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Estimating cash usage in the euro area

Abstract

The overall use of cash is difficult to measure. Basically, this problem arises partly from the unique property of cash being an anonymous means of payment. Cash can be used for instance in personal payment transactions without any official record. Cash transactions are not always even registered by electronic account point-of-sale systems like retailers' cashier desks.

This paper offers a calculation scheme to estimate the use of cash based on the distribution of banknotes from ATMs and bank branches (OTC withdrawals) and a few additional assumptions based on stylized facts about the cash cycle. So essentially this procedure follows the channels through which the public gets the cash in their possession. The advantage of the procedure is that most of the data are available from public statistical sources and so the estimates can be updated easily each year. Cash usage estimates are also calculated by euro country, which enables one to compare these estimates with other estimates of cash usage, e.g. from questionnaires, and then calibrate the parameter estimates used in these models. For instance, in 2009 cash usage for EU12 countries was estimated at around 2400 billion euro, and it has remained relatively stable during last few years. To ensure the reliability of these estimates, some Finnish data sets were used to assess the nature of the cash holdings of households and firms. Special emphasis is paid to the distribution of cash holdings.

Keywords: usage of cash, cash transactions, ATM withdrawals
JEL Codes: E42, E41

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1. Introduction

It is widely known that overall use of cash and banknotes in particular is difficult to measure precisely (cf. e.g . Boeschoten, 1992). Basically, this arises from the unique property of cash being an anonymous means of payment. Cash payments do not require cash registers and are not always registered by electronic point-of-sale account systems like retailers' cashier desks. Another key problem is related to the dual role of cash as both a payment means and a store-of-value means, the latter relating especially to the high denomination banknotes. The latter type of cash holding makes it difficult to measure the active use of cash accurately. High denomination banknotes can be held for very long periods and are not necessarily used in cash transactions. To make the measurement problem even more complicated, different banknote denominations are typically used for different purposes. Nowadays a major part of the cash in euro countries is withdrawn from Automatic Teller Machines (ATMs). Over-the-counter (OTC) withdrawals in bank branches occur mainly where larger amounts of cash or high denominations are needed.[1] The smallest banknote denominations and coins are usually used only as change and end users of cash get them from retailers, which cannot always be regarded as the primary use of cash.

These measurement problems further complicate the modelling of cash usage because euro currency migration across the euro area has greatly affected the circulation and return frequencies of euro banknotes.[2] In many euro countries, the cumulative net issuance of certain banknote denominations is negative, which means that these banknotes are imported in greater amount to the issuing country than are issued by its domestic national central bank (NCB). Therefore the use of common euro banknotes is more difficult to measure as accurately than the previous national legacy currencies of euro countries. It has been estimated, based on bank bulk transports outside the euro area that at least 20 - 25 percent of euro banknotes have migrated outside the euro area. Euro banknotes have been heavily exported to Eastern-Europe and Russia, in particular from Germany and Austria, which may further distort the measurement of active use of banknotes within the euro area. It is also very likely that large amounts of high denomination euro banknotes have been stored in these non-euro countries. The reason for this seems obvious, since euro currency is regarded as better secured against inflation (ECB's inflation target), especially in the light the depreciation of their national currencies.

However, it is in many respects important to evaluate the total amount of cash transactions. One reason is to compare the development of different means of payment. We may also want to estimate the unit costs of payments, to obtain information on cost efficiency in retail payments. The total volume of cash payments is also significant for evaluating the overall societal costs of cash and for planning optimal cash services for the economy. The organisation of cash services also feeds back to the demand for cash services of the public. In principle, national central banks are planning the extent to which cash services should be provided for the economy or at least these plans are closely related to the division of tasks in cash services between NCBs and private professional cash handlers. Central banks have the obligation to analyse, innovate, guide and suggest improvements to the cash cycle operations of the national economy and in the euro area. Central banks can also affect the popularity of cash as a means of payment by setting various restrictions on the handling of

[1] Of course in this respect there are quite large differences across euro countries. It should be also remembered that the typical ATM denominations of banknotes are usually the middle-value denominations 50€ and 20€ banknotes. In few euro countries (DE, LU and AT) also 100€ banknotes are frequently available in ATMs. Quite a many euro countries offer also smallest banknotes denominations (10€ and 5€) in the ATMs, which helps NCBs to maintain the quality of the banknotes in circulation.

[2] Return frequency here is the number of times banknotes return to the national central bank within a year. The distribution of ATM banknotes is not usually greatly disturbed by migration, since they are mainly used in domestic cash consumption spending.

cash or providing different mixtures of free-of-charge and chargeable services regarding cash etc.[3] It should be remembered however that the eurosystem position is neutral towards the different means of retail payments (cash, cards or other electronic forms of payment).

This study investigates the estimation of cash usage in the euro area. In Section 2, we briefly compare the different ways available for estimating and evaluating cash usage. In section 3, we investigate the possibility to estimate the value of cash payments in the euro area based on ATM and OTC distributions of cash.[4] Since we want to estimate cash usage, we have to track the cash distribution from the different sources to the end use of cash at the points-of-sale. For our calculations we try to obtain for each euro country the best available information for estimating cash usage in that country. The use of cash in this cash line can be measured since cash usage is not mixed with electronic payments. Cash is put in wallets as ATM or OTC withdrawals until it runs out and the wallets are filled again, and even if the particular means of payments (banknotes and coins) are changed during this process the original cash value withdrawn from the bank account is not exceeded. Cash can be transferred also to somebody else for use, e.g. to spouses or children, but this does not increase the original amount of cash to be spent. Only cash transactions (cash recycling) between consumers or between companies can increase cash usage.

For all euro countries, the ATM distributions of cash are available, but OTC distributions of cash are available only for some euro countries. The so called cash back - cash advances at POS terminals - are also available only in a few euro countries, but their significance as a primary source of cash is minimal. We present a simple framework for a typical euro area cash cycle, where recycling of cash is also taken into account. In practice however it is hard to assess the recycling parameters of credit institutions (CI), cash-in-transit (CIT) companies and the public. Actual cash payments (not transfers) can take place also between consumers or companies, which are not registered as cash payments in any statistics. These payments will increase the use of cash apart from that registered for ATM or OTC withdrawals.

The calculation scheme based on cash distribution flows tries to incorporate the stylized facts about the cash cycle for estimating the value of cash usage.[5] Even if this cannot be completely exhaustive, we can always fine tune to the system later with recycling parameter adjustments. This investigated in section 4.

In section 5, we compare results from the calculation scheme for questionnaire studies and other studies available on cash usage by euro country. Other rough comparisons of the use of cash can be done also e.g. by applying the return frequency of banknotes to the banknote stock put into circulation. These comparisons for a few countries are presented in section 6. Microeconomic evidence of ATM and OTC distributions are briefly analysed in section 7. There we focus on both size distribution and frequency of withdrawals, which allows us to evaluate the usefulness of our estimates of cash usage.

Finally in section 8 we summarize the findings. To be realistic, we also address the caveats of the procedure to evaluate cash usage. Our intention here is to start an easily available, simple and inexpensive approach to cash usage calculations, an approach that will see further improvements in the future.

[3] Within the euro area NCBs offer as minimum basic services free for professional cash clients for 6 hours a day in at least one location.
[4] These channels of cash distribution are also reviewed in a recent ECB (2011) study.
[5] Even if cash cycles in the euro area differ e.g. in cash distribution shares, CIT companies have an increasing role in cash cycles between NCBs and Credit Institutions in most of the euro countries.

2. Possible ways to measure the use of cash

There are at least four different ways to reveal the total (transaction) use of cash. We compare the following procedures:

1. **Cash register estimates of cash usage.** In principle the use of cash and card payments are registered separately by retailers' cashiers at shop desks that use modern electronic point-of-sale devices. In most cases, retailers acknowledge at least the total amount of sales and, as the card payments are known by retailers of bank accounts, the amount of cash payments can be calculated by subtraction. This information is however rarely separated e.g. by banknote denomination, and so is mostly available only in value terms. Partly this information could be derived also from the CIT company returned cash information. So even though this way of estimating cash usage is the most accurate in single retail shops, it does not necessarily help much in finding out the total aggregate use of banknotes by denomination. In most cases it may be very valuable in assessing the overall use of cash in value terms if a large sample is used.

2. **The income and consumption statistics approach to cash usage**. The national income statistics include estimates of private or household consumption by consumption item on the national level, and by applying cash payment shares for these different items one can calculate the final use of cash. From consumption statistics, we have to follow those household consumption items, which are based on monetary transactions. This means that imputed consumption items (like imputed rents on owner-occupied housing), which are not paid in money terms, are excluded. Currently, consumer statistics may also include an estimate of the monetary consumption, and if the value of card payments is deducted, we get an estimate of cash payments.[6]

For a few euro countries, studies exist that include estimates of cash-purchase shares by consumption item. For example an Austrian study by Mooslechner, Stix and Wagner (2006) provides very detailed information about the different means of payment including cash by institutional sector.[7] Similar type questionnaire information on cash payments used in purchasing different consumption items can be found in the DBB study on retail payments (2009). These approaches can also help in estimating the number of cash transactions if the average size of payment is estimated.

3. **Cash usage estimates based on statistics on the distribution of cash**. In this paper, we study the possibility to calculate the use of cash based on the sources that the public receives the cash. Eurosystem currency in circulation statistics contains the information on NCB issuance of banknotes. Other sources of collected ECB statistics on ATM withdrawals and data on bank branch OTC withdrawals can be used to estimate the use of cash for each euro country.[8] In this methodology, ATM and OTC distribution of banknotes are seen as the primary sources of cash for the public. In most euro countries, ATM distribution of cash is the major source of banknotes, but high denomination banknotes (defined usually as 500€ and 200€) are exclusively distributed from bank branches as OTC withdrawals. Cash advances at POS terminals (cash back at retailers' cashier desks) could be added into the estimates as well, though that channel of withdrawing cash from the bank account is currently insignificant in the euro area.

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[6] Some items in household consumption are not paid for by either cash or cards, but with credit transfers or direct debits. These items could be reduced directly before allocating payments to cash and cards.

[7] In Austria cash payments share in early 2005 was as high as 70 % of total household payments by value, which is among the highest in the euro area.

[8] ATM and OTC withdrawals of cash and cash advances at POS terminals are available from ECB Blue Book publications on ECB's web-page http://sdw.ecb.europa.eu/reports.do?node=1000001964.

4. Cash usage estimates based on cash questionnaires. Questionnaires can also be helpful, especially in assessing the share of cash payments by consumers. Direct questions proposed to the public easily provide information about payment-environment changes that cannot be approached via statistics. The problem is that they have only limited value in assessing aggregate payment variables. The main reason is that the total amount of cash crucially depends on "big cash users", who have both large cash balances and may also use a lot of cash. By contrast, those who withdraw cash very frequently and have very small cash balances are quite irrelevant from the point of view of aggregate cash balances and cash usage. For obvious reasons, the "big cash users" represent only a tiny portion of total population (of households and firms) and at least small survey studies may completely fail to include (correct) responses from these agents. Questionnaires can also be quite expensive and burdensome to arrange.

Table 1. Pros and cons of different ways of measuring cash usage

	cash register method	**consumption statistics**	**distribution of cash statistics**	**questionnaires**
population transaction measures available	no estimate	no estimate	only indirectly available with add. assumptions	only sample based estimates
population spending data available	not possible	best estimate	quite reliably estimated	
reliability at source	best accuracy	very good	good	moderate
accuracy in individual payments	very good	no available	no available	fairly good
accuracy in aggregate payments	no relation	very good	good	no relation
appropriate in studying	retailer payment behaviour	macroeconomic relations	overall trends and development	special topics
misclassification	small probability	very reliable	reliable/based on banks accounts	possible
cost of study	moderate	small	small	large
timeliness: response rate	very high	perfect	very good	very good
sampling error	some	no	no	can be large for small samples
timeliness of statistics	good	good	rather good	good
coverage error	medium	no	small	large
measurement error	small	not much	moderate	moderate

3. The distribution approach to estimating the use of banknotes

For most consumers in the euro area, the primary source of cash and banknotes is ATM withdrawals. Roughly 2/3 of the cash in the euro area is distributed through ATMs to the public. In Finland, around 85 % of cash is delivered to consumers via ATMs. In Southern Europe (IT, GR, PT) banknotes are still more frequently distributed from bank branches. The distribution of cash via ATMs - with domestic cards within the euro country - is also known for all EU countries and published in the ECB's Blue book. The exact distribution of banknotes by denomination is known for only a few countries, but the collection of ATM banknote denominations is known. In most of the euro countries 20€ and 50€ banknotes are available in ATMs, and they usually form the largest share of the banknotes issued from

the NCB.[9] Smaller 5€ and 10€ 'change' denominations are available in ATMs at some range in a few euro countries, and 100€ banknotes are available in ATMs only in Germany, Austria and Luxembourg (see Table 1). It should be emphasized that different banknote denominations are used for different purposes, which should be taken into account in the analysis for the use of banknotes.[10]

High denominations (500€ and 200€) are not available in ATMs, and therefore they must be withdrawn from bank branches as over-the-counter (OTC) withdrawals. Besides being used in payments, these high denomination banknotes (HDBs) are frequently used as a store-of-value (hoarding) means, which complicates the analysis of their usage. The return frequency of HDBs is lower than those used frequently in daily purchases. It is possible that the holding time of HDBs is bimodal or has a very long right hand tail, as these banknotes are used partly for specific purposes quite rapidly, e.g. within a week for a transaction, while some of these banknotes are held for longer time periods as a form of liquid asset. The store-of-value motive for holding HDBs is in principle sensitive to the level of interest rates as a cost of investment. The general public usually holds only very small amounts of banknotes in their possession, which makes the transaction demand for cash inelastic to the interest rate. As HDBs can be taken into and out of these cash stocks, this will also complicate the analysis based on the flows of cash. As mentioned earlier, high denomination euro banknotes are frequently used as a store-of-value also outside the euro area; this part of HDBs is probably even more immobile.

