Web Appendix

for: The challenges facing currency usage: will the traditional transactions medium be able to resist competition from the new technologies?

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CONTENTS

This Web Appendix contains four parts. Part A augments the presentation of data in the main text by showing a series of figures that depict the evolution of currency usage in several OECD nations. Part B discusses the failure of one e-money venture, i.e. DigiCash's eCash, as an illustration of the problems that e-money faces. Part C presents some evidence on the costs of using cash versus its electronic competitors. Finally, Part D provides a great many details that elaborate the regression analysis in the main text.

PART A. LARGE BANK NOTES

Figure A1. Notes with a value greater than £50 as a % of total currency outstanding

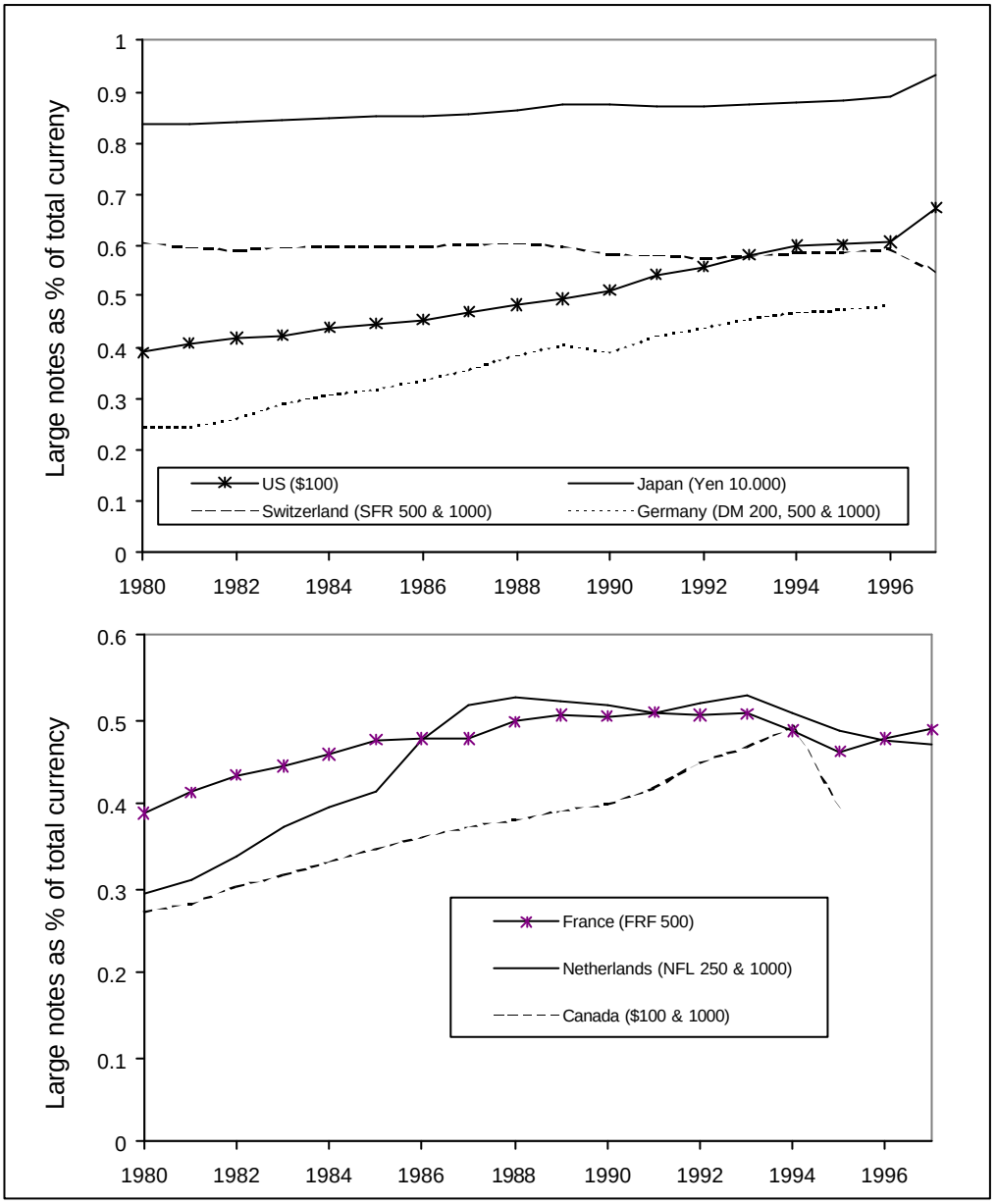


Figure A2(a). The real value in home currency of total cash outstanding (Aggregate/Large/Small)

