U.S. CASH AND CARD PAYMENTS OVER 25 YEARS

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Abstract

A model is developed and implemented to determine the share of (legal) cash payments in the U.S. over the last 25 years. U.S. payment data are not the best and our results represent …rst-round estimates. From 1974 to 2000, the share of cash in consumer payments apparently fell from 39% to 16%. Although there may have been multi-year upward and downward trends in cash use during this period, cash use has fallen absolutely since 1992. During this period, cards clearly replaced cash as well as some checks. Although cash use is falling, it will not go to zero.

1 Introduction.

In providing payment services, banking …rms and other payment processors need to determine the likely future demand for various payment instruments–from providing cash through branch o¢ces and ATMs to increasing the availability of card terminals to expanding computer and telecommunication facilities involved in processing electronic payments. Our purpose is to illustrate, over the past 25 years, trends in the use of cash, card, and check payments in the U.S. Our focus is on legal, reported activities as opposed to determining the value of cash used in the underground economy associated tax evasion, drug sales, and other illegal activities generally. Such information is useful for bank planning purposes concerning branch and ATM network expansion versus increased investment in electronic payment processing facilities and communication networks.

In what follows, Section 2 brie‡y outlines and contrasts the apparent use of cash and other payment instruments in the U.S. with that in Canada, Europe, and Japan. Serious data problems exist, making any attempt to determine U.S. legal use of cash a di¢cult exercise. These problems–and our proposed solutions–are presented in Section 3. A simple direct calculation relying on the value of consumer expenditures, the value of card payments, and (estimated) consumer check transactions is developed to approximate the unknown value of U.S. domestic cash transactions in Section 4. In Section 5, a behavioral model of cash use is developed, estimated, and assessed for robustness. This model uses time-series information on changes in the stock of cash outstanding, the value of card and consumer check payments, the number of ATM and card terminals in place, the interest rate, and the value of personal consumption expenditures. The evolution of payment instrument use in the U.S. over 1974-2000 is illustrated in Section 6. This result is contrasted with an approximate method often used to indicate the level of cash in cross-country comparisons. Although the large expansion of ATMs has made it easier to obtain cash, the expansion of card terminals at the point of sale have contributed to a recent decline in the share of cash used to purchase goods and services after 1992.

2 Payment Instrument Use Across Countries.

2.1 Approximating the Use of Cash Across Countries.

Cash has many useful attributes as a payment instrument. It is universally accepted as …nal payment, is a mobile store of value, and is easy

to obtain from banking o¢ces or (today) from ATMs and "cash back" arrangements at the point of sale. It is also cheap to produce. It only costs about $0.04 to print a $100 bill. As cash production is a government monopoly, the di¤erence between its production cost ($0.04) and its face value ($100) represents seigniorage revenues for the government. While this production cost rises as currency wears out and is replaced with new notes, the existence of seigniorage revenues reduces the need for governments to borrow to meet their budgeted expenditures. By borrowing less, governments save the interest expense it would otherwise have to pay. With an interest rate of 6%, borrowing costs are reduced by $6 annually for each new $100 note put into circulation. This cost savings clearly more than o¤sets the cost of replacing currency as it wears out since even the most used $1 notes have an average lifetime before replacement of about 1.5 years.[1]

Cash is also cheap to accept at the point-of-sale. The "all-in" cost of accepting cash is $0.12 per transaction at U.S. supermarkets (Food Marketing Institute, 2001). This compares to $0.36 per check, $0.34 per on-line debit card transaction, and $0.72 per credit and o¤-line debit card payment.[2] On a cost-per-dollar of sales basis, accepting cash costs $0.009 per dollar transacted. Check costs are slightly lower at $0.008 as are on-line debit cards (also at $0.008). But the cost-per-dollar of sales for credit cards and o¤-line debit cards is twice that of cash (at $0.018). Of course, these cost di¤erences are not "seen" by the consumer as supermarket prices make no distinction among the instruments used for payment.[3]

Over time, cash has been replaced in many types of transactions by increased use of non-cash payments–checks, debit cards, credit cards, and ACH payments (credit transfers and direct debits). Checks, followed by credit cards and then debit cards, have increasingly replaced cash for many point-of-sale (POS) transactions that exceed more than just

[1] In Europe, the largest value Euro note in circulation is equivalent to $500 (500 Euros). Notes worth 200 Euros also exist. Although some countries (Spain, Greece, Ireland, and Portugal) have decided not to issue 500 Euro notes (and possibly even 200 Euro notes as well), substantial seigniorage bene…ts will be realized even though it is recognized that very large denomination notes facilitate illegal activities.

