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# An Economic Analysis Of E-Payments Diffusion In Asia

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## Abstract

*We illustrate the diffusion of cash and electronic payments in five Asian countries--Japan, Korea, Singapore, Taiwan, and Thailand--as well as Hong Kong, an important economic zone of China. The purpose is to compare cash and other payment instrument use across these countries, determine the trend in cash use over 1995-2003, and illustrate how the transaction share of electronic payments in non-cash transactions has changed. This can provide a foundation for comparing payment system efficiency and technology adoption among Asian countries. We further note the apparent bank and retailer costs of accepting different payment instruments to get some idea on whether or not replacing cash transactions with electronic payments may lead to social benefits. A logistic projection of the share of electronic transactions in non-cash payments and the intensity of cash use in consumption is then presented.*

**Keywords**: Diffusion, Innovations, Electronic Payments, Asia

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## 1. Introduction

Are Asian economies moving towards the so-called cashless society? Forecasting results in this paper contributes to that debate. Cashlessness has been on the policy agenda of many central banks since the information technology revolution spawned many new electronic finance and payment schemes. Such developments also have broad implications for promoting efficiency in financial systems as well as maintaining financial and monetary stability, and provide insightful lessons on how countries can promote the use of electronic payments to catch up along the efficiency frontier.

Most people give little thought to how they make payments. Although the social cost of a country's payment system may comprise upwards of 2% to 3% of gross domestic product (GDP), and account for 5% of the value of an average transaction, consumers rarely face the direct costs of making a payment (Humphrey et al., 2003). In more recent studies, such social cost can be just under half a per cent of GDP (Gresvik and Haare 2008). Payment expenses borne by retailers are typically folded into the price of the good being purchased while banks often recoup their payment expenses through fixed fees or from deposit balances that pay no or a low interest rate.

Developed countries, realising that electronic payments (excluding credit cards) are a cheaper method of payment than paper-based giro and cheque instruments at the bank

and retailer level, have been shifting to electronic substitutes. In particular, debit cards have substituted for cheques and cash. Although data on cost savings are very difficult to obtain, it is estimated that the shift to electronic payments and substitution of ATMs for traditional banking offices in Europe over 1987-1999 has reduced bank operating cost by some $32 billion, saving 0.38% of 12 nations' GDP (Humphrey et al. 2006).

The situation is quite different in Asia where cash use is very high and cheque and other paper-based payment instrument use has been minimal. Here the availability of electronic substitutes, while progressively replacing the small number of cheques, has made little progress in replacing cash. Some national governments, generalising from the experience of developed countries which had a larger number of paper-based instruments that could be replaced, have concluded that they too should shift from cash and cheque use to electronic payments.

While evidence exists that electronic payments often are only one-third to one-half as expensive as paper-based payments at the bank level in developed countries, this cost difference need not apply to cash (Humphrey et al., 2003). Indeed, the information that exists for retailers is that accepting cash at the point of sale is cheaper per transaction than accepting a cheque or card payment (especially for low transaction values). Thus shifting from cash to electronic card payments at the point of sale may not be as beneficial as has been the shift from cheques and paper-based giro transactions to electronic substitutes. Even so, for convenience reasons, many consumers in developed countries (excluding Japan) seem to favour card use over cash and have made this shift themselves when an electronic alternative exists (Humphrey et al., 1996).

Although consumers may find cards more convenient than cash, a reduction in cash use has implications for government revenues and debt. When the growth of cash in circulation starts to slow, annual returns to governments from seigniorage will also slow. Seigniorage comes from issuing currency that costs from $.05 to $.08 per note to print (depending on anti-counterfeit designs) but generates revenue to the government equal to the face value of the notes issued. As the expense of issuing, distributing, and maintaining fitness of currency in circulation is markedly less than

the interest cost of servicing debt of the same face value, this difference is seigniorage revenue to the government. If cash use falls absolutely, revenues will be needed to redeem currency that no longer circulates and seigniorage revenues would be replaced by debit service costs.

Reduced use of cash has other implications as well. In addition to the effect on implementing of monetary policy (Drehmann et al. 2002), the difficulty of tracing cash transactions makes tax evasion and other illegal activities simpler so reduced use of cash may, depending on the anonymity of its replacement, also reduce tax evasion. To address these negative aspects of cash use, Norway now requires all cash transactions exceeding NKr 100,000 (about $16,000) be reported to authorities in order to limit tax evasion, black market activity, and money laundering (Ministry of Finance, 2004). Singapore, perhaps seeking the same ends as well as retaining seigniorage revenues, has been investigating the possibility of substituting government-issued smart cards to replace cash (Kok 2002). More generally, Singapore has provided financial support for programs to improve the efficiency of their payment system (e.g., cheque truncation, mobile phone and other electronic payment arrangements) and relaxed regulations restricting e-money issuance by non-banks (Monetary Authority of Singapore 2002; 2004). In Japan, the government has supported legislation intended to promote electronic banking and called for greater investment in information technology by financial institutions in order to improve payment system efficiency (Financial Services Agency 2004). Although considerably less direct, Taiwan and Hong Kong have implemented policies benefiting electronic payment activities. In Thailand, the focus to date has been on determining the cost of payments at the bank level (Jitsuchon and Khiaonarong 2000; Thailand Development Research Institute Foundation 2004). Thailand has also implemented a joint-review of payment service fees with the aim of encouraging electronic payments and lowering transaction costs as well as strengthening the competitiveness of financial institutions.

In what follows, we describe the data sources and methodology used and then illustrate the relative use of cash and electronic payments in five Asian countries--Japan, Korea, Singapore, Taiwan, and Thailand--as well as Hong Kong, an important economic zone of China. This aims to contribute towards the wider body of research

on innovation diffusion research, particularly in the context of banking (Rogers, 1983; Fichman 1992; King et al. 1994; Premkumar et al. 1994; Liao et al. 1999; Allen 2000). The purpose is to compare cash and other payment instrument use across these countries, determine the trend in cash use over 1995-2003, and illustrate how the transaction share of electronic payments in non-cash transactions has changed. This can provide a foundation for comparing payment system efficiency and technology adoption among Asian countries. We further note the apparent bank and retailer costs of accepting different payment instruments to get some idea on whether or not replacing cash transactions with electronic payments may lead to social benefits. A logistic projection of the share of electronic transactions in non-cash payments and the intensity of cash use in consumption is then presented. Forecasts of likely cash use in a country assists in making decisions concerning the possible issuance of new currency or coin denominators, continuing investments in cash distribution centers, and in projecting annual seigniorage revenues. It also helps in determining the near term efficiency of a country's payment system (a consideration in negotiating/adopting current free trade agreements for the provision of financial services).