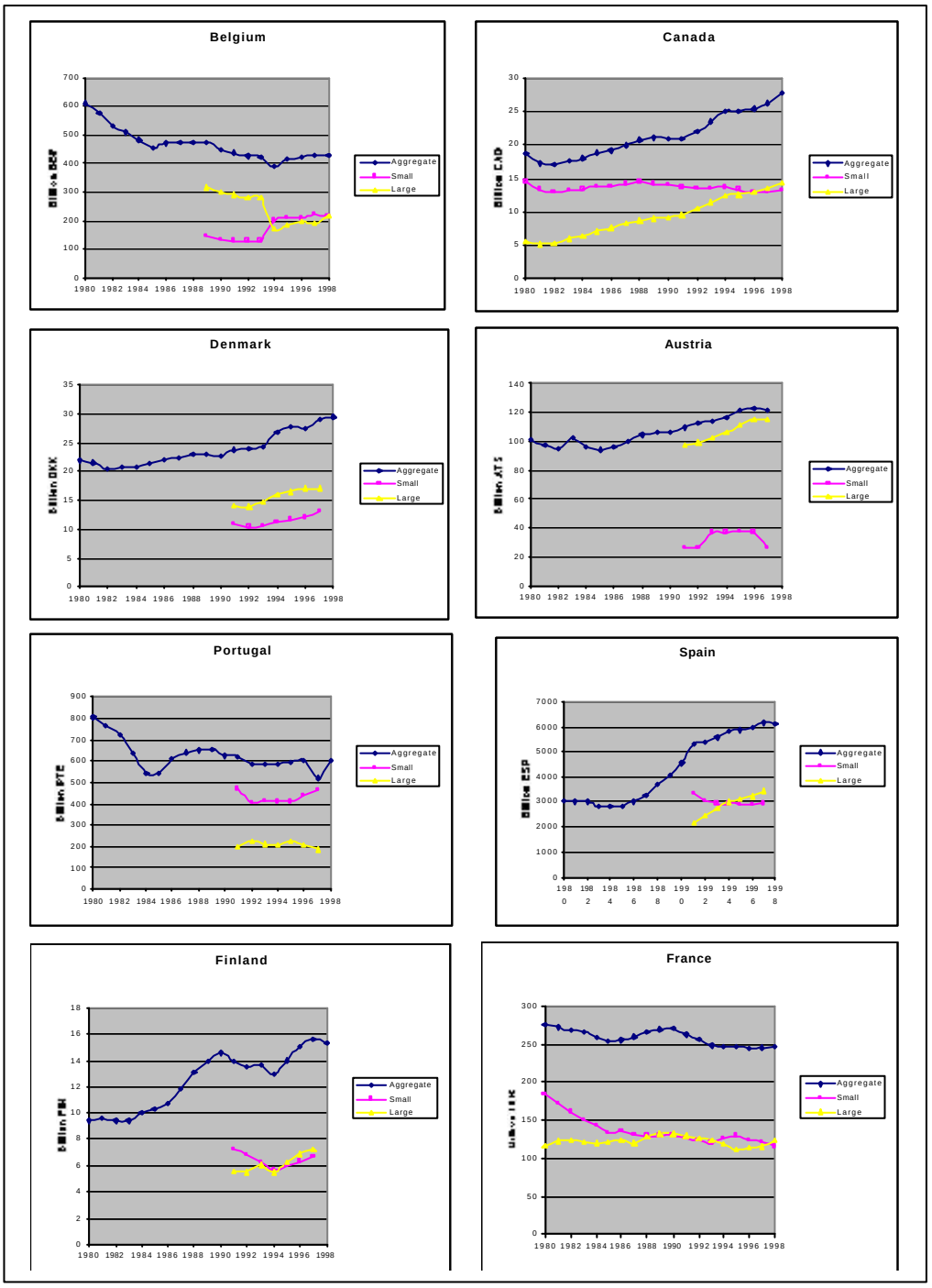
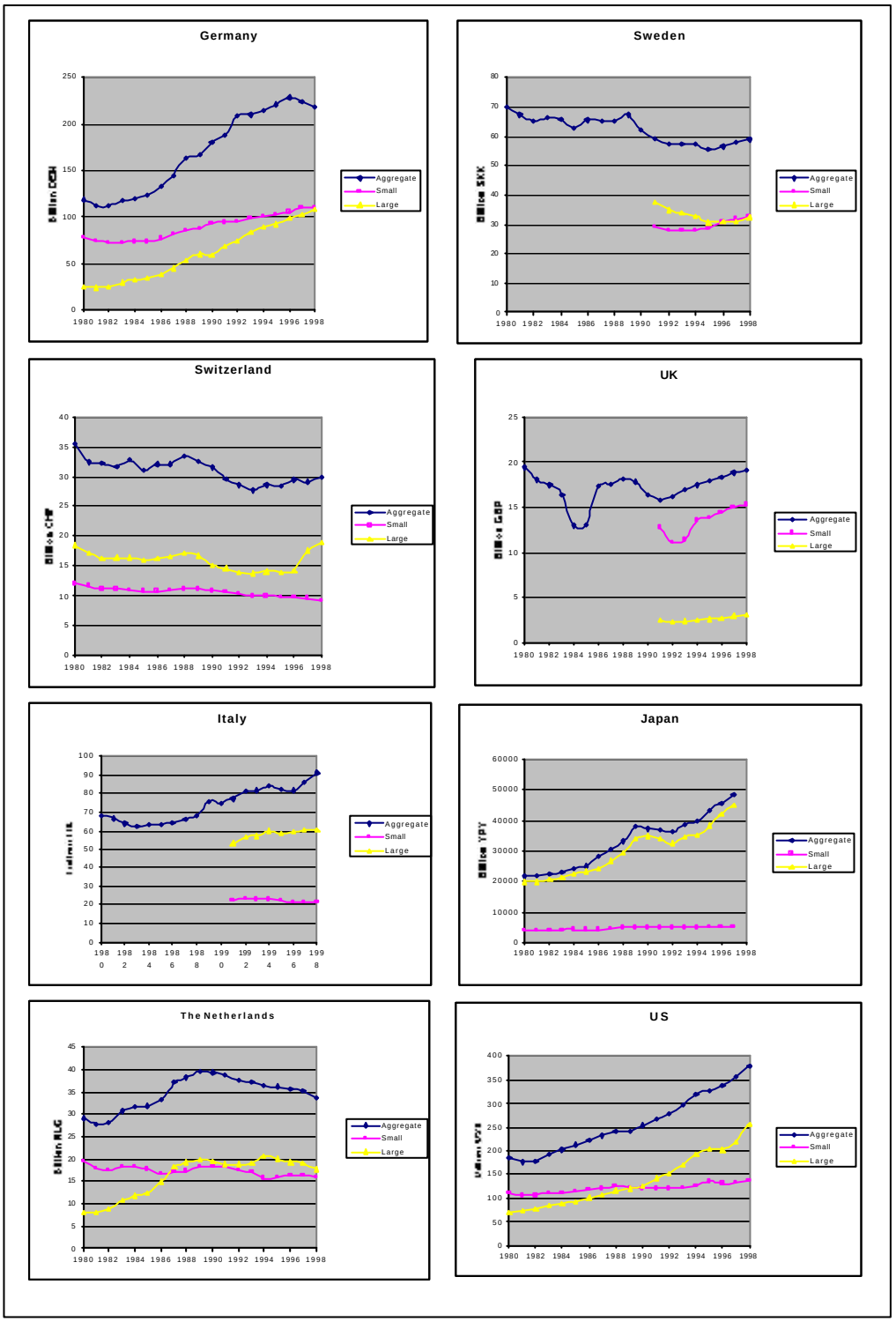


