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The Demand for Large Bank Notes

IN MANY COUNTRIES the high share of the largest bank note denomination in the total currency circulation contrasts sharply with its limited use in payment transfers. This somewhat puzzling phenomenon has been discussed more than once for the U.S. $100 bill, which has a value share of nearly 50 percent (see Anderson 1977; Kimball 1981; Porter and Bayer 1984). However, the phenomenon is the more remarkable for countries like Switzerland, Germany, and the Netherlands that issue a denomination at the upper end of the bank note range whose face value is five to fifteen times as high as the $100 note. In the Netherlands this is the Fl. 1,000 note with a face value at end-1990 of more than U.S. $500.[1] The circulation of this Fl. 1,000 note has grown dramatically (see Table 1). At year-end 1987, Fl. 1,000 notes accounted for almost 45 percent of the value of bank notes in circulation, and this was thus the most important denomination in terms of value. At that time, there were approximately fifteen million Fl. 1,000 notes in circulation. This works out at an average of one of these notes per head of the population and over 2.5 notes per household, compared with less than one note per household just ten years earlier. Nevertheless, Fl. 1,000 notes are seldom encountered in the course of everyday payment transactions.

Analysis of the development of macroeconomic variables reveals that the remarkable increase in the importance of the Fl. 1,000 note since 1980 cannot be solely

[1]See Table B in the Appendix for a comparative overview of the highest denominations in a number of OECD countries.

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TABLE 1

DEVELOPMENT IN THE CIRCULATION OF FL. 1,000 NOTES

Year-end	Circulation		Number of Notes per Capita	Percentage of Value of Total Bank Note Circulation
	Value in Billions of Guilders	As % of National Income		
1955	0.7	2.3	0.06	16.9
1960	0.8	1.9	0.07	15.7
1965	1.3	2.0	0.11	16.9
1970	2.0	1.8	0.15	20.5
1975	3.8	1.9	0.28	26.0
1980	6.4	2.1	0.45	29.4
1985	12.1	3.2	0.84	41.4
1986	12.6	3.3	0.87	41.6
1987	14.9	3.8	1.02	44.2

attributed to an increased transactions demand including inflation, but that there was apparently a demand shift (Fase 1985). This means that the Fl. 1,000 note is presumably being used to an increasing extent as a means of hoarding in addition to being a means of payment. The sharp rise in the average time in circulation for the Fl. 1,000 note, that is, the time elapsed between the moment of note issue by the Bank and the date on which it returns, supports this hypothesis. Between 1980 and 1989 this average circulation time has increased from 0.6 to more than 1.3 years.

In order to check whether these conclusions are borne out by microeconomic evidence, for the Netherlands a specially designed nonstandard survey was carried out in 1986. The main purpose was to provide quantitative micro-based insight into the use of higher denominations. As these form the major part of the currency circulation the outcomes should have policy implications for the interpretation of money and particularly currency holdings. The present article describes the design of the survey and its principal results. Further it analyzes our own findings in view of economic theory against the background of statistical evidence obtained from other sources of information.

1. SURVEY DESIGN

In view of the delicate nature of the enquiries on note holding, the textbook sample approach seemed to be inappropriate to carry out the survey. Apart from a high nonresponse rate, direct questioning about possession and usage of Fl. 1,000 notes would, in all probability, have led to a considerable response bias. To illustrate this hypothesis, in the 1963 survey of Consumer Finances sponsored by the Federal Reserve, American consumers were not even asked about their cash holdings because it was felt that accurate responses would be very unlikely. As it was, checking accounts and savings accounts, which were surveyed, were underreported by about 50 percent (Anderson 1977). In our second illustration a survey of money demand in the Netherlands, conducted in 1971, and largely based on a written questionnaire, Cramer and Reekers (1972, 1976) could account for only 22 percent of the Fl. 1,000 notes in circulation. Likewise, in the United States, Avery, Elliehausen, Kennickell,

and Spindt (1986) could trace with their survey among U.S. households only 11 to 12 percent of notes and coin in circulation outside banks. In view of these experiences we decided to adopt a more qualitative survey, comprising elements of a Delphi approach, extended to sectors usually not covered to any great extent by surveys, if at all.

The methodology underlying our survey within the various sectors distinguishes balances, either kept for payments, or as a store of value. Information on the cash balances is obtained by indirect questioning on

1. the proportion of turnover in a sector paid by cash, say: *pcash;*
2. the proportion of cash turnover paid by Fl. 1,000 notes, say: $p1000$;
3. the number of days that notes are kept before they are used for payments or deposited at banks, say: t.

The value of the holdings of Fl. 1,000 notes, denoted by $V1000_i$, for transaction purposes in sector i equals

$$V1000_i = (pcash_i * p1000_i * PT_i * t_i)/365$$

with PT_i the value of incoming and outgoing transactions per sector, obtained from national accounts. This approach has the advantage that the respondents are indirectly questioned on the use of cash in general and Fl. 1,000 bank notes in particular within their sector. For the more permanent holdings of Fl. 1,000 notes no such indirect approach was available. The respondents were asked therefore directly about those holdings. However, in certain sectors, like drug trade, no clear distinction could be made between the two types of cash holdings.

The survey was carried out in three phases.[2] In the *first phase,* eight exploratory interviews were conducted among specialists in the field of cash payments or in certain strongly cash-oriented branches of the Dutch economy. For the relevant individual sectors which these discussions helped to identify, the size of the payment flows and the number of units were derived from various public sources of information, principally the Netherlands Central Bureau of Statistics. Brief telephone interviews were subsequently conducted among 130 respondents taken from the various sectors in order to obtain rough estimates of the proportion of cash payments within the payment flows, the share accounted for by Fl. 1,000 notes within each cash payment flow and the average length of time for which these notes were held. The respondents were not asked directly about their own dealings but were asked to make estimates of the averages for these variables in their particular sector. The number of respondents per sector were chosen on the basis of turnover figures and the degree of sector homogeneity. Within homogeneous subsectors the respondents were chosen at random. On the basis of an earlier orientation for drug trade and gambling sector it was preferred to interview experts in the relevant field. On the

[2]The subsequent results and the number of respondents per sector are summarized in Table A in the Appendix, which also contains the figures on the turnover and the number of units by sector.

basis of the information thus obtained, along with the data concerning the number of units and the total payment flow per sector, an initial estimate was calculated of the numbers of Fl. 1,000 notes held in each sector. This estimate localizes more than 70 percent of the circulation of Fl. 1,000 notes (Table A in the Appendix).