[2] These costs include the time it takes to complete di¤erent transactions at the checkout station, the wage and fringe bene…ts of the various accepting/verifying/accounting employees, armored courier costs (for cash), check and other fraud expenses, bank charges, electronic network transaction fees, and credit card fees.

[3] However, credit card users often receive an inducement in the form of frequent ‡yer miles or a cash rebate from the card issuer. This, along with convenience and safety concerns, a¤ects consumer choice of which instrument to use.

a nominal amount.[4] This replacement of cash has reduced seigniorage revenues from what they would otherwise have been. O¤setting this trend of cash replacement in legal domestic trade and exchange is the fact that the value of $100 and $50 notes has expanded by 57% in the last …ve years and now accounts for 72% of the value of all currency and coin issued. As these high value notes are not often seen in legal domestic trade (indeed they are at times just not accepted), their use is largely for illegal domestic activities and for transactions and a store of value overseas.

While the value of the stock of cash in circulation is known, it is very di¢cult to determine the value of the ‡ow of cash used for payments. Indeed, cash payment ‡ow data are not available in any country. It is even more problematic to try to determine the ‡ow of cash payments between legal and illegal activities. As a result, most attempts to approximate the use of cash in a country have used indirect measures, such as the stock of currency and coin in circulation (CURR) relative to the value of goods and services being produced domestically (GDP). For the U.S. and Germany, further di¢culties obtain as large percentages of cash are held outside the country. Porter and Judson (1996) estimate that some 60% of the value of U.S. currency may be outside the U.S. (largely in Mexico and Latin America) while Boeschoten (1992) estimates that 35% of Germany's currency is outside of Germany (mostly in Eastern Europe).[5]

The (adjusted) ratio of the value of currency and coin in circulation (CURRa) to the level of GDP (CURRa=GDP) for the U.S., Canada, 10 countries in Europe, and Japan is shown in Table 1.[6] The countries are ranked by their apparent reliance on cash, with the U.S. being the lowest (at 1.7%) and Japan being by far the highest (at 12.0%).[7] By

[4] Also, ACH (Automated Clearing House) payments have made some limited progress in replacing checks for consumer and business bill payments but have been more successful for employee payroll and retirement disbursements.

[5] In these instances, Grisham's Law leads to a signi…cant transfer of income from developing countries to a developed country but creates the possibility that some time in the future–when currency outside a country "comes home"–this foreign …nanced debt will be retired, although no sinking fund is being created for this eventuality (Sprenkle, 1993).

[6] The 10 European countries are: Belgium, France, Germany, Italy, Netherlands, Portugal, Sweden, Switzerland, Spain, and the U.K. Currency values for the U.S. and Germany are reduced by 60% and 35%, respectively, to re‡ect values held outside of the country. Truncated checks in Germany are counted as electronic payments.

[7] The assumption here is that for the same level of economic activity (GDP), countries that use a large amount of cash for payments will also have to hold a larger stock of cash to support these payments. As the turnover of cash can easily di¤er among countries (e.g., as when cash is more easily accessed via ATMs in one country

Table 1: Cross-Country Indicators of Cash and Non-Cash Payments, 1999

		Number of Non-Cash Transactions Per Person			
Country:	CURRa/GDP	Total	Paper	Electronic	% Electronic
U.S.	.017	294	180	114	39
Canada	.038	178	59	119	67
Europe	.049	131	27	104	79
Japan	.120	25	10	15	40

this measure, the U.S. uses less than half as much cash as either Canada or Europe while Europe uses less than half as much as Japan. Clearly, the U.S. and Japan are at opposite ends of the cash-use distribution for developed countries. Anecdotally and statistically, this di¤erence is associated with crime rates and personal safety issues (Federation of Bankers Associations of Japan, 1994; Humphrey, Pulley, and Vesala, 1996).

