Cash, Paper, and Electronic Payments: A Cross-Country Analysis

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A COUNTRY'S PAYMENT SYSTEM is what makes its real and financial markets work. When commodities are exchanged for cash, check, giro, credit card, or debit card payments—rather than for other commodities—trade expands as transaction costs fall and production specialization increases.

But what determines which payment instrument is used and why are some used more intensively than others? Is payment instrument use strongly tied to standard demand theory influences (such as relative prices and income) or do institutional, habit, and simple payment availability differences across countries dominate? What has been the pattern of payment instrument use over time and how similar has this been across countries? Finally, how large are the payment substitution relationships and what does this imply for the future use of different payment instruments, especially between paper and electronic payments?

To address these questions, we analyze the payment systems of fourteen developed countries using payments data over 1987–1993 recently constructed by the Bank for International Settlements (BIS). In these countries, there were 119 billion noncash payments in 1993, an increase of 34 percent over 1987. While 35 percent of these payments were electronic, this rises to 62 percent when the United States is excluded. Since the cost of an electronic payment ranges between one-third to one-half that of a check or paper giro payment (Robinson and Flatraaker 1995; Hum-

phrey and Berger 1990), the social cost of a country's payment system—which is probably between 2 percent to 3 percent of GDP—can be reduced by promoting the shift to electronics. In this paper we identify the countries that have been most successful in this regard and attempt to determine the factors associated with this change.[1]

In what follows, measures of cash use across countries are compared in section 1 and related to the level of all noncash transactions. Cash use and noncash transactions are negatively related, as may be expected, but—unexpectedly—this implied substitution is due more to differences in use across countries than it is to changes in use over our seven-year period. Section 2 focuses on the relative levels of noncash paper and electronic payments. Although a high percentage of electronic payments is associated with intensive use of cash across countries, current trends will reverse this relationship in the future: both cash and noncash paper instrument use will be low while electronics will be high. As shown in section 3, in most countries check arid paper giro transactions per person have reached a peak and are falling.[2] Overall, the annual number of electronic transactions per person rose by twenty-four during 1987–93 while paper-based payments rose by ten. Excluding the United States, the shift to electronics is even more evident: per person electronic payments rose by thirty-three while paper-based payments rose by three (with check use falling absolutely).

A statistical model of the economic and institutional determinants of use of five types of paper and electronic payment instruments is described in section 4 with results presented in section 5. The analysis first covers the ten developed countries for which payment instrument price data are available. Time and country dummies are included to capture unspecified time-series and cross-country effects and to gauge the conditional explanatory power of price, income, availability, institutional, and lagged use variables. In a second estimation, the country dummies are restricted to zero in order to force the coefficients on the remaining variables to catalogue differences in payment use across countries. The price variables (which yield fragile results) are also dropped, permitting us to cover payment use in all fourteen developed countries. Elasticities are computed from the model to indicate the level and significance of substitution among the various payment instruments, as well as between these instruments and cash. Conclusions are presented in section 6.

1. CASH HOLDINGS AND NONCASH TRANSACTIONS

Cash is, by far, the most used payment instrument. The few surveys or estimates that exist place the proportion of cash transactions among all transactions at 90 per-

1. Our focus is on retail payment instruments used for consumer and most business payments; wholesale payments over large-value wire transfer networks account for less than 1 percent of transactions, are of exceptionally large value, and have been excluded.

2. Giro payments, which are common in Europe, are equivalent to a preauthorized bill payment in the United States. Giro is Greek for something that goes around in a circle and describes the movement of funds from the giro organization to a payor, from the payor to a payee, and finally from the payee back to the giro.

cent for the United Kingdom, 86 percent for Germany, 83 percent for the United States and Finland, and 78 percent for the Netherlands (Boeschoten 1992, pp. 73–74; Humphrey 1984, p. 6; Virén 1993). While data on total cash transactions are extremely sparse, two indirect indicators of cash use exist and are shown in Table 1. Column 1 shows the U.S. dollar value of cash held by the public divided by population in 1993 and is used to rank the fourteen developed countries.[3] By this measure, each person in Switzerland, Japan, and the Netherlands holds over $1,300 while each person in the United Kingdom, United States, and Finland holds less than half that amount. The range between the highest user of cash (Switzerland at $2,676 per person) is more than six times that of the lowest (Finland at only $438).

An alternative measure of cash use is the ratio of currency value to GDP, which is shown in column 2. There is good agreement between the three highest and three lowest users of cash for these two measures and a similar—but not exact—correspondence elsewhere. Deflating data on currency per person over 1987–93 by country-specific consumer price indices (to control for inflation differences) and regressing this measure of real currency per person on the ratio of currency to GDP (which already controls for inflation) yields an r of .91. Thus, the two measures are similar indicators of cash use. However, our analysis of noncash payment instruments is in terms of annual transactions per person and so we rely on the first cash measure—cash holdings per person—in the following analysis.

The differences in cash use across countries seen in Table 1 are related to differences in the public's demand to hold cash for transactions, precautionary, and speculative (hoarding) purposes (Laidler 1985).[4] Cash holdings per person rise with real per capita income but fall with inflation and higher interest rates (the opportunity cost of holding idle cash balances).[5] These demands are affected by the extent of illegal activities—including the avoidance of taxes—across countries. In addition, low crime rates in Japan and most of Europe make it safe for consumers and retailers to rely more on cash while a high crime rate, which exists for the United States, has a dual influence: more cash use by the criminal element can be offset by less cash use by consumers and retailers who fear theft.[6]

The availability of automated teller machine (ATM) terminals tends to raise cash use while the availability of credit and debit cards and their terminals tends to reduce it (Boeschoten 1991, 1992). Debit card payments in particular are close substitutes for cash since both are used to initiate small-value retail payments. In European

3. Cash held by the public is defined as total currency and coin outstanding minus the value held idle in the banking system and that held in reserve by the government.

4. Boeschoten (1992) suggests that cash hoarding is important in the Netherlands, and probably also in Germany and Switzerland as well. Hoarding is inferred from very low circulation rates observed for large-denomination currency when compared to the amounts known to be outstanding.

5. Regressing (nominal) cash holdings per person (in U.S. dollars) in 1993 across countries on the average historical short-term interest rate over 1987–93 (which reflects the joint effect of real interest rates and inflation) yields a negative relationship with r = −.64.

6. Even if the value of U.S. cash outstanding per person of $1,272 is not adjusted for the 60 percent estimated to be held overseas, this value is still lower than that for Switzerland, Japan, Germany (also unadjusted), and the Netherlands and is roughly on par with that for Sweden, Norway, Italy, and Belgium.

TABLE 1

CASH HOLDINGS AND ANNUAL NONCASH TRANSACTIONS PER PERSON (Fourteen developed countries, U.S. $, 1993)

Country:	Value of Cash Holdings per Person[1] (1)	Currency to GDP Ratio (2)	Country:	Noncash Transactions per Person (3)
Switzerland	$2,676	7.86%	Italy	29
Japan	2,387	8.43	Japan	39
Netherlands	1,300	6.49	Switzerland	67
Sweden	1,210	4.63	Sweden	93
Norway	1,198	4.61	Norway	97
Italy	1,191	5.75	Belgium	101
Belgium	1,187	5.95	U.K.	115
Germany[2,3]	995	3.89	Finland	120
Denmark	775	2.88	Denmark	124
France	759	3.58	Canada	128
Canada	716	3.43	Germany	139
United Kingdom	520	2.84	Netherlands	146
United States[2]	509	2.06	France	157
Finland	438	1.97	U.S.	292

[1]Domestic currency values were transformed into U.S. dollars using an average exchange rate over 1987–93 to reduce exchange rate "noise" in the statistical analysis.
[2]The actual values of cash held per person in Germany ($1,530) and the United States ($1,272) in 1993 are reduced by 35 percent and 60 percent respectively, to account for estimates of the value of currency held outside of these countries. The data in columns 1 and 2 were adjusted accordingly [see Porter and Judson (1995) for the U.S. estimate, which they cite as being roughly two-thirds held outside the country].
[3]GDP data for Germany differs among various BIS publications.

countries known for their relative emphasis on card-based payments, such as Finland, France, Denmark, and the United Kingdom, cash holdings per person are relatively low (Table 1). The expanded availability of ATM terminals can both raise the overall use of cash in transactions (by making cash withdrawals more convenient) and at the same time lower average idle cash balances held by the public (as would be predicted from a Baumol-Tobin model with a lower transaction cost for cash withdrawals). The strength of this substitution, as well as the substitution of other payment instruments for cash, can be roughly gauged by comparing cash holdings with the number of all noncash transactions in Table 1.