Figure A2(b). The real value in home currency of total cash outstanding (Aggregate/Large/Small)



PART B. THE FAILURE OF DIGICASH'S ECASH

eCash is a software-based e-money system based on David Chaum's one-way token system (Furche and Wrightson (1996)). In 1994 the issuer, DigiCash, undertook a much publicised pilot exercise with so-called "CyberBucks". A year later DigiCash started to license eCash to banks such as Mark Twain Bank (US), Merita Bank (Finland), Deutsche Bank (Germany), Advance Bank (Australia) and the Swedish Post. But, in spite of the high profile pilot exercise and impressive customer list, the system never really took off and in 1998 DigiCash had to file for bankruptcy. (Two other early internet payment systems that also were not successful were First Virtual and CyberCash, see Böhle 2001). DigiCash's lack of success is somewhat puzzling. After all, it provided a secure method of payment over the internet, and also a relatively high degree of anonymity, and so, on such a basis, should have had a good chance of success.

There are a number of reasons why DigiCash eventually failed, besides the general slow acceptance of such e-payment systems. First, the way to use the system was hard to understand; users had to install their own software, and payments took fairly long to complete. Especially for small value payments, the time and effort required was too much for many customers. Second, eCash is not as close to cash as it may seem; it has a lot of features of an account-based system (Böhle 2001). The receiver has to submit the tokens to the issuer who would credit the value to an eCash account; so, on the side of the payee, anonymity was limited. Third, DigiCash made serious strategic mistakes in the marketing of eCash. What had fascinated many people during the pilot exercise was that eCash seemed to offer a possibility to pay anywhere on the internet. But eCash licences were covering only customers of a particular bank. Thus, Mark Twain bank customers who wanted to use DigiCash could only make payments to other Mark Twain Bank customers, but not to Merita or Deutsche Bank customers. Therefore, each licensee could basically offer only a proprietary payment mechanism. This proved to be a non-starter.

PART C. TENTATIVE COST COMPARISONS

Costs of payment media are difficult to measure. Even if they could be measured correctly they would be difficult to compare because payment modalities differ substantially: there are large-value and small value payments, remote payments and face-to-face payments, etc.

Nevertheless, there are a number of cost studies and they mostly provide a positive picture for cash (relative to alternative transactions technologies). Most studies show that cash still is a highly competitive means of payment. Studies of American, Dutch and German retail organisations found that cash is the cheapest means of payment at the POS (see Table C1). Relative payment costs of UK banks show a similar pattern. According to the estimates of Retail Banking Research (a market research and consultancy company) the cost per cash transaction are the lowest (see Table C1).

These results seem surprising because it is often assumed that the large costs of cash handling make cash expensive for merchants. However, from the point of view of the retailer the relevant costs are not just the direct costs of a particular payment device. Retailers are interested in the costs of the entire payment process – including the time it takes to complete a transaction. Zellekens and Rueter (1996) show that "speed of payment" is a decisive cost factor. Whether a supermarket has to man 5 or 6 cash counters over the day is much more important than the question whether epurse handling at the end of the day is half an hour faster than sorting out cash receipts. Since cash still is a very fast means of payment the overall costs of using cash are comparatively low – even when cash handling in the back office and cash delivery to the bank is included in the cost study.

