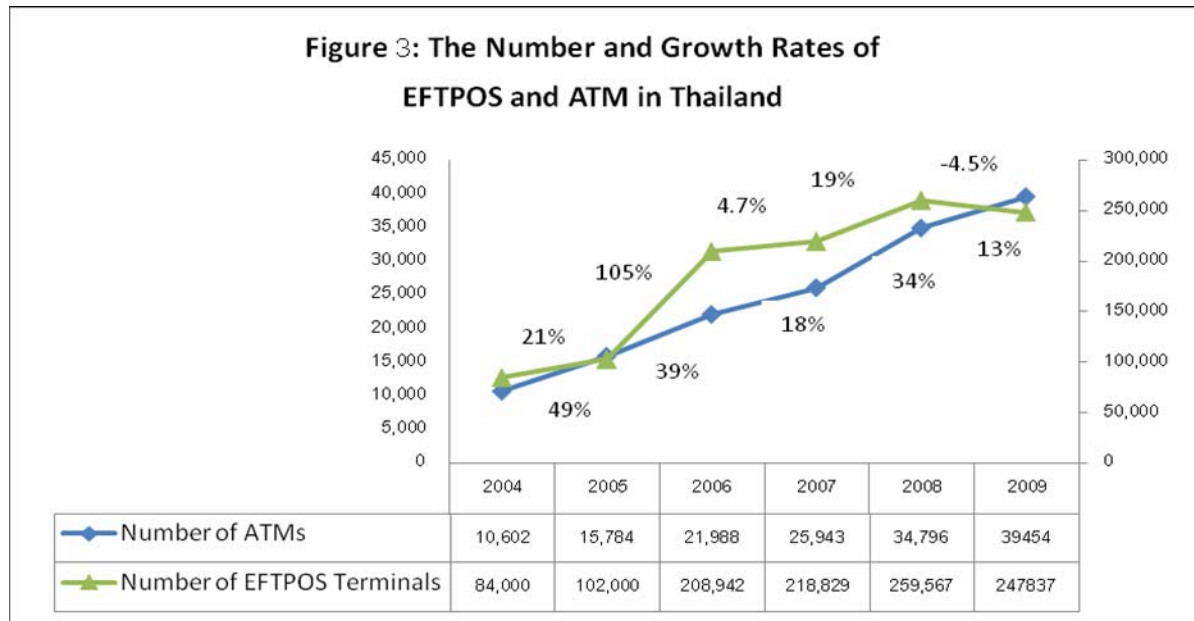
Although debit card with ATM withdrawal has experienced the largest portion as mentioned above, this seems to be not the case when judging in terms of the value of transactions. As is evident from Figure 2b, some forms of the paper-based payment instruments, particularly interbank cheque, has continued to record the lion share in the total value of non-cash transactions in retail payments. The share of cheque accounted for around 80% in the total value of non-cash transactions over the years 2004-2009. Second importance is the transaction made through debit card. Its share rises from around 5% in 2004 to 11% in 2009. Although debit card gained the highest share in terms of the volume of transactions, this seems to be not the case when judging in terms of the value. This may in part reflect the fact that debit cards are often used for conducting transactions for small-value payments. Cheques, by contrast, are normally used by businesses for making relatively larger-value payments. Personal cheques, with relatively small-value payments, remain inactive in Thailand.

A close look at the aggregate data reported in Figure 3 provides a number of interesting observations. For one thing, it indicates while e-payments has continued to grow over the past many years, some form of paper-based payment instrument, especially cheques, tended to have still retained the lion share in the total value of non-cash transactions over the corresponding period. As one can see, in value term, the share of cheques usage was recorded at nearly 80% over the years 2004-2009. For another, it indicates that most of the e-payment instruments have been used for the purpose of small value fund transfer and/or micro payments.³

It is important to note that the expansion of payment cards in Thailand has been reinforced by the rapid increase in the card payment infrastructure, especially EFTPOS terminals. As one can see from Figure 3, the expansion of EFTPOS and ATM has been progressing at a healthy rate. The number of ATMs increased from 10,602 to 39,454 during the years 2004-2009, representing the increase of more than 3 times during the same period. In a similar vein, the number of EFTPOS increased from 84,000 to 247,837. This points to

³ The recent figures from the Payment Systems Department of the BOT suggests that the majority of debit card usage tends to be associated with transactions in the form of cash withdrawing from ATM rather than direct payment made from the debit cards. Noticeably, this accounts for more than 90% of the total transactions.

the increase of nearly 3 times. Noticeably, the rates of increase tend to be much higher when compared with some emerging economies with similar stage of development to Thailand. In the case of Egypt, for instance, the number of ATMs increased from 4,000 to 15,000 during the period of 2004-2009. During the same time span, the number of point-of-sales (POS) increased from 10,000 to 38,837.⁴