The annual number of noncash transactions per person is shown in column 3 and is composed of all paper-based payment transactions (check, paper giro) and all electronic payments (electronic giro, credit card, and debit card point-of-sale (POS) payments).[7] While there was a six-fold difference in the implied use of cash per person between Switzerland (highest) and Finland (lowest), there is a ten-fold difference in the number of noncash transactions per person between Italy (the lowest at twenty-nine per person per year) and the United States (the highest at 292). Importantly, high cash use per person in column 1 is associated with low use of noncash payments in column 3, indicating weak substitution ($r = -.79$). It is also of interest

7. Electronic giro transactions include direct debits, direct deposits, and other automated clearing house (ACH) payments. Most ATM transactions represent cash withdrawal, not direct payments for goods or services, and thus were excluded as a noncash payment. In the United States, cash withdrawal, cash or check deposit, and account transfers represent, respectively, 86 percent, 10 percent, and 3 percent of ATM transactions; bill payments are only 1 percent (Board of Governors of the Federal Reserve System 1991).

TABLE 2

CHANGES IN CASH HOLDINGS AND ANNUAL NONCASH TRANSACTIONS PER PERSON OVER 1987–93[1]
(Fourteen developed countries, U.S. $)

Country:	Changes in Noncash Transactions per Person (1)	Percent Change (2)	Changes in Real Value of Cash Held per Person (3)	Percent Change (4)
Italy	4	17%	216	27%
Japan	10	35	137	6
Switzerland	23	52	−547	−19
Sweden	3	4	−183	−15
Norway	13	15	−129	−10
Belgium	27	35	−176	−14
United Kingdom	25	27	−49	−10
Finland	3	3	−14	−3
Denmark	18	17	33	5
Canada	17	15	52	9
Germany	35	34	61	7
Netherlands	43	42	−77	−6
France	40	34	−35	−5
United States	57	24	87	23

[1] Changes in columns 1 and 3 compare annual numbers of transactions from 1987 to 1993.

to determine the implied elasticity between noncash transactions and use of cash. Regressing the log of noncash transactions per person over 1987–93 on the log of real currency use per person over the same period gives a pooled cross-country time-series elasticity of −.68, meaning that a 6.8 percent rise in noncash transactions is (significantly) associated with a 10 percent reduction in cash use (the $r = -.64$).

The relationship between noncash payments and cash use over time is isolated in Table 2. This table shows the change in the number of annual per person noncash transactions and cash holdings between 1987 and 1993. The countries are ranked by their level of noncash transactions in 1993 (lowest first)—the same as that for these transactions in Table 1. All fourteen countries experienced a rise in the annual number of noncash transactions per person over this seven-year period.[8] The average person in the United States, the Netherlands, and France increased their annual noncash transactions by over forty between 1987 and 1993 while transactions in Sweden, Finland, and Italy only rose by four or fewer. Eight countries experienced a reduction in cash use when noncash transactions rose while six experienced an increase in both. Interestingly, the first group consists of European countries while the second group includes the United States, Canada, Japan, and Italy. Thus it appears that in Europe the substitution between cash and noncash has been stronger than in the other developed countries.[9]

8. Although Italy (which had the fewest noncash transactions) had close to the smallest increase in use (four) and the United States (which had the most) had the largest increase (fifty-seven), the rise in noncash transactions over 1987–93 was heterogeneous and only weakly related to the level of noncash use overall. Otherwise, the changes in use shown in column 1 would progressively rise going down the column.

9. The falling share of cash in M1 from 1983 to 1993 in all of our countries (except Italy and Japan) implies that the share of payments made by cash has decreased relative to noncash transactions which rely on deposit money. In Norway, Finland, and the United Kingdom, this reduction has been quite dramatic (International Monetary Fund, International Financial Statistics).

In contrast with Table 1 where the cross-country, time-series relationship between noncash transactions and cash use is negative and significant ($r = -.79$), there is no relationship between these two variables when only the changes in Table 2 are considered ($r = -.01$). Since the changes in cash holdings and noncash transactions essentially represent only a time-series effect, the negative relationship found in Table 1 is seen to be primarily due to differences across countries.

2. NONCASH TRANSACTIONS: PAPER VERSUS ELECTRONICS[10]

For all fourteen countries, there were seventy-seven billion paper transactions in 1993 and forty-two billion electronic transactions.[11] The impression that paper dominates electronics is due solely to the pattern of use in the United States. The United States accounts for 64 percent of the 119 billion noncash transactions (but only 36 percent of the population). When the United States is excluded, paper and electronic transactions number seventeen billion and twenty-six billion, respectively, showing for the other thirteen countries that electronics dominates paper.

The country-by-country payment composition is shown in Figure 1 where each bar shows the annual number of noncash transactions per person in each year over 1987–93. As seen, the number of noncash transactions has risen for all countries between 1987 and 1993 (consistent with the uniformly positive changes in column 1 of Table 2). The shaded portion of each bar indicates the number of paper-based transactions per person in each year over the seven-year period. Except for Japan, France, and the United States, paper-based transactions have fallen or are flat over 1987–93. However, the rise in paper transactions in Japan and France has been less than the rise in electronic payments. Electronic payments per person have risen in all fourteen countries over 1987–93 and, with the exception of the United States, this is the primary reason for the rise in noncash payments.

The comparison between paper and electronic payments can be seen more clearly in Table 3 where the annual number of these two types of transactions are shown for one year (1993). Countries are ranked by the number of noncash payments made per person (lowest first, as in Table 2). The level of noncash transactions does not appear to be related to the (paper/electronic) composition of these payments. This is evident from the unordered ranking of the percent of electronic payments in column 3.

What is striking, however, is the vast difference in yearly per person use in paper and electronic payments across countries. Switzerland, Japan, Belgium, and the

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10. The cost difference between electronic and paper-based payments—noted above—makes the paper-electronic distinction of greater economic importance than an alternative distinction, such as that between provisional and final (retail) payments. A provisional payment is one that may be reversed for insufficient funds (like a check debit transfer) while a final payment is one that would not even be initiated unless the funds were sufficient, so there are no reversals (like a giro or ACH credit transfer). The provisional-final payment distinction is, however, of great importance for wire transfer networks which focus on large value payments.

11. Paper and paper-based transactions always refers to noncash paper transactions (checks and paper giro).
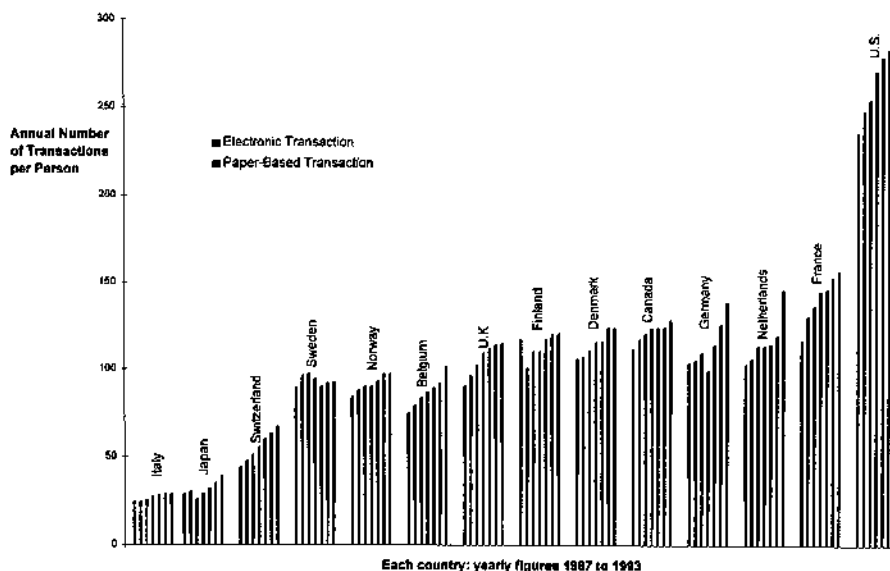
FIG. 1. Annual Number of Noncash, Paper, and Electronic Transactions per Person (fourteen developed countries)

Netherlands all initiate fewer than twenty paper instruments annually per person while the United States initiates over 230, and is clearly an outlier for no other country initiates even 40 percent of this figure.[12] There is less dispersion regarding electronic payments: only Italy initiates less than twenty electronic payments per person annually while Denmark, Germany, and the Netherlands initiate just over one hundred.