In the *second phase* of the survey, this initial estimate was checked in greater detail by means of 190 telephone interviews. On this occasion the respondents were asked not so much for their own estimates but whether they thought the estimates derived from the initial survey were plausible, or if not, what they should be. To avoid biased answers and nonresponse, the questions were carefully worded. In each case the questions were unambiguously related to the trade as a whole and not to the company or personal situation of the respondents themselves. In a number of sectors, including the "other retail outlets" sector, the results were so varied that a further subdivision became necessary. Again, the degree of heterogeneity within the sectors and the size of the turnover were the main criteria for the sample size per sector, while per subsector the sample was chosen at random. This phase led to a considerable downward adjustment of the initial estimates. The results and the reported standard deviations show even for the various subsectors a high degree of heterogeneity. In addition to the 190 interviews, because of the high nonresponse rate in the household sector in the first phase, in an omnibus survey two thousand households were asked the use of Fl. 1,000 notes as a means of payment and as a means of hoarding. The results affirmed the findings for the twenty respondents from the first phase. The original estimates for those sectors not included in this second telephone survey, namely, industry, other services, households, the drug trade and the gambling community, were left unchanged.

In the *third phase* the holdings in a number of sectors not considered thus far were traced by means of interviewing insiders in the relevant fields. These sectors included foreigners and caravan dwellers as well as car dealers and car-breaking yards. For some sectors in the first rounds, especially for the sectors covering "grey" or even illegal activities, expert interviews are to be preferred to surveying a great number of respondents. Moreover, the Fl. 1,000 notes kept by the banking sector were estimated from the figures on their till money. Thus, the number of nonlocated Fl. 1,000 notes in circulation was reduced by nearly twelve percentage points compared with the estimate in the second phase.

2. THE MAIN RESULTS

With the above sampling strategy it was possible to trace almost 60 percent of the Fl. 1,000 notes in circulation (Table 2). According to the estimates, almost 25 percent of the Fl. 1,000 notes are to be found in the drug trade and the partly legal, but mainly "underground," gambling community. A further 9 percent of Fl. 1,000 notes are in the hands of private households. This works out at an average of 0.2 notes per household. Other sectors which stand out are the motor trade (including

TABLE 2

ESTIMATED DISTRIBUTION OF HOLDINGS OF FL. 1,000 NOTES

Sector	Present Study for 1986[a]		Cramer/Reekers' Estimate for 1971[b]
	% of Notes Held	Total Value (Millions of Guilders)	% of Notes Held
1. Agriculture and fisheries	4.6	557	0.9
2. Industry	1.7	206	1.0
3. Construction	2.0	242	1.0
4. Motor trade	6.7	811	0.6
5. Retail trade	2.8	339	1.3
6. Wholesale and distributive trade	1.2	145	0.9
7. Hotel, catering, and licensed trade	0.2	24	0.2
8. Real estate	1.8	218	0.1
9. Other services	1.4	169	1.0
10. Households	9.3	1,125	6.8
11. Banks and government	6.4	774	4.9
12. Foreigners	2.7	327	—
13. Caravan dwellers	2.9	353	—
14. Drug trade	10.1	1,211	—
15. Gambling community	3.7	448	—
Subtotal	57.5	6,949	18.7
16. Financial institutions	1.0[c]	121	1.0
17. Transport	1.4[c]	169	1.4
18. Other institutions	0.2[c]	24	0.2
19. Abroad	1.0	85	1.0
Known holdings	61.1	7,348	22.3
Unknown holdings	38.9	4,752	77.7
Total	100	12,100	100

[a]Percentages expressed in terms of average number of notes in circulation in first half of 1986.
[b]Cramer and Reekers (1972); percentages of number of notes in circulation on 31 March 1971.
[c]Additions to original survey estimates on basis of percentages estimated by Cramer and Reekers (1972).

scrap yards) and caravan dwellers. According to our survey, these sectors hold more than 6 percent and 3 percent, respectively, of the total number of the issued Fl. 1,000 notes, being equivalent to an average of eighty-six and fifty Fl. 1,000 notes per economic unit in these latter sectors, respectively. The latter information was obtained by persons who were all acquainted with the two sectors concerned and had no difficulty in conducting the necessary confidential interviews relating to use of Fl. 1,000 notes.

Not only in absolute terms but also in relation to the estimated amount of cash changing hands, the drug trade and gambling community stand out regarding use of Fl. 1,000 notes. Then, following at some distance, come the motor trade, other services, and agriculture and fisheries. According to the results, there is a clear relationship between the number of Fl. 1,000 notes kept and the degree to which illegal transactions and transactions not declared to the tax authorities are likely to occur. The only clear exception is construction. Although this is traditionally a sector where a high number of illegal transactions and tax evasion take place, our estimates indicate a remarkably low holding of high denomination notes. The average number of notes per economic unit, incidentally, show a picture broadly in line with the frequency of use per sector.

3. A CLOSER LOOK AT THE RESULTS

In order to analyze the results obtained from the survey, we consider three aspects of particular interest to the issuer of bank notes. These concern the holding of notes by sector, the holding and use of notes by households, and the extent to which the Fl. 1,000 note is used for hoarding purposes.

3.1 The Distribution of Holdings

Owing to the qualitative nature of the survey method employed, a fairly large degree of uncertainty is attached to the results. The number of respondents per sector very often is rather small, the subdivision into sectors is not exhaustive, and in a few of sectors there is a certain amount of overlapping. Owing to the latter situation, the estimated proportion of the notes in circulation is perhaps upwards biased.