Table C1. Costs of Alternative Payment Methods for Retailers

cost per transaction:	Cash	Cheque	ACH/Giro	Credit Card	Online Debit	e-purse
Holland (EUR)	0.095	--	0.19	2.5	0.22	0.25
Germany (DM)	0.17-0.29	0.98-1.39	1.32	--	1.32-1.71	0.378
UK (£)	0.083	0.45	0.5 (paper)	0.3 ('cards')	--	
USA ($)	0.12	0.36	0.24*	0.72	0.34	--

*Notes:**: electronic benefit transfer at the POS. *Sources*: US: Food Marketing Institute (2001); Germany: Zellekens and Rueter (1996) and Schneider (1998); Holland: Jaarsma and van Rijt-Veltman (2000) quoted in Van Hove (2000b), UK: Retail Banking Research.

Not all studies, however, reach the same conclusion. In a study of payment costs in Iceland and Belgium, De Grauwe, Buyst and Rinaldi (1999) find that card payments are cheaper than cash payments (see Table C2).

Table C2. Costs of Card and Cash Payments in Belgium and Iceland 1997

	Cards	Cash
Belgium	26 BFr (1.3%)	22.6 BFr (9%)
Iceland	29 BFr (1.6%)	125 BFr (n.n.)

Sources: De Grauwe, Buyst, Rinaldi (1999); percentages in brackets refer to transaction costs in per cent of the average transaction value; in 1997 one US$ was equal to 35.77 Belgian Francs.

PART D. EMPIRICAL ANALYSIS

Data

We look at annual data for 16 OECD countries: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States. For large and small bills we have however only data for the entire period for a subset of these countries (Canada, France, Germany, Japan, Netherlands, Switzerland and the United States).

Our measures of nominal GDP, direct and indirect taxes are taken from the OECD data base. The price level, overall nominal taxes, the end-year nominal money market interest rate and the dollar home currency exchange rate are taken from the IMF's International Financial Statistics. Data on aggregate currency outstanding come from this same source. For the statistics of small and large bank notes, as well as the statistics of EFTPOS, ATMs, card and cheque payments, we use data from the BIS (2000, 1998 and 1996c), the EMI (1997) and the ECB (1999b). The sum of the two separate series of large and small bill differed marginally from the IFS, but in no case does this make any difference to the direction and significance of the individual variables in our regressions. The population is taken from the World Development Indicators.

For all countries, data for the crime index for at least some years are provided by the UN (see UNCIJN (2001)). For Germany and the US, the series are extended with data from national institutions (see BKA (2001) and US Department of Justice (2001)). For Belgium, Netherlands and Portugal, we use the number of convicted criminals as a proxy for total crime. We assume that the number of total crime to convictions is the same in 1995 as in all other years.

All regressions are done using Stata7. The code and dataset are available either on the Economic Policy website or from the authors on request.

Unit root tests

We use the Im-Pesaran-Shin test (1997) and Hadri's LM test (1998) to test our data for unit roots.[1] The Im-Pesaran-Shin test is an augmented Dickey Fuller test with the null of a unit root in all countries. As in the case of the Dickey Fuller tests, the test is one sided and the H0 can be rejected for a large negative test statistic. Hadri on the other hand proposed a Lagrange Multiplier test with the null of stationarity of all individual series. This is similar to the well known Kwitkowski, Philps Schmidt and Shin (1992) test in the pure time series framework. In the limit the test statistic converges to the standard normal distribution.

The results are tabulated in Table D1. For real GDP per head and real cash per head it is clear that the series have a unit root.[2] In the case of the differenced data, we see that the test statistics for the Hadri LM test are less significant even though one could still reject the null of stationarity in the case of heteroscedastic disturbances across countries. The results of the Im-Pesaran-Shin tests are, however, quite clear in rejecting the null of a unit root at the 1% level. We only report the test results of the Im-Pesaran-Shin test with one lag. Adding lags does not change the results. Given the short time span of our data, we also feel that one lag is the best specification for our sample.

Both Im-Pesaran-Shin and Hadri tests are only valid for balanced panels. This limits our possibilities for small and large bills, as there are several countries for which data were only available since 1991. We therefore look at three cases: a) countries where data

[1] For an excellent survey on unit root test and cointegration in panel data see Baltagia and Kao (1999).

[2] We only show the results for the per capita series. The unit root tests for aggregate cash, Large, Small and GDP are however similar.

are available from 1980-1998, b) all countries in the time period from 1991-1997 and c) same as a) without Japan. As for small bills per head (in real terms) the results mirror real cash in all three cases.

Table D1 Unit Root tests for Aggregate/Large/Small per capita

	Hadri Ho	Hadri He	IPS	IPS trend
All countries from 1990-1998				
Cash	34,01***	29,63***	-1.23	-2.09
D(Cash)	1,31*	1,53*	-2,76***	-2,97***
GDP	35,56***	32,29***	-1.08	-2.28
D(GDP)	0,99	1,65*	-2,72***	-2,76***
C, FR, G, Jap, Neth, Switz, US from 1980-1998				
Large	23,76***	20,87***	-1,26	-0,46
D(Large)	3,29***	1,51**	-1,75	-2,16
Small	22,16***	19,64***	-0,90	-2,189
D(Small)	1,62**	1,24*	-3,34***	-3,56***
All countries from 1991-1998				
Large	9,18***	8,20***	-1,15	-1,48
D(Large)	-0,15	1,72**	-1,58	
C, FR, G, Neth, Switz, US from 1980-1998				
Large	25,00***	20,56***	-0,99	-0,51
D(Large)	4,92***	2,48***	-2,25***	-3,03***