Comparing the relative importance of electronic and paper-based payments in all noncash transactions, nine countries initiate 50 percent or more of their noncash payments electronically. Since electronic payments are the only source of growth of the noncash payments in eleven countries and the primary source of growth in two of the remaining three (Figure 1),[13] it is instructive to contrast electronic payments with the use of cash across countries. The relationship between the percent of electronic payments (Table 3) and currency holdings per person (Table 1) is shown in Figure 2 for 1993.

Figure 2 is divided into four quadrants which indicate the split between electronic and paper-based transactions and how these noncash transactions relate to a country's intensity of cash use. Over all fourteen countries, the average person initiated

12. Checks are the only important paper instrument in the United States and almost twenty are written per person per month. These checks, however, are a combination of those written by consumers (57 percent), business (40 percent), and government (3 percent). While traveler's checks and money orders are also paper-based, they only account for around 5 percent of check volume (Humphrey and Berger 1990) and have been neglected.

13. While France, Japan, and the United States are the three countries where paper-based payments per person did not fall over 1987–93, the United States was the only country where the growth in paper transactions per person (at thirty-one) was larger than that for electronics (twenty-six).

TABLE 3

ANNUAL PAPER AND ELECTRONIC TRANSACTIONS PER PERSON[1] (Fourteen developed countries, 1993)

Country:	Number of Transactions per Person:		Percent Electronic Payments (3)
	Paper-Based (1)	Electronic (2)	
Italy	23	6	20%
Japan	9	31	78
Switzerland	2	65	97
Sweden	24	68	74
Norway	58	40	41
Belgium	16	85	84
United Kingdom	57	58	50
Finland	40	81	67
Denmark	24	100	81
Canada	76	53	41
Germany	36	103	74
Netherlands	19	128	87
France	86	71	45
United States	234	59	20

[1]Countries are ranked by the number of noncash payments per person, lowest first. Numbers shown have been rounded off.

61 percent of their noncash transactions electronically and held $1,133 in cash (these figures are shown as dashed lines which define the quadrants). Figure 2 tells us that most countries essentially fall into only two of the quadrants: they either rely mostly on paper-based payments and hold relatively little cash or they tend to use both cash and electronics intensively.[14]

Countries in the upper right quadrant commonly use cash for small value point-of-sale payments while larger-value bill payments are usually made by electronic credit transfers or direct debits. The lower left quadrant is comprised of countries where checks are an important instrument for all kinds of noncash payments: point of sale, consumer bill payments, and business disbursements. Countries in the upper left quadrant often rely on plastic card payments in place of cash for small value point-of-sale payments while electronic credit transfers dominate bill payments and disbursements.

The lack of countries that use both paper and cash intensively (lower right quadrant) indicates that there has been a stronger historical trade-off between paper and cash than there has been, to date, between electronics and cash. However, as shown in Table 4, this is likely to change in the future. Table 4 ranks countries by their percent use of electronics (lowest first). Countries with below-average use of electronics, of course, rely on paper-based payments while those with above-average use of electronics use few paper-based instruments. This table shows the change in paper-based and electronic transactions per person over our seven-year period, along with the corresponding change in cash holdings. Countries which currently have below average use of electronic payments (top half of Table 4) increased their average per person use of paper instruments by only two payments over seven years

14. Yamaguchi (1993) developed a similar figure using a currency/GDP ratio in place of real currency per person. Either measure gives very similar results since, as shown in Table 1, the two measures are quite collinear.
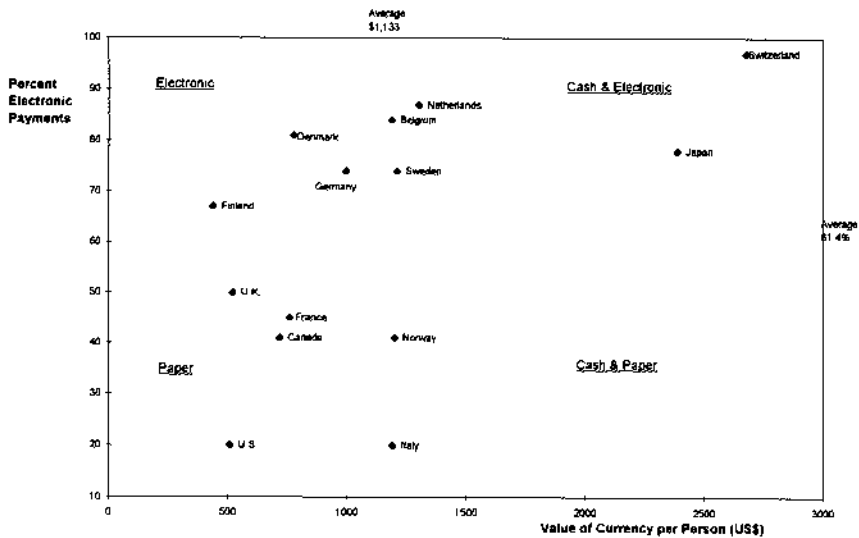
FIG. 2. Percent of Electronic Payments and Value of Currency per Person (fourteen developed countries, 1993)

while the average number of electronic payments per person rose by twenty-four.[15] For these countries, the real value of cash holdings rose by an average of $24 per person. However, if Italy is excluded, average per person cash holdings would have fallen by $15. Thus it is clear that the rise in electronic payments in countries that rely on paper-based payments is associated with a flat or negative growth in per person use of paper instruments as well as of cash. A negative relationship is clearly evident for countries that already have a relatively high-percentage use of electronics (bottom half of Table 4). Here the average rise of thirty additional electronic transactions per person over 1987–93 is associated with ten fewer paper-based payments and a reduction of $96 in average cash use.

If the trends shown in Table 4 continue, then it is only a matter of time before the countries in Figure 2 will move up—showing greater use of electronics—and over to the left—showing a reduction in cash use. Although Figure 2 currently suggests a positive relationship across countries between electronic payments and cash holdings, consideration of the trend evident within countries suggests that most will move toward the upper left quadrant in the figure. Put differently, electronic payments substitute for both cash and paper-based payments.[16] What is interesting in this process is the general uniformity of the expansion of electronic payments per person across countries, especially that between countries that do and do not now

15. If the United States is excluded, average per person use of paper instruments would have fallen by three transactions rather than risen by two.

16. This takes place mainly through the substitution of credit and debit card payments for cash in small value point-of-sale transactions and the substitution of electronic giro and ACH transfers for check and paper giro payments for larger-value bill payments and disbursements.

TABLE 4

Changes in Paper-based and Electronic Transactions per Person and Cash Outstanding over 1987–93[1] (Fourteen developed countries, U.S. $)

	Changes in:		
Country:	Paper-based Transactions per Person (1)	Electronic Transactions per Person (2)	Real Value of Cash Outstanding per Person (3)
Below-Average Use of Electronics:			
United States (20%)	31	26	$ 87
Italy (20%)	0	4	216
Canada (41%)	−6	23	52
Norway (41%)	−15	28	−129
France (45%)	8	33	−35
United Kingdom (50%)	−4	28	−49
Average:	2	24	24
Above-Average Use of Electronics:			
Finland (67%)	−20	23	−14
Sweden (74%)	−20	23	−183
Germany (74%)	−3	38	61
Japan (78%)	2	8	137
Denmark (81%)	−17	35	33
Belgium (84%)	−9	35	−176
Netherlands (87%)	−7	50	−77
Switzerland (97%)	−2	25	−547
Average:	−10	30	−96

[1]Although the country ranking is different, columns 1 and 2 add up to column 1 in Table 2 (except for rounding) and column 3 repeats column 3 of Table 2.

use electronic payments intensively. This is in contrast to the more heterogeneous experience regarding changes in per person use of cash and paper-based payments.