The picture we were able to construct, however, is in a number of respects remarkably similar to the findings of Cramer and Reekers (1972), which were based on logged counts by financial institutions, major companies, and a large part of the retail trade as well as on a survey conducted among over fifteen hundred small companies and households. The estimated percentages of notes held by the sectors industry, construction, the wholesale and distributive trade, hotel, catering, and licensed trade, other services, and banks are of a comparable order of magnitude despite the intervening years (Table 2).

For the sectors agriculture and fisheries, the motor trade, real estate, and households, however, the estimates produced by the present survey are considerably higher. This is at least partly due to the more indirect qualitative approach. The combined share of the first eleven sectors in Table 2, which are covered by both studies, totals 38 percent in the case of the present survey compared with 19 percent in the case of the Cramer and Reekers survey. On top of that, according to our survey, 20 percent of the Fl. 1,000 notes are held by foreigners working in the Netherlands, caravan dwellers, the drug trade, and the gambling community.

Despite the inclusion of these last four sectors, and the use of a survey method which made allowances for the delicate nature of the subject, initially over 40 percent of the holdings of Fl. 1,000 notes could not be accounted for. Some of the untraced notes are bound to be held in sectors not included in the study. According to the estimates of Cramer and Reekers, for instance, a total of over 2.5 percent of Fl. 1,000 notes can be traced to the currency holdings of financial institutions (excluding banks), to the transport sector, and to social institutions, churches, associations, educational establishments, and local authorities. The existence of another 1.0 percent or so of the Fl. 1,000 notes can be explained by the flow of payments abroad using these notes, which amounted to some Fl. 2 billion in 1985. In addition, it is possible that some Fl. 1,000 notes are held abroad for speculative reasons. All told, however, only some 5 percent of the notes in circulation which are still unaccounted for can be explained in this way (Table 2).

Presumably, therefore, the holdings of notes may have been underestimated in a

number of sectors. One possible reason for this is that the possession and use of Fl. 1,000 notes is very unevenly distributed within the sectors, with many holdings of a small number of notes and a relatively small number of holdings of large or very large number of notes. This possibility is confirmed, at least in the case of households, by the results of the supplementary omnibus survey, which we shall discuss later. If there is in fact a skewed distribution of this kind, then the respondents will have underestimated the true average to the extent that their answers reflect the modal value rather than the mean.

Since the respondents were asked to give an average figure for their particular sector as a whole—and not for their own situation—it is not possible to determine what shape the distribution actually has. This means that it is also impossible to determine the relationship between modal and mean values. A rough sensitivity analysis, however, indicates that between a quarter and a third of the nonidentified holdings of notes could be explained by a distortion of this kind. If we assume, for the sake of simplicity, that the holdings of Fl. 1,000 notes follow a (negative) exponential distribution, which is in defiance of the discrete character of the distribution, but not of the data (generally the mean equals the standard deviation), the actual mean amounts to 1.44 (= 1/ln 2) times the median. By correcting the estimates in this way the unexplained proportion of the circulation of Fl. 1,000 notes diminishes with some twelve percentage points, or one-third. If it is assumed that not the median but the modus is reported, when holdings are estimated at zero, the correction would be even considerably larger. Moreover, if the skewness of the distribution curve for the holdings of Fl. 1,000 notes differs from one sector to another, this could also distort the figures for the percentage of notes held by the various sectors.

A second important reason for the high proportion of unexplained holdings is presumably the tendency of respondents to understate the numbers and amounts involved as far as possession and use of Fl. 1,000 notes is concerned. The results of our telephone survey confirm this conjecture. For instance, a number of respondents mentioned the existence of hoarding of Fl. 1,000 notes, but denied their use in transactions, which appears rather inconsistent. Contrary to the above-mentioned understatement arising from the skewness of the distribution, this source of understatement cannot be tackled by enlarging the sample, but requires additional qualitative research. For a number of sectors, including agriculture and fisheries, construction, and the hotel, catering and licensed trade, additional information obtained from insiders would possibly lead to an upward revision of the figures, as has already been the case with the motor trade, for example. The other sectors, however, are too large and too heterogeneous for this approach.

3.2 Households' Holdings of Fl. 1,000 Notes

In the same way as for most of the other sectors, an attempt was made in the second phase of the survey to improve the initial estimates of the numbers of Fl. 1,000 notes held by households. Since the questions asked necessarily related fairly directly to hoards of notes or, in some sense, inefficient cash management, the nonresponse rate was very high by usual standards and the reliability of the answers

was too low for the results to be considered as providing any significant improvement. Finally, a random survey technique was resorted to in the case of households. To this end, a number of questions relating to familiarity with and possession and use of Fl. 1,000 notes were included at our request in the omnibus survey conducted by the Centre of Marketing Analyses and Social Scientific Research in May 1986.

Almost 95 percent of the two thousand respondents aged fifteen and over had seen a Fl. 1,000 note at some time. Despite this high level of familiarity, however, use of these notes is not very widespread according to the survey results. A quarter of the population never uses them and a quarter uses a Fl. 1,000 note only once a year. On the other hand, there are also people who spend and receive these notes very frequently. The results show that the possession and use of Fl. 1,000 notes exhibits a highly skewed distribution.

On average, the respondent in the random sample came into the possession of one or more Fl. 1,000 notes, either withdrawn from an account or received in some other way, 2.0 times a year and spent one or more of these notes 1.4 times a year. The fact that Fl. 1,000 notes are received more often than they are spent cannot be solely explained by hoarding.[3] Presumably, people spend more notes at once than they receive or withdraw. Assuming that two notes are withdrawn or received on average on each occasion and that they are held for an average of five days, the transaction requirement for Fl. 1,000 notes can be estimated at 0.6 million notes, or 5 percent of the notes in circulation at year-end 1985.[4]

In addition, it was found that, according to the survey, 1.8 percent of the respondents held Fl. 1,000 notes as a means of saving. People aged fifty and older tend to do this more than the younger generation. On average they have savings of three notes. This information applied to the Dutch population as a whole also gives a figure of around 0.6 million Fl. 1,000 notes held by way of savings. The total number of Fl. 1,000 notes held by households for transaction and hoarding purposes combined, therefore, works out on the basis of the omnibus survey results at 9.3 percent of the notes in circulation in 1985. This figure is not significantly different from the 9.2 percent arrived at in the initial phase of the survey.