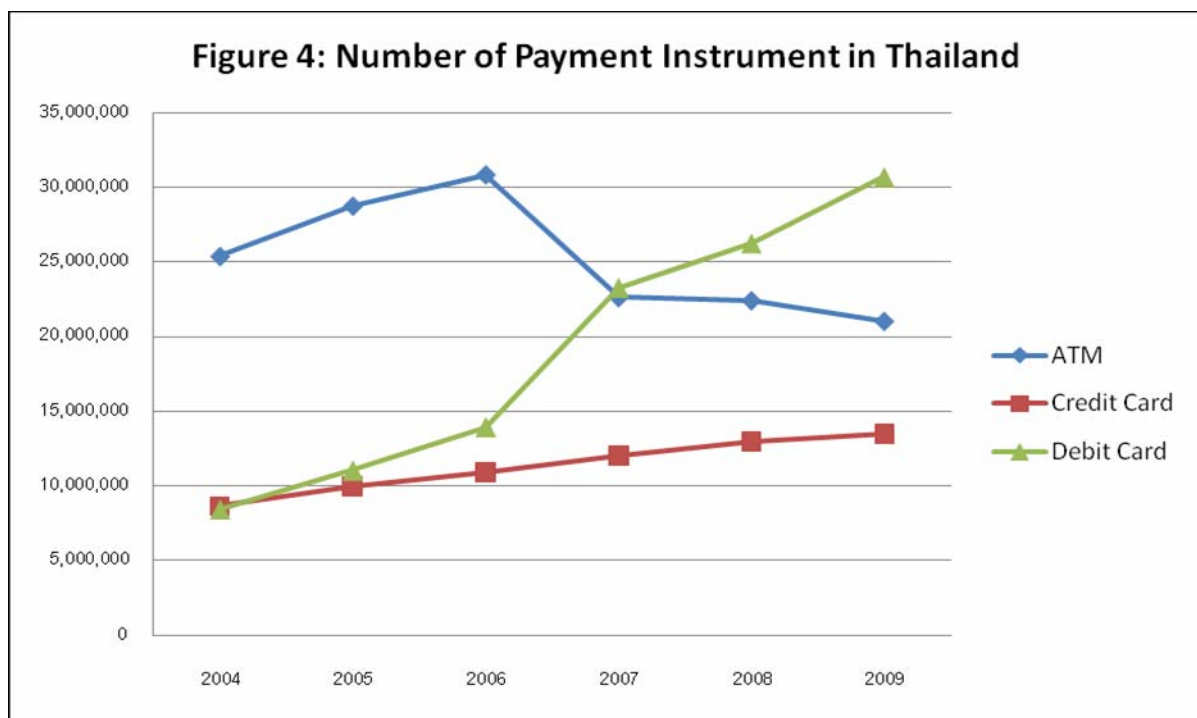


Source: Authors' own calculation based on Bank of Thailand database

As can be seen from Figure 3, these new types of card payment infrastructure, in particular EFTPOS and ATM, have experienced reasonably high growth rates over the past many years. Noticeably, the growth of EFTPOS terminals shot up to 105 percent in 2006. This was mainly due to the introduction of a chip card [by VISA] in Thailand. In effect, commercial banks are required to invest in this sort of new technology and, thus, increasing the number of EFTPOS terminals to the level where they could capitalize on economies of scale. For ATM, its growth reached the highest value in 2005 at 49%. During 2006 and 2009, ATM growth fluctuated between 13% and 39%. The growth of payment infrastructure has, to some certain extent, contributed to a greater presence of e-payment in Thailand when compared with some countries in the SEACEN region.

⁴ Further details can be seen in "Payment card usage and demand on the rise, says Visa".

A closer look to the number of card payment instruments in Figure 4 provides many interesting things. First, it indicates that some types of card payment instruments have experienced a significant growth over the years 2004-2009. In terms of number of payment cards, the number of debit cards jumped from around 8.4 million in 2004 to around 30.7 million in 2009. This represents an increase of nearly 4 times over the period under review. Second, on the contrary, it shows that certain type of card payment instruments has showed sign of declining trend. As one can see, the number of ATM cards increased from around 25.4 million in 2004 to record the peak number at nearly 30.9 million in 2006. Nevertheless, since 2007, the number of ATM cards started to record a declining trend. It reduced respectively to around 22.6, 22.4, and 21.0 million in 2007, 2008, and 2009.



Source: Calculated from data of Bank of Thailand

Significant increases of card numbers and the continued expansion of the network density of payment terminals have contributed to the increased use of payment cards in making payment transactions in Thailand. This includes small value payment transactions and retail payments which are normally paid by cash. A good example in this regard can be seen from the growing use of debit cards in making small and medium-size payments. As mentioned early, debit card payments have gained increased share, both in terms of volume and value over the period of 2004-2009. Although it is unlikely that cash will be completely

replaced by payment cards in the near future, evidence so far seems to suggest that there tends to have a partial substitution of cash through card payments for the case of Thailand.

2.2 Some International Experience of Payment Instrument Use

It is perhaps useful at this point to provide some reference to the experiences of some countries in the SEACEN region. As pointed out in Hataiseree (2008), Korea is probably the only country in the SEACEN region with prevalent use of e-payments. Noticeably, e-payments have currently surpassed the use of cheques as the preferred means of making non-cash payments.⁵ In volume term, the share of e-payment amounted to 80%, while that of paper-based instruments accounted for only 20% in 2006. Similar observations can be made when considering in value term, although the pace of growth tended to be relatively less pronounced when compared with the former case. With the risk of oversimplification, the degrees of e-payment penetration in Korea have been much higher than those in other SEACEN member banks.

In the case of Malaysia, although e-payments have gained an increasing share in the past many years, cheque usage has still retained the significant portion in the total non-cash payments. As indicated in Hataiseree (2008), the share of e-payments in volume term has jumped up from around 44% of the total non-cash transactions in 2001 to about 77% in 2006. This has come up with the expense from cheque usage which recorded the sharp decline from around 56% to 23% over the corresponding period. Nonetheless, the development of this kind seems to be less clear when looking at the figures in value term. In the latter case, the share of e-payments of the total non-cash transactions recorded a marginal increase from around 2% in 2001 to 6% in 2006. Accordingly, it is evident that cheque use still dominates the retail payments in Malaysia when judging in terms of the value of the transactions.

For a broader perspective, it can be said that Thailand has relatively low rate of e-payment used when compared to many industrialized countries. As portrayed in Figure 5,

⁵ Similar experience can be seen in the case of the United States. According to the Federal Reserve Study, it was found that, for the first time ever, the number of e-payments, including credit card, debit card, and automated clearinghouse (ACH) payments, has exceeded check payments since the year 2003 onwards.

Thailand tends to have a relatively low degree of debit card usage. This can be clearly seen when judging from the number of debit terminals per 10,000 individual together with debit cards per person. In the United States and Canada, for instance, both of these countries have a high number of debit terminals and reasonably high degree of debit cards per person, ranging from around 13.23-14.24 for the number of debit terminals and 0.89-1.17 for debit cards per person. Similar observations can be seen from most European countries, especially those of the UK, Finland and the Netherlands. By contrast, Thailand has relatively few debit cards per person of around 0.14 despite having a reasonably degree of debit terminals of about 8.4. Overall, it can be said that countries that have high degree of debit card usage tend to have high card adoption by consumers and high adoption of terminals by merchants.

Figure 5: Debit Card Usage: Cross-Countries Comparison

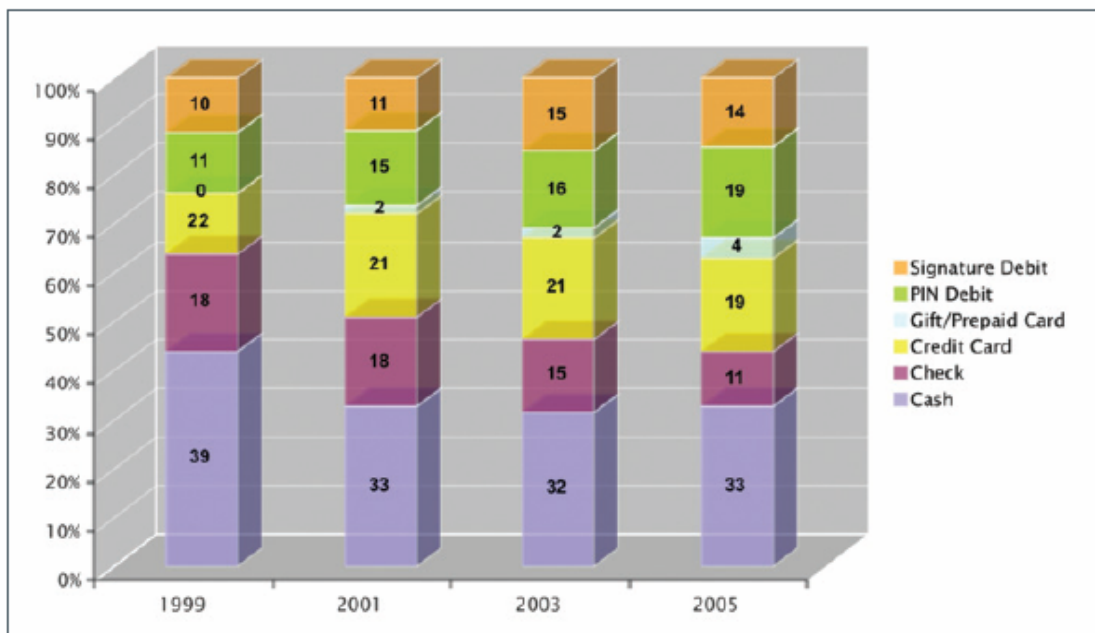
Country	Debit Terminals/10000	Debit Cards per Capita
Thailand	8.4	0.14
Japan	1.57	3.06
Germany	6.01	1.10
Austria	9.03	1.02
Belgium	10.96	1.33
Switzerland	11.16	0.83
Netherlands	11.53	1.34
Sweden	12.17	0.63
US	13.23	0.89
Canada	14.24	1.17
UK	14.54	1.06
Italy	16.14	0.49
France	16.63	0.74
Finland	17.66	0.79