3. COMPOSITION OF NONCASH TRANSACTIONS

Noncash transactions rely on five payment instruments. Paper-based transactions are composed of checks and paper-based giro payments. The number of times a person used each of these instruments during 1993 is shown in the bar diagram in Figure 3a. The lightly shaded (bottom) portion of each bar indicates check use per person per year. As seen, check use dominates use of paper-based giro payments in eight of the countries. This is primarily due to the fact that many previously paper-based giro payments have already moved to electronics in giro-dominated countries while there has not been a similar shift to electronics in check-dominated countries (the United States, Canada, France, and the United Kingdom).

Electronic transactions are made up of electronic giro, debit card (POS), and credit card payments.[17] Per person use of these instruments is shown in Figure 3b. Electronic giro payments (bottom portion of each bar) dominate the other two categories of electronic payments in eleven countries. The three exceptions are Finland

17. Electronic giro payments include direct debits (preauthorized bill payments) and ACH transactions (direct deposit of payroll and corporate cash management debits).
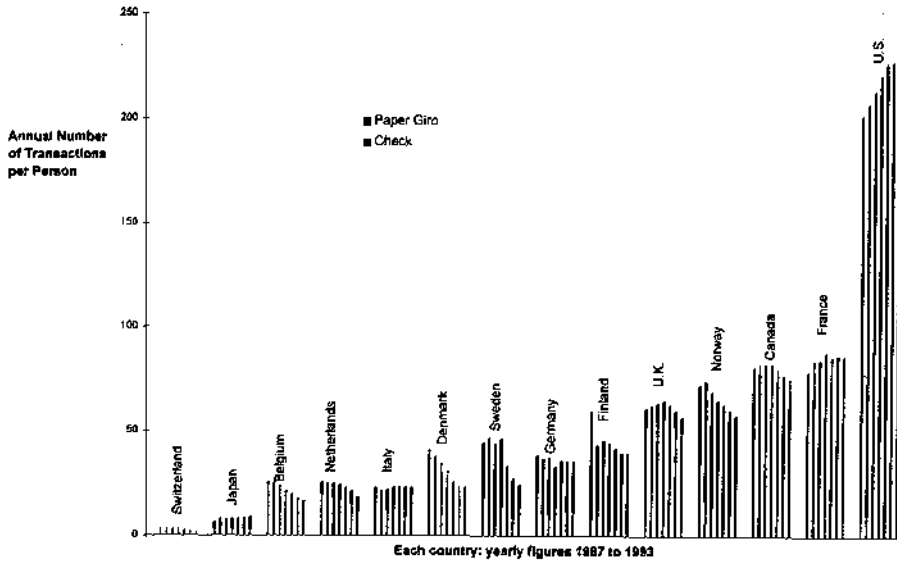
FIG. 3a. Annual Number of Paper Transactions per Person (fourteen developed countries)

which relies on card-based payments and the U.S. and Canada who rely on credit cards (top shaded portion of each bar).[18]

In terms of per person use of different payment instruments, the fourteen developed countries can essentially be divided into two groups: the four countries— United States, France, Canada, and the United Kingdom—that write the most checks per person and the remaining ten that rely heavily on giro payments (either paper or electronic). Check and all giro payments accounted for 76 percent to 100 percent of all noncash payments per person across countries in 1987 and from 64 percent to 97 percent in 1993. The average reduction in the share of check and giro payments was nine percentage points, a reduction that merely reflects the increasing share of credit and debit cards in noncash transactions.

In almost every country, check and paper giro transactions per person have reached a peak and are falling. However, as a total, the annual number of electronic transactions per person rose by twenty-four during 1987–93 while paper-based payments rose by ten. Excluding the United States, the shift to electronics is even more evident: annual electronic payments per person rose by thirty-three while paper-based payments rose by three (with check use falling absolutely).

These shifts in the use of paper and electronic payment instruments occurs for retail point-of-sale transactions (where credit and debit cards replace cash and checks), consumer bill payments (where electronic giro transfers are replacing checks and paper giro transfers), and disbursements like payroll and other business

18. Credit cards, by providing short-term credit, are more than just a substitute payment method. In the United States, 73 percent of the value of credit card expenditures represents revolving credit (Nilson 1995).
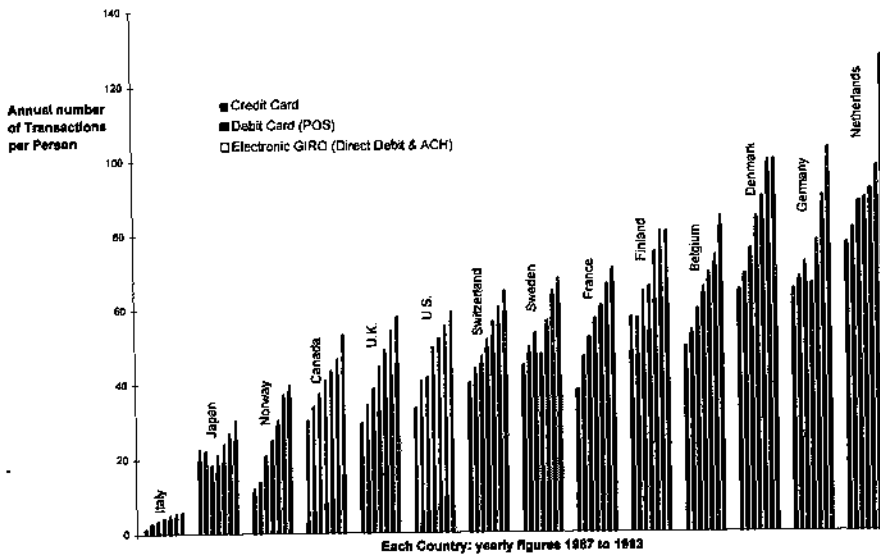
FIG. 3b. Annual Number of Electronic Transactions per Person (fourteen developed countries)

payments (which experience the same substitutions as consumer bill payments). Detailed data on payment instrument use by even these three general transaction categories does not exist. However, information on the average value per transaction for our five payment instruments in Table 5 provides some indication of the purposes for which the different payment instruments are often used. The low average value per transaction for credit and debit cards indicate that these two payment instruments are used primarily for retail point-of-sale transactions, not for bill payments or disbursement. We know from practical experience that check and paper and elec-

TABLE 5

AVERAGE VALUE PER TRANSACTION[1] (Fourteen developed countries, U.S. $, 1993)

Country:	Check (1)	Paper GIRO (2)	Electronic GIRO (3)	Credit Card (4)	Debit Card (5)
Italy	$ 2,215	$ 5,097	$98,210	$111	$121
Japan	79,754	532	5,202	163	165
Switzerland	1,690	n.a.	60,909	132	61
Sweden	1,243	1,775	1,008	43	68
Norway	1,591	1,761	2,148	131	42
Belgium	2,523	1,676,139	1,728	109	60
United Kingdom	1,360	2,022	652	69	40
Finland	20,704	(900 average)		44	42
Denmark	1,904	(8,146 average)		129	57
Canada	9,068	0	461	55	39
Germany	3,571	20,358	11,956	83	56
Netherlands	80	194	6,185	0	61
France	600	516,965	8,504	60	60
United States	1,147	0	3,981	45	24

[1]Countries are ranked by the number of noncash payments per person, lowest first. U.S. dollar exchange rates for 1993 were used.

tronic giro payments are primarily used for bill payments by consumers and disbursements by business. The large average values shown for these three instruments in most of the countries reflects the large-value business payments that are made.[19] Median values per transaction would give greater weight to the numerous smaller-value consumer payments made by check and paper and electronic giro instruments but this information does not exist.