Consumers load their cash holdings into their wallets mostly from ATMs and for larger transactions and more specific purposes they have to go to bank branches for larger amounts of cash or high denominations. The banknotes loaded from ATMs are usually spent during several payment occasions until they run out, after which the wallets are re-loaded. The exact number of transactions made by each banknote is usually unknown, but for most people the amount of cash spent mostly coincides closely with ATM withdrawals. Again most people seldom use high denomination banknotes or withdraw smaller change banknotes from bank branches.[11]

As the euro currency is a very international currency and the euro area is very wide as such, it should be remembered that the largest ATM banknotes are also frequently used in other euro countries. This migration of euro banknotes is significant although the main bulk of the euro banknotes are used in domestic purchases. In many countries the largest ATM denominations were also withdrawn heavily during the financial crisis, probably due to their easy availability, even though the main increase was witnessed in high denominations.

The cash spending trail in retail stores and shops is easy to follow, as for cash payments change is almost always given in smaller banknotes and coins. Card payments are made mostly in exact amounts, and only rarely is cash given as cash back, because the customer needs cash for other payments. Basically, the use of cash can be seen as an alternative to spending purchasing power (resources) from overnight deposit accounts similar to the use of the card payments. If cash and card spending were more mixed in the spending, it would be impossible to follow cash spending from cash distribution.

Like ATM distribution of cash the OTC withdrawals of cash are also spent until cash runs out. In some cases OTC withdrawals of cash are simply for making credit transfers between bank accounts because it is faster and mostly free of charge, but we cannot separate these cash transfers from the statistics.

[9] For instance in 2010, for the 12 original euro countries (EU12), the ATM denominations of banknotes accounted for 83.8 % of the value of banknotes issued by the NCB.
[10] This difference is also emphasized in Fischer, Köhler and Seitz (2004).
[11] In the latest Bank of Finland consumer survey in January 2012 about 75 % of consumers said that they hardly ever withdraw cash from bank branches. In this respect, however, there is some discrepancy between different euro countries.

Therefore simply by summing up the ATM and OTC withdrawals of cash, a minimum amount of cash usage can be estimated. In addition to these professional channels of receiving cash, the public can make cash payments among themselves. If retailers (companies) use cash payments among themselves or individuals pay for transactions between themselves, these uses of cash are not recorded by ATM or OTC distributions of cash. In many euro area countries, these cash payments between companies are important (around 20-25 % of corporate payments), whereas e.g. in Finland these payments are currently very rare.[12] The bulk of cash purchases between retailers and consumers are on the other hand recorded by electronic points-of-sale, but usually these statistics are not collected by National Statistical Offices. Mostly only turnover or sales is available.

Ordinary consumers recycle cash between themselves by paying for person-to-person purchases, small private loans etc. between them. This is actual cash recycling, but if parents give income transfers in the form of cash to under-aged children or to the spouse, this may not be a true recycling of cash, but rather transferred cash spending. In practice we do not have much data on these income transfers, but their share in the total cash spending might be rather limited. A rough guess could be that this public recycling cannot be higher than 15 percent of the total cash distribution.

To summarize there are 3-4 channels by which economic agents can get banknotes in their possession:

1. **ATM distribution:** Usual assumption is that banknotes dispensed through ATMs form more than half of total consumer cash distribution. Recent rough estimates suggest that ATM distribution of cash in the euro area accounts for around two-thirds of banknote distribution. However, the selection of ATM banknotes is often limited to the middle denominations, as ATMs provide banknotes for ordinary daily expenses.
2. **Bank branches (OTC) distribution:** High denomination banknotes and larger single amounts of cash are mostly distributed to the public from bank branches. In some euro countries, a significant part of the smaller banknotes (change banknotes) is also distributed to smaller private companies (retail shops, small entrepreneurs etc.) from bank branches.
3. **Cash back (cash advances at POS terminals):** Distribution of cash directly from retail shop counters is available in some euro countries. The importance of cash back is mostly very limited and it accounts less than 2 percent of the total distribution of cash in the euro area.
4. **Income transfers within the public (between consumers and companies B2B):** Ordinary cash payments between consumers and companies are recorded by the ATM, OTC or as cash back as these transactions are performed across institutional sectors, but recording the final usage of cash is complicated by the recycling of cash within each sector. Cash payments between individuals are often performed e.g. within the family, but these transactions cannot always be regarded as a primary source of cash, rather they are merely secondary spending of the received cash originally from deposit account withdrawals or other sources. These transfers are mostly unregistered. However occasionally cash payments are used between individuals for exchange of goods or services. These payments are not registered by the above mentioned sources of cash, and not necessarily in taxation either. Similarly cash payments between companies are not included in the ATM, OTC or cash back sources of distributing cash for payment use, if the origin of the cash is for instance cash payment made by consumers. The cash payments for other companies for production inputs are mostly tax deductible and no value added is generated at this point for the buying company. In any case, the recycling of cash among the consumers and partly among companies could be included in cash usage. As no official or other statistics are available on this recycling, we may have to assume

[12] See also the ECB (2011). In 8 major euro countries 62 % of companies had cash income and AT, ES and DE companies received more than 50 % of their income as cash.

something about the size of this 'public recycling'. Partial answers could be also obtained from consumer (public) questionnaires. One further complication in the basic cash cycle model is that firms can pay wages partly in cash from the cash flow they receive from their sales. In our stylised model these payments are included into the public recycling.

Table 2a. Banknotes in ATM distribution by euro country (EU12)

	500	200	100	50	20	10	5
Austria			x	X	X	x	
Belgium				X	x		x
Finland				X	x	x	
France				X	x	x	
Germany			x	X	x	x	x
Greece				X	x		
Ireland				X	x	x	
Italy				X	x	x	x
Luxembourg			x	X	x	x	x
Netherlands				X	x	x	x
Portugal				X	x	x	x
Spain				X	x	x	x

In Finland, 10 euro notes have been in limited distribution from Eurocash Finland 27 ATMs while the banks' unified Otto network distributes only 20 and 50 euro notes.

Table 2b. The value of ATM withdrawals of cash (with domestic cards inside the country) in EU12

	BE	DE	GR	ES	FR	IE	IT	LU	NL	AT	PT	FI	EU12
2000	20.95	253.87			66.00	12.00	71.02	.58	40.72	13.50	15.29	16.80	510.73
2001	22.43	260.53	23.58		71.00	16.00	73.25	.63	44.59	14.90	16.80	17.40	537.53
2002	24.87	265.03	28.44	77.19	76.00	15.00	94.29	.69	52.96	14.60	18.80	17.30	656.73
2003	27.13	303.57	32.44	85.82	81.00	22.00	71.69	.66	50.91	14.70	20.22	17.40	727.33
2004	27.51	340.24	35.03	90.46	85.20	22.32	76.97	.67	51.01	15.70	21.95	17.20	784.11
2005	27.58	361.67	37.18	95.87	98.18	21.90	79.07	.70	55.34	15.88	24.28	16.90	855.51
2006	29.57	381.35	41.56	101.81	100.28	24.90	83.33	.72	55.71	16.83	26.29	16.60	787.23
2007	34.05	298.77	44.02	107.40	106.78	28.10	91.08	.74	55.88	17.84	28.10	16.40	829.16
2008	38.79	311.19	46.88	109.94	114.84	28.74	97.91	.75	55.16	16.60	29.17	16.60	866.57
2009	43.45	317.43	47.66	107.17	120.86	24.42	91.87	.76	53.77	17.80	20.57	16.40	872.16
2010	45.32	315.48	47.17	107.98	123.35	22.32	122.9	.77	52.00	17.80	30.33	15.70	901.13

Source: ECB Blue book, Table 13 1a.

4. The effect of recycling on the measurement of cash usage

In order to measure the use of cash, it is useful first to form a description of the cash cycle in the euro area countries. Even if the cash cycles in the euro area are somewhat different, they have many similarities, and we can draw up a stylized version of the cash cycle that can be used in calculating the cash usage. This model is also helpful in understanding the points where cash is recycled by the professional cash handlers (banks or CITs). By knowing the cash flows between professional cash handlers, the cash usage can be evaluated. A description of the German cash cycle is available in the DBB (2011a) Monthly Report for year 2009.

The ATM distribution of banknotes by euro value in the euro area (12 original countries) is presented in the table 2. Here we have not included this in the recycling due to the recently introduced banknote-recycling ATMs (CRMs) since their significance is so far limited in size. We see that ATM distribution of cash already exceeded 900 million euro in 2010 in the EU12.

Even though the described 'cash distribution based' approach may seem clear to follow, the practical problem lies in the fact that not much publicly available official data exist on bank branch withdrawals (OTC distribution) for the euro countries. ECB Blue Book statistics provide data on OTC cash withdrawals (and deposits) for Germany, Spain, Italy, Netherlands, Portugal (up to 2008) and in principle for Greece. Germany, Spain and Italy also were cash-prone countries, while Netherlands and France were classified as cash-averse according to the TNS public survey on the use of high denomination banknotes done in September-October 2008. Finland and other Nordic countries have also been card dominated payment countries since the mid-2000's.[13]

It is also worthwhile to consider the adequacy of the data from OTC withdrawals, as small entrepreneurs and other self-employed persons withdraw change banknotes from bank branches. Cash is partly recycled directly over the bank counter immediately, and bank accounting does not register this fully. For this reason some euro countries do not publish OTC withdrawals. In most euro countries change cash (small denominations and coins) is however provided also by CIT companies directly to retailers. As mentioned previously, very rarely do detailed data exist on the denomination composition of OTC withdrawals. The important aspect in using cash is the value of the payment.

To circumvent these difficulties, i.e. the absence of direct OTC banknote distribution data, one can estimate OTC withdrawals using data either from CIT deliveries of banknotes to bank branches or NCB issuance of high denomination banknotes.

If direct bank branch counter data is unavailable, CIT companies' deliveries could be used with the credit institutions (CI) recycling rate to account for the total OTC distribution of cash. Credit institutions recycle part of the banknotes that they receive from the public as deposits, which must be taken into account in making calculations on the use of banknotes.

1. Proxy for missing data on OTC banknote withdrawals =

CIT deliveries of banknotes to CI * (1 + CI recycling rate of banknotes over the bank counter)

If this substitute for the OTC withdrawals of banknotes does not exist, then we must go one step further back in our calculations and rely on the national central banks' (NCB) deliveries of banknotes to the CIT companies. There most likely is some recycling of banknotes between CIT companies and credit institutions. However, this recycling does not affect ATM distribution of banknotes. In many cases the bulk of ATM

[13] These questionnaires are broadly summarized in the ECB (2011) study.

banknote denominations are supplied only through ATMs, which are usually the middle denominations of banknotes, like 20€ and 50 € banknotes.

The ATM loading of banknotes is normally done by either CIT companies or credit institutions. Quite recently also private ATM companies have started the ATM distribution of banknotes with lighter portable small convenience ATMs, which are usually located in shops and other stores.