## 2. Data and Methodology

Six Asian countries are included in the sample: Hong Kong (China), Japan, Korea, Singapore, Taiwan and Thailand. Annual data was obtained for the period 1995-2003 giving a total number of 54 observations. Payment data were obtained from the Bank for International Settlements (BIS, 2005), the Executives' Meeting of East Asia-Pacific Central Banks and Monetary Authorities (EMEAP, 2002), the South East Asian Central Banks Research and Training Centre (Torreja 2001a, 2001b), and national central banks and monetary authorities. Aggregate data on the number and value of credit and debit card transactions are based on figures for Visa and MasterCard banks cards from the Nilson report and represent only purchases. This includes all spending for goods and services and sales via the Internet, mail order, telemarketing, and all other forms of direct marketing, and excludes cash advances and withdrawals.

Data on currency in circulation, GDP, and household consumption expenditure, including non-profit institutions serving households, are from the International Financial Statistics compiled by the International Monetary Fund, and the Asian Development Bank. Population statistics and age breakdowns, where the adult cut-off age is defined as 20 and above, are from the Demographic Yearbook, United Nations Statistics Division. Adult population estimates are made on the ratio of adults to total population for the most current and available year (Hong Kong, Japan, Korea and Thailand are based on 2001; Singapore is for 2000). For Taiwan, adult population, also defined as aged 20 and above, are based on actual figures published in the Statistical Yearbook of the Republic of China, 2004, Directorate General of Budget, Accounting and Statistics.

Adjustments were made to the statistical data to allow for cross-country comparisons and to account for missing data. National currencies are converted to international US dollars using the purchasing power parity (PPP) conversion factor for 2002 (World Bank, 2004). For Taiwan, the PPP conversion factor was derived from the Central Intelligence Agency World Factbook. US dollar purchase values of bank card transactions obtained from the Nilson Report were converted to national currencies using annual average exchange rates and re-converted to international US dollars using the PPP conversion factor.

Missing data was estimated using the linear model with predicted values added to the missing values. Where predicted values were negative, this was adjusted to zero except for bankcard values for Korea and Thailand for the period 1995-96, where the card-share value to total household consumption expenditure for 1997 in each country is used to approximate the value of card transactions in the two preceding periods. The following missing data were predicted: the value of ATM cash withdrawals for Hong Kong (1995-96, 2003) and Korea (1995); the value of bank card purchases, covering credit card and debit card transactions, for Hong Kong, Japan, Korea, Singapore, Thailand (1995-96 for all countries) and Taiwan (1995-97); the value of cheques for Hong Kong, Japan, Korea, Singapore, Thailand (1995-96 for all countries) and Taiwan (1995-97); and the value of cash for Taiwan (1995-97).

The share of card, cheque and cash transaction values to total household consumption expenditure for each country was calculated as follows. Total card values are based on the purchase value of credit and debit card transactions from Visa and MasterCard as reported in the Nilson Report, and converted to US dollars using PPP conversion rates. Total cheque values were calculated by multiplying the average value per bank card to the number of cheque transactions for a given year. This provides a better approximation on the value of personal cheques and avoids the inclusion of relatively large-value corporate cheques. Total cash values were calculated by finding the difference between household consumption expenditures and the sum of card and cheque transaction values.

For Korea, ATM cash withdrawals are from the Bank of Korea and are based on the usage of CD/ATMs across financial institutions and not on the usage among the financial institutions themselves. Thailand cheque volumes for 1995-2003 include actual inter-bank and estimated intra-bank transactions. The Bank of Thailand estimates the share of intra-bank transaction volumes at 30% of the industry's total.

Following Meade and Islam (1995), we apply logistic S-curves to forecast the adoption and dispersion of new technologies in industry. This is particularly used to fit and forecast the share of electronic payments in total non-cash transactions and also the share of cash in consumer payments. While this approach has been adopted in earlier studies, its application to the Asian context has been lacking (Jyrkonen, 2004; Snellman et al., 2001; Snellman and Vesala, 1999).

## 3. Cross-Country Use of Cash and Electronic Payments

Over fifty years ago, the only real substitute for cash at the point of sale in most countries was the paper cheque, which is still strongly used in the U.S., the U.K., and France. This was also true for developing countries although cheque use was comparatively small. In many European countries, an additional paper-based substitute for cash involved giro transactions for bill payments and employee disbursements using a national network of post offices and the mail. Finally, a paper-based credit card network developed in the U.S. to serve travelers since, with thousands of only local banks, access to cash was difficult and accepting cheques was

risky. As technology and telecommunications improved, giro transactions in Europe became electronic as did credit card transactions in the U.S. and overseas. More recently, access to cash dramatically improved with the development of ATMs, which expanded into debit card networks in the U.S. and especially Europe as substitutes for both cheques and cash.

| | (Currency & Coin)/GDP | Cheques per Person | Electronic Payments Per Person [2] |
|---|---|---|---|
| France | 2.0 * | 64 | 151 |
| Germany | 3.3 * | 2 | 160 |
| Italy | 4.7 * | 9 | 47 |
| Japan | 14.6 | 1 | 30 |
| Singapore | 8.1 | 21 | 409 |
| Hong Kong | 10.5 | 18 | 8 |
| U.S. | 2.4 [1] | 126 | 152 |

**Table 1. Indicators of cash and non-cash use across countries, 2003**

**Source: BIS (2005). A * indicates that data are for 2001, the latest that is available for some countries.**

**[1] The actual U.S. ratio is 6.1 but was reduced since some 60% of the value of currency is believed to circulate outside of the country.**

**[2] Electronic payments includes credit/debit cards and card-based e-money for point of sale transactions along with credit transfers and direct debits for giro and ACH transactions for bill payment, employee disbursement, as well as business to business payments.**

One indicator of cash use in a country is the ratio of the value of currency and coin in circulation to the value of GDP. Some idea regarding the cross-country use of cash is shown in Table 1 along with per person use of cheques and electronic payments. In terms of cash use, the U.S. appears to use less cash for transactions than does Germany or Italy, which, in turn, uses less cash than Singapore, Hong Kong, and Japan. In terms of cheque use per person, the U.S. and France are clear outliers (as would be the U.K. if it were included) compared to the de minimis use of cheques in the other countries. The number of electronic payments per person is generally inversely related to the ratio of cash in circulation to GDP, suggesting a broad substitute relationship that is most evident when comparing Japan and Hong Kong with, say, France, Germany, and the U.S.