Notes: Figures for other countries, except Thailand, are from Amromin and Chakravorti (2007). Thailand's figures are based on the authors' own calculation for the year 2004.

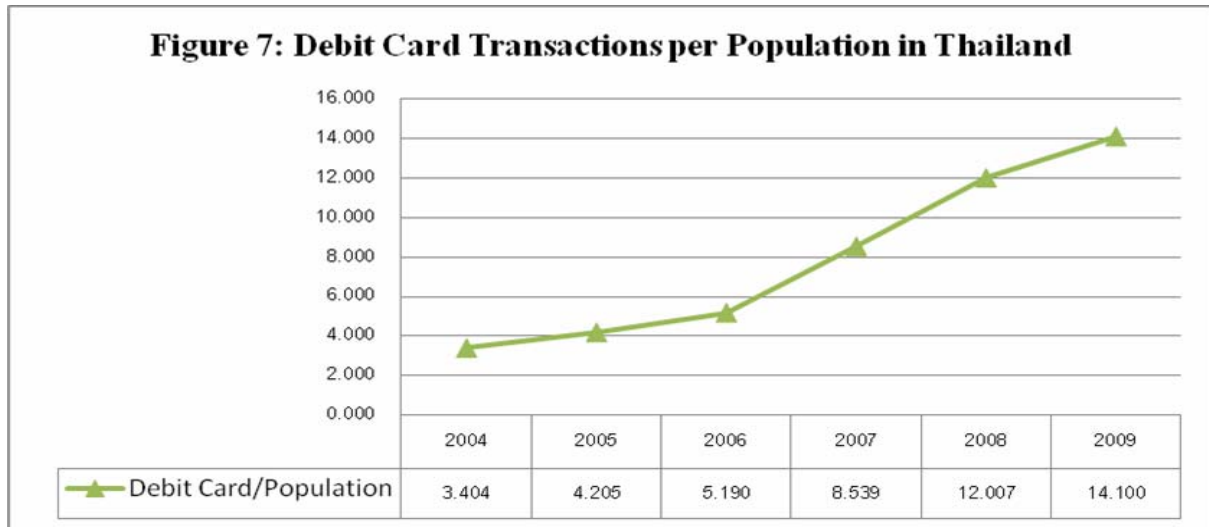
A closer look at the experience in many advanced countries also show that there has been significant shifted from the use of cash to some form of electronic payments. In the United States, for example, the share of debit card increased significantly from around 21% in 1999 to around 37% (33% in 2005) in 2009, while the share of cash tended to record the continued decline from around 39% to around 28% during the same period (Figure 6).

Similar experience can be seen for most European countries. As documented elsewhere (see, for example, Amromin and Chakravorti (2009)), there tended to have rapid growth in e-payments in most of European countries. As reported there, e-payments accounted for a vast majority of all non-cash payments in the period under review. Apart from this, there tended to have remarkable growth in debit card usage for most of European countries during the past many decades. As a reflection for this, the number of debit card transactions per person per year in many of the European countries showed sign of a rising trend over the years, rising from fewer than 10 debit card transactions per person per year in 1990s to more than 70 debit card transactions per capita in 2000s. Although Thailand have experienced continued increased in the use of debit cards over the years 2004-2009, the average number of debit card transactions per person as shown in figure 7 accounted for only 8 debit card transactions per person per year. This appears to be reasonably low when compared with the figures obtained from most industrialized countries.

Figure 6: In-Store Consumer Payment Preference in the US

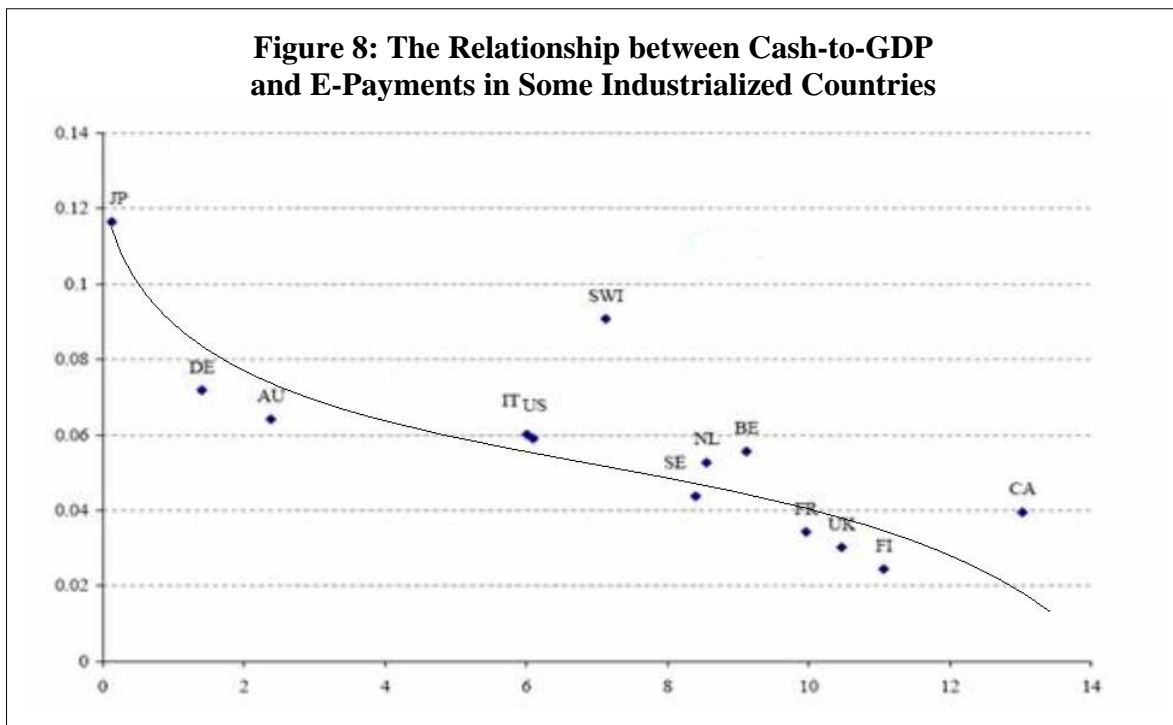


Source: 2005/2006 Study of Consumer Payment Preferences; American Bankers Association/Dove Consulting; www.aba.com