In principle, it would be expected that the greater a country's stock of domestic cash relative to GDP, the lower the number of non-cash transactions per person in that country. As seen in Table 1, this expectation is realized. The U.S. has the lowest use of cash and the largest number of non-cash transactions per person per year (294). Japan is just the opposite with the highest use of cash and the lowest annual number of per person non-cash transactions (25).

2.2 Electronic Payments Across Countries.

Non-cash payments can be usefully divided into paper-based payments (checks and paper giro payments) and electronic payments (card payments, giro and ACH credit transfers, and direct debits). This distinction is useful since an electronic payment typically costs less than half that of a paper-based transaction used to make the same type of payment.[8] Countries with a larger proportion of their non-cash payments in electronic form will thus have a lower cost and a more e¢cient payment system.

The number of paper-based and electronic payment transactions are

versus another), the cash use rankings shown in Table 1 are only approximate.

[8] The way that di¤erent electronic and paper-based payments are initiated, processed, and paid is very similar across countries even though the composition of payments can di¤er considerably. Thus the …nding that an electronic payment costs less than half as much as a paper-based payment in both the U.S. (Humphrey, Pulley, and Vesala, 2000) and Norway (Robinson and Flatraaker, 1995) more than likely applies to other countries as well.

also shown in shown in Table 1.[9] Although apparently overstated in the past, it still is the case that the U.S. relies heavily on checks for non-cash payments. With 180 checks written per person per year, U.S. citizens write three times more checks than do citizens of Canada and almost …ve times more checks and paper-based giro credit transfers and direct debits (for wage disbursements and bill payments) than those in Europe. On average, a person in Japan only writes 10 paper-based transfers a year (mostly credit transfers for bill payments rather than checks). In the U.S., a low level of domestic cash use, a relatively unconcentrated banking system, no postal giro, and large geographic distances between trading centers all have made the check the most used (and historically most cost-e¢cient) non-cash payment method for point-of-sale, bill payment, and wage disbursement transactions.

Although the U.S. relies heavily on paper-based payments, it also initiates more electronic payments per person than Europe or Japan. This is partly due to the heavier reliance in these countries on cash transactions but is also in‡uenced by di¤erences in income levels which lead to more transactions generally. As a percent of all non-cash payments, only 39% are electronic in the U.S. while 70% are electronic in Europe. The large di¤erence between the low number of electronic payments per person in Japan (15) and the U.S. (114) is partly due to the fact that basically only bill payments (which are consolidated and paid once a month) and wage disbursements are made electronically in Japan while cash transactions in Japan replace what would be card payments at the point-of-sale in the U.S.

3 Serious Problems with U.S. Payment Data.

Although data on card transaction volumes, payment values, and terminals are adequate, there are serious problems with U.S. cash and check data. Although the value of cash issued as well as that actually in circulation (and net of inventories held by the Treasury and Federal Reserve Banks) are both known, only a few estimates exist regarding the value that may be in circulation within the U.S. Based on the methodology used, the Porter and Judson (1996) estimate that some 40% of the value of currency circulates within the U.S. (with 60% overseas) is in our view the most reliable and has been used in Table 1. Other estimates exist

[9] As discussed below, the volume of U.S. checks has been adjusted to re‡ect the results of the latest payment use survey. Current survey data for 2000 suggest that 49.1 billion checks were written while published data had put this …gure at 68 billion for 1999.

suggesting that the …gures are essentially reversed.[10] Only one author purports to have estimated a time-series of U.S. currency stock used domestically, although the ‡uctuation over relatively short intervals is considerable.

Our model uses domestic cash stock information in …rst di¤erence form and so we are more concerned with approximating changes than levels. We determine this from the variation in the value of all coin and currency in circulation but without any $50 or $100 notes in order to approximate the value of the stock of cash most likely used in domestic legal transactions. Total coin and currency outstanding in 1999 was $628 billion, of which $50 and $100 notes comprised $451 billion (72%). Thus our measure of the value the stock of cash used for domestic legal transactions is $177 billion (28% of the total). Of this, coin was $27 billion and the value of $1, $5, $10, and $20 notes totaled $150 billion (of which $116 billion (77%) is in $20 notes).

Aside from the fact that large value notes are not commonly used in legal cash transactions in the U.S., changes in the value of smaller denomination notes in Norway–which has good data on domestic cash holdings–closely parallels econometric estimates of the stock of cash used in legal activities (Humphrey, Kaloudis, and Øwre, 2000). As well, many researchers use changes in the value of a country's largest denomination note as a …rst approximation of changes in illegal activity, which is why we delete $50 and $100 notes in what follows for our de…nition of cash in circulation (CURRb).