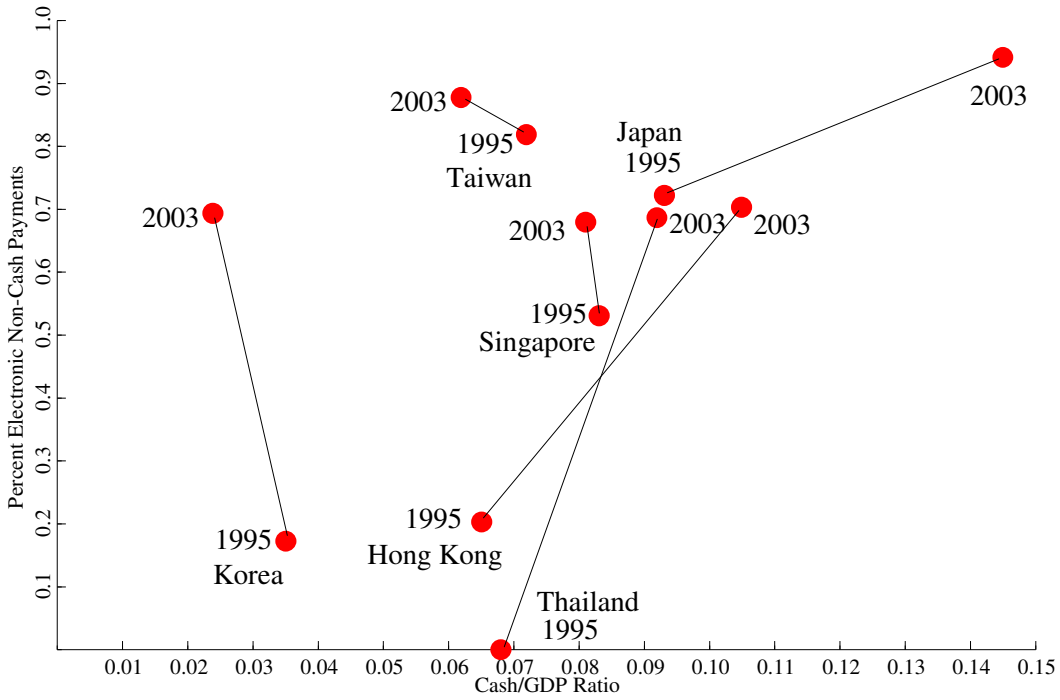


**Figure 1. Electronic payments and use of cash, 1995-2003**

**Sources: Asian Development Bank (2003), EMEAP (2002), Torreja (2001a, 2001b)**

Figure 1 shows the relationship between the indicator of cash use (the ratio of cash in circulation to GDP on the X-axis) to the share of electronic transactions in non-cash payments between 1995 to 2003 for the Asian countries we are interested in. All six Asian countries (including Hong Kong as a "country") have raised their share of electronic payments in total non-cash transactions to where this share is around 70% or higher in 2003. At the same time, the apparent intensity of cash use has expanded for three countries (Japan, Thailand, and Hong Kong), stayed approximately the same for one (Singapore), and fallen for two (Korea and Taiwan).

Figure 2 shows the yearly evolution of the value of cash in circulation as a ratio of GDP over 1995-2003 for all six countries. There is a more or less consistent rise in this ratio for Japan, Thailand, and Hong Kong and reduction for Korea and Taiwan. According to this indicator, only Korea seems to have reduced its cash use to levels experienced in the developed countries seen in Table 1.

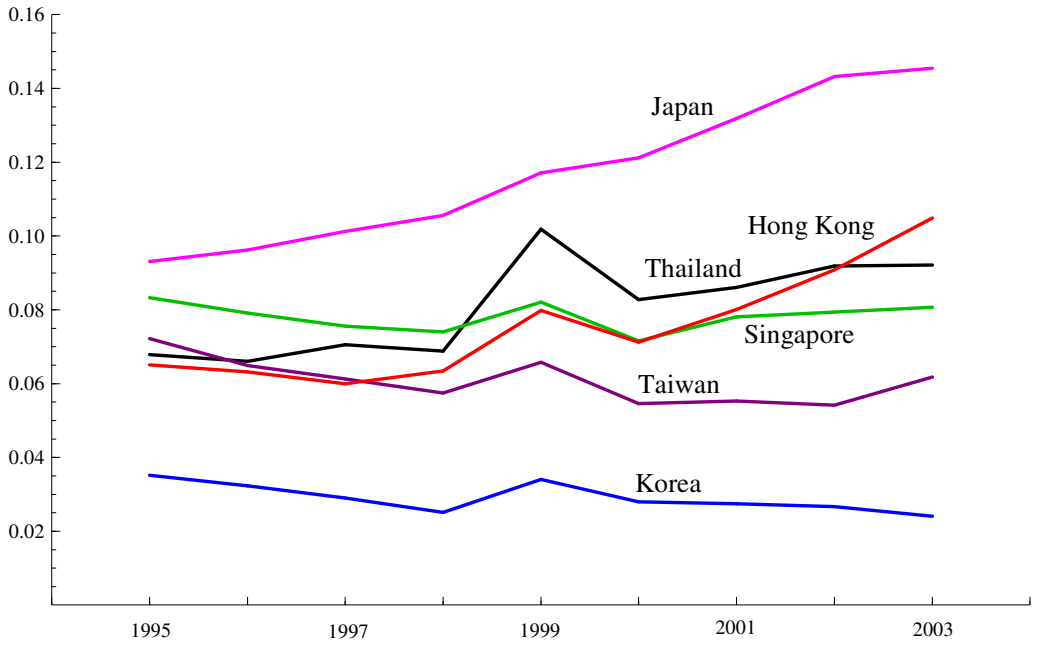


**Figure 2. Cash to GDP ratio, 1995-2003**

**Source: Asian Development Bank (2003)**

The yearly evolution of the share of electronic transactions in all non-cash payments is shown in Figure 3. Here the greatest increase in the share of electronics has been achieved by Thailand, Korea, and Hong Kong. By 1995 Japan and Taiwan had already achieved a relatively high share of electronic payments and consequently show only a slight increase going forward to 2003. As is seen in Table 1, France and the U.S. have a much greater scope for continuing to substitute electronic payments for cheques than do Japan, Singapore, or Hong Kong. For these and other Asian countries, the growth of electronic payments is dependent on reducing cash use rather than shifting away from cheques (or paper-based giro payments) as has occurred so far in developed countries.