2. Proxy for missing data on OTC banknote withdrawals =

NCB deliveries of banknotes to CIT * (1 + CIT recycling rate of banknotes from their customers)* (1 + CI recycling rate of banknotes over the bank counter)

To perform the calculations for the missing OTC withdrawals, we also need estimates of CI and CIT recycling rates. If statistics or expert opinion does not exist, these recycling rates can be calculated for reasonable ranges of recycling rates such as 0 – 0.5. There is no direct statistical basis for these recycling rates, and these rates are by and large the most uncertain aspect of these calculations. In the euro area, the ECB decision on the recycling framework of banknotes was made in 2007, and the collection of biannual data of CIT recycling of banknotes was also initiated.

With these options for calculations, we can obtain estimates of the total usage of cash. These estimates can be compared with cash usage estimates derived e.g. from the retail sector or other statistics received from national statistics. From other studies it has been found e.g. that cash is especially heavily used in the hotel and restaurants business, wholesale and retail trade plus in addition in the trade and repair of motor vehicles.

There are rather wide differences in the organisation of the cash cycles among euro area countries. In a few countries, the NCB performs only wholesale sorting (NL, FI, IE, LU), while other NCBs provide also sorting services for a wide range of clients (BE, DE, FR, GR, ES and IT). In most of the euro countries, CIT companies perform the sorting for retailers and credit institutions' bank branches. The involvement of central banks in the euro area also varies widely e.g. the number of NCB branches varies from 1 (LU, NL and IE) to close to 100.

The calculations based on available cash distribution statistics from ATMs and over-the-counters (OTC) distribution at bank counters plus assumptions of the recycling rates can be found in table 4. For countries like Germany, Spain, Italy and Portugal the estimates of banknotes usage must be quite reliable, as they depend only on the assumption of the public recycling rate. Given that the statistics on ATM and OTC distribution of cash is accurate. In the case of Finland, the CIT company deliveries to banks are known precisely, but CI recycling rate, i.e. the recycling that banks apply to banknotes returning from the public, is close to the actual magnitude.

Figure 1. Stylized cash cycle with ATM and OTC withdrawals and recycling

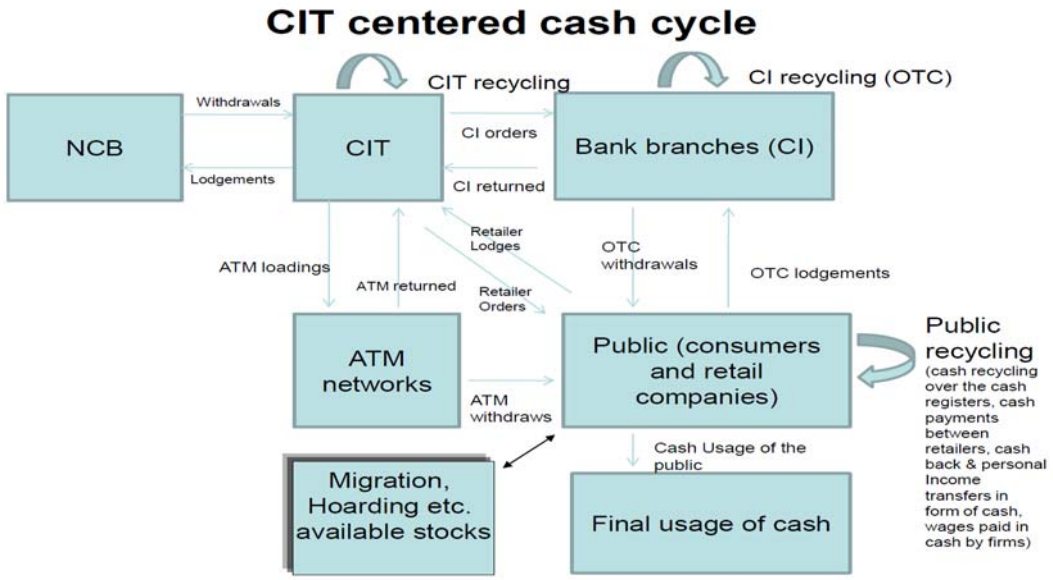


Table 3. OTC distribution of cash from bank branches in the EU12, 2002 – 2010

	BE	DE	GR	ES	FR	IE	IT	LU	NL	AT	PT	FI	EU12
							OTC withdrawals						
2002							365.32				21.94		387-3
2003							328.43				24.55		353.0
2004			1050.70	254.19			339.10				19.69		1663.7
2005			1051.16	208.47			205.08		15.74		133.37		1613.8
2006			1245.35	249.96			210.66		15.11		138.07		1859.2
2007		394.48	1548.95	236.81			213.23		16.04		122.62		2352.1
2008		379.47	614.55	252.35			206.08		15.94		65.21		1533.6
2009		369.43	574.00	249.19			270.17		11.24				1474.0
2010		336.39	582.88	248.94			149.07		6.26				1323.5
							OTC deposits						
2002							324.84						324.8
2003							326.51						326.5
2004			1088.27	544.58			325.94						1938.8
2005			1161.67	251.95			330.46						1962.5
2006			1422.14	315.17			350.36		68.35		150.1		2318.9
2007		677.45	1934.74	428.35			381.72		65.11		166.14		3632.0
2008		653.13	1066.49	417.70			399.95		68.48		141.24		2701.6
2009		606.62	1327.51	385.54			521.39		68.15		96.16		2905.8
2010		580.69	848.15	386.75			499.18		64.78				2370.2
							OTC advances at POS terminals						
2002													
2003			.01									.11	
2004			.01									.13	
2005			.01									.16	
2006			.03								.01	.18	
2007			.03			.49					.01	.15	
2008			.05			.60					.01	.13	
2009			.05			.61					.01	.08	
2010			.03			.55					.01	.32	

Source: ECB Bluebook Table 8.

Table 4. Summary of the assumptions related to the distribution model approach

	Assumption	Relevance of assumption
1	ATM withdrawals of cash are mainly used for domestic purposes	Almost 98 % of ATM withdrawals are made with domestic-issued cards; however these banknotes could be used outside the home country
2	If OTC withdrawals are not available, they can be approximated by CIT deliveries of banknotes to banks with recycling	CIT deliveries to bank branches can be recycled in Credit Institutions over the counter
3	If even CIT deliveries of cash is not available, then OTC cash distribution can be based on NCB withdrawals of banknotes, which is also subject to CIT cash centre recycling.	In most euro countries CIT companies handle transports from NCBs to CIT cash centres and distribute cash to ATMs, CI branches also deliver change cash (small denominations and coins) to retailers.
4	Both ATM and OTC withdrawals are subject to public cash recycling	Personal payments between individuals and B2B cash payments are rarely recorded in statistics, but these are assumed to be rather limited.
5	Cash back has not been taken directly into account in these calculations	Cash back and wages in cash are public cash recycling
6	High denomination banknotes are available only from bank branches	Euro 500 and euro 200 banknotes are not available in ATMs in the euro area
7	Cash bulk transfers outside the euro area could be deducted from NCB cash issuance, as they are not used in the euro area	Banknote migration outside the euro area complicates the estimation of the cash usage and banknote deliveries for hoarding purposes outside the euro area
8	Smallest change banknote deliveries can be taken out of OTC distribution since this part of cash is mainly withdrawn by retailers from bank branches to be used as change in consumer payments and does not represent primary cash usage by end-users of cash	OTC withdrawals are concentrated on high denominations and small denominations, as high denominations cannot be obtained elsewhere and small entrepreneurs can get change cash from bank branches. The share of ATM denominations from OTC withdrawals is usually low.
9	ATMs that only distribute banknotes have begun to be replaced by cash recycling machines (CRM), which can deposit and authenticate banknotes and recirculate them to other customers.	In these calculations we have not taken CRMs into account, since the volume of this recycling is still rather limited.

5. Empirical results of cash usage estimation for the EU12 area

The calculations based on available cash distribution statistics of ATMs and over-the-counter (OTC) distribution at bank counters and the assumptions for recycling rates for the EU12 countries can be found in tables 5. Tables 5a-5b present the cash usage calculations for years 2009 - 2010. Where OTC distribution was not available, we used NCB issuance of banknotes (excluding the smallest change banknotes) as a substitute. This data has been taken from the ECB CIS2 statistics. For Finland only did we use, CIT companies' deliveries of banknotes to bank branches instead of the NCB withdrawals of banknotes, the former being regarded as more precise data than NCB issuance for this estimation.[14] In these cash usage calculations, we used mostly a 15 % assumption for the public recycling rate of cash and 25 % for the CIT recycling rate.[15]

From these calculations, we see that the estimates of cash usage vary quite steadily around 2 400 billion for the first three years with some lower ones for 2010. For countries like Germany, Spain, Italy and Portugal, the estimates of the use of banknotes are likely to be slightly more reliable, as they depend only on the assumption about the public recycling rate. However, if we were trying to assess domestic cash spending, it would be necessary to investigate the extent of banknote migration and foreign demand for banknotes. Certainly, it is usually the case that cash distributed from ATMs is mostly spent in the home country. Regarding OTC distribution of high denomination banknotes the migration to other euro countries and to non-euro countries may well be more extensive. Change banknotes withdrawn by entrepreneurs are most likely used in domestic purchases as change cash, similar to coins. Migration of euro cash within the euro area has certainly affected cash distribution in some of the euro countries. In some euro countries, the net issuance of a few denominations of banknotes has turned negative. NCB net issuance of the main ATM banknotes is still generally strongly positive, as these banknotes are mostly used for domestic cash purchases. The tourist net migration of some denominations is stronger in southern Europe, which affects also NCB issuance of these banknotes. In the case of Germany, the bulk transfers abroad of banknotes via German banks do not directly affect ATM or OTC distribution.[16]

Given that, the statistics on ATM and OTC distribution of cash should be accurate. The ATM distribution of banknotes seems to have increased quite steadily, except for the drop in the German ATM withdrawals from 2006 to 2007 by around 100 M€ (see Table 2). The overall trend in ATM distribution has been increasing, partly because in the euro area bank branches have been replaced by ATMs. Signs of a slight decrease in the ATM distribution of cash can be seen in recent years only in IE, FI and NL. Total ATM withdrawals in the EU12 reached 900 million euro in 2010. Cash recycling machines (CRM) are still of modest importance, so we have not yet included this recycling in the calculations.

OTC distribution is a bit more problematic, as only for 5 or 6 countries (IT, ES, DE, NL, PT and GR) have given systematic information on it, and even here there seems to be problems in the figures even if we leave out Greece's figures altogether.[17] It is however fortunate that many of the biggest countries are among the

[14] This data was obtained from *Automatia*, which is responsible for cash services for all banks operating in Finland. For Finland an estimate of around a 33 % CI recycling rate for banks in their OTC cash operations was used.
[15] Country specific tables of the cash usage calculations can be asked from the authors.
[16] Or at least we assume that the bulk transports of high denomination banknotes are not included in banks' OTC withdrawal statistics.
[17] Greece figures of OTC distribution of cash exceed usually multiple times the annual GDP, which seems a bit strange; for instance in 2010 OTC withdrawals were 528.9 billion euro, while the Greek nominal GDP was 227.3 billion euro (see Table 3). Greek OTC withdrawals of cash also exceeded for instance German OTC withdrawals, yet Greek ATM withdrawals of cash were only 47.2 billion euro. Therefore in the case of Greece we used NCB withdrawals of cash as a basis for distribution calculations. Most likely OTC withdrawals in Greece include some transactions other than just cash withdrawals.

respondents. The OTC distribution of cash in these five countries (excluding Greece) comprises around the same magnitude of cash distribution as ATM distribution of banknotes for the entire EU12.

It is also worthwhile to compare OTC withdrawals with OTC deposits (see Table 3). Regarding our aim to measure cash usage, one may well ask whether OTC deposits would better represent the use of cash by the public. However, we feel that OTC withdrawals better represent the assessed demand for cash by banks than does the returned cash from the public. OTC deposits also include gone payments of bills by entrepreneurs that have received cash in payments, which would have complicated the interpretation. It is however interesting that in all the countries that have gathered OTC data for the ECB, deposits are usually significantly higher than OTC withdrawals. It can be argued however that OTC deposits are not totally useless, and if we add ATM withdrawals and OTC deposits, we arrived at an upper bound for cash usage.[18]

Table 5 presents the calculations of cash usage based on ATM and OTC distribution. The figures show quite steady estimates for cash usage, maybe partly because ATM and OTC distribution are substitutes. As bank branches have been replaced by ATMs this may not be surprising. The biggest empirical problem in these calculations is of course that we do not have convincing or reliable data on the recycling rates. We might guess from everyday observations and experience that public recycling is quite limited, but CI and CIT recycling rates certainly vary from one euro country to another. CIT recycling is also increasing in the euro area, as the Eurosystem framework for recycling banknotes has been in operation from the beginning of 2007. NCBs have also been closing branches, and CIT banknote sorting have been supported by expanding NHTO deposit schemes, which has led to increased cash handling by private professional cash handlers.