A second serious problem concerns the check data. Importantly, only two comprehensive publicly available surveys of national check use exist: one for 1979 and the other some 20 years later for 2000.[11] The 1979 survey distinguished between "on us", Federal Reserve, and private sector processed checks. Building on this market share information and utilizing the well-reported volume and value data on Federal Reserve processed items, estimates of national check volumes and values were generated (and volume growth rates compared with check printing concerns).

However, two di¢culties arose. First, when the Federal Reserve priced its payment services in the early 1980's, the market share shifted

[10] Doyle (2000), using a di¤erent methodology, estimates that 70% is domestic (30% overseas) while Feige (1996) estimates that 60% is domestic (40% overseas).

[11] Although some consulting …rms have apparently generated estimates of check use at various points in time, these data are not publicly available (Majors, 2002). For recent time periods, a proprietary newsletter has provided estimates of check as well as cash use (Nilson, 2001) but does so without a full description of how these estimates were obtained. Later, we contrast our cash use estimate with that derived from this source.

away from Reserve Banks toward private clearing houses (Frodin, 1984). While an ad hoc adjustment was made to the Federal Reserve's market share, there was no new survey until 2000 to accurately recalibrate this component of the calculation method used. Second, commercial banks in competition with Reserve Banks for check processing volume provided expedited collection and cash management services and so attracted most of the higher value checks. Reserve Banks focused on processing relatively low dollar value items where the ‡oat bene…ts from costly expedited collection could not be cost-justi…ed. This value mix changed during the 1990s when Reserve Banks implemented their own expedited collection services. The resulting rise in the value of Federal Reserve processed items likely contributed to the apparent overstatement of the calculated value of checks written.[12] As a result, the published data for both check volume and value after 1979 may have been increasingly inaccurate over time but, until the 2000 survey, no one knew by how much.

We require time-series data on the value of (essentially) consumer checks as these are the ones that replace cash at the point-of-sale and, in turn, are replaced by credit and debit card transactions. But neither the check volume nor the value data are broken out in this manner (except for the two survey point estimates). Our solution is to adjust the yearly published check volume data to re‡ect the new survey information and then multiply this adjusted volume …gure by the average value of a credit card transaction (to approximate the unknown average value of a consumer check). This yields a time-series of the approximate value of consumer check expenditures (and abstracts from large value business checks which today and in the past dominate the check value …gures).[13]

[12] As detailed in the 1979 survey, the distribution of the value of checks is highly skewed toward a relatively few very large dollar items then written by business and government.

[13] The 1979 survey gave a total check volume …gure of 32.8 billion checks while the 2000 survey gave 49.1 billion. The published check volume …gure for 2000, based on methodology described above, is 68.5 billion. Thus between 1979 and 2000, check volume apparently rose by 16.3 billion, not by 35.7 billion in the published data. Multiplying the di¤erence in each year's published volume …gure (i.e., VOL_t - 32.8 billion) by the ratio 16.3/35.7 = .45658 gives a time-series of adjusted changes in check volume since 1979. The assumption here is that the degree of volume overstatement observed between 1979 and 2000 also applies to each year in the series. This reduces each year's volume growth rate by 4% to 28%, depending on the year (as compounding increasingly overstates the later …gures). Thus the adjusted series is obtained from $(VOL_t - 32.8B)(.45658) + 32.8B$.

4 Determining Cash Use Directly.

In the past it was not uncommon to use cash for bill payments, wage disbursements, and some large value …nancial transactions. Since the 1950s and 1960s, this practice has been largely replaced in most developed countries by safer and more convenient check and giro payments. As a result, the use of cash in the U.S. since 1970 has been mostly restricted to consumer point-of-sale transactions where cash, checks, and debit and credit cards are the typical payment method.[14]

The use of cash for consumer payments (CASH) can be approximated by subtracting the value of all card payments (debit DCARD and credit CCARD) and an estimate of consumer check payments (CHECK) from the value of personal consumption expenditures (PerCons) in the national income accounts: CASH = PerCons ¡ DCARD ¡ CCARD ¡ CHECK. Figure 1 illustrates the value of these variables over 1974-2000. In this direct calculation, the value of checks keeps approximate pace with the growth in personal consumption expenditures, with the exception of a recession period during the early 1990s. This is when the average value of a credit card transaction fell and reduced our computed value of consumer checks. Since the value of cash is determined as a residual (as shown above), this resulted in an apparent bulge in the value of cash payments for the same period. As seen, the total value of cash payments falls over 1992-2000 and is approximately ‡at from 1995 forward. The reduction in cash use is due to the continued growth in checks and the expansion of cards.