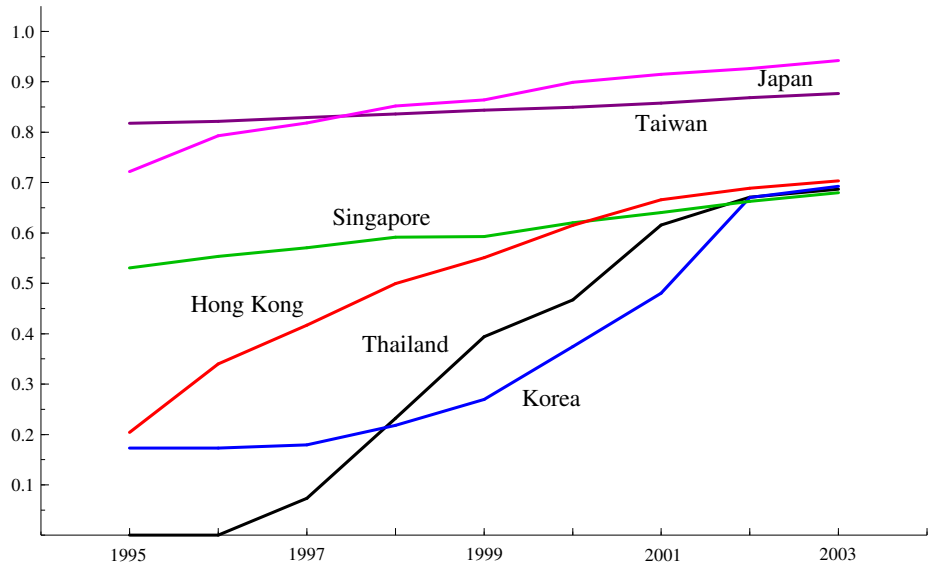


**Figure 3. Percent of electronic non-cash transactions**

**Sources: EMEAP (2002), The Nilson Report (2003)**

### 3.1 Alternative indicator of cash use

It is possible to determine an alternative measure of cash use from the following:

Cash = Consumption - Cheque - DCard – Ccard (Equation 1)

where:

Cash = estimated value of consumer cash payments;

Consumption = observed value of household consumption;

Cheque = observed/approximated value of cheques;

DCard = observed/approximated value of debit card payments; and

CCard = observed/approximated value of credit card payments.

The estimated value of cash from Equation 1 is a residual measure but is likely a more accurate indicator of the legal value of cash used in consumer point of sale and bill payments than is the ratio of cash in circulation to GDP. Circulating cash (especially the largest currency denominations) are commonly used in unreported illegal activities. As explained in Khiaonarong and Humphrey (2005), the data used to compute this alternative cash measure involves assumptions, linear interpolations, and other procedures needed to compute Equation 1. This is not unusual as payment data

for developed countries is often only marginally better (for Europe) and sometimes worse (for the U.S.).

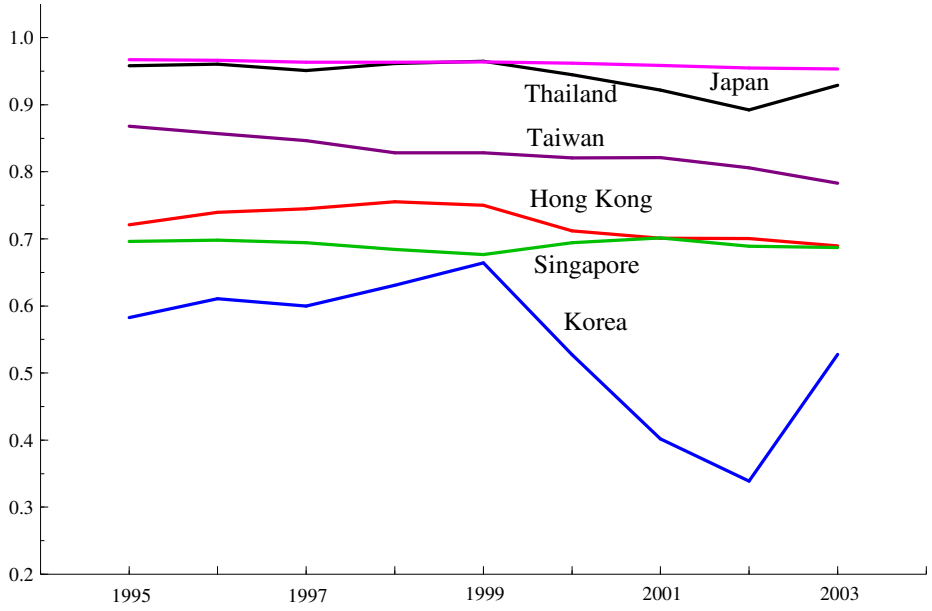


**Figure 4. Percent cash use in consumer payments**

**Sources: International Monetary Fund (2004), EMEAP (2002), The Nilson Report (2003)**

The ratio of the value of cash computed from Equation 1 to total household consumption in our six countries is shown in Figure 4. Using such a ratio controls for differences in the level of disposable income across countries. Both Japan and Thailand appear to use cash for over 90% of their purchases and bill payments while Taiwan has a ratio in the mid to low 80% range. Hong Kong and Singapore both rely on cash for around 70% of their consumption while Korea is lower still at or below 60%. The large apparent reduction in cash use in Korea after 1999 is associated with a sharp rise in credit card purchases between 1999 and 2002. New entry of non-bank cards into the market and over-promotion of credit card use by all issuers led to this result. So much credit card debt was incurred that cash withdrawals on one set of cards held by consumers was increasingly used to pay off balances on others. The resulting debt spiral inflated credit card purchases and thereby reduced our measure of cash use in consumption. Interestingly, although our credit card data excludes cash advances and withdrawals, many consumers pay their credit card bills using cash instead of an electronic payment.

The apparent levels of cash use for legal consumer payment activities in Hong Kong, Singapore, and Korea are similar to those currently estimated for Norway (53%), Spain (around 60%) but far higher than for the U.S. (20%). Cash use in the U.S. is low because over the last fifty years cheques significantly replaced cash for point of sale and especially bill payments. Indeed, as early as 1975, the share of cash in consumer payments was only a little over 30%. Except for the U.K. and France, Europe did not experience a large degree of cash replacement from cheques and only more recently has the share of cash fallen, largely due to the use of debit cards (Snellman et al. 2001). For our six Asian countries, the European experience of debit cards replacing cheques is the most likely near term outcome, rather than the European experience of cards replacing cash. Japan, for example, has long had the opportunity to replace cash with credit or debit cards but little substitution has actually occurred. The main reason for this result seems to be that Japan is a relatively safe country with many ATMs so the need for an alternative to cash is correspondingly lower than elsewhere (Federation of Bankers Associations of Japan 1994).

Another way to view cash use is in terms of the average value spent per adult per year. For comparability, the cash values estimated in (Equation 1) have been translated into U.S. dollars using purchasing power parity exchange rates and are shown in Figure 5. The average adult in Japan spends about $18,000 in cash each year while the average adult in Korea and Thailand spends between $4,000 and $6,000 per year. The range for Singapore, Taiwan, and Hong Kong is between $11,000 and $15,000 a year. These differences, of course, reflect different disposable income levels as well as savings rates but what is interesting is that these approximations to real cash expenditure levels have been relatively flat over 1995-2003 even as these countries (Japan excepted) were growing.