Due to the migration effect, it can be argued that lodgements might be regarded as a better measure of high denomination banknote usage within the euro area. Another fact speaks in favour of using lodgements instead of withdrawals in the case of HDBs: which is the tendency of credit institutions to order too many HDBs for safety reasons, to meet any unexpectedly high demand for HDBs by the public.

Recycling is the most common for ordinary banknote denominations that are available in ATMs and which are mostly used in retail shops and other similar points-of-sale. Even though HDBs are not available in ATMs, these banknotes are in some cases recycled by CIT companies or by banks over-the-counter as well. An individual may also make large cash payments with HDBs e.g. credit transfers from one bank to another with HDBs, as cash withdrawals are free while other types of credit transfers may be costly or may take too long because of banking days. Recycling (CIT, CI or by the public) somewhat complicates the calculations on the use of HDBs and cash for making payments in general.[19]

High denomination banknotes excessively emigrate from Germany, Ireland, Luxembourg and Austria, while countries like Belgium, Portugal and Spain had net immigration of HDBs. For all of five euro countries were OTC distribution figures are available (DE, ES, IT, PT, NL), OTC lodgements are larger than withdrawals, but only for Italy are these sums roughly of the same size. A plausible interpretation is that in the other countries private companies (smaller retailer shops) return cash out from sales through bank branches, and this cash does not go directly through other channels for CIT companies for counting and sorting. The cash usage estimations may be more reliable for OTC withdrawals than for lodgements, as lodgements include return of ATM banknotes from consumers.

[18] In Finland cash deliveries (CI cash orders) to almost all bank branches (except S-Bank) are available via Automatia's information system, and they have been quite close to cash returned from bank branches to CIT centres. In the case of Finland, CIT deliveries to banks are known precisely, but the CI recycling rate, i.e. the recycling that banks apply to the cash returning from the public at bank counters, is partially recycled.

[19] In a number of euro countries e.g. second market sales of used cars are expected using high denomination banknotes, especially if the buyer is from another euro country or is living outside the euro area, as credit transfers are a slow, risky and offer unavailable means of payment in these cases.

On average, bank counter (OTC) withdrawals are roughly three times as large as ATM withdrawals (see ECB, 2009). High denomination banknotes are preferred in cash transactions only rarely, when larger amounts of cash payments are involved. The user profile of HDB users is somewhat more likely to be males between aged 25 to 54, and more frequently also self-employed than workers. The HDB public survey also revealed that almost half of HDBs are spent within a week, even though a larger part of these banknotes is likely to be hoarded than of smaller denominations. It may be reasonable to assume that a larger part of HD banknotes are withdrawn more for specific purposes than are other denominations, which are more likely to be spent on ordinary daily purchases.

According to the ECB survey, around a fourth of consumers have also withdrawn high denomination banknotes apart from regular ATM withdrawals (ECB, 2011). The country-specific differences seemed to be large among euro countries related to national conventions and payment habits. For instance the Dutch had the largest average OTC withdrawals while in the Netherlands the share of ATM distribution of banknotes was the highest (78 %) among those euro countries where both ATM and OTC withdrawals are possible. In Germany, the amounts of cash withdrawn from ATM and OTC are roughly of the same magnitude.

According to an earlier Belgium study about cash payments at POS in 2003, the cash transactions were estimated to be only 52.2 billion euro, which is only somewhat larger than the ATM distribution of cash (NBB, 2005). OTC withdrawals or deliveries of cash to banks are not available for Belgium, but cash usage could be significantly larger than ATM distribution, since wages are partly paid in cash and also cash hoarding could be higher, since the issuance of high denomination banknotes is higher in Belgium than in most of the euro area countries. In the distribution model wages paid in cash are included in the public recycling. According to the TNS-opinion study (ECB, 2009) highest proportion of cashless incomes seem to appear in Germany, France and Netherlands, but otherwise considerable part of people receive at least part of their income in form of cash.

Table 5a. Cash usage in the euro area (EU12) in 2009

	Estimated use of cash in euro area (EU12) countries in 2009, billion euro											
	ATM distribution	**OTC distribution**			**Recycling rates (0 - 1) [4]**			**Alternative estimates of the public's total usage of cash**				
		First option	2. alternative	3. alternative	Assumptions							
	ATM withdrawals of banknotes	OTC withdrawals of banknotes excl. change banknotes [1]	CIT deliveries to CI	Banknote gross withdrawals of banknotes from the NCB (excl. change banknotes)	Public recycling rate [2]	CI recycling rate at the bank counter	CIT cash centre recycling rate [3]	Minimum estimate without recycling	Mininum estimate with public recycling	ATM distribution plus CIT deliveries and CI recycling	ATM distribution plus NCB distribution and CIT recycling	**Best available estimate**
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(a+b)	(1+e)*(a+b)	(1+e)*a+(1+e+f)*c	(1+e)*a+(1+g)*d	
BE	43.45			41.1	0.17		0.15				98.1	**98.1**
DE	317.43	318.5		437.5	0.15			635.9	731.3			**731.3**
GR	47.66	573.3		42.9	0.15		0.25				108.4	**108.4**
ES	107.17	242.5		81.8	0.15			349.7	402.1			**402.1**
FR	120.86			153.2	0.15		0.25				330.5	**330.5**
IE	25.42			31.7	0.15		0.25				68.9	**68.9**
IT	91.87	266.5		78.4	0.15			358.4	412.1			**412.1**
LU	0.76			11.1	0.15		0.25				14.7	**14.7**
NL	53.77	9.3		20.8	0.14			63.1	71.9			**71.9**
AT	17.80			55.5	0.15		0.25				89.9	**89.9**
PT	29.57			9.4	0.15		0.25	29.6			45.8	**45.8**
FI	16.40		2.4	12.6	0.16	0.32				22.6	31.7	**22.6**
EU12	**872.16**	**1410.1**		**976.0**								**2396.3**

Assumptions:

[1] Here it is assumed that 5 and 10 euro banknotes distributed over the bank counters are mostly received by retailers and other companies that use these banknotes as change, which therefore cannot be regarded as final use of cash by consumers or companies. OTC withdrawals data on these change banknotes was taken from NCB gross issuance.

[2] Public recycling (between different households and between companies) is applied to both ATM and OTC distribution of cash

[3] Credit Institution (CI) recycling is applied only to OTC distribution (withdrawals) of banknotes

[4] Recycling rates are here based on a rough assumption only. The sensitivity of these assumption on the calculations can be tested with the formulas in the alternative estimates row.

Sources: ATM and OTC withdrawals are available in the ECB's Blue Book statistics, and NCB withdrawals of banknotes are available in the ECB's CIS2-statistics.

Table 5b. Cash usage in the euro area (EU12) in 2010

Estimated use of cash in euro area (EU12) countries in 2010, billion euro												
	ATM distribution	OTC distribution			Recycling rates (0 - 1) [4]			Alternative estimates of the public's total usage of cash				
		First option	2. alternative	3. alternative	Assumptions							
	ATM withdrawals of banknotes	OTC withdrawals of banknotes excl. change banknotes [1]	CIT deliveries to CI	Banknote gross withdrawals of banknotes from the NCB (excl. change banknotes)	Public recycling rate [2]	CI recycling rate at the bank counter	CIT cash centre recycling rate [3]	Minimum estimate without recycling	Mininum estimate with public recycling	ATM distribution plus CIT deliveries and CI recycling	ATM distribution plus NCB distribution and CIT recycling	**Best available estimate**
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(a+b)	(1+e)*(a+b)	(1+e)*a+(1+e+f)*c	(1+e)*a+(1+g)*d	
BE	45.32			36.2	0.17		0.15				94.6	**94.6**
DE	315.48	285.2		435.4	0.15			600.7	690.8			**690.8**
GR	47.17	582.2		48.6	0.15		0.25				115.0	**115.0**
ES	107.98	241.5		93.4	0.15			349.4	401.9			**401.9**
FR	123.35			153.5	0.15		0.25				333.7	**333.7**
IE	22.32			29.5	0.15		0.25				62.6	**62.6**
IT	122.91	145.3		84.1	0.15			268.2	308.4			**308.4**
LU	0.77			9.6	0.15		0.25				12.8	**12.8**
NL	52.00	4.8		17.6	0.14			56.8	64.8			**64.8**
AT	17.80			54.5	0.15		0.25				88.6	**88.6**
PT	30.33			10.5	0.15		0.25	30.3			48.0	**48.0**
FI	15.70		2.4	12.5	0.16	0.32				21.8		**21.8**
EU12	**901.13**	**1259.00**	**2.41**	**985.30**								**2243.0**

Assumptions:

[1] Here it is assumed that 5 and 10 euro banknotes distributed over the bank counters are mostly received by retailers and other companies that use these banknotes as change, which therefore cannot be regarded as final use of cash by consumers or companies. OTC withdrawals data on these change banknotes was taken from NCB gross issuance.

[2] Public recycling (between different households and between companies) is applied to both ATM and OTC distribution of cash

[3] Credit Institution (CI) recycling is applied only to OTC distribution (withdrawals) of banknotes

[4] Recycling rates are here based on a rough assumption only. The sensitivity of these assumption on the calculations can be tested with the formulas in the alternative estimates row.

Sources: ATM and OTC withdrawals are available in the ECB's Blue Book statistics, and NCB withdrawals of banknotes are available in the ECB's CIS2-statistics.

Table 6. Cash usage estimates based on return frequencies and cash holdings in 2008, billion euro

Different measures of banknotes put into circulation				**Frequency**	**Cash usage**		
	actual value of banknotes	Capital key calculation value	*Mufa* cash holding based value	Average return frequency	Actual circulation based estimate	Capital key based estimate	Cash holdings based estimate
Austria	6.7	20.7	28.6	3.92	26.11	81.04	112.11
Belgium	2.1	24.8	24.7	2.52	5.23	62.55	62.34
Finland	8.4	12.4	5.8	2.13	17.90	26.33	12.35
France	69.9	141.5	77.9	3.04	212.50	430.17	23682
Germany	328.4	208.2	182.1	4.26	1397.31	885.73	774.87
Greece	20.8	20.2	6.9	3.18	212.50	430.17	236.82
Ireland	23.2	9.5	13.1	.99	22.92	9.45	12.97
Italy	139.5	129.9	168.0	.98	136.68	127.33	164.44
Luxembourg	52.6	2.0	1.6	2.96	155.76	6.02	4.74
Netherlands	23.9	39.0	39.4	1.40	33.44	54.63	55.16
Portugal	1.6	17.3	10.7	2.68	4.22	46.47	26.68
Spain	83.1	76.01	117.2	2.15	176.76	163.45	251.98
EU12	760.1	765.4	676.0	2.79	2120.75	2135.50	1886.04

ECB's Monetary Union Financial Accounts (MUFA) is available only for 2002 - 2008.

6. Comparison of distribution cash usage estimates to other studies and methods

The recycling parameters can be calibrated from additional national data sources such as questionnaires forwarded to CIT companies.[20] Cash questionnaires can be therefore used to calculate the proper size of the public and/or CIT recycling rates.

6.1 The case of Germany

The Deutsche Bundesbank's (DBB) study (2009) on payment behaviour did not give any exact value for cash payments, but 21 percent of the German respondents paid exclusively with cash, even though they had payment cards. Consumers had on average 118 euro in their wallets, with median holdings of 90 euro, while the average ATM withdrawal was around 215 euro. In the 2010 published study about the withdrawal behaviour in Germany we can find an estimation of the total cash holdings for people above 18 years. According to this people in Germany hold about 14.5 billion euro for transactional purposes. The share of cash in retail transaction volume in Germany was as high as 82.5 % and the euro value of cash payments from the turnover was 58 percent. [21]

Estimates of cash holdings of national residents are found in the ECB's Monetary Union Financial Accounts. These ECB's MUFA statistics provided quarterly estimates of total cash holdings of German residents only up to 2008, but at the end 2008 these were 182.1 billion euro. [22]

A DBB study (2011a) on the other hand shows the German banknote cycle and estimates the consumer cash consumption in 2009 at 702 billion euro and retail turnover in cash at around 542 billion euro in Germany. Migration and hoarding are not estimated in this study, but the banknote cycle shows many useful aspects of the German cash cycle.