The present estimate of holdings for transaction purposes also agrees closely with the findings of other surveys on the use of Fl. 1,000 notes. For instance, on the basis of results of a survey on behalf of the Nederlandsche Bank in 1983, the turnover of Fl. 1,000 notes for that year is estimated at Fl. 10 billion. The necessary holdings of notes for this volume of transactions was estimated at around Fl. 400 million or 5 percent of the notes then in circulation.

A comparable figure can be arrived at from the information concerning cash pay-

[3]If the difference between issues and withdrawals and receipts of Fl. 1,000 notes is attributed exclusively to hoarding, this gives an estimate of at least seven million notes for the number of Fl. 1,000 notes held in hoards in 1985, while the actual number of notes in circulation increases by only one million.

[4]According to the results of a survey conducted on behalf of the Nederlandsche Bank in 1983, an average of around eleven days elapses between two consecutive cash withdrawals. Partly on the basis of this figure, the average retention time of a Fl. 1,000 note has been taken as five days for the present purpose.

ments by households derived from a survey of spending behavior in which the Nederlandsche Bank participated in the years 1984–1986 (Boeschoten and Fase 1989). According to this study, in value terms, households make almost 40 percent of their payments in cash. In 1986, this represented a sum of around Fl. 80 billion. Over 15 percent of this sum is made up of payments of Fl. 1,000 or more. In paying these amounts, it is estimated that twelve million Fl. 1,000 notes were used. Even assuming a rather low turnover rate of twenty-five times per year for cash transactions balances (Cramer and Reekers 1976; Avery et al. 1986), a circulation of Fl. 1,000 notes of just over Fl. 500 million should have been enough to meet the transactions requirements of households.

According to all three studies referred to, the holdings of households for transactions purposes therefore amount to around 5 percent of the total number of Fl. 1,000 notes in circulation. The closeness of agreement is remarkable. It is even more remarkable when one considers that the three random surveys were quite different in design and approach. Moreover, in two of the three surveys, respondents were not asked direct questions about their own particular use of Fl. 1,000 notes, so the amount of distortion in the estimates is therefore presumably small.

As far as the use of Fl. 1,000 notes by households for hoarding purposes is concerned, we have only the results of the omnibus survey to go on. A considerably greater degree of uncertainty is therefore attached to this estimate, particularly since it is based on direct questions relating to a rather tricky subject. Suspicion of financial institutions and the desire for secrecy are important reasons for holding financial assets in this non-interest-bearing form. Thus there are plenty of reasons for assuming that people will tend to quote figures which are on the low side rather than on the high side and that therefore the share of Fl. 1,000 notes in circulation held in hoards by households is in fact higher than the estimated 5 percent.

3.3 The Fl. 1,000 Note as a Means of Hoarding

According to the survey, 60 to 70 percent of the Fl. 1,000 notes are used as a means of hoarding. This estimate is in fact based solely on the findings for just some of the sectors covered by the study and is therefore no more than an indication. Other estimates, however, give comparable or higher percentages. An earlier tentative estimate on the basis of information from a continuous budget survey among one thousand households on spending patterns arrived at a figure of 90 percent (Boeschoten and Fase 1989). This percentage, which was derived from the difference between the estimated requirement of households for Fl. 1,000 notes for transaction purposes and the actual number of notes in circulation, presumably results in an overestimate of the numbers of these notes in hoards.[5]

Even estimates arrived at by more direct methods, however, point to very sub-

[5]This analysis was necessarily restricted to households. Business transactions, in which relatively more Fl. 1,000 notes are presumably involved, are therefore not included. In addition, the fact that the cash withdrawals are generally made in notes of larger denominations, and that these notes are therefore represented more frequently in cash holdings for transactions purposes than one would assume on the basis of the amounts paid, also leads to an overestimate of the number of Fl. 1,000 notes held in hoards.

stantial hoards of notes. As we have seen, a holding of Fl. 1,000 notes for transaction purposes of around 0.6 million should presumably be enough to fund the Fl. 12 billion in transactions which households pay in Fl. 1,000 notes out of their total cash payments of Fl. 80 billion each year. No estimates are available concerning the volume of business transactions paid for in cash. Using the results of the survey, however, a figure of Fl. 60 billion[6] can be put on these transactions for 1985 as a very rough estimate, of which Fl. 20 million is paid for with Fl. 1,000 notes. For a turnover rate of twenty-five, around 0.9 million Fl. 1,000 notes would therefore be needed for these transactions. This means that a total of 1.5 million Fl. 1,000 notes, or less than 15 percent of the notes in circulation, would suffice for the payments made by households and the business community together. On this basis, therefore, the remaining 85 percent of notes must fulfil a hoarding function.

A more general method of estimating the volume of notes held in hoards is based on the development in the return rate of bank notes. This is the number of times that a note of a certain denomination returns on average to the Nederlandsche Bank each year.[7] The underlying thinking is that the return rate of a note of a particular denomination reflects the intensity of its use as a means of payment. If the actual numbers of notes of a particular denomination received turn out lower than the return rate that might be expected on the basis of use for payment transactions alone, this can be attributed to hoarding.