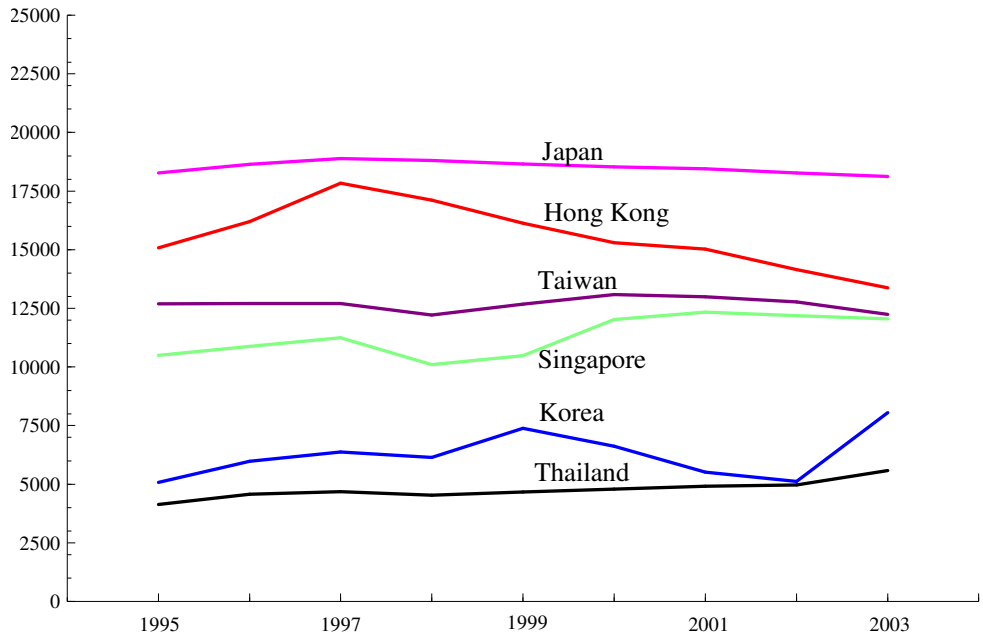


**Figure 5. Value of cash used per adult per year**

**Sources: International Monetary Fund (2004), United Nations (2004)**

Have electronic payments made much of an inroad to cash use in Asia? The answer has to be that to date electronic payments have been replacing cheques (Figures 1 and 3) but do not seem to have affected cash use very much if at all (Figures 2, 4, and 5). The experience of our six Asian countries has not, so far, followed the pattern of some countries in Europe or the U.S. where the share of cash use in consumer transactions has been declining. We next examine the limited information that exists on the cost of different payment instruments to assess the degree that explicit reductions in bank or retailer costs may lead to savings if electronic payments did replace cash.

## 4. Costs of using different payment instruments

Very little information is available on the bank cost of supplying different payment instruments or on the retailer cost of accepting them. Even less information exists concerning cash. Given the data available, we focus on the payment cost of cheques, debit cards, and cash for use at the point of sale.

### 4.1 Bank payment costs

Norway has collected representative information on the bank cost of handling different payment instruments for more than a decade. This is the only country we know of that does so. The bank cost data includes labor, building, materials, and computer expenses incurred in processing payments as well as allocated bank branch office expenses associated with the various payment types. The approximate weighted average bank cost per transaction over 1988-2001 has fallen from $2.52 to only $0.95, a reduction of 62% over 13 years (Gresvik and Øwre 2002). Bank costs in Norway for cheques, debit cards, and cash are shown in Table 2. Cheque costs are very high at $4.02 compared to other countries that use far more cheques but exclude associated branch costs (e.g., $0.35 for Spain or $0.43 for the U.S.). This compares to $0.44 in Norway for a debit card transaction. Thus the bank cost of a debit card is only 11% as much as the cost of a cheque and 31% of the cost of supplying cash. For banks, substituting electronic debit card transactions for cheques or even cash could reduce their operating cost.

| Country/Year | Cheque | Debit Card | Cash |
|---|---|---|---|
| Bank Payment Costs: Norway/2001 | $4.02 | $.44 | $1.35 - $1.52 |
| Retailer Payment Costs: | .28 | .10 - .23 | .07 |
| Australia/2001 | .65 - .93[1] | 1.14 | .12 - .20 |
| Germany/1999 | 1.25 | .34[2] | .12 |
| U.S./2000 | | | |

**Table 2. Illustrative bank and retailer costs for cheques, debit cards, and cash**

**Sources: See Humphrey et al. (2006). Data converted into U.S. dollars. [1] Cheques are truncated and collected electronically, lowering cost. [2] On-line debit card.**

### 4.2 Retailer expense of accepting different payment instruments

Retailer costs are based on limited survey information. As seen for Australia, Germany, and the U.S. in Table 2, cash appears to be markedly cheaper to accept than either cheques or a debit card. Taking the average of the costs shown across these three countries suggests that the retailer cost of accepting a cheque averages $0.77, is $0.55 for a debit card, and only $0.12 for cash. A recent study in the Netherlands comparing the social cost of retailer acceptance of a debit or "cash in a chip" card payment versus cash found that cash was cheaper for transaction values less than $17 but that its electronic substitute was cheaper to accept for values greater than $17 (Raa and Shestalova 2004). Thus cash need not always be cheaper--it can depend on transaction size. This seems to mirror consumer behavior as well since in many developed countries consumers prefer a card payment to cash when the transaction amount is relatively large but use cash when the transaction value is relatively small.

It appears that while retailers benefit from accepting cash relative to other payment instruments, banks may not. This sets up a conflict since, in large measure, it is the consumer--not usually the bank or the retailer--who selects out of the alternatives available which payment instrument to use in transactions. Banks can try to introduce the debit card as an alternative to cash but would likely face some resistance by retailers and garner only slow adoption (if incentives are not offered) by consumers. Currently, these bank-consumer-retailer trade-offs are being made in Asia with little consideration of other issues, such as tax evasion, illegal activity, and government seigniorage revenues.

### 4.3 Estimating the number of cash transactions

It is difficult enough to estimate the value of cash payments in a country. It is harder still to try to approximate the volume or number of cash transactions. When time-series data are too short to use an econometric model (as is the case for our Asian countries), the value of cash payments in a country can be approximated from the equality: Cash = Consumption - Cheque - DCard - CCard, which we implemented above and used to generate Figures 4 and 5. A similar approach to approximating the total number of cash transactions is not possible since the total number of all payment transactions in a country (unlike the value of personal consumption) is unknown. However, if sample survey data are available for a set of retailers, these data can be

factored up to approximate the value and volume of cash transactions as well as the average value per transaction. For example, in the U.S. there exists a rather comprehensive survey of the cost of different payment instruments accepted at supermarkets (Food Marketing Institute 2001). The 2000 survey reports the percent of payments by number of transactions (cash 43%, cards 23.7%, cheques 33%) and value (cash 19.5%, cards 30%, cheques 50.6%). Combined with survey information on the number (23.3 billion) and value ($1.6 trillion) of card transactions in the entire U.S. in 2000 (Gerdes and Walton 2002, Table 1), this yields an estimate of the total consumer cash transaction volume of 42.3 billion, value of $1.04 trillion, with an average value per cash transaction of $24.60. This ad hoc approach gives values similar to a more careful analysis which reports 50.9 billion consumer cash transactions for a value of $1.09 trillion and an average value per transaction of $22 (The Nilson Report 2003).