Notes: Tests are done by using the logarithm of real Cash/Large/Small/GDP per capita. Hadri LM test with homosecedastic (Ho) or heteroscedastic (He) errors: H0 - all series are stationary. Im-Pesaran-Shin tests with one lag and one lag and trend: H0 - unit root in the panel. *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level *Sources*: see text

In Table D1 only the results for case a) are reported for small bills. The results for large bills per head (in real terms) are less clear in confirming the stationarity of the differenced series. Looking at case a) where we observe the longest time span of data, both the Im-Pesaran-Shin and the Hadri test indicate that even this series is not stationary. The results for the Hadri tests for case b) are ambiguous as one can still reject the null of stationarity if one assumes heteroscedastic disturbances across countries.[3] It seems, however, that the rejection of a unit root for the differenced data in case a) is driven by Japan.[4] Dropping Japan from the sample yields the same pattern as for overall cash, where the Im-Pesaran-Shin test rejects the hypothesis of a unit root at the 5% level.

[3] Due to the short time span of the data, the Im-Pesaran-Shin test could not be run with 1 lag and trend.

[4] The Dickey-Fuller statistic for the differenced series of large bills per person in Japan is −2.44, implying a significance level, as given in the MacKinnon tables of just 13% to reject the null of a unit root.

With this evidence we feel that we can also assume that the differenced series of large bills per capita are stationary in the panel.

Table D2 Unit Root tests for the interest rate and ATMs/EFTPOS per capita

	IPS	IPS trend
All countries from 1990-1998		
Interest rate	-2,24***	-3,33***
All countries from 1991-1998		
ATM	-1,13*	-4,33***
ETPOS	-0,73	-4,83***

Notes: ATMs and EFTPOS are measured on a per capita basis. Im-Pesaran-Shin tests with one lag and one lag and trend: H0 - unit root in the panel. *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level. *Sources*: see text

Tests for cointegration

Given the stationarity of the interest rate in our panel (see Table D2), we only test for cointegration between real GDP/ real GDP per head and real cash/ real cash per head. A country-specific Johansen trace test reveals that one can reject the hypothesis of no cointegration for nine countries. To test whether there are cointegration relationships in the panel we use three different tests; a likelihood-based test for cointegration for panel data, in the spirit of Johansen trace tests proposed by Larsson, Lyhagen, and Löthgren (2001) and two residual based tests: a Lagrange multiplier test for the null of cointegration proposed by McCoskey and Kao (1998) and the Pedroni panel t-test (1999), which is a pooled augmented Dickey-Fuller test with the null of no cointegration. The LLL and the McCK test allow for heterogeneous cointegration relationships in the panel, whereas the Pedroni panel t-test assumes a common cointegration relationship. All our tests are done allowing for country specific trends. The latter is necessary as some country series show a negative, whereas some a positive, trend (see Figure A2). As Larsson, et al., report weak properties of their test in small samples, we only use the panel t-test and McCK test for Large and Small.

The results for our data are shown in Table D3. They support the hypothesis of cointegration in the aggregate as well as in Large and Small. For the per capita series the original McCK test yields conflicting evidence. The original test is constructed by using averages of individual country regression results, correcting for endogeneity by dynamic OLS. This shortens the time span of the individual series considerably.[5] Using OLS instead of dynamic OLS, the tests no longer reject the null of cointegration for the aggregate cash holdings per capita and large bills per capita.

[5] McCoskey and Kao propose using either the fully modified estimator of Phillips and Hansen (1990) or a dynamic OLS regression (Saikkonen (1991), Stock and Watson (1993)), which includes lags and leads of the differenced right hand variables in the regression. We chose the later method, including one lag and one lead for differenced GDP as this was easier to implement in Stata.

Table D3. Test for Cointegration

	Cash	Cash per Capita	Large per Capita	Small per Capita
LLL-Test				
0 unit roots	8.01***	11,62***		
1 unit root	-1,33	0,12		
Panel t-test	-198***	-206**	-120***	-134***
McCK-test	-1,65*	-2.90***	-2.47**	-3.68***
McCK-test no DOLS		-0.422	-0.14	-2.50***

Notes: Tests are done by using the logarithm of the real Cash and real GDP or the logarithm of real Cash/ Large/Small per capita and real GDP per capita, Panel t-test: H0 - no cointegration, McCK-test: H0 – cointegration. *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level. *Sources*: see text

Given the strong results of the panel t-test, we estimate the cointegration relationships assuming a common cointegrating vector for all countries and country specific time trends. To generate the cointegrating vector, we use the between-dimension estimator proposed by Pedroni (1996, 2001) as well as the within-dimension DOLS panel estimator of Mark and Sul (2001). Pedroni simply takes the average of the country individual cointegration vectors, whereas Mark and Sul do a modified DOLS regression of the demeaned data in the panel.

The results are extremely promising especially in the case for cointegration of real cash and real GDP. Here both methods find a highly significant common cointegration vector around $?=(1, -0.675)$: P-method $?_P=(1, -0.680)$; MS-method $?_{MS}=(1, -0.678)$ when correcting for endogeneity and $?_{MSnoE}=(1, -0.672)$ when not. All results are significant at the 1% level. Given that all results are remarkable similar, we take $?=(1, -0.675)$ as the common cointegration vector.[6] This vector is also within the 95% interval confidence of all the country individual cointegration vectors except Spain.