The increase in German banknote issuance after euro changeover clearly cannot be explained by the domestic transaction demand growth. Rather, as is concluded in Bartzsch et al. (2011a) and Bartzsch et al. (2011b), a major part of DBB issued banknotes are related to banknote migration either by Germans exporting them via travelling to euro countries and outside euro area or by shipments abroad from Germany. The active circulation of banknotes issued from DBB in Germany was estimated to be only around 30 percent at the end of 2009. It was also estimated that the active circulation of banknotes in Germany has been around 130 billion euro since 2005 up to 2009, which accounts for only one-third of banknotes issued by the DBB. However, observing the difference between flows and stocks and taking into account that DBB return frequency was 4.3 on average, banknotes worth 130 billion euro roughly equates to 558 billion euro worth of cash transactions.

This estimate of active banknote circulation seems to be somewhat low, if we take into account that ATM withdrawals of cash in Germany were 317 billion euro and OTC withdrawals 369 billion euro in 2009 (together 686 B€), even taking into account that Germans exported 8.4 billion euro net worth of banknotes during 2009. Net shipments of cash outside the euro area have annually amounted to between 5 and 15 billion euro. The net shipments of cash are ordered through commercial banks, but they are not included in OTC distribution of cash. Migration of euro cash may also partly explain the difference in the estimates. Even if the cash usage had been around 900 billion euro, this could have been done with rather limited

[20] Also ECB statistics on CIT recycling of banknotes could be used as reference. Return frequencies can be used as reference even though they are based on the capital key calculations on the banknotes put into circulation.
[21] If this turnover portion of cash is applied to the consumer debit card spending statistics for Germany, we arrive at the following estimate of total cash spending of consumers in 2009: 2.27 * 115.81 B€ = 262.6 B€.
[22] Here we have compared the calculations for 2008 only, since this was the last year for which the Mufa statistics were compiled.

amount of banknotes in circulation, as the banknotes circulate and return to the central bank a few times a year. To sum up, there are plenty of estimates around, but the trouble is that it is not easy to assess or order these various estimates into a uniform framework.

We can also compare cash usage estimates from the distribution approach to other rough methods of calculating cash usage like the cumulative net issuance of banknotes times the average return frequency of banknotes to NCBs. The actual circulation of banknotes does to give us a reliable estimate of the cash usage in Germany due to net shipments and banknote migration by the German populace. The capital key approach is artificial also, but it could be used as a reference for what the cash usage could have been in a normal situation. The cash holdings of German residents multiplied by DBB average return frequency could yield us at least another comparative estimate of the German cash spending. In the German case, the cash holdings applied to average return frequency yield an estimate of 775 billion euro in 2008. Thus this estimate is also much in the same range as the others (see Table 6).

6.2 The case of the Netherlands

No official or other recent published estimates of cash usage exist for Netherlands either. However, a projection of a recent study has been used to obtain a figure for cash usage. The Dutch retail association performed a comprehensive study of retail payments in 2009 (Pleijster and Ruis, 2011). Based on extrapolations from this study, the value of cash payments in point-of-sales terminals was estimated at around 57.1 billion euro.[23] However, this estimate was also limited to POS terminals. Adding recycling to the distribution model, we end up with 81.5 billion euro (without small change banknotes 72.5 B€), of which ATM and OTC distributions alone total 63 billion euro. In addition the distribution approach does not separate the hoarding motive from the transactions.

It might be the case that the Dutch use euro banknotes quite heavily also outside of the Netherlands, and the distribution model somewhat exaggerates cash usage, since the alternative estimates of the cash usage based on cash holdings times the average return frequency yield around 55 billion euro of cash usage in 2008 (Table 6).

The coverage of the Dutch retail study done in association with the retail association was exceptionally high as it represents around 85 % of POS transactions. The average cash payment in the Netherlands was estimated to be relatively low, namely 12.5 €, while the total number of cash payments was very high, 2.35 times as high as debit card payments, even though the value of debit payments was 76.1 billion euro.[24]

6.3 The case of Finland

In Finland, no official or even unofficial estimate for the usage of cash is available. Statistics Finland does estimate the cash holdings of the different sectors in their financial accounts. The actual cumulative net issuance of euro banknotes put into circulation by the Bank of Finland is around twice of the estimated cash holdings of Finnish sectors, as the major part of euro cash is assumed to have migrated outside Finland (Figure 2).

The Federation of Finnish Financial Services (FFFS) provides aggregate card payment statistics and also handles annual questionnaires about the most common retail payment shares of consumers. Figure 3 shows

[23] This estimate for 2009 57.1 B€ was done by Nicole Jonker, and it is quite close to the sum of ATM and OTC withdrawals, 63 billion euro in 2009. In a more recent study Jonker, Kosse and Hernandez (2012) POS cash payments were estimated to be 53 billion euro in 2010. In addition person-to-person cash payments were 8.6 billion euro worth, so in total cash usage is 61 around billion euro, which is quite close to the distribution model calculation yielding 65 B€. Based on this public recycling rate of cash in Netherlands could be around 14 percent.

[24] Earlier comparative results can be found in Jonker and Kettenis (2007).

the consumers' assessment of their most commonly used daily payment media, which clearly shows the decline in cash payments and increase in card payments in retail payments. Card payments have dominated the major retail payment media since mid-2000, and currently less than 30 percent of consumers regard cash as their main payment medium. Similar results have been obtained from Bank of Finland consumer questionnaires. The FFFS questionnaire can be combined with official consumption statistics to get an estimate of cash and card usage. This cash usage estimate can be compared with the cash distribution estimate, and questionnaires can be used to calibrate the recycling parameters to get more consistent cash usage estimates with the distribution method.

If household consumption expenditure is used to measure ordinary daily retail payments, then housing expenditure (rents) and out-patient health services can be deducted directly from this figure, as they are paid overwhelmingly as credit transfers. The questionnaire percentage shares can be multiplied directly by the household consumption statistics to get the payment expenditure value. This card usage estimate can also be compared with the FFFS statistics collected from banks' card payments (Figure 4). This card payments estimate slightly exceeds the actual 40 billion euro. These calculations lead to cash usage of 22-23 billion euro in Finland, whereas the ATM and OTC distribution of cash has been about 18-19 billion euro in recent years. In some respects, the domestic use of cash seems rather limited, currently only about half of the euro value of card payments. Based on banknotes put into circulation from BoF and migration estimates, cash is still very popular in travelling and on holidays in the euro area.

The cash holdings of Finnish residents combined with the average return frequency of the banknotes yields on 12 billion euro estimate of cash usage in Finland (see Table 6). For Finland this estimate seems rather low, since for instance the ATM distribution also has been quite steadily around 16 billion euro for the last decade. Most likely the cash holdings of Finns are slightly larger than the MUFA estimate and the financial accounts estimate.

6.4 Cash holdings and cash usage

Cash usage can also be approached by combining the estimate of cash holdings combined with the NCB return frequency of banknotes. These calculations are presented below for three different concepts of cash holdings. The first is the actual cumulative net issuance of banknotes, the second is the capital key calculation and the last one is the ECB's MUFA statistics estimate of cash holdings of residents living in each of the EU12 countries.

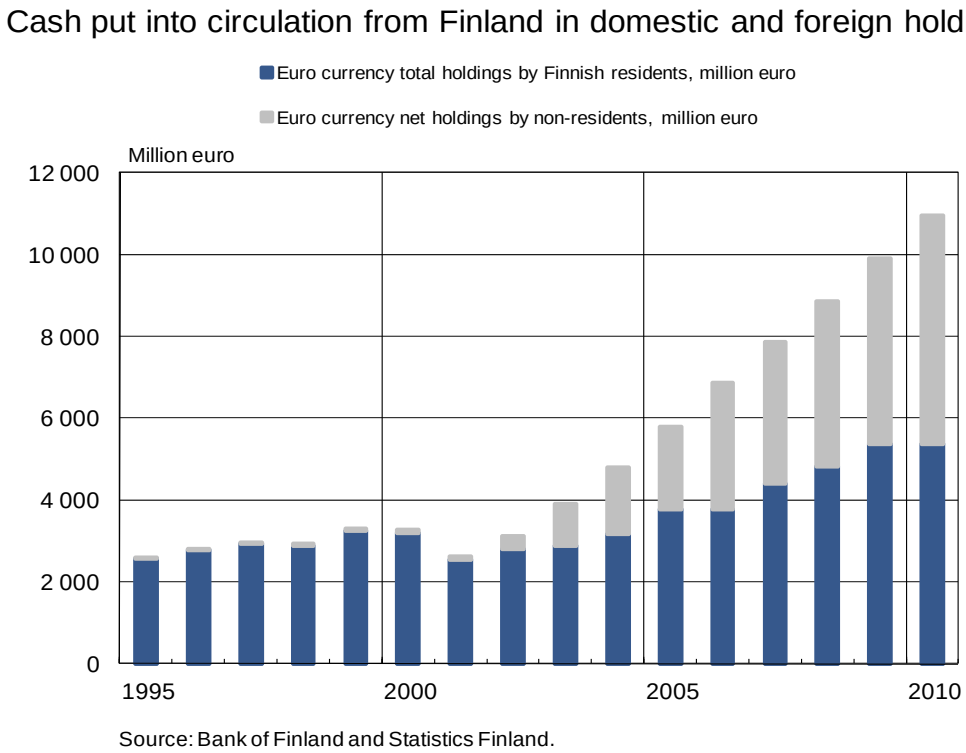
The actual cumulative net issuance of banknotes is heavily affected by migration between euro countries and by bulk transfers of high denomination banknotes outside the euro area for Germany and Austria. For this reason the stock of banknotes put into circulation is a meaningful measure only for some euro countries. [25]

In the capital key calculations, the total cumulative net issuance of euro banknotes is (artificially) divided among euro area countries using the cash capita key, which is based on GDP and population. The financial accounts (MUFA) estimates are based on an economic model-fitted value, where explanatory variables for each country included GDP, interest rates, deposits etc. In most of the euro countries, financial accounts

[25] The true stock of banknotes put into circulation is not even available in the IMF monetary statistics for every euro country, but instead the capital key based net issuance is published. Quite recently Eurostat has also suggested that capital key figures should be used for cash holdings estimates in the financial accounts.

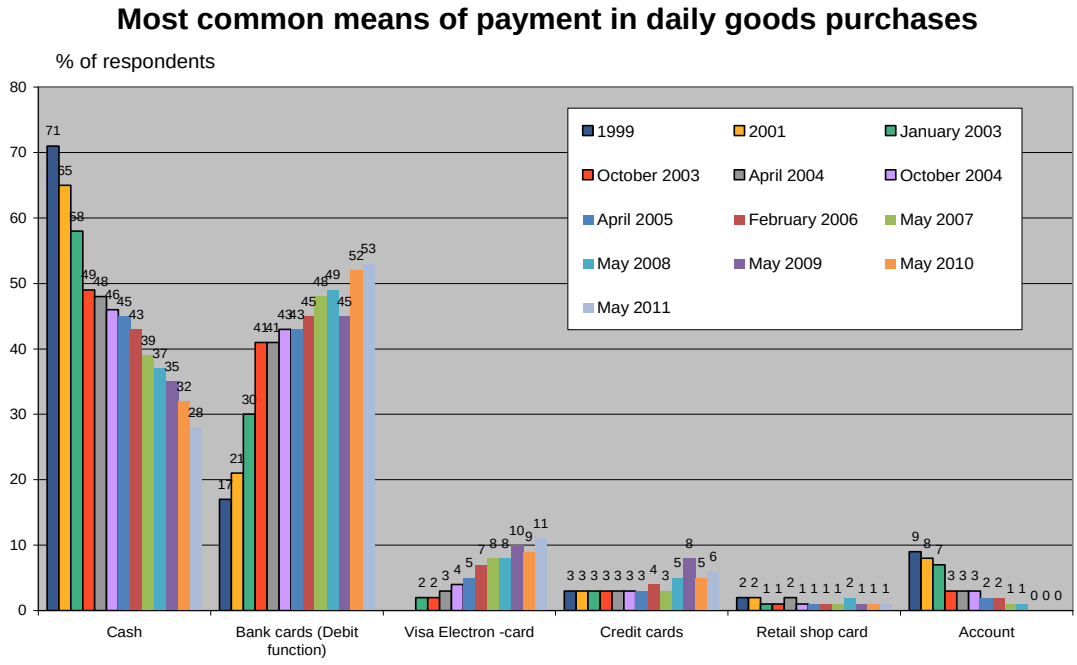
figures give realistic figures for actual cash holdings within a country, as these figures are not affected by migration or outflow of banknotes outside the euro area. When the average return frequency is applied to these figures, we also get quite reasonable estimates of the cash usage (Table 6). These figures are also relatively close to the cash distribution model calculations.