While we know of no data for our six Asian countries regarding the number of cash transactions, this information could be developed using straightforward sample surveys and would be especially important if the average value of cash transactions were divided into (say) four parts, such as very small, small, medium, and large. When electronic payment cards substitute for cash, large and medium size cash transactions are the first to be affected. Only later will cards affect smaller cash payment values. Since the substitution of cards for the very smallest size cash transactions has to date been unsuccessful even in developed countries, it would be best to concentrate on cash payments at retail outlets (which would primarily cover medium and large cash transactions) since this is where cards initially have the greatest likelihood of substituting for cash.

## 5. Projecting shares of electronic and cash payments in Asia

Logistic and Gompertz growth or S-curves have been used in a variety of situations to forecast the adoption and dispersion of new technologies in industry. The logistic S-curve is used here to fit and forecast the share of electronic payments in total non-cash transactions and also the share of cash in consumer payments. In a detailed empirical comparison, Meade and Islam (1995) have shown that the standard logistic and

Gompertz S-curves outperform more complicated models. The logistic curve we estimate specifies a payment share (St) as a function of time (t):

$$\ln(St/(1 - St)) = a + b\,t + et \quad \text{(Equation 2)}$$

where:

b = the coefficient of diffusion or the slope of the S-curve.

In Equation 2 the pattern of initial payment instrument substitution is used (via symmetry around its inflection point) to predict the remaining pattern of replacement. The non-linear, symmetric logistic curve and the Gompertz non-linear, asymmetric curves ask too much of our limited data (which has few degrees of freedom and inflection points) to be reliably estimated here so we implement only the linear, symmetric logistic model (Equation 2).

### 5.1 Share of electronic payments in non-cash transactions

The results of the logistic estimation where St = (number of electronic transactions)/(total number of non-cash transactions) are shown in Table 3 and Figure 6. Fitted shares are shown for 1995-2003 and correspond to, but are smoother than, the progression of observed shares shown in Figure 3. Extending the time period forward yields projected shares for 2004-2013. The S-shape of these curves is best seen for Hong Kong, Korea, and (especially) Thailand. Initially, adoption of new technology rises at an increasing absolute rate, reaches an inflection point when it expands at a constant rate, and then continues to rise but at a decreasing rate as the adoption of new technology saturates the potential market (which here, plausibly enough, is very close to 100% for electronic payments and 0% for cheques).

| | Fitted | | | | Predicted | | $\ln(S_t/(1 - S_t)) = a + b\ t$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 1999 | 2003 | | 2008 | 2013 | a | B | $R^2$ adj |
| Hong Kong | .27 | .52 | .75 | | .92 | .98 | -1.24 | .263 | .92 |
| Japan | .74 | .87 | .94 | | .98 | .99 | .83 | .219 | .99 |
| Korea | .12 | .34 | .66 | | .91 | .98 | -2.33 | .333 | .90 |
| | | | | | | | | | |
| Singapore | .53 | .61 | .68 | | .75 | .82 | .05 | .077 | .99 |
| Taiwan | .81 | .85 | .87 | | .90 | .92 | 1.41 | .058 | .98 |
| Thailand | .02 | .23 | .83 | | .99 | 1.00 | -4.69 | .700 | .91 |

**Table 3. Fitted and forecasted shares of electronic payments.**

**Note: All estimated parameters are significantly different from zero at the 99% level of confidence, except one (where the significance level was 95%). There were 9 time-series observations (7 d.f.). The $R^2$ value is adjusted for degrees of freedom.**

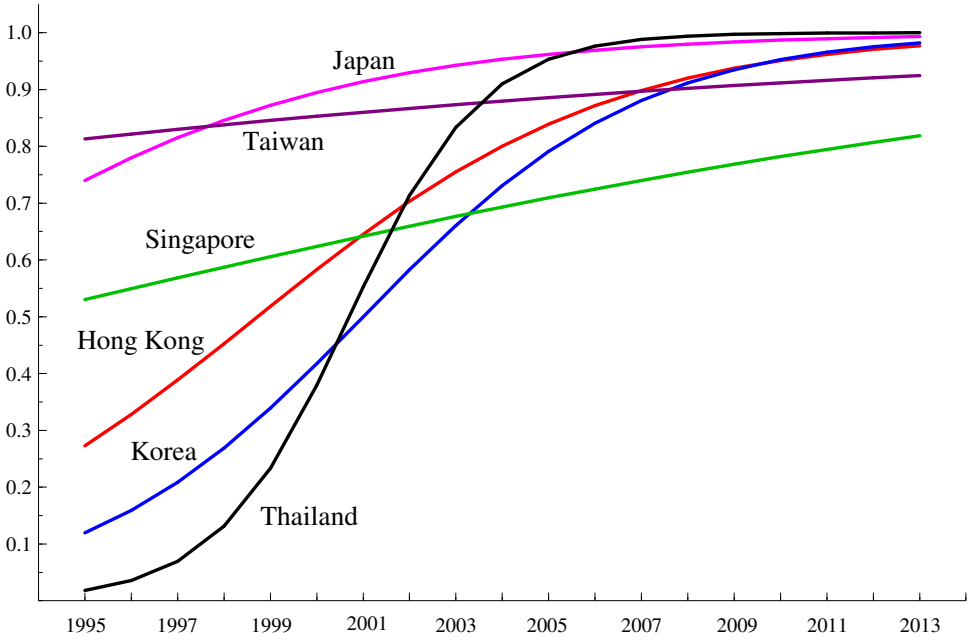


**Figure 6. Predicted share electronic non-cash transactions.**

**Source: Author's calculations**

The curves in Figure 6 are based on the estimated equations in Table 3. The high R2s are partly the result of the short time period for which payment data are available but mostly they are high because the observed payment share data in Figure 3 that was used in the estimation actually varies in a manner specified in (Equation 2). All the parameters were significantly different from zero and are of the expected sign. Fitted share values for 1995, 1999, and 2003 are shown in Table 3 as well as 5-year and 10-year forward projections. While only Japan has an electronic payment share in the .90s in 2003, the projection suggests--if past trends continue--that all but Singapore will be in that position in five years. In summary, five of the six countries will by 2008 be in the final stages of substituting electronic payments for cheques. At the same time, depending on the availability of card terminals, the use of incentive pricing for payment transactions by banks/retailers, and consumers' assessment of the benefits of cash versus electronic payment methods, electronics may begin to play an important role in replacing cash (at least for legal, higher value transactions).