In Table 3, the proportion of hoarded Fl. 1,000 notes in circulation has been estimated for the period 1965–1987 using this method. If we take the lowest value for the return rate of Fl. 1,000 notes over the observation period as the normal return rate in the absence of hoarding, then we get an estimate of 77 percent for 1987. Even if we take the return rate for Fl. 25 notes, which are preeminently used as a means of payment, as the norm in view of the possible variations of the return rate over time, we arrive at a comparable figure of 76 percent. However, this method gives implausible negative percentages for the years up to 1970 since the return rate of Fl. 25 notes was greater than that of Fl. 1,000 notes in those years. It is therefore not always possible to take the return rate as a measure of intensity of use. Notes that are being intensively used in a particular payment system may continue circulating in this system without regularly returning to the Bank. Even so, the sharp increase in the number of Fl. 1,000 notes in circulation in response to the announcement in 1987 of the automatic reporting by the banks to the tax authorities of interest payments, which came into operation on 1 January 1988, is not reflected in the estimates given in Table 3. This is because this increase was coupled with a very substantial additional flight of capital abroad in the form of bank notes. The consequent increase in the return rate is wrongly interpreted by the estimating method used in Table 4 as an increase in the intensity of use. After correction for this

[6]This is roughly a third of the total volume of cash payments. This result is based on the fact that cash withdrawals from business accounts are estimated to represent a third of all cash payments.

[7]This figure is calculated as the quotient of the number of notes received by the Bank each year and the average number of notes in circulation for the denomination concerned. The relevant key figure can be found in the Annual Report of the Nederlandsche Bank.

TABLE 3

ESTIMATE OF THE NUMBER OF FL. 1,000 NOTES IN HOARDS

Year	Circulation (Yearly Average Number in Millions)	Percentage of Notes in Boards			
		On the Basis of Return Rate		On the Basis of Life of Notes	
		Highest Rate for Fl. 1,000 Note[a]	Rate for Fl. 25 Note	Shortest Life of Fl. 1,000 Note[a]	Life of Fl. 25 Note
1965	1.2	18	−63	37	25
1970	1.8	48	−7	38	46
1975	3.5	52	35	64	73
1980	6.0	60	54	75	85
1985	11.4	77	74	68	81
1986	12.1	78	76	71	86
1987	13.1	77	76	72	85

[a]On the basis of three-yearly averages 1958–1960.

distortion, more than 80 percent of the Fl. 1,000 notes in circulation in 1987, according to the estimates, serve as a means of hoarding.

The above problems are partly overcome by taking, like Anderson (1977), the average life of a particular denomination of bank note as a measure of intensity of use instead of the return rate. If the actual number of rejects turns out lower than one would expect on the basis of the average life of the notes if used exclusively as a means of payment, this can be attributed to the fact that some of the notes in circulation are held in hoards and are therefore not subject to the usual wear and tear. Although the estimates arrived at in this way differ slightly from those based on return rates, as far as change with time is concerned, amongst other things, they all indicate that a very substantial proportion of the Fl. 1,000 notes in circulation, maybe as high as 85 percent, is used as a means of hoarding.

The outcomes on the hoarding of the Fl. 1,000 note are in fair agreement with the estimates of Anderson (1977) and Whitehead (1982) for the United States. According to the estimates of Whitehead, which hardly differ from the results found earlier by Anderson, in 1980 more than 80 percent of the $50 bills and 90 percent of the $100 bills was hoarded. For total currency the estimated share of currency in hoards

TABLE 4

CIRCULATION IN ELEVEN INDUSTRIAL COUNTRIES AT END-1987

Country	Circulation per Capita (in U.S. Dollars)		Circulation as Percentage of GNP	
	All Bank Notes	Highest Denomination	All Notes	Highest Denomination
Belgium	1,294	896	8.1	5.6
Canada	583	32	3.6	0.2
France	770	368	4.3	2.1
Germany	1,298	313	6.5	1.6
Italy	811	536	5.6	3.7
Japan	1,936	1,659	8.4	7.2
Netherlands	1,297	573	7.8	3.5
Sweden	1,143	65	5.6	0.3
Switzerland	3,286	1,501	10.3	4.7
United Kingdom	449	60	3.2	0.4
United States	871	411	4.7	2.2

as a percentage of currency outstanding rises from 56 percent in 1960 to nearly 70 percent in 1980. The considerable growth of the use of currency as a means of hoarding is confirmed by the estimates of Kimball (1981) on the basis of the changing composition of currency flows to and from Federal Reserve Banks and by the slowdown of the turnover rate of currency, measured by Laurent (1979). Likewise the survey results of Avery et al. indicate that less than 15 percent of the stock of currency in the United States (adjusted for vault cash and known losses) is held for transaction purposes by the sampled population of individuals. All these outcomes suggest that the hoarding of larger banknotes is not only connected to a high face value in absolute terms but also to their position at the top end of the bank note range. This would imply that the highest bank notes in other countries, as shown in Table B in the Appendix, are probably also hoarded to a considerable extent.

4. THE USE OF CASH REVISITED

The astonishing large per capita demand for currency and especially larger bank notes is a rather general phenomenon (Table 4) that has frequently been discussed in the literature [see, for instance, Cagan (1958); Porter and Bayer (1984)]. An interesting question is whether this phenomenon fits into any theoretical framework.

In the literature the demand for currency is hitherto mostly explained from the transactions motive only, building on the Baumol (1952) and Tobin (1956) inventory transactions approach, extended with a stochastic element by Whalen (1966) and Miller and Orr (1966). The basic assumption for a positive demand for currency is merely that some payments are cheaper when using currency than when using demand deposits. The simple version of the inventory-theoretic approach, based on the minimization of the transaction and opportunity costs of holding cash results in the well-known square root law

$$M = \sqrt{\alpha . Y/2r} \tag{1}$$

with M the average money holding, Y the predetermined value of transactions, r the interest rate, and a constant transaction cost α. This simple version holds only under very strict assumptions with respect to, for instance, the spacing of withdrawals (see Akerlof and Milbourne 1978) and the limitation to one alternative means of exchange, but suffices in this context by way of illustration. The demand for money rises with transactions and diminishes with rising opportunity costs, the elasticities—in this sample case—being 0.5 and -0.5 respectively.