From the data presented so far, it is clear that the United States (along with Canada) relies on checks while most of Europe (along with Japan) tends to rely on giro payments as their dominant noncash payment instrument. But why did the U.S. payment system develop so differently? The answer seems to lie in two historical facts. First, while banks provided the main savings service to the general public in the United States, the postal service played an important role in Europe. Because the postal service is a single entity and had a nationwide branch office network, it was only a relatively small step to bring in business accounts and offer first local, then regional, and finally nationwide bill payment services to its savings account holders—establishing the postal giro system. Often only later would European banks, who wished to tap consumer deposits and being few in number, agree jointly to develop a competitive bank giro network within their countries. With centralized accounting, it was possible to determine whether a payor had sufficient savings to cover a payment before a payment was made (credit transfer). Being centralized, the movement of funds from payor to payee accounts takes place within a single organization, making the shift from paper to electronics an internal issue similar to that which has occurred within—but not between—banks in the United States in the 1960s and 1970s.

The second historical fact is that the United States is a geographically large country and the banking system, although starting out as a national monopoly (for example, the First and Second National Banks of the United States), is highly unconcentrated. Until quite recently, banks were restricted to operate only within a state or to have only a single office. With both consumers and businesses restricted (for legal and convenience reasons) to holding their funds at different local or regional banks, account information was not centralized. When payors and payees have accounts at different and geographically dispersed banks, the only cost-effective way to make a noncash payment—prior to the development of low-cost electronic communication—was to use a check. Thus intensive check use is the logical outcome of limiting the concentration of the banking system in a geographically large country. At some point, when enough large U.S. banks obtain a strong nationwide presence and/or when POS terminals become more available than they are at present, the United States will become more like Europe and increasingly use a final payment method to replace provisional check payments.[20]

19. Although wire transfer payments on Fedwire, CHIPS, CHAPS, and BOJ-NET have been excluded for the United States, United Kingdom, and Japan in Table 5, exceptionally large-value business payments in many other countries are not always sent over separate wire transfer networks and thus could not be removed.

20. A debit card which activates a real-time payor account balance inquiry is, in effect, equivalent to a giro point-of-sale transaction.

4. A MODEL OF PAYMENT INSTRUMENT USE

To enhance our understanding of the factors that influence payment instrument use both over time and across countries, we employ the following five-equation model:

$$I_i = f(P_j, GDP, POS, ATM, I_{j,t-1}, CASH, CRIME, CR5) \tag{1}$$

where

I_i	= annual transactions per person for payment instrument i $(i = 1, \ldots, 5)$ refers to check, paper giro, electronic giro, credit card, and debit card;
P_j	= price of payment instrument j $(j = 1, \ldots, 5)$; see Appendix for more detail;
GDP	= real per capita GDP for each of fourteen developed countries (nominal GDP deflated by each country's cost-of-living index and translated into U.S. dollars using an average exchange rate over 1987–93);
POS	= number of POS terminals per person;
ATM	= number of ATM terminals per person;
$I_{j,t-1}$	= use of payment instrument j in the previous year $(j = 1, \ldots, 5)$;
$CASH$	= real value of cash held per person (in U.S. dollars using the same procedure applied to GDP);
$CRIME$	= the number of violent crimes (per 100,000 inhabitants) for each country;
$CR5$	= the (asset) concentration ratio of the largest five banks in each country.

Price and Income

Demand theory suggests that the per person use of noncash payment instrument i $(I_i; i = 1, \ldots, 5$ instruments) is related to the instrument's own price (P_i), prices of related instruments $(P_j, i \neq j)$, and a country's real per capita income (GDP). Although theory suggests that own and cross-price relationships among payment instruments should be important determinants of payment instrument use, in practice the influence of prices as measured is likely to be very weak. For many users the effective marginal cost of an additional transaction is zero. Furthermore, in most countries there has been little variation in payment prices over time. With respect to per capita income, surveys of U.S. payment practices indicate that individuals with higher real incomes initiate more noncash transactions (Avery et al. 1986). A similar relationship likely exists across countries when real income differences are large.

Payment Availability and Force of Habit

Suppliers of credit and debit card services know that use of these instruments is strongly related to the number of users who actually hold these cards and the num-

ber of retail outlets that have the card readers or terminals necessary to initiate transactions. This positive relationship between availability and use for new payment instruments reflects the influence of user convenience (Vesala 1993, section 4.3). Instead of carrying larger amounts of cash, which has to be replenished, or writing a check at the point of sale, which requires a checkbook and usually involves the presentation of one or more pieces of personal identification, users can offer a credit card or debit card (along with a PIN number). In our analysis, the number of POS terminals per person (*POS*) is used to represent the availability of credit and debit card equipment necessary to initiate transactions.[21] The number of ATM terminals per person (*ATM*) is also included since ATMs reduce the transaction expense of obtaining cash, lowering the relative user cost of cash as an alternative to the other five payment instruments. At the same time, ATM growth can be positively associated with debit card (and possibly credit card) use since debit cards use the same communications network and since ATMs increase consumers' awareness and acceptance of electronic transactions. No availability indicator is used for check and giro payments since the means to initiate these transactions is already well established and there is no constraint on their availability to users who wish to employ them.[22]

Numerous surveys of payment instrument use have demonstrated that just because a new payment instrument is available does not mean that it will be adopted quickly. Indeed, in most countries the pace of change from established payment method (cash, check, paper giro) to new instrument (electronic giro, credit and debit cards) has been considerably slower than industry predictions. In part, this is due to a lack of strong explicit incentives, such as full cost-based pricing of each transaction, but it is also due to the fact that users are slow to adopt payment methods that differ from those they have been using successfully. This probably results both from force of habit and, particularly for electronic payments, resistance to new technology. Indeed, it is the youngest segment of the adult population that has the greatest adoption rate of new payment methods since this segment is also the group that has the least experience with established methods, is more accepting of new technology, and thus more open to change given the incentives (including convenience) which may exist. In this sense, there is considerable inertia in payment instrument use and the current composition of use will depend strongly on the past composition. Force of habit is incorporated into the analysis by making per person payment instrument use in time period t ($I_{j,t}$) a function of the use of all payment instruments in period $t - 1$ ($I_{j,t-1}$), an approach which avoids a simultaneity problem.[23] The real value of cash held per person—the ratio of cash in the hands of the public to population,

21. Separate data on the number of credit card terminals are not available. Information on the number of (bank-issued) credit cards is available but not very useful as users differ, sometimes considerably, in the number of cards they hold so the relationship between cards outstanding and card transactions is clouded.

22. The number of bank and giro offices (post offices for a postal giro) was considered as an availability indicator for check and giro transactions. While these offices are important when opening an transaction account, they are not needed to initiate transactions at the point-of-sale or through the mail.

23. Since the lagged usage variables—particularly lagged own use—may dominate the empirical relationship, we will compare results with and without their inclusion below.

deflated by a cost-of-living index, and adjusted for an average exchange rate (*CASH*)—is also included as a substitute to noncash payment instrument use.[24]

It is instructive at this point to discuss the interpretation of elasticities with respect to lagged payment instrument use. In general, the elasticity of payment instrument i to a change in instrument j ($\partial \ln I_i / \partial \ln I_j$) may be expected to be the inverse of the elasticity of j to a change in i ($\partial \ln I_j / \partial \ln I_i$). Technically, this would not be the case for our model since the time periods are different so $\partial \ln I_{i,t} / \partial \ln I_{j,t-1} \neq 1 / (\partial \ln I_{j,t} / \partial \ln I_{i,t-1})$. Leaving this objection aside, would we otherwise expect the substitution between pairs of payment instruments to be the inverse of one another?[25]

The answer is no; we should not expect inverse symmetry for substitution among payment instrument pairs, at least not at our level of aggregation. This is because not all payment instruments can in fact be used in all payment situations and our model is not rich enough to capture all of the factors influencing changes in use of all payment instruments. For example, a check or a credit card payment can be replaced by a debit card transaction at retail outlets that have POS terminals and accept these instruments (food stores, gas stations, etc.). But a debit card cannot replace a credit card for those transactions where the user desires credit and defers actual payment nor (at the present time) can a debit card replace a check (or giro payment in Europe) for utility, mortgage, insurance, and similar bill payments. For the estimated elasticities in our model to exhibit the desired symmetry (that is, for the partial derivatives to actually hold all relevant economic factors constant) we would have to fully control for these other factors in the debit card, check, and credit card equations. We do not presume to do so in this analysis; therefore, we do not impose inverse symmetry in estimation.