Source: Authors' own calculation based on Bank of Thailand database

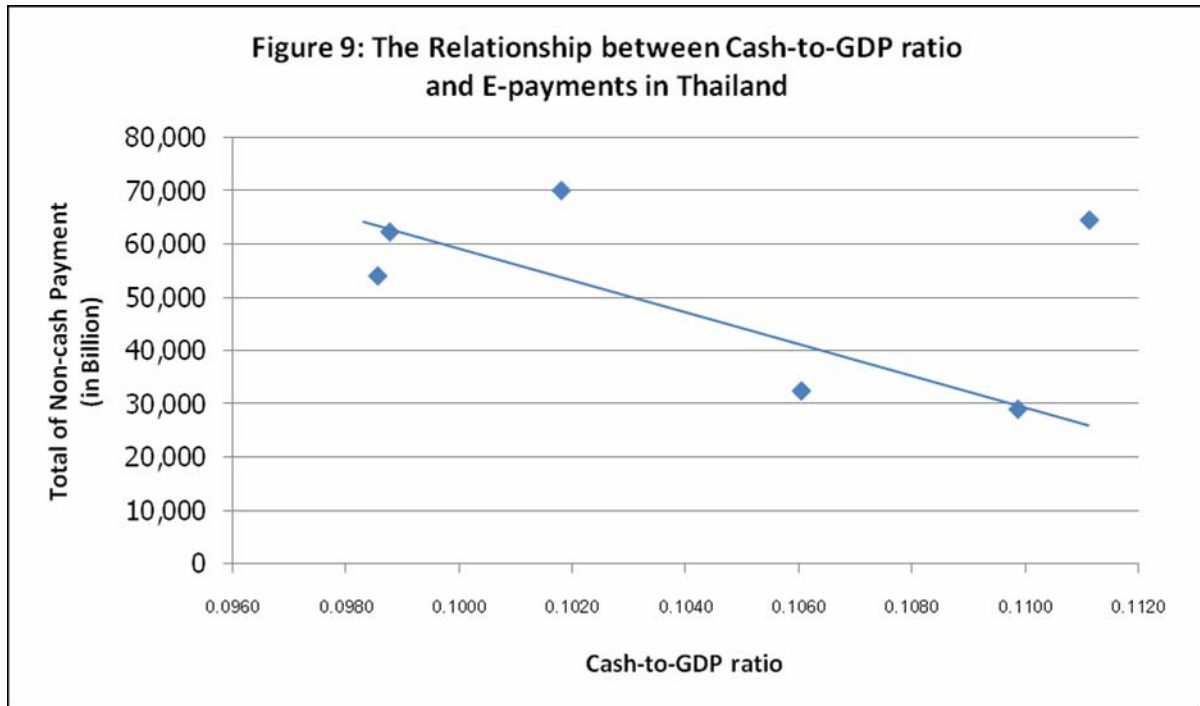
Interestingly, evidences in many countries suggest that there tended to have negative relationship between indicators of non-cash payments and the measures of cash usage. As pointed in many empirical studies, significant increase in a country's non-cash transactions would generally result in the lowering of the stock of currency in circulation in that country (Humphrey (2004), Amromin and Chakravorti (2007)). This suggests that non-cash transactions could, to certain degree, substitute for some cash transactions. A closer look at Figure 8 lends support to the mentioned notion. As one can see from Figure 8, there tends to have a negative relationship between currency-to-cash ratio and the number of debit card terminals. Some good examples for this can be seen from the case of Finland and the United Kingdom. As one can see, these two countries have the lower use of cash and the largest number of non-cash transactions per person per year. Indeed, it can be inferred from the evidence shown in Figure 8 that countries with a relatively high density of debit terminals tend to have lower currency-to-cash ratios. This highlights the importance of debit cards as a substitute for cash transactions, as they are mainly used for small and medium-value purchases.



Note: Evidence shown in this figure are from Amromin and Chakravorti (2007)

Similar experience can also be seen for the case of Thailand, though with the relatively less degree. As one can see from Figure 9, the non-cash payments (in-house cheque, inter-bank cheque, debit card, credit card, and ATM card) tended to have negative correlations with the cash-to-GDP ratio. This suggests that the higher use of noncash payment could result in the reduction of the level of cash usage in Thailand. Presumably, the magnitude of this relationship appears to be low to produce any significant impact on the overall cash usage. In other words, it can be said that magnitude of substitution between e-payment and currency usage appeared to be weak in the Thai context. As one can see, the outlier point occurred in 2009: that is the high level of non-cash payment usage was correspondent with the high cash-to-GDP

Since there have been significant increases in the use of some form of e-payments offered by commercial banks and non-banks, it would be interesting to assess the extent to which this sort of development has affected both the use of cash and the demand for cash in Thailand over the past many years. The next section provides such an assessment using econometric techniques



Source: Calculated from International Financial Statistics various issues and the Bank of Thailand data base.

Note: Non-cash payments comprise of In-house cheque, interbank cheque, debit cards, credit cards, and ATM cards.

3. An Empirical Investigation of Impact of E-payments on Cash Demand in Thailand

3.1 Econometric Determination of Cash Use

In this section, we analyze the influence on cash usage in Thailand resulting from changes in a set of major determinants. The starting point is to formulate the long-run money demand function of the following form:

$$M^d/P = f(SC, r, X) \quad (1)$$

Where M^d is the nominal money demanded, and P is the price level, so that the real money balance is a function of scale variable (SC), as a measure of economic activity, and the opportunity cost variables (r). The later variable reflects the foregone earnings from not holding assets which yield higher rates of return to money. X represents other important variables. According to the theory of money demand, optimal stock of real money balance is postulated to positively relate to real income, and inversely relate to interest rates. Application of this theory to the empirical analysis of money demand function in Thailand has been carried out by many economic researchers. Some good examples include the study by Hataiseree (1993) and Hataiseree and Phipps (1996).

To examine the degree to which some forms of e-payment would substitute cash usage, we estimate the following currency demand equations with the inclusion of additional measures of the effects of e-payment instruments.

$$\begin{aligned} \text{Currency}_t = & \alpha_0 + \alpha_1 \text{DebitCard}_t + \alpha_2 \text{GDP}_t + \\ & \alpha_3 \text{DepositRate}_t + \alpha_4 \text{ATM}_t + \varepsilon_t \end{aligned} \quad (2)$$

Where $\alpha_1 < 0$, $\alpha_2 > 0$, $\alpha_3 < 0$ and $\alpha_0 =$ Constant or intercept term

$\text{Currency}_t =$ Currency used in circulation in period t . The quarterly data used in the models are calculated from the value of cash that circulates in Thai economy during each month. Currency includes banknotes and coins in circulation deducted by currency held by

government and Depository Corporation, which are commercial banks, finance companies, specialized banks, saving corporative, and money market mutual funds.⁶

$DebitCard_t$ = Value of transaction made through debit cards in period t. It includes only the portion of the value of transactions that make payment for goods and services but excludes cash withdrawals transactions.⁷

GDP_t = Gross Domestic Product of Thailand in period t. It is quarterly data in the unit of Thai baht.