As pointed out by, for example, Sprenkle (1969) and Akerlof and Milbourne (1978) the transactions model appears to underpredict actual cash balances. In explaining the growth of the demand for currency the transactions approach is relatively more successful (see Kimball 1981). This may, however, be the result of a parallel movement of the additional explaining factors with total transactions. The outcomes of this study confirm, at least for the Netherlands, the inadequacy of the

transactions motive as the sole explaining factor of the amount of cash holdings. The finding that only about 15 percent of the actual circulation of the largest Dutch bank note would suffice for transactions purposes, implies that at least 35 percent of the total bank note circulation is used for other purposes. As there are strong indications that the same phenomenon, be it to a lesser extent, also holds for the next lower denominations (see Boeschoten and Fase 1989), this percentage can be even 50 percent or more.

Many authors consider the large currency circulation and especially its growth relative to the outstanding demand deposits, despite the widespread use of currency substitutes like credit cards and checks, as an indication of a growing underground economy (Cagan 1958; Gutmann 1977; Feige 1979; and Tanzi 1982). Because currency transactions are less easily traced than transactions carried out by check, currency has a decided advantage over checks for those who wish to avoid taxes. The higher probability of detection lowers the expected yields of alternative means of payment, thus causing, according to the square root formula, a higher demand for currency. The results shown in Table 3 indeed indicate that a considerable share of the holdings of the highest denomination in the Netherlands is located in illegal sectors like the drug trade and in sectors where tax evasion is the most likely to occur. The cash transactions in the underground economy alone can, however, not explain the high currency figure. Even if the underground economy would amount to 10 percent of GNP, and all relevant transactions totalling about Fl. 150 billion (Boeschoten and Fase 1984) were paid in cash, at a turnover rate of cash of twenty-five, a currency circulation of less than Fl. 6 billion would suffice. If all underground transactions were paid with Fl. 1,000 bills—which is not the case—they would require at most 50 percent of the Fl. 1,000 notes outstanding, while according to the findings in section 3 there is an excess of about 85 percent. As the turnover rate of transactions cash balances is probably higher than twenty-five (see Avery et al. 1986) and black market transactions are paid partly by check (Feige 1979), the need for cash for the underground economy is, however, much lower. Therefore, as has also been concluded by Kimball (1981) and Porter and Bayer (1984) for the United States, the use of cash for transactions in the underground economy can at most explain part of the high per capita currency circulation in the Netherlands.

A second, and perhaps more important, explanation for the high currency figures is hoarding. Akerlof and Milbourne (1978) point to the hoarding of currency as a major complication in explaining the size of cash holdings. Moreover, several studies mentioned earlier give, mainly on the basis of currency figures, indirect evidence for a considerable amount of currency hoarding. The present study affirms, at least for the Netherlands, this hypothesis.

The question arises why households would hoard such large amounts in the form of bank notes with the nominal interest as opportunity costs and with the risk of loss, theft, or destruction. The answer seems to be the unique combination of liquidity, security, and privacy of this financial asset (Kimball 1981). The lack of one or more of these qualities may cause lower yields of alternative assets and, according to the inventory model, result in higher currency holdings. Bank notes are

extremely liquid in the sense that they can be used and changed directly and in any amount without loss of value. Thus, besides an outstanding means of payment for transactions, they can also be an attractive means for precautionary balances. By this we mean the need for liquid resources to deal with unforeseen contingencies as well as with large disbursements that are known in advance. As far as the gains in transfer costs, that is, the costs of transferring alternative assets in means of exchange, exceed the opportunity costs with respect to foregone interest or other yields, it can be economically preferable to hold precautionary balances in cash.

The liquidity of bank notes and of currency in general is connected with its security. In so far as the risk perception regarding the loss of value of other assets, be it financial or real, exceeds their yields, individuals can prefer to hold wealth in the form of currency. The well-known rise of currency holdings in wartime illustrates this security aspect.

The third, and in combination with the two other features probably most important, quality of currency as a means of hoarding is the privacy it provides. The lack of bank statements and records allows holders of currency to conceal the existence of such hoards. As pointed out by Anderson (1977), the desire for privacy can be based on solely legitimate motives. Some may simply not want anyone to know how much they have in savings. Others may be shy and feel uncomfortable in the white-collar atmosphere of banks or they may dislike the prying that is involved in opening a deposit account. Still others may be classical misers.

Holding wealth in the form of currency in order to conceal accumulated earnings or wealth from tax authorities can, however, have purely economic reasons. Reportedly, the large tax evader or drug dealer frequently accumulates sizable amounts of currency in the larger denominations. These cash balances may be maintained, despite high interest rates, to avoid arousing suspicion in converting this currency into other assets. When it becomes profitable to do so, the holder may purchase a legitimate business or launder the illegal gains.

Assuming a constant expected before tax interest rate r_i on asset i, the expected value of unreported earnings W_o^u after t years in case of tax evasion follows from

$$W_t^u = (1 + r_i - p_i \cdot \beta)^t \cdot W_o^u \tag{2}$$

where p_i is the probability of detection in the case of holding W_o^u in the form of asset i, and β is the fraction of the amount outstanding that has to be paid to the tax authorities in case of detection. From (2) it appears that keeping unreported or illegal income in the form of an interest-bearing asset i instead of in a cash hoard is worthwhile only if

$$(r_i - p_i \cdot \beta) + p_c \cdot \beta = r_i - (p_i - p_c) \cdot \beta > 0 \tag{3}$$

with subscript c indicating currency. Generally speaking the probability of detection for interest-bearing financial assets is considerably higher than for currency. Thus especially for illegally acquired income, where β may be even higher than 1, the

interest earnings do not outweigh the losses expected due to the higher probability of detection.

But also in the case of legally acquired but unreported earnings, the high value of p_i—especially since the introduction of automatic reporting by the banks to the Dutch tax authorities of interest payments for several financial assets—keeping unreported earnings in the form of interest-bearing assets does not make sense. Thus, leaving apart moral feelings, for holding unreported earnings, especially if they have been illegally acquired, currency has to be preferred as a store of value to interest-bearing assets.