This result does also not change substantially if one looks at the cointegration of real cash per capita and real GDP per capita. Here results are, however, not quite so clear cut: the MS method (no DOLS) leads to a common cointegration vector of $?_{MS}=(1, -0.731)$ (significant at the 1% level) whereas the P-method yields $?_P=(1, -0.620)$ (significant at the 1% level). Theoretically there is no reason why the long run relationship of the per capita variables should differ from the long run relationship between the overall series. We thus use $?=(1, -0.675)$ as the cointegration vector for the per capita series as well.

For small and large bill holdings per person the results are much weaker. They depend heavily on the method used and on the countries included in the regression. For example, when taking all countries independent of the time-span for which the series are available, the P-method results in $?_{PL}=(1, -0.72)$ for Large and $?_{PS}=(1, -0.60)$ for Small whereas the MS-method comes up with $?_{MSL}=(1, -0.58)$ for Large and $?_{MSS}=(1, -1.79)$ for Small. We

[6] As McCoskey and Kao, Mark and Sul propose using either the fully modified estimator or a dynamic OLS regression, we used the latter as Mark and Sul show that for their test the small sample properties of DOLS are better then the fully mo dified estimator. Using DOLS or FMOLS also yields a consistent cointegrating vector using the P-method. Because of our small sample we did not use the DOLS method in this case.

feel that these unstable results are primarily driven by the lack of data to cover all countries over the whole time period. It is unclear to us which method yields the "true" coefficient. To resolve this problem we assume that the long run relationship of Large/Small per capita with respect to GDP per capita is similar and equal to the long run relationship of aggregate cash per person. Even though we argue in the rest of the paper that small and large series behave differently, we think that this is the best we can do, especially given the strong results for the overall series. Furthermore a quick test for the basic equation showed that the exact specification for the cointegration vector does not play a crucial role. Taking $?_S$=(1, -0.60) for Small and $?_L$=(1, -0.72) for Large did not substantially change the results.

In order to find out if we could use an "Engel-Granger" type set up for our estimation, we tested for endogeneity by doing a Durbin Wu Hausmann test. This reveals that even though the lagged residual of a regression of differenced GDP on its lag is near significant in some counties, it is not significant in the overall panel. Given this result and the non-significant difference between the MS-estimator which corrects and the one which does not correct for endogeneity, we take weak exogeneity of GDP as given. Also note that the currency data are end-of-the-year figures, whereas the GDP data are for the year as a whole. Moreover, most studies show lags in the effects of monetary impulses on the real economy. So, it is also theoretically highly improbable that current end-year money could be influencing current (through the year) GDP.

To take care of the country specific time trends, we regressed the difference of cash per capita minus 0.675*GDP per capita on a trend for each country and took the residuals as the error correction term. The equivalent was done for large and small bills per person.

Table D4 Panel estimation for the basic equation with real cash and real GDP

	Aggregate	Large	Small
GDP	0.56***	0.43***	0.48***
i	-0.003***	-0.003***	-0.004***
ECM	-0.37***	-0.29***	-0.42***
R^2	0.49	0.37	0.35
R^2-adj	0.45	0.30	0.29

Notes: Regressions are done by using the logarithm of real Cash/Large/Small/ GDP. Estimated with country specific effects, which are however not reported. *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level. *Sources*: see text

As the estimation for the cointegration vector in the per capita case differed slightly from the non-per capita case, we constructed the ECM for the latter as well and used it in our basic equation. The results are shown in Table D4. As one should expect, the normalisation to a per capita basis does not change the results substantially (compare with Table 5 in the main text).

Table D5. Estimation for the basic equation on a country level (Aggregate Cash)

	GDP	i	ECM	cons	R^2	R^2-adj
Belgium	-0,97	-0,11**	-0,44*	0,05	0,57	0,47
Canada	0.75***	-0.006***	-0.64***	0.05***	0.83	0.79
Denmark	0.21**	-0.004**	-0.33**	0.05**	0.54	0.44
Finland	0.4	0.01	-0.42	0.03	0.46	0.34
France	0.67***	-0.0005	-0.31	-0.16	0.61	0.53
Germany	0.56*	-0.01	-0.33	0.03	0.26	0.10
Italy	-0.72	-0.002	-0.61***	0.05**	0.64	0.56
Japan	1.24***	-0.01**	-0.25	0.06***	0.52	0.43
Netherlands	-0.79	-0.009	0.14	0.068	0.10	-0.10
Austria	0.43	-0.05*	-0.62***	0.03	0.59	0.50
Portugal	0.68*	-0.007*	-0.79**	0.04	0.69	0.62
Spain	1.08	-0.001	-0.15	0.04	0.44	0.31
Sweden	0.75***	-0.003*	-0.86***	0.01	0.69	0.63
Switzerland	1.49***	-0.009***	-0.72***	0.005	0.74	0.68
UK	0.87	-0.005	-0.49**	0.02	0.37	0.23
US	0.58	-0.005***	-0.37**	0.05***	0.70	0.64

Notes: Regressions done on the logarithm of real Cash/Large/Small/GDP per capita. *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level. *Sources*: see text

Table D6. Estimation for the basic equation on a country level (Large and Small)