$DepositRate_t$ = Deposit rates offered by commercial banks. Various rates are used in the models. Those rates are saving deposit rates and three-month time deposit rate.

ATM_t = Value of transactions made through ATM machines. This value includes both withdrawal transactions made by ATM cards and debit cards from ATM machines only.⁸

ε_t = The error term.

The demand for currency in equation (2) is represented by the currency in circulation. The currency comprises of notes and coins. Noticeably, notes account for the lion share, representing more than 95% of the total value of currency in circulation over the years 2004-2009. In this setting, currency demand is hypothesized to depend on the Gross Domestic Product (GDP), alternate payment instruments such as debit cards and ATM, and the opportunity cost of money.

Following the standard specification of money demand function, the GDP, representing the relevant transactions variable, is expected to have a positive relationship with demand for currency. The higher national income practically induces more spending of citizens. This leads to the higher demand for currency.

⁶ The covariance analysis between currency in circulation and currency used in the economy that deducts those held by central government and depository corporation shows that they have very high correlation at around 0.9986. The graph not shown here illustrates the replication of the two sets of data.

⁷ Some earlier studies, for example, Amromin and Chakravorti (2007), use the number of debit card terminals at the POS as a proxy variable to represent the substitution effect of debit cards on some cash transactions. However, this sort of data is available in Thailand only on a yearly basis not a quarterly basis.

⁸ The number of ATM and transactions seems to be more preferable than the one used here. However, these variables are not used here, as they are not available on a quarterly basis.

As argued in the previous section and in some other studies (See, for example Amromin and Chakravorti (2007)), advances in payments technology have resulted in a substitution of non-cash payments for cash. The influence of this sort of financial-innovation effect on currency holdings may be captured in several ways. Some previous studies use the number of ATM cards or EFTPOS terminals as proxy variables for this. This study, following the study by Amromin and Chakravorti (2007), uses transactions value made through debit cards and ATM. From the view point of econometric analysis, these figures have the advantage over some other mentioned variables, as they are both available on a quarterly basis. Debit card is expected to have a negative relationship with demand for currency since card holders use debit cards as a payment instrument instead of using cash for payments.

Interest rate, represented by deposit rates, is anticipated to exert a negative impact on currency demand. An increase in interest rate would generally lead to a higher opportunity cost of holding currency. This tends to induce people to reduce their holdings of currency in favor of some other attractive assets. Therefore, the coefficient associated with interest rate should have a negative sign, reflecting interest rate foregone from holding money instead of depositing it in commercial banks.

3.2 Estimation Results and the Effects of E-payments on Cash Use

In what follows, we present the results of the estimation of the demand for currency, using the OLS (Ordinary Least Square) method. The results from Table 3.1 show that all of the explanatory variables have the expected signs and reasonable coefficients. The estimated coefficients of all explanatory variables are highly significant, mostly at 1% level. The explanatory power of the models is also high, judging from the reasonably high values of R^2 of around 0.58 to 0.74.

As seen from the first column of Table 1A, where all variables are in log of *first-difference form*, the coefficient of GDP was found to have a statistically positive relationship with currency in circulation. The relatively high level of estimated coefficient of 0.42 reflects the importance of economic activities in influencing the currency demand. This result seems to be in line with many of previous studies on the determinants of currency holdings. This includes, for instance, the study of Snellman *et al.* (2001).

As expected, changes in interest rates are found to exert the negative influence on the currency demand.⁹ This reflects that cash holdings tend to be sensitive to the opportunity cost of holding cash. However, the estimated coefficients on interest rates seem to be reasonably low of around 0.03-0.04. This may reflect that a significant proportion of cash in circulation is held for transaction purpose rather than store of value. As cash demand for transaction purpose constitutes a predominant share of currency in circulation, it tends to have a limited sensitivity to changes in interest rates. Some earlier studies on the determinants of cash demand also find the negative influence of short-term interest rates on demand for cash. In the study by Amromin and Chakravorti (2007), for instance, short-term interest rates were found to cause changes in large denomination currency holdings.¹⁰

Interestingly, the coefficient on debit cards is found to have a statistically *negative* relationship with the stock of currency in circulation. This heightens the importance of e-payments on cash use. The estimated coefficient suggests that a 10% increase in debit cards transactions would result in the reduction of cash transactions by 1.5%, *ceteris paribus*. The findings of negative influence of debit cards on currency demand are generally in line with many earlier studies. In the study of Rinaldi (2001), debit cards are found to have negative effects on Belgian currency in circulation. Similar findings are also seen in the study of Stix (2004). In the latter study, the cash demand in Austrian is found to be significantly and sizably affected by debit cards usage.

⁹ We tried to perform the empirical tests using various definitions of short-term interest rates. But, it appears that only the 3-month deposit rates of commercial banks have provided the best results, in terms of statistical test and reasonable magnitude of the coefficients.

¹⁰ For small denomination currency holdings, however, interest rates were reported to have no significant influence on the currency. As it has been argued, the failure to find the empirical evidence to support the effect of interest rates on the stock of small-denomination currency tends to reflect the role of the small-denomination currency as transaction purpose. By contrast, the holdings of the large-denomination currency tend to reflect the role as store of value. This follows that they seem to more responsive to the changes in interest rates as the measurement of the opportunity costs of currency holdings.

Table 1A
The Impact of Debit Cards on Currency Demand in Thailand

Dep Var: Cash	Model 1	Model 2	Model 3	Model 4
Debit Card _t	-0.150*** (t=-3.55)	-0.149** (t=-2.263)	-0.086 (t=-1.667)	-0.13** (t=-2.82)
GDP _t	0.416** (t=2.305)	0.396* (t=1.939)	0.387* (t=1.978)	0.42** (t=2.37)
Saving Deposit _t (max value)		-0.008 (t=-0.969)		
Saving Deposit _t (min value)			-0.237 (t=-1.483)	
Time Deposit _t (max value)	-0.029*** (t=-3.006)			
Time Deposit _t (min value)				-0.03** (t=-2.50)
ATM _t	0.601*** (t=4.667)	0.451** (t=2.234)	0.475** (t=2.470)	0.54*** (t=3.09)
Constant	0.001 (t=0.069)	0.006 (t=0.726)	-0.002 (t=-0.195)	0.001 (t=0.07)
R-squared	0.742	0.582	0.613	0.69
Adjusted-R ²	0.673	0.471	0.510	0.6
D-W stat	1.877	1.771	1.465	1.88

Notes: *, ** and *** represent the statistically significant at 90%, 95% and 99%, respectively. T-values are in parentheses. All variables, except for deposit rates, are expressed in logarithms with the first-difference form.