Illegally acquired or black income, as described before, must by definition stay unreported. With regard to legally acquired income individuals can, however, outweigh tax evasion in combination with keeping earnings in a cash hoard against reporting the income and holding it in the form of interest-bearing assets. In the case of reporting and holding W_o in the form of financial asset i at a constant expected marginal income tax rate τ, the resulting value after t years follows from

$$W_t^r = (1 + (1 - \tau) \cdot r_i)^t \cdot (1 - \tau) \cdot W_o \,. \tag{4}$$

Whenever W_t^u exceeds W_t^r it is preferable to keep W_o unreported. We assume for the sake of simplicity a probability of detection of zero for cash hoards. The break-even time horizon t_o (in years), from when on it is preferable to report income and to hold W_o in the form of an interest-bearing asset i, then follows from

$$t_o = -\ln(1 - \tau)/\ln(1 + (1 - \tau)r_i) \,. \tag{5}$$

The time horizon indicates the attractiveness of keeping earnings concealed and hoarding it in the form of currency. According to (5), tax evasion combined with hoarding is the more attractive, as the tax rate is higher and the interest rate is lower. For instance, at a 6 percent interest rate, an individual in the 40 percent tax bracket would be as well off only after about fifteen years by paying his income tax and earning 5 percent before tax on the remaining income (Table 5). This illustrates that at least in the case of tax evasion there can be strong incentives for hoarding currency, especially for shorter periods. Besides the evasion of income tax there can,

TABLE 5

BREAK-EVEN TIME HORIZONS FOR HOARDING (IN YEARS)

	Interest Rate						
Tax Bracket	2%	4%	6%	8%	10%	12%	14%
20%	14.1	7.1	4.8	3.6	2.9	2.4	2.1
30%	25.7	12.9	8.7	6.5	5.3	4.4	3.8
40%	42.8	21.5	14.4	10.9	8.8	7.3	6.3
50%	69.7	35.0	23.4	17.7	14.2	11.9	10.3
60%	115.0	57.7	38.6	29.1	23.4	19.5	16.8
70%	201.3	100.9	67.5	50.8	40.7	34.0	29.3

Explanatory note: The figures, computed with formula (5) give the time horizons within which it is economically more lucrative to keep earnings concealed in hoards rather than to receive interest payments but pay tax.

however, especially for older people, be other economic motives to hoard currency, such as evading inheritance duties or, at least in the Netherlands, bypassing the regulation that individuals with a wealth of more than Fl. 8,000 have to contribute to their stay in homes for the elderly, while others do not.

Some rather convincing indirect evidence for the importance of these motives is the apparent sensitivity of the bank note circulation to fiscal disturbances. Thus the publicity of a raid by the Dutch fiscal authorities on a major bank in 1983 caused an autonomous and permanent rise of the bank note circulation of about 10 percent, mainly located in Fl. 1,000 notes. The announcement of the introduction of the automatic reporting on interest payments by banks to the tax authorities in 1987 had a similar effect. Likewise the German announcement of a 10 percent withholding tax on interest payments at the end of 1987 resulted in an autonomous rise of the German bank note circulation of between 5 and 10 percent. Such shifts from saving deposits into currency are economically meaningful only as far as tax evasion is at issue. Otherwise neither automatic reporting nor withholding tax has any influence on the yields from financial assets.

5. SUMMARY AND CONCLUSIONS

Using a qualitative sample design this article shows that it is possible to account for 60 percent of the Fl. 1,000 notes in circulation in the Netherlands. More than a third of the notes traced in this way are held by the drug trade, gambling community, and motor trade sectors. A large proportion of these notes presumably represents money that people want to keep hidden from the authorities because of the way in which it was acquired. Of the other sectors, households and the currency holdings of banks account for the largest share. The nearly 40 percent of notes unaccounted for can presumably be put down to underestimating of the holdings in the various sectors. As far as they go, however, the results of the study indicate that around 10 percent of the Fl. 1,000 notes are held by households, half for the purpose of transactions and half for the purpose of hoarding. The markedly similar results of the qualitative approach and the additionally applied conventional survey indicate that conventional survey methods may be equivalent or even more appropriate in sectors such as households and certain industries. In sectors such as caravan dwellers and drug trade, however, the applied qualitative approach contributed significantly to the estimates, where the more conventional survey methods appeared inappropriate.

The results of the study also suggest that 60 to 70 percent of the Fl. 1,000 notes in circulation are used as a means of hoarding. The findings of studies based on information relating to payments and the payment system and on circulation figures even indicate that around 80 percent of the Fl. 1,000 notes in circulation are used as a means of hoarding. At year-end 1987, this would represent Fl. 12 billion or almost 35 percent of the total currency circulation. The estimated degree of hoarding of Fl. 1,000 notes, as well as its considerable growth, show a remarkable similarity with the figures estimated for the $50 and $100 bills in the United States. Hoarding in the

form of currency can be meaningful from an economic point of view, especially where illegal or unreported income and wealth are concerned. This phenomenon probably explains to a considerable extent the high demand for large bank notes in particular.

The findings imply that even in the case of a strongly diminishing transaction demand for cash as a consequence of financial innovations and electronic payment systems, there still remains, at least in terms of value, a considerable demand for cash as a means of hoarding. Moreover, the findings have consequences for the interpretation of M1: as the narrow money aggregate appears to contain a sizable component that is not used for transactions but is held for some other purpose, the concept of M1 as used principally for transactions is distorted.