This sequence of events is perhaps seen more clearly when changes in estimated values of these variables over 1974-2000 are divided into three time periods corresponding to local maximum and minimum values of the share of cash in personal consumption. These are shown in Table 2. Over the years indicated in the …rst column of this table, the following equality holds for each row: ¢PerCons = ¢CASH + ¢DCARD + ¢CCARD + ¢CHECK. For example, in the …rst period the change in the value of personal consumption expenditures over 1974 to 1982 was $1,096 billion. Over the same period, the change in cash use was $65 billion, the change in debit card value was zero, the change from credit card use was $127 billion, and the change in consumer check value was

[14] ACH payments are excluded from our analysis since they have basically only replaced business and government checks for wage, retirement, and bene…t (Social Security) disbursements, plus replacing some consumer checks for bill payments. The volumes in current pilot programs where checks written at the point-of-sale are truncated and the transaction is completed through the ACH are currently too small to be included.

Table 2: Changes in the Value of Personal Consumption and Payment Instrument Use, 1974-2000

Years:	¢ Personal Consumption	¢ Cash Use	¢ Debit Card Use	¢ Credit Card Use	¢ Check Use	Pct. Pt. Change in Cash Share
1974-1982	+1,096	+65	0	+127	+904	-18.2
1982-1992	+2,153	+1,170	+16	+283	+684	+17.5
1992-2000	+2,418	-331	+407	+862	+1,480	-19.1

$904 billion (82% of the total change).[15] During this period the estimated share of cash in personal consumption expenditures steadily fell from 39% in 1974 to a low of 21% in 1982–a reduction of 18 percentage points.

A second period from 1982 to 1992 saw a rise in the change in cash and card use and a corresponding reduction in checks. The estimated share of cash regained much of what it lost during the prior period, rising from 21% in 1982 to a local high of 38% (+17 percentage points). In the …nal period covering 1992 to 2000, debit and credit card use expanded and comprised 53% of the change in personal consumption expenditures while checks accounted for 61%. This sums to greater than 100% because the change in the use of cash was a negative 14%. Cash use apparently fell by $331 billion during this period and its share in personal consumption was 19% in 2000. In contrast, the change in card use expanded to the point where it was close to equaling the change in consumer check use and clearly is a major reason for the reduction in cash use.

An alternative way to illustrate changes in U.S. payment instrument use over 1974-2000 is shown in Figure 2 where the value levels in Figure 1 are reexpressed in index form (1974 = 100). This serves to contrast payment instrument percent growth rates relative to each other as well as to personal consumption. As seen, from 1974 to 1992, debit and credit card values grew at about the same pace as personal consumption, with checks generally growing slightly faster and cash growing slightly slower. After 1992, however, the growth rates are quite di¤erent. While growth in the value of consumer checks continued to slightly outpace that of personal consumption, the growth of debit plus credit card value dramatically increased while that for cash fell. Thus it is clear that both

[15] Checks accounted for 82% of the change in personal consumption expenditures over 1974-1982. As illustrated below, 82% is not the share of checks in total personal consumption expenditures, which in this exercise was 48% in 1974 rising to 67% in 1982. Only if the check share was stable over time would the percent share and percent change be the same value.

cards and checks replaced cash in consumer payments. This, at least, is the picture we obtain using our adjusted payment data in a simple direct calculation to approximate cash used for consumer payments.

5 Model of Cash Use.

5.1 Model Speci…cation.

We now develop an alternative procedure to estimate the share of cash in total personal consumption expenditures. Traditional money demand analysis has been concerned with how the stock of currency outstanding (as part of the money supply) is a¤ected by the level of economic activity and the interest rate. Our analysis, based on Snellman, Vesala, and Humphrey (2000) and Humphrey, Kaloudis, and Øwre (2000), uses this foundation to estimate the ‡ow component of money demand.