Table 1B
The Impact of Debit Cards on Currency Demand in Thailand

Dep Var: Cash	Model 1	Model 2	Model 3	Model 4
Debit Card _t	-0.189*** (t=-4.598)	-0.283*** (t=-4.283)	-0.022 (t=-0.373)	-0.15*** (t=-4.18)
GDP _t	0.360* (t=2.026)	0.294 (t=1.07)	0.301 (t=1.109)	0.41** (t=2.45)
Saving Deposit _t (max value)		-0.029*** t=-(-4.40)		
Saving Deposit _t (min value)			-0.399*** (t=-4.443)	
Time Deposit _t (max value)	-0.032*** (t=-8.206)			
Time Deposit _t (min value)				-0.04*** (t=-8.91)
ATM _t	0.674*** (t=6.170)	0.892*** (t=5.12)	0.308 (t=1.644)	0.60*** (t=5.80)
Constant	0.14 (t=0.08)	-1.07 (t=-0.36)	4.91* (t=1.88)	-0.15 (t=-0.09)
R-squared	0.976	0.944	0.944	0.98
Adjusted-R ²	0.97	0.93	0.931	0.97
D-W stat	1.007	0.996	0.815	1.4

Notes: *, ** and *** represent the statistically significant at 90%, 95% and 99%, respectively. T-values are in parentheses. All variables, except for deposit rates, are expressed in logarithms with level form

In addition, ATM was found to generate the *positive* influence on the currency in circulation. The positive impact of ATM suggests that the increased use of ATM has led to a growing demand for currency to settle payment transactions, particularly those of low-value transactions. It is quite common in the Thai context to see people, especially those working in small-and medium-sized manufacturing firms, line up in queue in front of ATM machines in order to withdraw money at the time right after the payday of each month.

In response to this sort of consumer's preference or behavior, most ATM operators have to well prepare to fill in ATM with cash. In many cases, it has been argued that ATM owners tend to overstock of cash in their machines. This seems to be particularly so, as it has been claimed, when they want to avoid reputational harm, especially in case where their machines do not have sufficient money for the customer's withdrawals. Such the increased demand by the ATM operators for cash would be another factor contributing to the higher level of the currency in circulation. The relatively high level of the estimated coefficients on ATM, in the range of 0.60-0.65, reflects that ATMs are a predominant source of cash in Thailand.

However, it is important to note that the relationship between ATMs and cash may be changing over time depending on the nature of payment card usage at point of sale. As argued elsewhere (see, for instance, Amromin and Chakravorti (2007)), the demand for cash by ATM operators may decrease following some further developments in the nature of domestic payment transactions. This seems to be the case when the number of ATM has stabilized and /or the amount of withdrawals per machine decrease.

In the Thai context, it is likely that the demand for cash will continue to increase in the near future. For one thing, the number of ATM tends to prevail the strong growth in many years to come due partly to the strategic move by many big Thai banks. For another, as pointed out in the previous section, there has been the strong growth in the number of ATM over the past many years, jumping from nearly 11,000 in 2004 to nearly 40,000 in 2009. This represents nearly 4 times increase in the number of ATM over the past 6 years.

To see whether the estimated results would be sensitive to the different types of model specifications, we estimate the model using data in *level form*. As is evident from Table 1B (Column 2), all of the estimated coefficients of the variables have the expected signs and the

level of statistical significance similar to those obtained from Column 2 of Table 1A. Interestingly, we also find the negative influence of debit cards on the stock of currency demand. It should be noted, however, that all of the estimated coefficients reported in Table 1B tend to have the greater values than those obtained from Table 1A.¹¹

For completeness, we also experiment with additional measures of e-payments like credit cards and cheques. However, as shown in Table 2A and Table 2B, we failed to find the empirical evidence in support of the effect of credit cards on the currency demand. This result seems to be not surprising in the case of Thailand. Unlike the experience in the check-based countries like the United States., check usage in Thailand appears to be associated with payment transactions by business-related activities. Payment by check at the POS or small payment transactions tends to be of minimal use in Thailand.

¹¹ We also experiment with additional measures of e-payments like credit cards (and check). However, we failed to find the empirical evidence in support of the effect of credit cards (and check) on the currency demand. This result seems to be not surprising in the case of Thailand. Unlike the experience in the check-based countries like the United States., check usage in Thailand appears to be associated with payment transactions by business-related activities. Payment by check at the POS or small payment transactions tends to be of minimal use. In the United States, by contrast, personal check tends to exert significant share in the total non-cash payments. Also, the use of personal check is related closely with debit card usage.

Table 2A:
The Impact of Credit Cards and Cheque on Currency Demand in Thailand

Dep Var: Cash	Model 1	Model 2	Model 3	Model 4
Debit Card _t	-0.15 (t=-2.62)**			-0.13 (t=-1.77)
GDP _t	0.37 (t=1.25)	0.57 (t=1.54)	0.22 (t=0.69)	0.81 (t=4.16)***
Time Deposit _t (max value)	-0.03 (t=-2.76)**	-0.01 (t=-1.11)	-0.02 (t=-1.77)*	-0.03 (t=-1.80)**
ATM _t	0.4 (t=1.97)*	0.42 (t=1.62)	0.37 (t=1.23)	
Credit _t	0.14 (t=0.70)	0.01 (t=0.06)	0.17 (t=0.72)	
Cheque _t	-0.14 (t=-0.75)	-0.45 (t=-2.41)**		-0.1 (t=-0.68)
Constant	0 (t=0.03)	0 (t=0.07)	-0.01 (t=-0.58)	0.01 (t=0.93)
R-squared	0.89	0.8	0.55	0.66
Adjusted-R ²	0.8	0.68	0.42	0.54
D-W stat	1.13	1.56	1.59	2.02

Notes: *, ** and *** represent the statistically significant at 90%, 95% and 99%, respectively. T-values are in parentheses. All variables, except for deposit rates, are expressed in logarithms with the first-difference form.

Table 2B
The Impact of Credit Cards and Cheque on Currency Demand in Thailand

Dep Var: Cash	Model 1	Model 2	Model 3	Model 4
Debit Card _t	-0.12 (t=-1.41)	-0.16 (t=-3.68)***	-0.19 (t=-1.38)	
GDP _t	0.61 (t=1.34)	0.05 (t=0.16)	1.09 (t=4.10)***	-0.38 (t=-1.02)
Time Deposit _t (max value)	-0.03 (t=-1.81)	-0.03 (t=-6.59)***	-0.06 (t=-3.12)***	-0.02 (t=-4.10)***
ATM _t	0.76 (t=4.54)***	0.65 (t=4.83)***		0.51 (t=2.92)**
Credit _t	-0.22 (t=-0.79)	0.15 (t=0.74)		0.21 (t=0.77)
Cheque _t	-0.27 (t=-1.56)		-0.04 (t=-0.24)	
Constant	1.59 (t=0.42)	3.25 (t=1.13)	-1.25 (t=-0.27)	9.74 (t=3.15)***
R-squared	0.98	0.97	0.92	0.95
Adjusted-R ²	0.96	0.96	0.9	0.93
D-W stat	0.98	0.99	0.79	1.39

Notes: *, ** and *** represent the statistically significant at 90%, 95% and 99%, respectively. T-values are in parentheses. All variables, except for deposit rates, are expressed in logarithms with level form.