Figure 2. Growth of cash demand in Finland



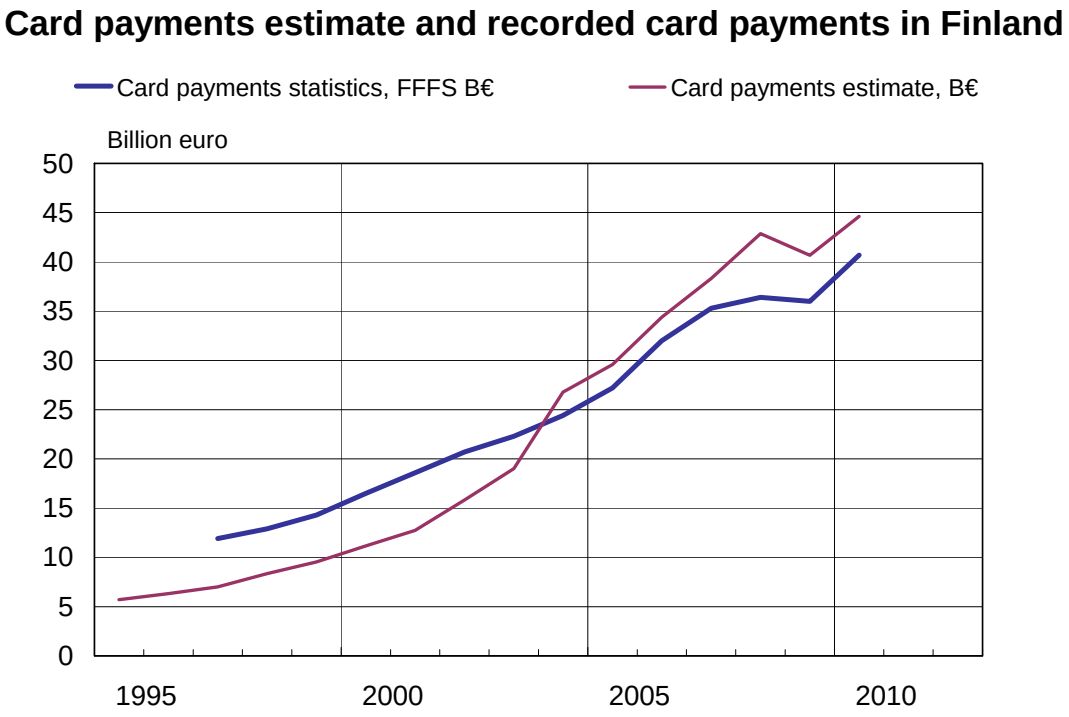
Source: Bank of Finland and Statistics Finland.

Figure 3. Cash payment motives in Finland



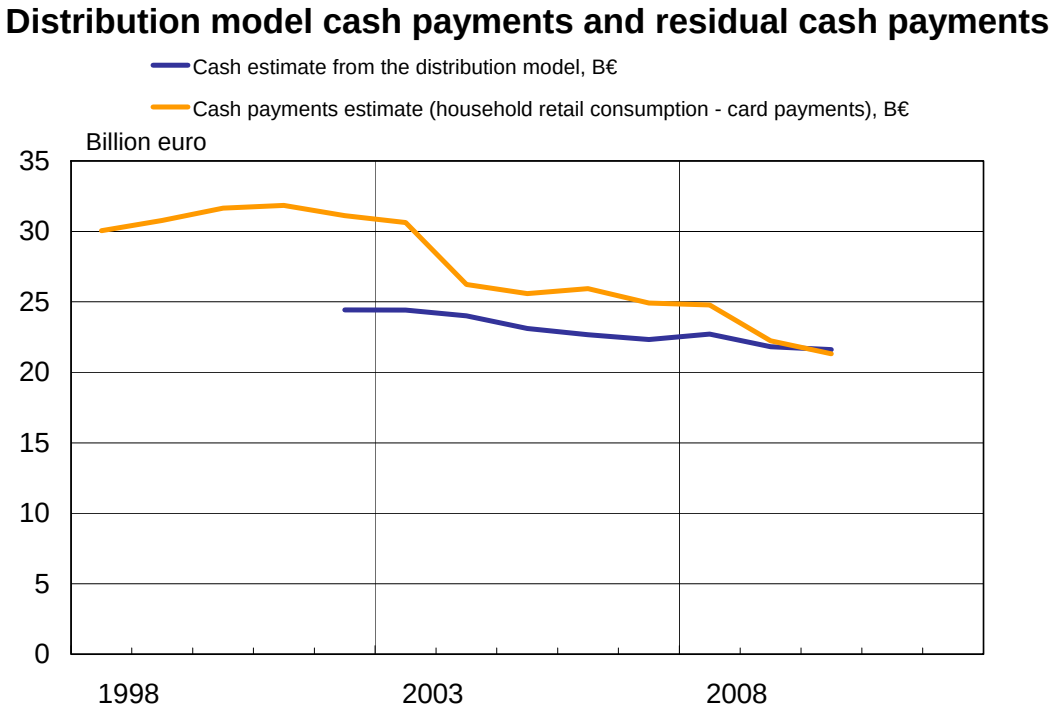
Source: Federation of Finnish Financial Services, Saving and use of credit, May 2011.

Figure 4. Estimates of card payments in Finland



Source: Statistics Finland and Federation of Finnish Financial Services.

Figure 5. Estimates of cash payments



Source: Statistics Finland and Federation of Finnish Financial Services.

7. Evidence from Finnish micro studies

The Bank of Finland has in recent years conducted several micro studies on the use of cash. These have focused on cash holdings, withdrawal behavior and attitudes of consumers and firms towards the use of cash and the quality of cash.

Next we summarize some of these studies from the point of view of the distribution of cash holdings. The reason for this perspective is that average values may grossly understate true cash holdings. This is especially true if cash holdings are estimated on the basis of withdrawals from ATMs. Many people who visit an ATM almost daily inflate the number of withdrawals and deflate the average value of sums withdrawn. In principle, the people who withdraw just 10 or 20 euro have so little cash that their aggregate cash holdings could be approximated by zero. By contrast, people who withdraw more than 200 euro are of more interest from the point of view of large cash holdings.

The problem is that the use of ATMs represents only a part of cash supply, and it appears that withdrawal practices are quite different in bank offices. The difference becomes even more pronounced when we take into account that firms probably use bank offices as the main venue for cash supply.

Here we report results from three consumer surveys (Tables 7, 8 and 9) that address mainly the everyday transaction behaviour of households. In addition we report results concerning surveys on bank customers: consumers, firms and, also banks' cash operators (Tables 10 and 11). These surveys were conducted among the customers of banks (the data were collected from those who visited bank during the survey period/day). Therefore, there is an obvious sample selection bias in the results, and it is not at all clear to what extent the results can be generalized to all households and firms. With firms, the sample selection problem is much more serious, and we can do very little to correct it (cf. however, the earlier studies of Hirvonen and Viren (1996) and Viren (1996).[26]

Next, we shortly summarize the main findings in the order of the subsequent tables:

Consider the mean values. For the 2007 consumer survey, the mean value of money balances held by all consumers is 70.68 euro. In the same survey, the mean value of cash used during one week turned out to be almost the same number (73.75 euro). On average, people used cash 3 times a week. In the 2008 survey, the mean value of cash balances was 72.69, which corresponds well with the 2007 survey values. In the most recent 2012 survey, the average monthly withdrawal was estimated at about 400 euro, which implies a weekly rate of 100 euro.

As for individual surveys, we add the following comments. In Table 7, for the 2007 consumer survey we observe some not so surprising findings: *ceteris paribus*, old people hold more cash than the young, and entrepreneurs and farmers have particularly large sums of money. But notice that old people do not seem to use more money than the rest of population. In terms of use of money, these groups are not distinguishable. By contrast, students seem to hold more money. As for the money balance – frequency of use nexus, we see that the relationship is very weak indeed. By contrast, there is quite a strong relationship between the amount of money used in transactions and the frequency of cash transactions.

Table 8, for the 2008 survey, provides more or less the same evidence as Table 7. The novel feature is that this survey is a question of the distance between home and the nearest ATM. As one might expect, the distance seems to have a positive impact on the size of cash balances, although the relationship cannot be estimated very precisely.

[26] In this study, 1.5 billion in Finnish markka cash holdings could be located at business firms. If this number is indexed by GDP and converted to euro, the sum would be about 500 million euro, which is equal to about 0.25 per cent of GDP.

The 2012 survey shows that the use of ATMs and Bank office (OTC) facilities differ greatly: ATMs are used on average almost once a week while bank offices are visited only roughly twice a year. The withdrawn sums also differ widely: the estimated annual sum is 3800 euro from ATMs and about 1000 from bank offices. Hence the total withdrawn amount of money is about 400 euro per month. This number is roughly consistent with the 2007 survey result (see above) that the average weekly use of cash in transactions is 73 euro. The problem with these numbers is that the OTC channel is used so rarely that there could be a very large sampling error in our estimates due to the relatively small sample size of our survey (less than 500). The problem is especially severe for OTC withdrawn sums of cash. As revealed in the 2006 bank office questionnaires (Table 10), there may be just one or two very large withdrawals, which may completely change the estimates of means values of withdrawn sums. In the 2012 survey, we also have the problem that exact sums are not available, so we make a subjective assessment of that mean value for the category "withdrawn sum of money is above 2000 euro". Our estimate is 3000, but equally well it could be 30 000.

As for the estimation result for the 2012 data, we refer to Table 9, which that includes models for the "cash user" dummy (the respondent mainly uses cash), the average withdrawn sum of money from an ATM (wa), the corresponding annual withdrawn sum of money (way), and the average monthly withdrawn sum of money from bank offices (bank).

It seems that ATM and ORC withdrawals are not substitutes. As seen in Table 9, OTC withdrawals "depend" positively on ATM withdrawals (and, in fact, vice versa). Thus, we may say that those people who use cash more than the average generally use both channels of withdrawal. The link is not statistically significant, but at least at the qualitative level it appears to be quite persistent and robust over different estimating specifications.

Otherwise, the results follow the same pattern as in the 2007 and 2008 surveys. There is a relatively clear gender difference in the withdrawn sums of money (both ATM and OTC). The age pattern is quite clear for ATM withdrawals but – presumably due to the small sample size – not so clear for OTC withdrawals. Basically, the withdrawn sums increase with the age.

As for occupations, two heavy users can be detected: farmers and entrepreneurs; whereas students and the unemployed show the opposite pattern. Basically, the same occupational pattern applies to ATM and OTC withdrawals, but there apparently are some exceptions. Students seem to use bank offices relatively often, obviously representing the withdrawal patterns of student loans.

All in all, the results seem to follow the same patterns as for the ECB surveys for 2008 and 2009 (see ECB 2011). In our case, the main problem is the relatively small number of observations, which in the first place shows up in the accuracy of estimates. Unfortunately, this lack of accuracy also affects the estimates of money holdings. The problem is that the distribution of money holdings (as well as withdrawals of money) is skewed and the importance of extreme observations is exceptionally large.

The questionnaires to bank customers (Tables 9 and 10) provide results quite different from those of the consumer surveys. This reflects at least two things. Withdrawals consist not only of withdrawals for everyday transaction purposes but also for exceptional (large) transactions. On the other hand, there is an obvious sample section bias in the data; the questionnaire was given only to those who visit a bank office (and who withdraw a nontrivial sum of money). It is no surprise that the withdrawn sums are large. Obviously this is true for firms, but the values for ordinary customers are also relatively high, the mean value of withdrawals being 1133 euro. Obviously this due to very large outliers, but even if we eliminate all withdrawals that exceed 10 000 euro, the average size of a withdrawal is 849 euro (this covers to 98.5 per cent of the sample). The size distribution of OTC withdrawals is illustrated in Figure 6 (the graphs refer not only to households but also firms and bank operators' assessments of withdrawal patterns).

A somewhat striking result of the survey is that even though old people seem to take out larger sums of money pensioners are not distinguishable from other groups. Another interesting feature of the data is the withdrawal frequency does not have a very strong impact on withdrawn money amounts. There reason becomes obvious from the estimates of coefficients of the frequency dummies. Money balances seem to increase with the frequency of withdrawals, but the relationship is not monotonous. Only when we have people who take out money every day or several times within a week are (withdrawn) money balances clearly larger than normally.

For firms (Table 11) the findings are not so striking. Big firms use more cash than small firms, but industry differences seem to be relatively small, and the frequency and cash balances nexus appears quite weak (firms that take out money only once a year obviously take very small sums, but the sums do not increase monotonically with frequency. The maximum is obtained at a frequency corresponding roughly to one visit to a bank office a week.