The ‡ow of cash used by consumers is estimated from changes in the estimated stock of domestic currency outstanding (comprised of all coin, $1, $5, $10, and $20 notes in circulation, CURRb) along with traditional determinants such as changes in consumer expenditures and the interest rate. In addition, as seen in Table 2, cards and checks can substitute for cash. The value of these payments and the di¤usion of the technology that in‡uences this substitution are incorporated directly into the analysis. Speci…cally, the number of available card or electronic funds transfer point-of-sale (EFTPOS) terminals allows card payments to replace both cash and checks at the POS while the concurrent expansion of ATM terminals and the possibility of receiving "cash back" from a POS transaction without incurring an ATM fee have made it easier to use cash. A force in the background has been some direct and indirect pricing of certain payment transactions (e.g., checks) and the assessment of ATM fees.[16] As these bank fees, when they exist, are not standardized and no reasonable time-series data are available on their level, the in‡uence of payment pricing on payment choice can not be separately identi…ed for the U.S.

The basic behavioral model is expressed in three equations. The …rst states that the sum of changes in the value of cash, card, and check payments equals the change in the value of personal consumer expenditures (¢PerCons):

(1) ¢CASH + ¢CARD + ¢CHECK = Á¢PerCons.

The parameter Á is estimated and not presumed to equal 1.0 (as was the case in the direct calculation of the previous section). Other in‡uences

[16] Depending on the level of deposit balances held by consumers at banks, charges may be assessed for additional checks written in excess of some number of "free" checks per month or for ATM use even when it is not a "foreign" ATM.

may well dominate or be collinear with personal consumption in the determination of cash use. The value of consumer use of cash (¢CASH) is unknown while reasonable information exists for the value of card payments (¢CARD). The value of consumer checks (¢CHECK), as noted above, is not directly observed but is approximated by multiplying the average value of a credit card payment in each year (currently around $70) by the (adjusted) volume of all checks written each year. By our calculation, total check volume is still increasing but at about the same rate as population growth. On a per person basis, check volume seems to have reached a peak in 1998 and is now ‡at.[17]

The second equation states that changes in cash used for consumer payments (¢CASH) is partly determined by lagged changes in the stock of coin and currency outstanding (net of $50 and $100 notes– ¢CURRb$_{t\,i\,1}$) and changes in the interest rate (¢r):

(2) $\quad ¢CASH = \bar{} ¢CURRb_{t\,i\,1} + ®_1 ¢r$

where:

$\bar{} = (\bar{}_0 + \bar{}_1 ATMPOP)$

so that yearly shifts in the number of ATM terminals per unit of population (ATMPOP) can a¤ect the relationship between the stock of currency in circulation and its use in payments. The change in currency stock is lagged one period as it is possible for ¢CASH and ¢CURRb to be contemporaneously correlated. Central banks have some ability to expand notes in circulation prior to and during an economic expansion when cash use rises. The reverse holds with a recession. However, decisions to print currency are clearly made ahead of its use. The number of notes to print are primarily determined by the rate of population growth, the rate of in‡ation, and the extent to which certain notes (typically those of lower value) e¤ectively wear out and need to be replaced.

Solving (1) for the unknown ¢CASH, setting it equal to (2), expressing the result in terms of the use of cards (since cards can substitute for both cash and checks), and allowing the relationship between card payments and the stock of currency ($\bar{}$) as well as checks (μ) to vary over time depending on the number of ATMs and the number of card or EFTPOS terminals per person (EFTPOP) gives the …nal equation of the behavioral payment model:

(3) $\quad ¢CARD = ®_0 + \bar{} ¢CURRb_{t\,i\,1} + \mu ¢CHECK + Á ¢PerCons + ®_1 ¢r + ²$

where:

$\bar{} = (\bar{}_0 + \bar{}_1 ATMPOP)$

$\mu = (\mu_0 + \mu_1 EFTPOP).$

[17] The same result was obtained earlier using unadjusted published check volume data (Humphrey, Pulley, and Vesala, 2000).