The findings that debit cards have exerted the *negative* impact on cash usage seem to be in general accordance with many earlier studies of the impact of e-payments on cash usage. As reported in Amromin and Chakravorti (2007), for most of 13 OECD countries, the increase in the debit card usage would lead to the decline in the demand for low denomination notes and coins. However, this seems to be not the case when the demand for high-denomination notes and coins is used as dependent variable.

The findings of the *negative* impact of the debit cards on cash usage have provided many implications. First, it suggests that the increased use of some form of electronic payment instruments like debit cards could replace part of cash transactions. Although the estimated coefficients reported here seems to be of marginal level, it has provided additional piece of evidence showing that the use of cash could be replaced by some form of e-payments. Greater diffusion of the card payment infrastructure may help increase the substitution effect between cash and card in Thailand in the near future.

Second, from the policy perspective, the gradual replacement of cash by debit cards would contribute to the lowering of bank costs in providing payment services. As documented elsewhere (see, for example, Humphrey, *et al.* (2003), e-payments (except for credit cards) are found to cost only one-third to one-half of their paper-based noncash equivalents. This would, in turn, lead to the cost savings for the country as a whole. In the USA, for example, the shift away from paper-based payments is reported to help save the nation's resource costs of around 0.5% of GDP. According to Humphrey, *et al.* (2003), the increased share of e-payments in 12 European countries is estimated to help reduce bank operating costs of around \$32 billion. This is equivalent to about 0.38% of GDP.

Although we can find the *negative* relationship between of the debit cards and cash usage, one need to be cautious in generalize this kind of results. For one thing, the actual value of transactions using debit cards tends to be in a small proportion when compared with some form of e-payments like credit cards. In the Thai context, the total value of debit cards for making purchases are reported to be of around 23.9 billion baht in 2009. This is much lower when compared with the total value of credit card transactions. As portrayed in Table 3, the total value of credit card transactions are nearly 1,040 billion baht in 2009.

Table 3: Transaction Value via Different Payment Channels

	2004	2005	2006	2007	2008	2009
Cash/GDP (%)	9	8	8	8	8	9
ATM-Cash withdrawal*	17.44	2840.0	3417.4	3810.9	4371.8	4593.8
Scheme Debit*	0.0	13.5	17.6	20.2	23.6	23.9
Scheme Credit*	408.8	667.4	816.0	919.8	1005.1	1039.4

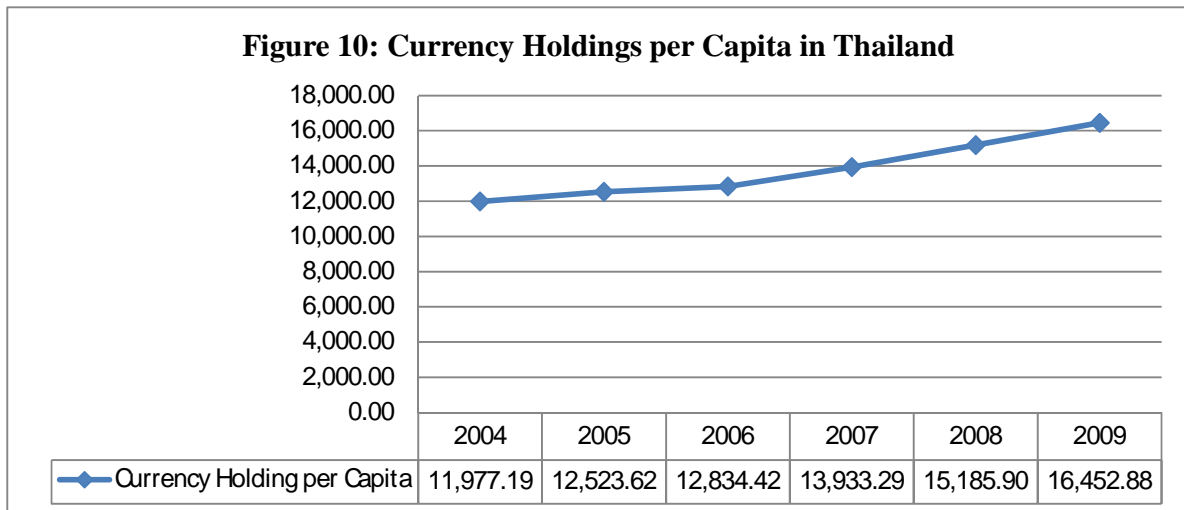
Source: Bank of Thailand

Unit: Billion Baht

* Data exclude Special Financial Institution

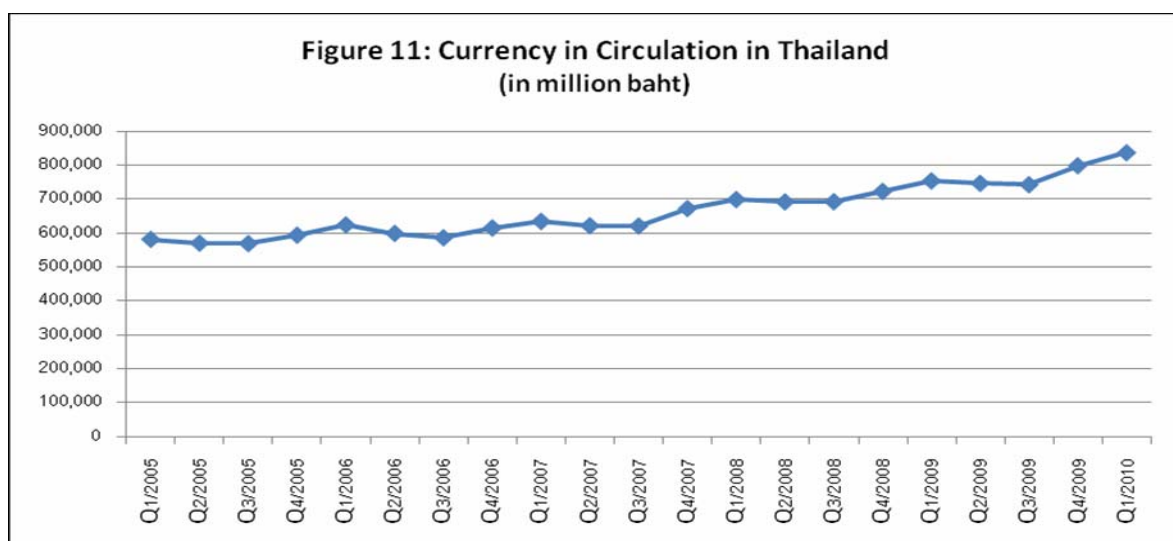
For another, the degree of debit card usage for making payments tends to be quite low when compared with the total value of debit card transactions (with the ATM withdrawer). According to the recent figures from the Payment Systems Department of the BOT, the portion of debit card usage for making payments accounted for only 3% of the total debit card usage in the first half of 2010. This suggests that this sort of e-payment development will not significantly affect the level of cash use in Thailand in the near future. However, for a successful replacement of cash by debit cards in some small value payments, it is likely that their application and acceptance will need to be much more broadly based to have any significant overall effect on the future use of cash. It follows that debit cards need to be widely used in certain specialized applications, especially those related to phone, subway, and bus use.