### 5.2 Share of cash payments in consumption

Applying logistic estimation to the observed shares shown in Figure 4, where St = (value of cash payments)/(total consumer payments) and S*t = 1 - St was used in (Equation 2), gave the fitted (1995-2003) and projected (2004-2013) cash shares in Figure 7. None of these curves evidence the traditional S-shape since none of the six countries is far enough down the road of substituting away from cash for consumer payments to have reached an inflection point. Earlier work indicated that Italy, Germany, the U.K., and other European countries have also not reached an inflection point in their declining use of cash (Snellman et al. 2001). All six Asian countries, as well as many in Europe, are only in the initial stages of replacing cash with electronic payment instruments, although some are more advanced in this process than others. The lack of an inflection point for the curves in Figure 7 is the reason the R2s for the logistic estimation in Table 4 are often very low.

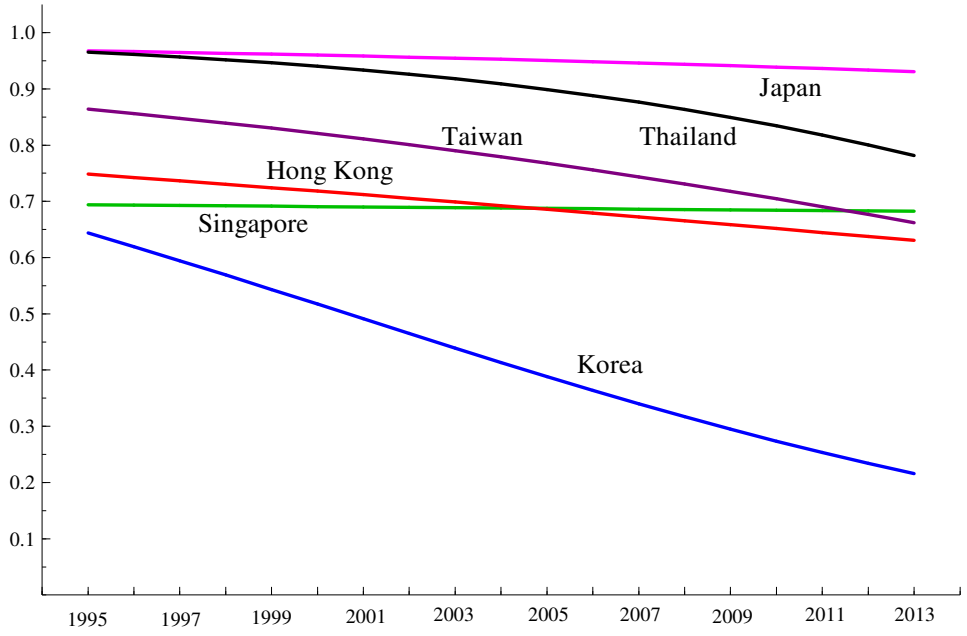


**Figure 7 Predicted share cash consumer payments.**

**Source: Author's calculations**

| | Fitted | | | | Predicted | | ln(S*t/(1 - S*t)) = a + b t | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1995 | 1999 | 2003 | | 2008 | 2013 | a | b | $R^2$ adj |
| Hong Kong | .75 | .72 | .70 | | .67 | .63 | -1.12 | .031 | .40 |
| Japan | .97 | .96 | .95 | | .94 | .93 | -3.45 | .045 | .92 |
| Korea | .64 | .54 | .44 | | .32 | .22 | -.70 | .105 | .33 |
| | | | | | | | | | |
| Singapore | .694 | .691 | .689 | | .686 | .682 | -.82 | .003 | -.08 |
| Taiwan | .86 | .83 | .79 | | .73 | .66 | -1.91 | .065 | .93 |
| Thailand | .97 | .95 | .92 | | .86 | .78 | -3.44 | .114 | .53 |

**Table 4. Fitted and forecasted shares of cash in consumer payments.**

**Note: All estimated parameters are significantly different from zero at the 99% level of confidence, except one (where the significance level was 95%) and another which was insignificant (the slope value for Singapore). There were 9 time-series observations (7 d.f.). The $R^2$ value is adjusted for degrees of freedom which, for Singapore, turns the unadjusted of $R^2$ = .05 into a negative value.**

The observed cash share information in Figure 7 and our logistic estimation results suggest that Hong Kong, Taiwan, and Thailand may see a slight but significant reduction in the share of cash used for consumer payments. A reduction in the share of cash need not also mean that the value of cash in circulation and the associated growth of seigniorage revenues will fall. Only when the share falls fairly rapidly would this be a concern. In contrast, the stable cash share outlook for Japan and Singapore indicates a stable rise in seigniorage revenues, although that stable share is much lower in Singapore (at .68) than in Japan (.94). The dramatic decline in the fitted and projected cash shares for Korea need to be discounted at present due to the previously noted data problems in that country. Overall, the cash share results indicate that the implementation of monetary policy is unlikely to be affected in our countries (neglecting Korea) since the cash share is projected to exceed 65% five years out and exceed 60% ten years out.

## 6. Conclusion

In summary, although not well known, the cost of making a consumer payment may on average comprise around 5% of the value of a purchase. The development of electronic payment alternatives to paper-based payment instruments and cash may permit resources to be saved by banks and retailers. Electronic alternatives also seem to be valued by consumers as a more convenient and safer way to initiate transactions.

Generalising from the experience of developed countries over the last decade or two, some national governments in developing countries have suggested that they too should shift from cheque and cash use to electronic payments. Much evidence exists that electronic payments (excluding credit cards) are generally from one-third to one-half as expensive as paper-based payments at the bank level. The six Asian entities we study (Hong Kong, Japan, Korea, Singapore, Taiwan, and Thailand) are well on their way of replacing cheques with electronic card payments. Indeed, although only Japan had achieved .90 share for electronic payments in non-cash transactions by 2003, all but Singapore are projected to achieve a .90 or higher share within five years (by 2008). Many European countries have achieved a similarly high share for electronic payments while others who have historically been large users of cheques (France, the U.K., and the U.S.) have much lower electronic non-cash payment shares.

In the latter case, this is because over the last 50 years, cheques replaced a large portion of consumer and even business use of cash while such replacement has been minimal in our six Asian countries (so there were fewer cheques to replace to begin with) (BIS, 2005).