The speci…cation of ¯ and µ allows for shifts in the relationship between cards and cash and cards and checks over time. More ATM terminals favors cash use while more card terminals favors cards. Once (3) is estimated, the change in consumer use of cash for legal activities can be determined from:

(4) ¢CASH = ¡¢CARD + µ¢CHECK + Á¢PerCcons.

5.2 Model Results.

Estimating our model using a non-linear procedure with annual data gave the parameter estimates shown in Table 3. The value of ¯ re‡ects the yearly relationship between cards and the stock of currency (and, indirectly, the ‡ow of cash) while µ re‡ects the relationship between cards and consumer checks. As seen in Figure 1, the values of cash, cards, and checks were all rising until 1992 when the value of cash started to decline. Thus in Table 3 the value of ¯ is positive, but falling, indicating that cards and cash were both rising but at a declining rate over the period. This relationship turns negative after 1996, suggesting the replacement of cash by cards. In contrast, the value of µ is positive and rising over the entire time period. Thus cards and checks are both increasing (as noted in Figure 1), but the increase in cards for a given change in checks is itself increasing, especially from 1990 forward. Thus cards were expanding more rapidly than checks from 1990 (see Figure 2). The relationship for ¯ is weak and not statistically signi…cant while that for µ is stronger and signi…cant.

A rise in interest rates should tend to reduce cash use and induce consumers to use cards or checks, suggesting a positive relationship. However, the sign is negative and insigni…cant. This is not unexpected. If a consumer holds $100 more in idle cash balances each day of the year the lost interest earnings from a deposit account paying 3% would be $3.00 annually, or $0.25 a month. While some consumers could be this sensitive to interest rates, most would not. Thus rising interest rates have not positively in‡uenced card use.

Finally, the value of Á is signi…cantly less than 1.0. If the data used are accurate, we may have expected Á to be close to +1.0 implying that equation (1) is close to an identity. However, after accounting for changes in the stock of domestic currency, the value of checks, the interest rate, and the growth of ATM and EFTPOS terminals, this did not occur. For illustrative purposes, equation (3) was reestimated with Á restricted to +1.0. After accounting for the in‡uence of the other variables in the model, setting Á = 1:0 gave a cash share of 49% for 2000. This clearly does not …t what we know about consumer use of

Table 3: Determinants of Card Use

$$\Delta CARD = \alpha_0 + \beta \Delta CURRb_{t-1} + \mu \Delta CHECK + \lambda \Delta PerCons + \alpha_1 \Delta r$$

α_0	=	-29.5		Value of β	Value of μ
β_0	=	.002	1980	.0020	.212
β_1	=	-.004	1985	.0012	.215
μ_0	=	.212*	1990	.0009	.240
μ_1	=	.121*	1995	.0003	.454
λ	=	.177*	2000	-.0020	1.438
α_1	=	-3.10			
adj. R^2	=	.91	* = signi…cant at the 95% level		
Sample size = 25					

cash and the restriction is rejected.[18]

6 Payment Shares in Consumer Expenditures.

The model estimated above is used to generate the predicted share of cash in consumer payments.[19] This prediction is shown in the last row of Table 4. It is contrasted with the cash share obtained through direct calculation in Section 4 (row 2) as well as an approximate indicator of cash use across countries–the ratio of cash in circulation (net of $50 and $100 notes) to GDP. These three series are also shown in Figure 3 over 1974-2000. The cash shares estimated from the model steadily fall over time, as does the ratio CURRb=GDP. The variation in the cash share from the direct calculation in Section 4 is likely the result of the way in which we calculated the value of consumer checks.[20] Overall, these three measures suggest that the share of cash used in domestic legal activities has fallen by about half over our 25 year period. Thus cash

[18] First di¤erenced data, which typically are stationary, were used to generate the estimates in Table 3. A Durbin-Watson test for positive autocorrelation was inconclusive while negative autocorrelation could be rejected. Second di¤erencing of the data was not attempted as an earlier analysis (Humphrey, Kaloudis, and Øwre, 2000) showed that second di¤erencing introduced more problems than it solved.

[19] The yearly estimated change in cash use derived from equation (4) is cumulated and added to a base estimate of cash for 1975, derived from the direct calculation method outlined in Section 4. This series is then de‡ated by the observed value of personal consumer expenditures to obtain an estimated cash share. Thus the cash shares in rows 2 and 3 in Table 4 are the same for 1975.