	GDP	i	ECM	cons	R^2	R^2-adj
Large						
Canada	0,88**	-0.003	-0,65**	0,07**	0.40	0.28
France	1,14**	0.002	-0,48**	-0.04	0.43	0.30
Germany	0,76**	-0.01	-0.28	0.10	0.35	0.21
Japan	1,12**	-0,02***	0.12	0,10***	0.52	0.41
Netherlands	-2.23	-0.01	0.09	0.14	0.09	-0.11
Switzerland	1.09	-0,02***	-0.31	0.05	0.44	0.32
US	0.25	-0.004	-0.22	0,09***	0.28	0.13
Small						
Canada	0,57**	-0.001	-0,44*	-0.01	0.44	0.32
France	0.37	-0,003*	-0,23*	-0.01	0.48	0.36
Germany	0.27	-0,006**	-0,32*	0,04***	0.56	0.47
Japan	0,81***	-0,004**	-0.29	0.01	0.62	0.53
Netherlands	1,56**	0.01	-0,80**	-0.07	0.45	0.33
Switzerland	0,62**	-0,003*	-0,66**	-0,01*	0.55	0.46
US	0,89***	-0.001	-0,69**	-0.004	0.57	0.47

Notes: Regressions are done by using the logarithm of real Cash/Large/Small/GDP per capita. Results are only shown for countries with more then 10 observations for Large or Small. *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level. *Sources*: see text

Country specific effects

In Table D5 and Table D6 we report the estimation results for the basic equation for the individual countries. As our sample for Small and Large bills is limited we only report country effects for Small or Large, where we had more than 10 observations per country.

Our basic specification performs quite well on the individual level and the R-squareds are remarkably high. Both the coefficients for the interest rate and for GDP have mostly the right sign and a high degree of significance. The coefficients of the error correction mechanism turn out to be always negative and are in general highly significant. There is however one consistent outlier, which is the Netherlands. No variable seems to have a significant influence there and the R-squared of the basic equation is just 0.1.

The results for Large and Small are quite similar to the result for aggregate cash balances. It is interesting to note that even though the error correction mechanism was not truly estimated for Large and Small, it performs well. The coefficients of the error correction mechanisms are always negative for Small and only show a positive (but insignificant) sign for Large for Japan and the Netherlands. As in the aggregate, the basic equation has no explanatory power in the Netherlands for large bills, which is in contrast to Small (R^2 in this case is 0.45).

Table D7 Estimation of the effects of international variables on the demand of large bills in hoarding countries

	World GDP	i US	ECM	cons	R^2	R^2-adj
Germany	1,34e-05	-0.02**	-0.09	0.54*	0.31	0.16
Japan	1.59e-07*	-0.002	-0.02	0.40**	0.28	0.12
Netherlands	2.11e-05**	-0.02	0.02	0.76**	0.33	0.18
Switzerland	1.91e-05	-0.026	0.57*	0.62	0.38	0.25
US	1.01e-06	-0.005	-0.18	0.12	0.27	0.12

Notes: Regressions are done by using the logarithm of the real value Large and the logarithm of the real value of world GDP in the home currency. *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level. *Sources*: see text

Effects of international variables

For the selection of countries where foreign holdings are believed to be particularly important, (USA, Germany, Switzerland, Japan, Netherlands) the fits are worse for Large than for Small or the aggregate. One reason why the individual equations for large currency holdings may differ is that foreign holdings would not react as much to changes in domestic measured real GDP or domestic interest rates. We therefore tried a measure of world GDP as an alternative. It was constructed as the sum of the GDPs of our 16 countries (in dollar values). We re-valued this measure into home currencies and divided it by the price level to get a real "world GDP". The US interest rate is assumed as the "world interest rate". To see the effect of global variables on large bank notes in the above five countries we regressed the logarithm of the real value of large bank notes

outstanding on the logarithm of real "world GDP", the US interest rate and a country constant.[7] Only in the case of the Netherlands did it improve the fit (see Table D7).

Table D8. Estimation for the basic equation and tax ratios on a country level (Aggregate Cash)

	GDP	i	TR_t	TR_{t-1}	ECM	cons	R^2	R^2-adj
Belgium	-0.49	0.009*	-2.21*	1.52	-0.42	0.35	0.66	0.51
Canada	0.64***	-0.007***	-1.59***	1.21***	-0.45**	0.144	0.98	0.96
Denmark	0.03	-0.012***	0.052	-0.73	-0.16	0.40*	0.77	0.64
Finnland	0.48	0.003	0.42	0.65	-0.49	-0.34	0.59	0.38
France	0.79***	0.0002	0.65	-1.74*	-0.47*	0.42	0.71	0.58
Germany	0.51	-0.01	1.47	2.72**	-0.19	0.46	0.48	0.26
Italy	-1.19*	0.004	0.01	0.54	0.74***	0.25	0.68	0.53
Japan	0.31	-0.03**	-0.01	-0.68	-0.67	0.29**	0.75	0.58
Netherlands	2.07	-0.002	1.37	0.60	-0.17	-0.65**	0.74	0.52
Austria	0.74	-0.005	0.58	-0.01	-0.54**	-0.17	0.62	0.43
Portugal	0.65***	-0.01***	0.15	0.35	0.79***	0.17	0.96	0.94
Spain	0.33	0.003	-0.18	1.62	-0.30	-0.27	0.66	0.51
Sweden	0.79***	-0.004**	0.05	0.10	-0.86***	-0.04	0.72	0.60
Switzerland	1.07***	-0.01***	3.42***	0.81	-0.63***	-0.38***	0.90	0.87
UK	1.10	0.002	-2.95	-1.55	-0.57*	1.57	0.46	0.17
US	0.45	-0.005***	-1.52*	1.37**	-0.27	0.09	0.81	0.73

Notes: Regressions are done by using the logarithm of real Cash/Large/Small/GDP per capita. *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level. *Sources*: see text

Effects of the Tax Ratio

For the tax ratio (TR) results are very mixed. Looking at the county specific effects (Table D8 and D9) no clear pattern arises. Whereas most of the time TR and its lag turn out to be insignificant we can also find coefficients which are positive and significant as well as coefficients which are negative and significant.