Institutional Influences

Two important institutional influences on payment instrument use across countries—among those few factors that can be measured—are the crime rate and the level of banking industry concentration. A high rate of violent crime (*CRIME*) will likely lead to a lower reliance on cash and a corresponding increase in the use of various noncash instruments.[26]

Concentration of the banking system should be inversely related to use of paper payment instruments, whether checks or paper-based giro payments. The more concentrated is the banking industry, the more likely it is that individual banks will have agreed to establish a jointly owned and centralized electronic payment network for consumer bill payments, point-of-sale transactions, and payments among

24. Ideally, the number of cash transactions should be used here, but this information does not exist. If the demand for cash for precautionary and speculative purposes, as a percent of total cash outstanding, varies across countries then this will bias the estimated substitution relationship between I_i and cash.

25. This issue is similar to the coefficient symmetry restrictions commonly imposed (but rejected statistically) in the cost and production function literature where substitution between inputs is estimated. In our case, the restriction would be one of inverse symmetry between payment instrument pairs.

26. The alternative of using the overall crime rate was considered, but rejected. The overall rate is dominated by property crimes which probably have less effect on payment user behavior than does the incidence of violent crime, since violent crime receives more publicity and is clearly more threatening.

businesses—namely a bank giro or something close to it. The banking system in many of our fourteen developed countries is highly concentrated; the principal outlier is the United States which has a very unconcentrated banking system. The asset concentration ratio for the top five banks (CR5) in the United States was .23 in 1993 while that for the remaining countries averaged .70 (and ranged from .31 to .98). Based on the 1993 data, it would take the largest ninety banking organizations to achieve a concentration ratio of .70 in the United States. Countries in Europe with a concentrated banking system also have had a long-established and effective postal giro system, a system which usually predated the development of bank giros. As a result, a high concentration in banking is likely to coincide with the existence of an historically important centralized postal giro network for consumer savings and payments.

5. MODEL ESTIMATION AND RESULTS

We estimated the five-equation model in (1) above in log-linear form[27] using data first for ten and then for fourteen developed countries over the period 1987–1993.[28] Separate equations for each of the five payment instruments (check, paper giro, electronic giro, credit cards, and debit cards) were estimated using ordinary least squares.[29] The coefficient estimates reflect elasticities for all variables except prices. Prices were kept in unlogged form since the computed user prices for checks and credit cards were often negative due to the imputed benefit users receive from payment float.

It is not possible to include in our model all of the historical, institutional, and cultural factors influencing payment instrument use across countries and—to a lesser extent—over time. To absorb the empirical consequences of such excluded influences, we include a full set of country dummy variables.[30] We also include a time-series dummy variable that takes on the value 1 for all countries in 1987, 2 in 1988, and so on.

The results for the fully specified model covering the ten developed countries with price information are contained in the first of the two columns shown for each of the five payment instrument estimations in Table 6. Price data were unavailable for France, Italy, Switzerland, and Denmark and these countries are initially excluded, giving sixty observations (34 degrees of freedom) for each equation. In general the results accord well with expectations. As expected, the inclusion of country dummy and lagged use variables results in very high values of R^2. The country

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27. Similar results were obtained for the linear model.
28. The original ninety-eight observations (fourteen countries times seven years) were reduced to eighty-four due to lagged payment instrument use.
29. When the same independent variables appear in all equations, there is no gain in efficiency from seemingly unrelated regression (SUR) techniques.
30. The excluded dummy variable in all estimated models is that for Japan.

Table 6

DETERMINANTS OF PER PERSON PAYMENT INSTRUMENT USE—RESULTS BASED ON DATA FOR FOURTEEN DEVELOPED COUNTRIES OVER 1987–1993

	Check Equation		Paper GIRO Equation		Electronic GIRO Equation		Credit Card Equation		Debit Card Equation	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
constant	-4.28	1.476	1.377	-2.756	2.632	5.063	-6.573	-7.004	20.251	-4.57
Price check	0.047	—	0.038	—	-0.019	—	0.066+	—	0.266+	—
Price giro	0.021	—	-0.124*	—	-0.077*	—	-0.052	—	0.354*	—
Price ccard	-0.021	—	-0.026	—	0.013	—	-0.162*	—	0.214	—
Price dcard	-0.871*	—	0.107	—	1.313*	—	0.106	—	0.823	—
gdp	-0.069	0.446	0.026	2.419*	-1.207*	1.132*	0.487	1.057+	-3.472+	-2.13*
POS Term.	-0.016	-0.365*	0.012	-0.574*	-0.027	-0.039*	-0.003	-0.482*	0.299*	1.425*
ATMs	0.123	0.171	0.114	0.114	-0.161+	-0.128	0.047	1.100*	1.819*	1.162*
check_1	0.535*	—	-0.044	-1.259*	0.054	-0.800*	-0.130	-0.924*	0.150	0.551*
papgiro_1	0.073	-0.169+	-0.108	—	-0.139	—	-0.278*	-0.208*	-0.612	0.059
eligiro_1	0.161	-0.513*	0.008	-0.585*	0.122	-0.115*	0.105	-0.565*	0.752+	0.568*
ccard_1	0.136	-0.369*	0.416*	-0.490*	0.255*	-0.331*	0.871*	—	0.166	0.043
dcard_1	0.032	0.129*	-0.075+	0.183	0.006	0.207*	0.005	0.065	0.285	—
cash	0.652+	-0.738*	-0.188	-2.167*	0.596*	-0.455+	0.266	-1.224	0.336	1.055*
crime	-0.124	1.27*	0.012	0.889+	0.752*	1.115*	0.487	1.689*	-1.304	-0.025*
cr5	0.732+	-1.364*	0.027	-1.254	-1.207*	-0.241	-0.166	-1.64*	-0.481	2.213*
Time	-0.098*	0.089+	-0.001	0.172	0.113*	0.109+	-0.015	0.140+	-0.095	-0.395*
Dum Bel	1.88*		-0.531		-0.801		0.607		4.447+	
Dum Ger	0.991		2.760*		0.326		0.852		5.370*	
Dum Neth	1.147		1.448*		0.174		0.408		5.680*	
Dum UK	2.550*		1.240		-1.293		1.727+		3.970	
Dum Nor	1.224		3.185*		0.460		1.098+		7.238*	
Dum Fin	0.540		1.647		0.684		-1.309+		6.542*	
Dum Sweden	0.785		2.391*		0.671		0.823		6.387*	
Dum US	3.29*		-2.088		-4.733*		0.823		6.150	
Dum Can	2.60*		-2.340		-2.863*		1.424		4.161	
Adj R-squared	0.996	0.871	0.996	0.309	0.995	0.698	0.997	0.748	0.983	0.840
Durbin-Watson Statistic	2.004	0.234	1.714	0.073	2.321	0.121	2.201	0.194	1.957	0.324

NOTES: * refers to statistical significance at the .05 level (two-tailed test).

+ refers to statistical significance at the .10 level (two-tailed test).

dummy variables absorb differences in per person payment instrument use (relative to Japan).[31]

In the paper giro, electronic giro, and credit card equations the own price coefficients are of the correct negative sign and carry statistical significance. The corresponding mean price elasticities are estimated to be very inelastic, and were $-.26$, $-.16$, and $-.09$, respectively. The elasticities for checks and debit cards are positive (at .02 and .03, respectively), but lack significance. Based on the price coefficients in *both* relevant equations, only electronic giro and debit card payments appear to be significant substitutes; there was no significant complementarity. The findings with regard to price coefficients are fragile, requiring conditioning on both the past usage variables ($I_{i,t-1}$) and the country dummies. The unconditional correlations between own prices and use are positive, a relationship that begins to be reflected in the regression results even if just the lagged usage variables are deleted from the equation.