The next stage in the substitution process would be the replacement of cash by electronic payments, a process which has started in the U.S. and some European countries (in Scandinavia) but, to date, has been weak in other European countries (e.g., Germany, Italy) as well as our six Asian countries (Humphrey et al., 2005). Some evidence exists suggesting that while banks could save costs if electronic payments replaced cash, retailers could find that their costs may rise. Thus the overall, social cost effect of such a substitution is not as clear as it has been for electronic payments replacing cheques and paper giro payments. While many consumers in developed countries seem to favor card payments over cash for convenience and safety reasons, this has not been the experience of Japan which has long had the opportunity for a similar substitution but has only moved slightly in that direction. The share of the value of cash in consumer payments for Japan was .95 in 2003 and is only projected to fall to .94 by 2008 whereas the projection for the other five Asian countries is for the cash share to fall below .75 for all but Thailand.

Although the projected share of cash in consumer payments is projected to fall for all but Japan and Singapore (where the share is expected to be stable), this reduction should have no real effect on the implementation of monetary policy and little near term affect on government seigniorage revenues. In the distant future, if cash use falls absolutely (as it is close to doing in some Scandinavian countries), cash in circulation will have to be redeemed through expanded government debt or (in the case of Thailand and perhaps other countries) sales of assets that currently back currency issue. These considerations and others, such as the relative social costs of replacing cash with electronic payments, would be important to determine before governments decide to provide inducements to shift away from cash for payments (as some are already doing).

## 7. References


Allen JP (2000) Information systems as technological innovation, *Information Technology & People*, 13(3), 210-221

Asian Development Bank (2003) Key indicators, Manila.

Bank for International Settlements (2005) Statistics on payment and settlement systems in selected countries. Committee on payment and settlement systems, Basel.

Carbo S, Humphrey D, Lopez L (2003) The falling share of cash payments in Spain, *Moneda y Credito*, No. 217, 167-189.

Central Intelligence Agency (2008) The world factbook, 25 March: https://www.cia.gov/library/publications/the-world-factbook/

Directorate General of Budget, Accounting and Statistics (DGBAS) of Executive Yuan (2004) Statistical yearbook of the Republic of China, Taiwan.

Drehmann M, Goodhart C, Krueger M (2002) The challenges facing currency usage: will the traditional transactions medium be able to resist competition from the new technologies? *Economic Policy*, 34, 193-227.

Executives' Meeting of East Asia-Pacific Central Banks and Monetary Authorities, (EMEAP) (2002) Payment systems in EMEAP economies. July, EMEAP Working Group on Payment and Settlement Systems.

Federation of Bankers Associations of Japan (1994) The banking system in Japan, Tokyo, Japan, 95.

Fichman RG (1992) Information technology diffusion: a review of empirical research, MIT Sloan School of Management, June.

Financial Services Agency (2004) Program for further financial reform, Tokyo, Japan, December.

Food Marketing Institute (2001) It all adds up: an activity-based cost study of retail payments, Washington, D.C.

Gerdes G, Walton J (2002) The use of checks and other noncash payment instruments in the United States, *Federal Reserve Bulletin*, 88, August.

Gresvik O, Haare H (2008) Costs in the Norwegian payment system 2007 – a brief overview of surveys and results, Norges Bank Staff Memo No. 9.

_____, Owre G (2002) Banks' costs and income in the payment system in 2001, Norges Bank *Economics Bulletin*, 73, 125-133.

Humphrey D, Vale B (2004) Scale economies, bank mergers, and electronic payments: a spline function approach, *Journal of Banking and Finance*, 28, 1671-1696.

_____, Kaloudis A, Owre G (2004) The future of cash: falling legal use and implications for government policy, *Journal of International Financial Markets, Institutions & Money*, 14, July: 221-233.

_____, Pulley L, Vessala J (1996) Cash, paper and electronic payments: a cross-country analysis, *Journal of Money, Credit and Banking*, 28 (4), 912-939.

_____, Willesson M, Lindblom T, Bergendahl G (2003) What does it cost to make a payment? *Review of Network Economics*, (2), 2, 159-174.

_____, Willesson M, Bergendahl G, Lindblom T (2006) Benefits from a changing payment technology in European banking, *Journal of Banking and Finance,* 30, June 2006: 1631-52.

International Monetary Fund (2004) International financial statistics, Washington, D.C.

Jitsuchon S, Khiaonarong T (2000) Payment income, cost and usage in Thailand. *Quarterly Bulletin*, Bank of Thailand, 40 (4), 37–54.

Jyrkonen, H (2004) Less cash on the counter – forecasting Finnish payment preferences, Bank of Finland Discussion Papers 27/2004.

Khiaonarong T (2003) Payment systems efficiency, policy approaches, and the role of the central bank, Helsinki: Bank of Finland *Discussion Paper* 1/2003.

King JL, Gurbaxani V, Kraemer KL, McFarlan FW, Raman KS, Yap CS (1994) Institutional factors in information technology innovation, *Information Systems Research*, 5(2), 139-169.

Kok LS (2002) Singapore Electronic Legal Tender (SELT) - A Proposed Concept. In Organization for Economic Co-operating and Development, *The future of money*, Paris, pp. 147-161.

Liao S, Shao YP, Wang H, Chen A (1999) The adoption of virtual banking: an empirical study, *International Journal of Information Management*, 19(1), 63-74.

Meade N, Islam T (1995) Forecasting with growth curves: an empirical comparison, *International Journal of Forecasting*, 11, 199-215.

Ministry of Finance (2004), Money Laundering Act, Norway.

Monetary Authority of Singapore (2004) Consultation Paper on Draft Payment Systems (Oversight) Bill, Singapore, 23 December.

_____, (2002) Annual report 2001/2002, Singapore.

Premkumar G, Ramamurthy K, Nilakanta S (1994) Implementation of electronic data interchange: an innovation diffusion perspective, *Journal of Management Information Systems*, 11(2), 157-186.

Raa T, Shestalova V (2004) Empirical evidence on payment costs and switch points, *Journal of Banking and Finance*, 28, 203-213.

Rogers EM (1983) *Diffusion of innovations*. New York: The Free Press.

Snellman, J, Vesala, J (1999) Forecasting the electronification of payments with learning curves: the case of Finland, Bank of Finland Discussion Papers 8/1999.

Snellman J, Vesala J, Humphrey D (2001) Substitution of noncash payment instruments for cash in Europe, *Journal of Financial Services Research*, 19, 131-145.

Thailand Development Research Institute Foundation (2004) Enhancing efficiency of Thai payment systems, Bangkok, Thailand.

The Nilson Report (2003) No. 799, HSN Consultants Inc., November.

Torreja ML (2001a) The payment and settlement systems in the SEACEN countries: volume I. The South East Asian Central Banks Research and Training Centre, Kuala Lumpur.

_____ (2001b) The payment and settlement systems in the SEACEN countries: volume II on country chapters. The South East Asian Central Banks Research and Training Centre, Kuala Lumpur.

United Nations (2004) Demographic yearbook, United Nations Statistics Division, New York.

World Bank (2004) World development indicators, Washington, D.C.