One could argue that for the countries with high foreign holdings national "bad behaviour", for which the tax ratio is a proxy, is not of great importance. This is, indeed, the case. Table D10 shows the effect of TR and its lag on large money holdings in different sub-samples. It turns out that the tax ratio has an insignificant effect in hoarding countries. A Wald test also rejects the hypothesis at the 5% level that the coefficients for TR in the hoarding countries (US, Germany, Japan and Switzerland) are equal to the coefficients in non-hoarding countries.

[7] Note that we do not look at the influence of the sum of GDP per capita on large bill holdings per capita. We tested this as well but the results were even worse than in Table D7. We think that this is driven by the fact that the sum of the 16 OECD country GDPs is a reasonable proxy for world GDP, whereas the sum of GDP per capita is not a good proxy for world GDP per head as the population in these OECD countries does not represent world population. The ECM for the overall series was constructed similar to the construction of the ECM for the per capita series.

Table D9. Estimation for the basic equation and tax ratios on a country level (Large and Small)

	GDP	i	TR_t	TR_{t-1}	ECM	cons	R^2	R^2-adj
Large								
Canada	1.21**	-0.010***	-0.68	1.13	-0.96**	0.05	0.89	0.82
France	0.90	0.003	-0.04	0.81	-0.46*	-0.37	0.45	0.20
Germany	0.62	-0.01*	0.70	-2.47	-0.28	0.69	0.46	0.24
Japan	0.32	-0.03	-0.36	-0.47	0.32	0.33	0.71	0.50
Netherlands	3.82**	0.003	2.21*	2.20**	-0.38*	-1.49	0.88	0.78
Switzerland	0.74	-0.02**	4.55	6.70**	-0.35*	-0.99	0.70	0.59
US	0.66	-0.002	-0.28	2.57*	-0.42*	-0.36	0.48	0.26
Small								
Canada	0.94	-0.004	1.41	0.98	-1.08	-0.45	0.72	0.55
France	0.45	-0.005***	-5.32***	1.88	-0.023	1.43	0.87	0.80
Germany	0.23	-0.007*	-0.09	-0.24	-0.33	0.15	0.57	0.39
Japan	0.53	-0.007	0.09	-0.42	-0.27	0.09	0.80	0.66
Netherlands	1.23	0.02*	-0.14	-0.23	-1.28**	-0.002	0.69	0.43
Switzerland	0.64***	-0.004**	-0.67	-0.73***	-0.12	0.63	0.47	0.73
US	0.69*	-0.002	-1.31	0.92	-0.46	0.08	0.62	0.45

Notes: Regressions are done by using the logarithm of real Cash/Large/Small/GDP per capita. Results are only shown for countries with more then 10 observations for Large or Small. *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level *Sources*: see text.

Table D10. The effect of TR in different sub-samples

	G, Switz, US	G, J, Switz, US	All countries except G, J, Switz, US
GDP	0.68**	0.65***	0.77***
i	-0.006***	-0.008***	-0.002
TR_t	0.33	-0.38	0.53**
TR_{t-1}	0.23	-0.11	0.68***
ECM	-0.19*	-0.20**	-0.29***

Notes: Regressions are done by using the logarithm of real Cash/Large/Small/GDP per capita. Estimated with country specific effects, which are however not reported. *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level. *Sources*: see text.

TR has also significantly different effects on small and large bills (see Table 7 in the main text). Whereas it cannot be rejected that the current tax rate affects both series in the same way, the lagged value has a profoundly different effect. The lagged tax ratio has a negative and significant effect on Small, whereas its effect on Large is positive and significant. A Wald test shows that the hypothesis of equal values for the coefficients of lagged TR on Large and Small can be rejected at the 1% significance level.

To see if certain taxes have different effects than others, we use the income tax on households over GDP (IT) and indirect taxes over GDP (INDI) in our regressions. Results for large bills are shown in Table D11. The coefficients turn out to be much

smaller and it seems that especially the lagged series have a positive effect on large bill holdings.

Table D11 Effects of direct and indirect taxes

	Aggregate	Large	Small
GDP	0.63***	0.46***	0.44***
i	-0.003***	-0.003***	-0.004***
IT_t	0.003**	0.004***	-0.001
IT_{t-1}	-0.0008	-0.0001	0.002**
$INDI_t$	-0.003	-0.006***	-0.002
$INDI_{t-1}$	0.002	0.006**	-0.006*
ECM	-0.36***	-0.29***	-0.43

Notes: Regressions are done by using the logarithm of real Cash/Large/Small/GDP per capita. Estimated with country specific effects, which are however not reported. *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level. *Sources*: see text

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