There are several reasons why we might expect the influence of measured prices to be modest. First, although published prices exist for check, giro, and debit card payments, in three countries users typically do not actually pay a per transaction price. In the United States, Canada, and the United Kingdom, consumers are given a choice of paying a per-transaction fee or holding a minimum balance and most choose to hold a minimum balance at their bank. With a minimum balance the marginal cost of a transaction to the user is zero. In six countries (Belgium, Germany, Netherlands, Norway, Finland, and Sweden) where users typically pay a per-transaction fee for many payment transactions, this price is considerably below cost. Giro transaction expenses, for example, are largely recouped by debiting a payor's account one day prior to the value date (the date the payment is actually made). Revenues earned on the payment float created subsidize the explicit price to the user. Check and POS transaction fees in these countries are also less than cost and banks make up the difference by paying below market rates on deposits.

Users of credit cards do not face a per-transaction price. Instead, credit card users typically incur a fixed annual fee while retailers that accept cards are charged a fee based on the value of the transaction. Although retailers incur different costs in accepting alternative payment instruments, they usually do not vary their price according to the payment method used. Instead, the different payment instrument costs are covered as a weighted average in the posted price.[32]

Second, even when users incur different prices for payment instrument use at the margin, as is common in the six countries noted above, differences among these prices are usually small—typically less than 1 percent of the value of the transac-

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31. The country dummies show significantly higher relative use of checks (for Belgium, United Kingdom, United States, and Canada), higher relative use of paper giro (for Germany, Netherlands, Norway, and Sweden), lower relative use of electronic giro (for United States and Canada), a similar relative use of credit cards, but considerably higher relative use of debit cards for all but one European country.

32. Among businesses, when the payment value is exceptionally large, price can vary according to the payment method used. When price does not vary, as is common at the retail level, cash and debit card users end up cross-subsidizing check and credit card users (as the latter two instruments are, according to surveys, more expensive for retailers).

tion. Thus simple differences in the convenience of using a particular instrument—which we cannot measure—may outweigh the price differences faced. Third, since the true user cost of a check and a credit card will include the imputed value of payment float—which depends on the interest rate, the value of the transaction, and the payment delay before final payment occurs—many users may only have a very rough idea of the total cost they incur. This will introduce noise into any statistical analysis that presumes that users know the prices they face and respond in a cost-minimizing manner. Finally, except for Sweden, Finland, and Norway, payment instrument prices seem to be quite stable over time so that, from a statistical standpoint, it is difficult to determine what may happen to payment use if prices were to be significantly altered in the future.[33]

Turning attention on the nonprice variables, real income per capita is strongly negatively related to the use of debit cards and electronic giros. This result likely reflects the fact that the highest levels of per person use of these two instruments exists in those European countries with less than the highest values of GDP per capita (and is not altered when U.S. data are excluded from the regression). The coefficient on the time-series dummy is significantly negative for checks and significantly positive for electronic giro payments, a finding that is in line with overall trends in payment instrument use in Figures 3A and 3B. And, as expected, the availability of POS and ATM terminals is strongly positively related to the use of debit cards, reflecting simple availability and a sharing of communication costs (as ATMs and debit cards usually use the same communication links).

The institutional variables, violent crime (CRIME) and the five-firm banking concentration ratio (CR5), were included to capture certain institutional differences across countries. However, for the model in column 1 for each of the payment instrument equations in Table 6, most of these differences are captured by lagged usage and the country dummy variables. Therefore, we should not be surprised by our finding that the coefficients on these variables are erratic and lack robustness across modest differences in specification.

As an alternative, suppose we delete the country dummy variables as well as the lagged own use variable. Then we force the remaining coefficients in our model to catalogue differences in payment use across countries. Column 2 of Table 6 contains the results of this experiment. Having already noted that the price coefficients are not robust for such a change in specification, we also drop all price variables, which allows us to add the four countries that do not have price data—France, Italy, Switzerland, and Denmark—for a total of eighty-four observations per equation. As expected, the explanatory power of the models is reduced, sometimes by a large amount. In addition, the Durbin-Watson statistic indicates strong positive autocorrelation, a finding that no doubt results from the large differences in use across countries now less strongly accounted for in the remaining independent variables.

When the focus is upon cataloging differences across countries, higher levels of

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33. Bank transaction fees may become more cost-based in the future if increased competition within the EU leads to a rise in deposit interest rates closer to market levels (reducing the implicit component of the user transaction fee and thus leading to an offsetting rise in the explicit component or price).

income per capita are associated with greater use of all payment instruments except debit cards. This is consistent with the finding, based on U.S. data, that higher-income individuals initiate more noncash transactions. Reflecting the strong substitution potential of debit cards at the point of sale, the greater availability of POS terminals is associated with diminished use of all instruments except debit cards, where—as expected—the relationship is strongly positive. Growth in the number of ATM terminals is significantly associated with growth in the use of only credit and debit cards.

Examining now the results for the lagged usage variables, most instruments—checks, paper and electronic giros, and credit cards—are observed to be significant substitutes for one another across countries. The notable exception is strong complementarity in the use of debit cards with checks and electronic giros, a finding that is unaffected when data for the United States are excluded. The complementarity between electronic giro and debit card transactions in part reflects the scope benefits of widespread (common carrier) electronic communication links that can handle these different electronic payments, rather than having separate dedicated networks.[34] Finally, all instruments except debit cards are shown to substitute for cash across countries, and only the negative coefficient in the credit card equation lacks statistical significance.

It appears then that all instruments (except debit cards) substitute with paper transactions (checks and paper giros). However, two principal categories of electronic transactions—electronic giros and debit cards—are complements. The data in Figures 3A and 3B, combined with these findings, suggest that check and paper giro use will likely decline with further growth of electronic payments while the instruments that make up electronic payments are likely to continue to expand together rather than replace one another. Since paper and electronic giro payments also substitute for one another, we should expect a continuing, if not accelerating, pattern of electronic payments replacing paper payments as well as cash.

Turning our attention to the institutional variables, violent crime per capita (*CRIME*) and five-firm banking concentration (*CR*5), we observe that increases in violent crime across countries are associated with increases in noncash payment instrument use, again except in the case of debit cards whose use is closely associated with more concentrated banking systems. As expected, greater banking concentration is associated with less reliance on paper transactions—checks and paper giros—but the expected positive association with electronic transactions is revealed only for debit cards.[35]

Overall, our effort to catalogue the factors affecting payment instrument use across countries has produced results that are instructive and in line with expecta-

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34. In many European countries, cooperation among different providers of payment services has been extensive and formed the basis for realizing communication scope economies. Such cooperation is more difficult in countries with strong antitrust laws.

35. The significance of the negative coefficient between *CR*5 and credit cards is removed if U.S. data are eliminated from the model and we note that the negative coefficient on electronic giros lacks statistical significance.

tions—except in the case of the debit card transaction equation. The reasons for the anomalous results for debit transactions are difficult to pinpoint; nonetheless, the data in Figure 3B suggest one explanation. Several countries exhibit almost no debit card transactions over the period 1987–1993 while others have experienced transaction growth approximating an order of magnitude (albeit relative to small initial levels)—far larger than the relative growth of other instruments. It is unlikely that the variables in our model will identify effectively the causes of this range of behavior. Nonetheless, the empirical associations with some of the variables will be large (as reflected in R^2), but not necessarily informative.

6. SUMMARY AND CONCLUSIONS

Payment system expenses are estimated to be between 2 percent to 3 percent of GDP.[36] This cost can be markedly reduced when paper-based payments are replaced by electronic payments, since the social cost of an electronic payment may only be from one-third to one-half that of a paper-based transaction. In this paper we examine the holding of cash and use of five noncash payment instruments in fourteen developed countries over 1987–1993, focusing on the determinants of a country's payment structure and substitution among noncash paper-based and electronic payments.

In the countries we examine, there were 119 billion noncash transactions in 1993, composed of check, paper giro, electronic giro, plus credit and debit card payments. The average person initiated 165 noncash transactions per year (or fourteen a month). Of these, 35 percent were electronic. The simple elasticity between real cash holdings per person and the annual number of noncash payments per person is −.68: a 10 percent reduction in cash holdings is associated with a 6.8 percent rise in noncash transactions. While cash and noncash use are negatively related, the implied substitution between them is due more to differences in use across countries than it is to changes in use over our seven-year time period.