Finally, consider the results from questionnaires for banks cash operators (notice that the sample size is only 54). The useful feature of bank officers' questions/answers is that they basically cover all banks' customers, frequent and not-so-frequent visitors and both households and firms. According to cash officers of banks, households account for about 80 per cent of withdrawn cash and 88 per cent of visits to bank offices.

There are some interesting aspects of these results. For households, we find that according to cash operators' estimates, there is a hardly any relationship between average withdrawal size and withdrawal frequency (Figure 7). It is also interesting that when operators are asked to estimate the average size of a withdrawal the result is much larger than that derived directly by dividing the sum of withdrawn money by the number of withdrawals. In the case of households, the direct estimate for the basis of total sum of withdrawals and the total number of visits is 289 euro. If, however, we compute the average withdrawn sum from the frequency distribution, we obtain a number as high as 2400 euro. [27] Their estimate of the average annual frequency of withdrawals is 34.5, which means that we obtain an estimate of 1560 euro for the amount of weekly withdrawals. The estimated frequency is obviously much larger than the number from the 2012 customer survey for households that visit a bank office at least one a year (the corresponding number is 6.3). Obviously, banks' cash officers' interpretation of their customers is quite different than their true customer population.

Cash officers were also asked for the maximum single household withdrawal from their bank office. The average value that 53 officers reported was 71 888 euro and the median was 50 000 euro (the maximum was 350 000 and the minimum 6 000 euro). It is clear see that survey results (with a small sample size) may change greatly even if just one such big withdrawal is included.

Firms' cash officers estimate that the average withdrawal size is 8322 euro and the average frequency is just over twice a month.[28] The average value of the maximum withdrawal they had experienced was 90744 euro (the median was 50 000, the biggest withdrawal was 535000 and the smallest 9 000). For firms, the relationship between withdrawal size and withdrawal frequency appears to be quite clearly positive, as it was in bank office survey results conducted among the firm (non-household) customers (Table 11). Thus, heavy users of cash visit banks often and withdraw large sums of money. This shows up in the distribution of withdrawal sizes and withdrawal frequencies (Figure 8). For firms, the distributions are much more skewed

[27] The number is based on the assumption that the try-values are located in the middle of the interval (i.e., 750 for the class is 501-999). Obviously this produces an upward bias to the numbers, but even if we take the lowest value for each class (i.e. 502 for class 501-999) we end up with an estimate of 633 euro, still well above 279 euro.

[28] Again, this number is much higher than the value obtained by dividing the weekly withdrawals by the number of visits by non-households customers, 771 euro.

than for households, indicating that there is really no typical firm. The difference is especially striking in frequencies, which may simply reflect different sales/market behavior. Looking at the characterization of non-household customers (by cash officers of the banks), the most typical are tax companies, car dealers, second-hand shop owners, and so on. Thus, it is not entirely surprising that large amounts of cash are still used among certain types of companies.

According to banks' cash officers only about 14 per cent of cash withdrawn from banks non-household customers goes abroad. By contrast, about 30 per cent is simply exchange money in the form of smaller denomination notes and coin. About one half of the visits to banks are motivated by this exchange money motive, but in value terms the share is obviously smaller.

If we look at the relationship between withdrawal size and weekly number of visits to a specific bank office, we find the relationship clearly negative for both households and firms (see the lower panel in Figure 7). This probably reflects the different levels of income and perhaps age differences in terms of households. In poor locations, the withdrawn sums are smaller and frequencies greater.

Table 7. Results from 2007 consumer survey

	m	*m*	*m*	*log(m)*	*log(m)*	*log(m)*	*use*	*cash user*
constant	54.66	14.067		2.876	2.446			
	(1.94)			(8,48)	(1.73)			
use	.175	.201	.172	.224	.232	.230		
	(2.36)	(2.06)	(2.37)	(3.97)	(3.41)	(4.10)		
m								.193
								(2.80)
frequency	-.346	-.143		-.018	-.033		.234	
	(0.65)	(0.23)		(0.52)	(0.94)		(6.51)	
less than once a m.			35.266			2.730		
			(1.25)			(7.75)		
twice a month			53.866			2.910		
			(1.87)			(8.27)		
twice a week			57.247			2.889		
			(1.95)			(7.89)		
every day			43.700			2.732		
			(1.31)			(6.88)		
female	-13.952	-12.916	-14.520	-.170	-.153	-.186	-4.68	-.275
	(1.52)	(1.21)	(1.56)	(2.92)	(1.73)	(2.49)	(0.59)	(2.08)
age: 20-34	-2.818	7.594	-3.187	-.085	.035	-.111	.47.44	-.783
	(0.27)	(0.58)	(0.30)	(0.55)	(0.20)	(0.71)	(3.21)	(2.95)
age: 35-49	-2.662	17.788	-4.399	.004	.309	-.028	52.67	-.495
	(0.17)	(1.08)	(0.27)	(0.02)	(1.62)	(0.16)	(3.92)	(1.81)
age: 50-64	.35.19	58.061	32.951	.407	.686	.366	.52.85	-.183
	(2.13)	(2.60)	(1.98)	(2.24)	(3.12)	(2.02)	(3.08)	(0.65)
age: >64	60.06	83.234	57.277	.756	1.000	.706	51.23	.111
	(2.39)	(2.42)	(2.28)	(3.03)	(3.12)	(2.85)	(2.58)	(0.30)
student	-18.834	11.443	-20.686	-.115	.180	-.139	28.25	.165
	(0.67)	(0.69)	(0.739	(0.41)	(0.81)	(0.49)	(2.25)	(0.75)
worker	-10.83	9.325	-9.431	-.096	.112	-.096	-6.72	.075
	(0.41)	(0.79)	(0.36)	(0.39)	(0.70)	(0.37)	(0.40)	(0.28)
white-collar	-15.809	9.306	-15.434	-.109	.108	-.117	-13.87	-5.81
	(0.63)	(0.68)	(0.36)	(0.45)	(0.64)	(0.46)	(0.83)	(2.01)
farmer	34.445	49.045	35.292	.738	.862	.691	-10.86	-.685
	(1.07)	(1.66)	(1.08)	(2.31)	(2.91)	(2.11)	(0.36)	(0.96)
entrepreneur	104.083	154.152	104.482	.622	.972	.617	-12.40	-.121
	(2.13)	(3.15)	(2.14)	(1.97)	(3.07)	(1.89)	(0.45)	(0.33)
pensioner	-22.515	-19.490	-21.409	-.331	-.347	-.329	-19.85	-.153
	(0.79)	(0.80)	(0.76)	(1.22)	(1.36)	(1.18)	(1.06)	(0.47)
house-wife	-33.775	-19.705	-34.717	-.214	-171	-.247	-25.05	.127
	(1.27)	(0.98)	(1.23)	(0.69)	(0.57)	(9.78)	(0.61)	(2.16)
unemployed	-33.775	-1.700	-35.763	-.374	-.061	-.388	-0.45	.173
	(1.27)	(0.12)	(1.26)	(1.37)	(0.32)	(1.39)	(0.02)	(0.51)
cash user	23.311	17.698	23.179	.218	.255	.266		
	(1.73)	(1.01)	(1.71)	(2.18)	(2.11)	(2.47)		
R^2	0.193	0.176	0.195	0.261	0.236	0.266	0.181	
SEE	91.87	92.79	91.90	0.737	0.749	0.736	80.56	0.447
n	478	478	478	478	478	478	487	
weighted	no	yes	no	no	yes	no	no	probit

Dependent variable: m = amount of cash held at moment of interview, use = amount of cash used within a week and cash user = respondent uses mainly cash (dummy variable)

Table 8. Results from 2008 Consumer survey

	m	*m*	*m*	*log(m)*	*log(m)*	*n*	*cash user*
constant	49.55	87.92	89.04	3.527	4.116		
	(1.82)	(2.51)	(2.51)	(10.14)	(8.64)		
distance to ATM	1.04	1.18	1.09	.020	.026	1.06	-.007
	(1.17)	(1.26)	(1.24)	(0.88)	(0.96)	(2.12)	(0.57)
female	-22.23	-9.53	-17.85	-.135	-.022	-22.05	-.221
	(3.26)	(1.55)	(1.98)	(2.59)	(0.39)	(3.22)	(1.46)
age: 20-34	-8.57	2.91	-4.68	-.096	.054	2.69	-2.408
	(0.80)	(0.53)	(0.43)	(0.87)	(0.60)	(0.27)	(2.19)
age: 35-49	7.98	14.39	8.58	.123	.228	14.80	-1.396
	(0.60)	(1.83)	(0.67)	(0.98)	(1.99)	(1.17)	(1.29)
age: 50-64	18.04	32.55	18.39	.223	.387	24.69	-1.365
	(1.25)	(3.51)	(1.28)	(1.70)	(3.18)	(1.79)	(1.26)
age: >64	19.73	33.27	18.77	.346	.462	26.32	-1.004
	(0.81)	(1.40)	(0.78)	(1.96)	(2.56)	(1.10)	(0.90)
pensioner	43.31	-17.90	31.00	.304	-.502	85.97	1.012
	(1.41)	(0.45)	(0.96)	(0.88)	(1.04)	(3.83)	(0.92)
director	109.21	39.99	101.03	.879	-.093	151.97	-.980
	(2.02)	(0.60)	(1.84)	(2.00)	(0.15)	(3.09)	(0.63)
housewife	8.20	-47.30	-4.68	.049	-.708	51.14	.704
	(0.31)	(1.31)	(0.16)	(0.13)	(1.41)	(3.34)	(0.57)
farmer	105.96	-35.44	91.78	.641	-.411	168.47	1.344
	(1.46)	(0.89)	(1.29)	(1.37)	(0.79)	(2.12)	(1.12)
student	-0.56	-54.51	-14.29	-.014	-.800	46.04	.776
	(0.02)	(1.59)	(0.51)	(0.04)	(1.70)	(5.69)	(0.69)
white-collar	6.80	-60.80	-3.75	.036	-.881	49.64	.014
	(0.27)	(1.80)	(014)	(0.11)	(1.90)	(3.77)	(0.01)
worker	11.05	-52.02	-0.17	.114	-713	54.12	.512
	(0.45)	(1.54)	(0.01)	(0.34)	(1.53)	(4.21)	(0.47)
unemployed	7.23	-32.60	-7.21	.138	-.375	50.34	1.404
	(0.27)	(0.89)	(0.25)	(0.40)	(0.74)	(3.39)	(1.25)
entrepreneur	76.52	-3.48	66.67	.510	-371	119.22	.576
	(2.25)	(0.09)	(1.86)	(1.43)	(0.76)	(4.45)	(0.51)
cash user			-15.85				
			(1.98)				
R^2	0.096	0.075	0.103	0.117	0.925	0.095	0.279
SEE	110.54	111.82	110.73	0.813	0.824	10.53	0.429
n	990	990	990	990	990	990	1009
weighted	no	yes	no	no	yes	no	probit

Dependent variable: m = amount of cash held at moment of interview. cash user = respondent uses mainly cash (dummy variable).