More importantly, as reflected in Figure 10, currency holdings per capita of Thailand have showed sign of increasing trends over the past 6 years. The ratio jumped from nearly 12,000 baht in 2004 to approximately 16,500 baht per person in 2009. This reflects an increase of around 37%. The significant increase in the currency holdings highlights the importance of cash in payment transactions. This may signal that cashless payment instruments have not yet been intensive use in many types of payment transactions, leading to a slow decline in the overall currency demand. Indeed, cash in circulation has showed sign of an upward trend over the past decade or so. As characterized in Figure 11, cash in circulation has continued to increase from around 740 billion baht in 2004 to nearly 880 billion baht in 2007. It then rose to nearly 1,050 billion baht in 2009.



Source: Authors' own calculation based on Bank of Thailand database

Taken together, empirical results presented in this section suggest that some form of e-payments like debit card payments can give rise to the reduction in the demand for cash over the period under investigation. Furthermore, GDP and interest rates are found to have significant influence on currency demand in such a way that the estimated coefficients are consistent with the theory of money demand. However, the degree of cash-card substitution tends to be minimal when judging from the estimated coefficient on debit cards. This tends to be consistent with the reasonably low degree of debit cards used for making direct purchases. As pointed out in the previous section, less than 5% of the total ATM withdrawal by the holders of debit cards is used for small and medium-value purchases.



Source: Authors' own calculation based on Bank of Thailand database

4. Conclusions and Policy Implications

Evidences so far tend to suggest that e-payment development in Thailand has shown a promising development, although the pace of the development has yet to quicken. As pointed in the paper, Thailand has experienced noticeable changes in the use of payment instruments and in the setting up of the country's card payment infrastructure. Several types of cash substitution products, especially debit cards, have experienced the strong growth over the past many years. Debit card (with the ATM withdrawer) has the leading position of instrument share, accounting for almost 47% of the total transactions of the cashless payments in 2009.

This paper has examined the impact of e-payments and card payments on the demand for cash in Thailand. The examination is based primarily on the estimation of standard demand for money model over the period 2005Q1-2010Q1 using the OLS estimation technique. Apart from standard macroeconomic variables like GDP and interest rates, some proxy variables related to e-payments are also incorporated into the model to account for possible effect of cash-card substitution. The inclusion of these variables has enabled us to analyze the impact of this sort of developments on the use of cash in Thailand.

Irrespective of the model used, the estimation results show that GDP and interest rates have exerted significant influences on currency demand, as suggested by the theory. The relatively high value of the estimated coefficient on GDP of around 0.42 implies that GDP, as a proxy for economic activity, constitutes important influence on the currency demand. Furthermore, ATM was found to have positive impact on currency demand. This suggests that the increased use of ATM would lead to the growing demand for currency to settle payment transactions, particularly those of low-value transactions.

Interestingly, empirical results suggest that some form of e-payments like debit cards significantly exert the negative on the stock of currency demand at an aggregate level. The estimated coefficient on debit cards of around -0.15 suggests that a 10% increase in debit cards transactions would result in the reduction of demand for cash transactions of around 1.5%. This implies that the greater use of debit cards would to some extent lead to the reduction in the use of cash for making payments. However, this sort of substitution process needs to be interpreted with cautious. As pointed out in the paper, the degree of debit card

usage for making direct payments tends to be quite low of only 3% of the total value of debit card usage. This suggests that it would take some time before this sort of substitution process would have significant impact on the future use of cash at the point-of-sale.

Despite the presence of certain degree of cash-card substitution, cash usage tends to remain significant as a major means of payment instruments in Thailand in the period ahead, especially those related to small payment transactions. The anonymity and store of value features of cash couple with its ease of use as a result of strong growth of ATMs are seen as key factors contributing to the strong preference of consumers in the use of cash for transaction purpose. Such a reflection lies in the relatively high value of Thailand's cash-to-GDP ratio of around 9-11% over the past many years. The continued increase in the currency holdings per capita from nearly 12,000 baht to 16,500 baht during the years 2004-2009 also highlights the importance of cash in payment transactions. As it is unlikely that electronic alternatives would succeed in mimicking all the benefits of cash in the near future, the general demand for cash will continue to grow at the current levels for the foreseeable future.

Nevertheless, the finding that debit card usage can lead to lower cash balances suggests that there are rooms for the banking system and the policy makers in Thailand to initiate changes in order to support the shift away from cash to e-payments. As the overall costs of most e-payments have been found to be only around one-third to one-half of the paper-based noncash payments, the greater use of e-payment instruments would give rise to the potential gain in resource costs for the country. Overall, the potential reduction in resource costs would incur the cost-savings for the country.

It is perhaps useful to briefly discuss some possible developments that will likely lead to the reduction of cash in the period ahead. One would be a prospective establishment of Local Switching in Thailand. The BOT has been looking to implementing the local switching in the near future. This establishment tends to have influences on the country's payment system. Chief among these would be the support of non-cash payments. The existence of this sort of network would also help reduce transaction costs. It enables transactions to be switched locally instead of being done by foreign networks such as Visa and Master Card. Being implemented in various countries, evidences show that this sort of network could lead to the reduction in transaction fees. Australia and South Korea are the outstanding ones

among this group of countries. Such a reduction in transaction fees would mean that the cost of using e-payment would be relatively lower. As citizens also consider the convenience from usage, this would be a sort of the sustainable support for the use of e-payment in Thailand.

The other development concerns the BOT's strategic move towards the reduction of cash and check usage in the near future. The BOT has approved a guideline for payment fees setting among commercial banks to reflect actual costs of services, and promote greater use of electronic media, with reduction in use of cheque and cash usage. The new payment fee structure among commercial banks has been in place for some time. The use of fee structure has, in fact, been successful in many countries, moving the whole economy to increasingly rely on electronic payment systems. While such a successful experience will be the case for Thailand is open to debate.

It is important to note, however, that one should not ignore the dimension of past history when judging the potential pace of acceptance of future payment methods or the realization of the intended effects of new payments technologies. Experiences in many countries have shown that it typically takes some time to shift the public's payment preference/habits from the use of relatively more traditional form of paper-based products to the relatively new forms of e-payment instruments in making payments. For example, in the case of the United States, it took at least a quarter of a century for the share of e-payment instruments/services (e.g. debit and credit payment cards) to surpass that of paper-based systems (cash and cheques). This tends to suggest that greater efforts need to be carried out in the move towards the successful reduction of cash and cheque usage of the country.

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