In all fourteen countries in 1993, paper-based payments totaled seventy-seven billion while electronic payments totaled forty-two billion. The apparent dominance of paper over electronics is due to the inclusion of the United States, which accounts for 64 percent of noncash transactions. When the United States is excluded, paper and electronic transactions number seventeen billion and twenty-six billion, respectively, so that for the other thirteen countries electronics dominates paper. With the exception of three countries (Japan, France, and the United States), paper-based transactions per person have reached a peak and have fallen or were flat over 1987–93. In all countries but the United States, electronic payments have been either the sole or the primary reason for the 34 percent rise in total noncash payments between 1987 and 1993. For the average person, the annual number of electronic giro payments rose by twelve while credit and debit card payments expanded by eight and

36. Wells (1994) estimates that the social cost of a check in the United States is around $2.80 so, with sixty-one billion checks written annually, this suggests a payment cost of perhaps 2.6 percent of GDP.

four, respectively. The total growth in these three electronic payment instruments (at twenty-four) was more than double the growth in paper giro payments (which was zero) plus that of checks (at ten, and due entirely to the United States).

These data underscore our principal observation that the movement toward greater use of electronic payment methods, though gradual, is uniform and unmistakable, both across countries and over time. However, this uniformity masks large differences in the *mix* of payment instruments used across countries. The factors we have identified as best explaining the observed payment patterns fall into two broad categories: (i) those that reflect payment option availability or the consequences of past payment patterns on the part of users; and (ii) those that measure relevant institutional, cultural, or historical differences across countries. Our analysis first covers the ten developed countries for which payment instrument price data are available. The explanatory power of the price, income, availability, institutional, and lagged use variables specified in our model are first determined jointly with time-series and country dummy variables to proxy for unspecified time and country-specific effects. In a second estimation, the country dummy variables are deleted in order to force the coefficients on the remaining variables to catalogue differences in payment use across countries. As the price effects (noted below) are fragile, these influences are also dropped so that payment use in all fourteen developed countries can be covered.

Own prices, which are small in magnitude, vary little over time, and may not depend on incremental use, are shown to have exerted little influence on the choice or use of payment methods. Mean own price elasticities for paper giro, electronic giro, and credit card use ranged from $-.09$ to $-.26$ and, while significant, appear to be quite inelastic. Price elasticities for check and debit card use were slightly positive but insignificant. In contrast, when the model was restructured to catalogue differences in payment use across countries, the influence of cultural and institutional factors has been strong. Not surprisingly, higher per capita incomes generate more noncash transactions, greater availability of new payment instruments encourages their use, the erosion of consumers' sense of security (proxied by the incidence of violent crime) increases the use of all noncash payment instruments, higher banking concentration is associated with a greater reliance on electronic payments (particularly giro payments), and the persistence of behavior patterns among users slows the change in payment use.

Historically, the evolution of a country's payment system shifts from barter, to widespread cash use, to paper-based noncash instruments, to electronics. The shift from cash to noncash payments has progressed at a different rate and taken a different path in Japan, Europe, and the United States. Japan has high cash holdings per person, low noncash use, and a high percent of electronic payments. Japan's low rate of violent crime suggests that the need to develop and use alternative noncash instruments for retail payments has been weak: cash use is high for point-of-sale transactions while use of point-of-sale cash substitutes is low (credit cards) or virtually zero (checks and debit cards). Noncash payments are almost entirely for bill payment and employee payroll disbursements where consumer convenience, a con-

centrated banking system, a centralized payment facility (postal banks), and payor cost considerations have shifted these formerly paper-based transactions to electronics (direct debits and credit transfers).

In contrast to Japan, Europe has essentially an intermediate level of cash holdings per person, an intermediate level of noncash use, but a similarly high percent of electronic payments. A relatively low rate of violent crime permits an intermediate level of cash use for point-of-sale payments with a corresponding intermediate use of point-of-sale cash substitutes (checks and debit and credit cards). Even so, the primary use of noncash payments is for consumer bill payment and business disbursement. Since savings accounts in most European countries have historically been provided by a centralized postal system (not the banks who traditionally concentrated on business and affluent customers), Europe has long relied upon paper-based giro transactions for bill payment. With the development of low cost electronic internal accounting methods, postal and bank giros have increasingly shifted their users to electronic bill payments and disbursements (credit transfers and direct debits).[37]

In contrast to either Japan or Europe, the United States has low cash holdings per person, high noncash use, and a low percent of electronic payments. A high rate of violent crime is associated with relatively low domestic cash holdings per person. In turn, low domestic cash use, an unconcentrated banking system, no postal giro, and large geographic distances between trading centers all have made the check the most cost-efficient noncash payment method for point-of-sale, bill payment, and disbursement transactions. The movement to electronic payments has been slow and has focused primarily on credit cards at the point of sale because of bank emphasis on expanding loan revenue, a pricing policy where the payee (not the payor) pays the credit card transaction fee, and a historical reliance on checks which (because of float) provide users with short-term credit.

APPENDIX

The data in this study was obtained from BIS reports, other published sources, and (for price data especially) personal contacts with many individuals at central banks and banking associations.[38] Prices for the different payment instruments were the most difficult to obtain and often had to be calculated from other information using the following definitions:

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37. Europe has long relied on final payments in the form of cash or giro credit transfers. This experience has probably led to a greater acceptability of final payment debit cards at the point of sale and reduces user acceptance of credit cards promoted by banks to increase loan revenues.

38. In this regard, we express our sincerest thanks to Mr. Allsop (Bank of England), Mr. Ecklin (British Bankers Association), Mr. Christensen and Mrs. Møller (Danmarks Nationalbank), Dr. Hanau and Mr. Dandorfer (Deutsche Bundesbank), Mr. Dankeld (Bundesverband deutscher Banken), Mr. Berg, Mr. Robinson, and Mrs. Hoen (Norges Bank), Mr. Valcamonicci (Banca D'Italia), Dr. Boeschoten (De Nederlandsche Bank), Mr. Dahlheim (Sveriges Riksbank), Mr. Vandecapelle and Mr. Van den Nieuwenhof (Association Belge des Banques), Mr. Hirvonen (Finnish Bankers Association), Mr. Reed (Bank of Canada), Mr. Oritate and Mr. Amano (Bank of Japan), and Mr. Snyder (Federal Reserve).

Per Transaction Prices:

check price = [(average minimum balance for transaction account)(real interest rate)/(average number of checks written per account per year)] + (bank price charged per check written) − (average value per check)(real interest rate)(average number of days a check is outstanding/365) + (cost to print a check and mail cost for the percent of checks that are mailed);[39]

paper giro price = published price + (average value of giro payment)(real interest rate)(1/365);[40]

electronic giro price = published price + (average value of giro payment)(real interest rate)(1/365);[41]

credit card price = {[(average annual fee) + (number of invoices per year)(check or giro price to pay credit card bill)]/(average number of credit card transactions per user per year)} − [(average value of a credit card transaction)(real interest rate)(number of days in invoicing period/365)];[42]

debit card price = published price.[43]

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39. Many European countries did not require a minimum balance but did charge an explicit fee for each check written. In the United States and Canada, the minimum balance approach was common and few check users paid an additional explicit fee. There is no float gain to writing a check in Canada.

40. Countries without a bank or postal giro system (for example, the United States and Canada) had a zero price. Giro payments are usually debited from the payor's interest earning account one day prior to the value date, adding a float cost (not a benefit).

41. See previous footnote. Electronic giro payments in the United States are ACH transactions (preauthorized direct debits and direct deposits) and were computed from the first part of the check price calculation (deleting any float gain or any check printing or mailing cost).

42. The price for credit card use only includes the transaction component, not the extra cost of any credit extended if the monthly invoice is not fully paid.

43. U.S. debit card price (*POS*) equals the electronic giro price (essentially the cost of maintaining a transaction account) plus an allocated portion of the user ATM fee which is from: (percent "on-us" ATM transactions)(percent of "on-us" ATM transactions that carry a bank fee)(the average "on-us" fee charged).

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