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APPENDIX: TABLE A

KEY DATA ON SURVEY ESTIMATION OF HOLDINGS OF FL. 1,000 NOTES

Sector / Phase:	Number of Units (Thousands)	Turnover (Billion Guilders per Year)	Survey Results: Number of Respondents 1	2	3	Share of Cash in Turnover (%) 1	2	(S)	Share FL. 1,000 in Cash Turnover (%) 1	2	(S)
Agriculture/fisheries	136.6	42.4	16			40.2			77.6		
farmers				19			16.7	(20.9)		24.1	(17.4)
casual work				12			2.6	(6.2)		5.0	(5.4)
cattle-breeding				12			31.7	(27.1)		32.6	(16.9)
nursery-gardens				11			15.6	(19.7)		10.0	(10.0)
Industry	46.5	551.0	16	15		0.8			37.7		
Construction	41.8	48.2	15	18		11.8	11.4	(17.6)	58.4	27.7	(21.1)
Motor trade	9.4	22.0	11	19	2	48.5	48.0	(34.8)	30.0	37.1	(20.2)
Retail trade	131.4	103.0	15		1	32.4			1.9		
butchers' shops				7			37.1	(21.1)		13.0	(6.2)
super markets				5			22.3	(3.8)		4.2	(3.7)
clothes shops				6			22.0	(19.7)		4.8	(2.8)
furniture shops				11			19.1	(13.5)		14.6	(14.2)
radio, tv and hifi				7			19.1	(19.3)		2.4	(0.9)
antique trade				11			41.5	(25.2)		16.1	(11.0)
Wholesale/distr. trade	62.3	246.0	10	13		2.7	3.3	(9.4)	70.6	17.7	(20.2)
Licensed trade	43.0	13.6	10	18		14.4	23.9	(21.2)	4.7	11.8	(3.8)
Real estate	29.0	36.5	10	15		5.4	5.5	(5.3)	77.3	46.9	(10.3)
Other services	29.1	6.8	10								
Households	5558.0	283.0	20	2000							
Cash banks	8.3		2								
Foreigners	140.0				2						
Caravan dwellers	7.1				2						
Drug trade	—	4.5	1								
Gambling community	—	1.5	1								
Unknown holdings											
Total		1373.6	138	190	7						

Explanatory notes:
The symbol S denotes standard deviation.
In phase 2 a number of turnover figures were slightly adapted; moreover the trade in new and second-hand cars was combined.
Changes in phase 3 are based on seven expert interviews, apart from the omnibus survey for the households sector. The figures on the motor trade include in phase 3 also approximately one thousand car-breaking yards.

APPENDIX: TABLE A (*Continued*)

Sector	Survey Results											
	Number of Days Notes are Kept			Notes Stored per Unit			Number of Fl. 1,000 Notes per Unit			Composition of Circulation Fl. 1,000		
Phase:	1	2	(S)	1	2	(S)	1	2	3	1	2	3
Agriculture/fisheries	12.5			8.5			14.3	14.3	4	16.2	4.6	4.6
farmers		14.9	(10.1)		2.1	(2.7)						
casual work		1.2	(1.3)		0.3	(0.6)						
cattle-breeding		5.4	(8.1)		1.4	(1.8)						
nursery-gardens		1.4	(3.5)		0.3	(0.7)						
Industry	4			3			3.7	3.7	3.7	1.7	1.7	1.7
Construction	5.5	4.8	(3.8)	14	3.8	(4.3)	16.8	5.7	5.7	5.8	2.0	2.0
Motor trade	7.5	5.9	(15.3)	14	2.1	(2.1)	38.1	10.0	88	4.9	0.7	6.7
Retail trade	5			5			5.1	2.6	2.6	5.6	2.8	2.8
butchers' shops		4.8	(2.1)		1.6	(1.8)						
super markets		1.9	(0.7)		—	(0.0)						
clothes shops		3.4	(3.4)		2.3	(2.3)						
furniture shops		1.8	(1.4)		4.5	(10.3)						
radio, tv and hifi		3.5	(3.6)		0.4	(0.9)						
antique trade		6.3	(3.0)		1.9	(2.4)						
Wholesale/distr. trade	5	2.3	(2.2)	10	2.1	(1.6)	10.8	2.3	2.3	5.6	1.2	1.2
Licensed trade	10	4.1	(4.4)	4.7	0.5	(1.3)	5.9	0.6	0.6	2.2	0.2	0.2
Real estate	9			15	4.4	(5.9)	18.4	7.4	7.4	4.5	1.8	1.8
Other services	5			5			5.8	5.8	5.8	1.4	1.4	1.4
Households				0.1			0.2	0.2	0.2	9.2	9.2	9.3
Cash banks										6.4	6.4	6.4
Foreigners									2.4			2.7
Caravan dwellers									50			2.9
Drug trade										10.1	10.1	10.1
Gambling community										3.7	3.7	3.7
Unknown holdings										29.1	54.2	42.5
Total										100	100	100

APPENDIX: TABLE B

THE HIGHEST DENOMINATION IN EACH OF A NUMBER OF *OECD* COUNTRIES IN 1987
(END-OF-YEAR FIGURES)

	Highest Denomination		Value in Dollars	Share in Value of Total Bank Note Circulation Percentage
Australia	$	100	72	30.6
Austria	Sch	1,000	89	77.1
Belgium	Fr	5,000	151	69.3
Canada	$	1,000	769	5.5
Denmark	Kr	1,000	164	50.6
Federal Republic of Germany	DM	1,000	632	24.1
Finland	Mk	1,000	253	18.9
France	Fr	500	94	47.8
Greece	Dr	5,000	40	61.8
Iceland	Kr	5,000	140	43.5
Ireland	£	100	168	0.8
Italy	Li	100,000	86	66.2
Netherlands	Fl	1,000	563	44.2
Norway	Kr	1,000	160	64.8
Portugal	Esc	5,000	39	70.5
Spain	Pes	10,000	92	10.7
Sweden	Kr	10,000	1,710	5.6
Switzerland	Fr	1,000	782	45.7
Turkey	TL	10,000	10	84.9
United Kingdom	£	50	94	13.3
United States	$	100	100	47.2

Explanatory note: In the United States denominations higher than $100, that is, $500, $1,000, $5,000 and $10,000 denominations, have not been printed since 1946. They have not been issued since 1969. Cf. R. D. Porter and A. S. Bayer (1984).