[20] Recall that when the average value of a credit card payment dropped, say due to a recession, so did the value of checks. This led to a rise in the directly calculated value of cash (see also the last paragraph in Section 3 and the second paragraph in Section 4).

Table 4: Direct Calculation and Statistical Estimates of Cash Shares

	1975	1980	1985	1990	1995	2000
CURR/GDP	.036	.028	.022	.019	.017	.015
Direct Calculation	.37	.24	.27	.38	.26	.19
Statistical Estimate	.37	.30	.27	.26	.19	.16

use appears to have been falling even before card use took o¤ over the last decade. Checks were replacing cash before cards started to play a major role here.

Our results are seemingly robust to a plausible alternative speci-…cation of the model in (3). For example, respecifying $\bar{} = (\bar{}_0 + \bar{}_1 EFTPOP)$ & $\mu = (\mu_0 + \mu_1 EFTPOP)$ and adding $\beta_2 ATMPOP$ to (3) gave a cash share value of .20 for 2000, versus .16 shown in Table 4. Looking at levels of cash use over a year, rather than shares, a proprietary payment newsletter caclulates cash use for consumer payments to be $1,018 billion in 2000 (Nilson, 2001). In contrast, our simple direct calculation approach gives $1,249 billion for 2000 while our estimated model (3) gives $1,032 billion. Given the poor state of U.S. payment data, this similarity in cash use values–one calculated, the other estimated statistically–is unexpected.

The full picture of U.S. consumer use of di¤erent payment instruments is shown in Figure 4. While the value of all consumer payment instruments rose over 1974-200, except for cash after 1992, the shares illustrate better the apparent trade-o¤s that have occurred among instruments. Focusing on the estimated cash and consumer check shares,[21] it appears that from 1974 to the early 1990s checks displaced cash, resulting in a slow decline in the estimated cash share. Some evidence from the Survey of Consumer Finances supports this view. Average cash holdings per U.S. household fell from $148 in 1984 to $100 in 1995, with the percent of household expenditures made in cash falling from 30% to 20% over the period (Porter and Judson, 1996, Table 1).

From 1990 onwards, the total number of (credit plus debit) card transactions almost tripled, from 10.8 billion in 1990 to 30.0 billion in 2000. The rapid growth of card transactions was facilitated by an even more rapid expansion of card terminals in place. These rose from 60 thousand in 1990 to over 2.5 million in 2000. As suggested in Figure 4, the rapid rise in credit and debit card payments accelerated the on-going

[21] The di¤erence between the estimated and directly calculated cash shares was noted when Figure 3 was presented. The consumer check share derived from this estimation is determined from 1.0 - estimated cash share - credit card share - debit card share.

reduction in the cash share and started to replace consumer checks as well.

What do these payment trends imply for the future? While card shares are rising, there is as yet no apparent in‡ection point to this expansion which could indicate (from a logistic curve standpoint) the level at which cards may achieve their market saturation. Cards currently have a market share of 28% and are on track to rise further. One consideration for the future of credit cards, however, is the possibility of merchants imposing an extra charge for credit card payments as occurs in some European countries today and may be possible in Australia shortly. Currently, this is contractually prohibited in the U.S. even though credit cards are essentially double the cost for merchants to accept than cash, check, or an on-line debit card.

The situation regarding cash is di¤erent. While the share of cash could fall below its current level of 16% to 19%, this reduction is likely to be slow unless stored value cards are widely embraced. To date, this has not occurred in the U.S. or Europe, where various "electronic purse" pilot programs have experienced a disappointing level of consumer acceptance (Van Hove, 2000).

The check situation is perhaps clearer. The current share of checks in consumer payments is estimated to be 53% but will be falling as a result of continued replacement by debit cards and because of a new way to clear checks written at the point-of-sale. Currently in the pilot stage, this procedure is dependent on retailer acceptance rather than consumer acceptance. Since costs are reduced, acceptance is likely, especially at larger retailers. When a check is written at the point-of-sale, it is put into a small terminal which reads the MICR line on the check containing the paying bank's identi…cation number and the check writer's account number. The amount the check is written for is obtained from an electronic cash register. With these three items, the check is truncated and the value is collected overnight via the ACH. Although consumers may continue to write checks to initiate the process, merchants will collect them electronically and transform a paper-based payment into an electronic one.

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