Table 9. Results from 2012 Consumer survey

	cash user	*wa*	*way*	*way*	*wb*	*wb*	*wb*
frequency		-.310			.168	.189	.152
		(4.23)			(2.67)	(3.00)	(2.71)
female	.010	-.266	-1.113	-1.725	-.572	-.506	-.340
	(0.07)	(3.37)	(2.57)	(2.31)	(2.00)	(2.00)	(1.46)
age <20	-1.370	-.215	-2.307	-2.021	.086	-.279	.097
	(1.90)	(1.58)	(2.47)	(1.40)	(0.19)	(0.51)	(0.20)
age: 20-34	-2.206	-.153	-1.910	-.807	-.21	-278	-.007
	(3.71)	(1.25)	(2.60)	(0.53)	(0.62)	(0.76)	(0.02)
age: 35-49	-1.388	.205	-.503	-.784	.825	.777	1.118
	(2.47)	(1.87)	(0.73)	(0.93)	(1.72)	(1.41)	(2.21)
age: 50-64	-1.215	.216	.010	.100	-.840	-.095	-.078
	(2.21)	(5.83)	(1.00)	(6.61)	(2.67)	(3.00)	(2.81)
age: >64	-1.163	.296	.715	.953	.120	-.143	.062
	(1.98)	(1.59)	(0.83)	(1.03)	(0.27)	(0.36)	(0.21)
pensioner	.678	.154	4.772	5.094	.835	.808	.388
	(1.94)	(8.50)	(8.06)	(7.20)	(2.94)	(2.69)	(1.54)
director	..	.112	6.998	8,617	-.006	-.041	-.481
		(5.12)	(2.41)	(1.83)	(0.01)	(0.11)	(1.10)
housewife	.800	.125	4.602	4.886	.569	-.508	.068
	(1.00)	(4.79)	(4.98)	(4.15)	(1.13)	(1.06)	(0.15)
farmer	-.093	.197	6.545	5.916	1.582	1.327	1.148
	(0.12)	(4.59)	(4.29)	(4.42)	(1.51)	(1.50)	(1.28)
student	.096	.084	4.236	3.713	.609	.666	.281
	(0.14)	(1.59)	(4.71)	(2.77)	(1.37)	(1.32)	(0.63)
white-collar	.180	.113	4.763	5.831	.435	.315	-.073
	(0.32)	(10.07)	(7.28)	(4.81)	(1.04)	(0.84)	(0.20)
worker	.681	.107	5.550	5.311	.619	.726	.430
	(1.22)	(9.35)	(7.60)	(6.27)	(1.47)	(0.84)	(0.85)
unemployed	.801	.091	7.009	6.558	-.525	-.335	-.747
	(1.23)	(5.02)	(2.85)	(2.89)	(1.60)	(0.95)	(1.76)
entrepreneur	.843	.118	4.614	4.586	2.377	-.041	1.671
	(1.40)	(4.97)	(4.64)	(3.39)	(1.74)	(0.11)	(1.58)
wa*fa							.002
							(0.94)
R^2		0.240	0.925	0.067	0.080	0.103	0.097
SEE	0.373	0.792	0.464	0.471	0.306	0.307	0.282
n	413	474	474	474	477	477	450
weighted	no	no	no	yes	no	yes	yes

Dependent variable: wa = usual amount of cash withdrawn from ATMs, way = wa*fa = amount of cash withdrawn from ATMs during one year and wb = amount of cash withdrawn from a bank office in one month.

Table 10. Results from 2006 survey of bank office consumers (households)

	wb	*Wb*	*log(wb)*	*wb*	*nb*
annual frequency = 2	.745	-1.980	4.743		
	(5.08)	(1.97)	(12.45)		
annual frequency = 4	1.439	-1.344	4.834		
	(2.61)	(1.34)	(13.68)		
annual frequency = 10	.549	-1.855	4.644		
	(17.01)	(1.89)	(13.46)		
annual frequency = 30	.740	-1.622	4.965		
	(3.54)	(1.69)	(14.61)		
annual frequency=45	1.677	-1.068	5.102		
	(3.95)	(1.349	(14.80)		
annual frequency = 120	1.766	-1.133	5.170		
	(10.24)	(1.34)	(14.92)		
annual frequency = 360	2.685	-1.122	5.203		
	(6.29)	(1.08)	(14.72)		
male		.334	.211		6.749
		(3.49)	(5.02)		(1.68)
age: 20-34		.760	.155		67.3
		(1.13)	(0.62)		(1.73)
age: 35-49		.761	.378		12.62
		(1.12)	(1.51)		(0.31)
age: 50-64		.702	.259		-26.85
		(1.04)	(1.03)		(0.68)
age: >64		1.119	.290		-30.67
		(1.33)	(1.12)		(0.78)
worker		1.137	.832	104.9	86.9
		(2.14)	(7.13)	(13.95)	(2.01)
pensioner		.831	.776	40.9	72.6
		(5.95)	(10.71)	(21.95)	(1.67)
white-collar		1.466	.923	94.8	89.9
		(2.68)	(8.41)	(11.52)	(2.04)
entrepreneur		2.861	1.198	90.8	85.1
		(2.16)	(8.33)	(7.84	(1.92)
unemployed		1.119	.631	41.7	48.2
		(1.94)	(3.49)	(4.63)	(1.10)
farmer		.942	.734	43.7	63.9
		(2.09)	(4.42)	(2.53)	(1.35)
house-wife		1.934	1.186	62.6	51.6
		(1.51)	(3.16)	(2.59)	(9.93)
student		.767	.465	151.4	109.4
		(0.98)	(2.42)	(5.83)	(2.86)
purchase of car		5.782	1.780		88.7
		(6.09)	(6.61)		(3.03)
vacation		.357	.376		21.9
		(1.45)	(1.67)		(0.86)
liquidity		.014	-.055		-13.0
		(0.07)	(0.25)		(0.54)
other purchase		.395	.311		12.4
		(1.73)	(1.40)		(0.51)
transport		1.252	.884		93.8
		(2.73)	(3.03)		(2.63)
transfer		.430	.544		31.9
		(1.53)	(2.08)		(1.08)
other		.468	.237		8.46
		(1.95)	(1.07)		(0.35)
saving		.136	.150		-18.8
		(0.52)	(0.60)		(0.76)
present		.351	.175		26.5
		(1.16)	(0.67)		(0.91)
auction		2.165	1.084		.36.7
		(1.80)	(2.18)		(0.64
purchase of house		7.521	1.002		.34.1
		(1.55)	(1.22)		(0.94)
import of goods		.492	.485		110.6
		(0.86)	(0.63)		(2.34)
R^2	0.040	0.215	0.306	0.104	0.345
SEE	3.269	2.987	0.831	87.99	81.34
N	1738	1738	1738	1744	1743

Dependent variable: wb = amount of cash withdrawn from bank account, nb = frequency of cash withdrawals in one year.

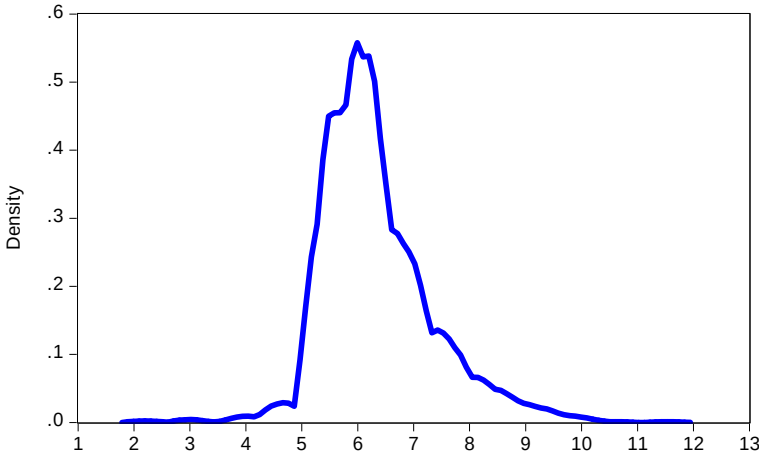
Table 11. Results from 2006 survey of bank office consumers (firms)

	Wb		*log(wb)*	*wb*	*nb*
small company	2.540		6.601		2.822
	(1.45)		(14.00)		(17.28)
medium size company	3.598		6.826		2.915
	(1.88)		(15.75)		(17.63)
large company	12.105		6.966		2.939
	(1.12)		(11.81)		(9.71)
size not known	1.082		6.561		3.539
	(0.54)		(11.34)		(4.74)
agriculture	-2.522		-.499		.404
	(1.57)		(1.62)		(0.53)
industry	-2.710		.418		.448
	(0.66)		(1.09)		(1.76)
construction	-.679		.745		.327
	(0.33)		(2.79)		(1.65)
commerce	.115		.887		.524
	(0.04)		(3.05)		(2.47)
transport	-1.144		.163		.336
	(0.33)		(0.33)		(1.23)
frequency = 1		-1.813	-.211	.800	
		(1.11)	(0.50)	(4.35)	
frequency = 6		-.482	-.033	2.909	
		(0.32)	(0.09)	(5.01)	
frequency = 12		.942	.247	3.702	
		(0.63)	(0.56)	(4.56)	
frequency = 60		1.939	.153	5.528	
		(0.83)	(0.38)	(3.68)	
frequency=360				3.811	
				(3.67)	
global firm				-1.031	
				(0.81)	
R^2	0.055		0.099	0.011	0.044
SEE	12.259		1.368	12.163	1.052
n	197		197	197	197

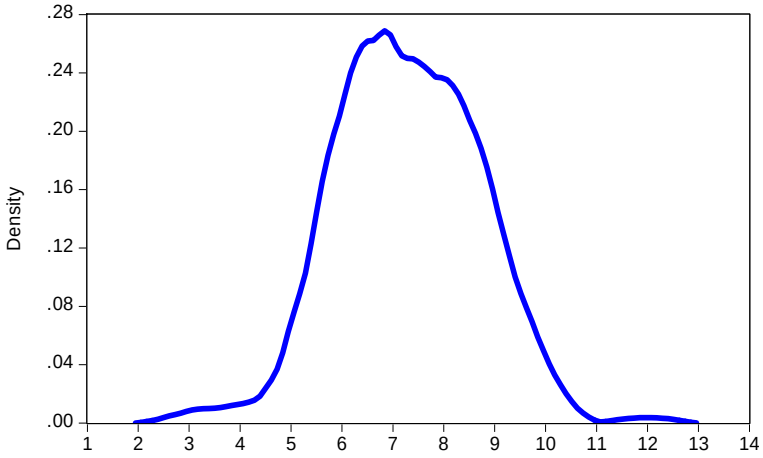
wb = withdrawn sum of cash and nb = withdrawal frequency.

Figure 6. Kernel densities of OTC withdrawals (in logs)

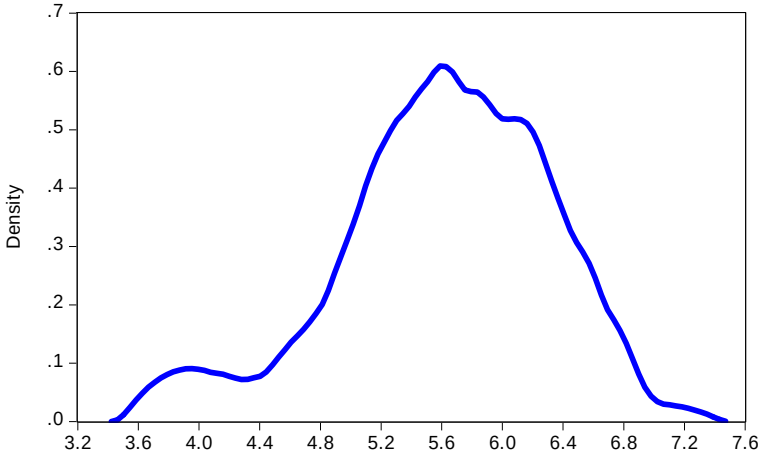
households' reponses



firms' responses



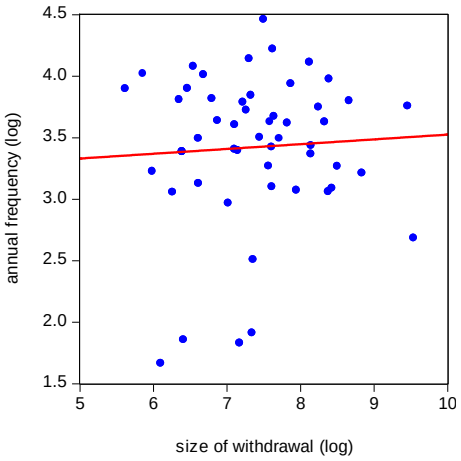
banks cash operators' estimates for all customers



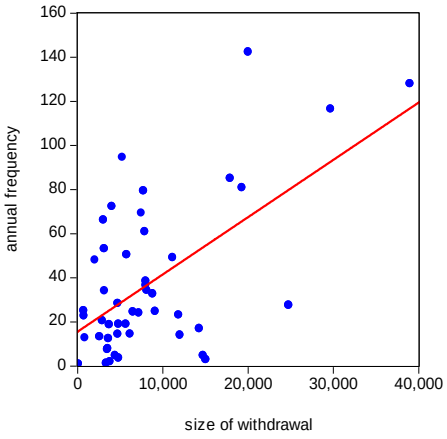
Mean values are 1133, 3857 and 335, respectively.

Figure 7. Cash operators' estimates of the OTC withdrawal sizes and frequency

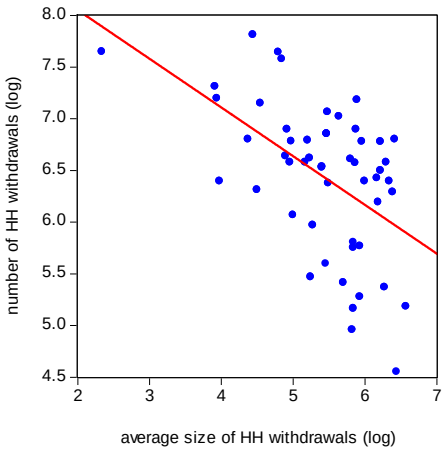
households



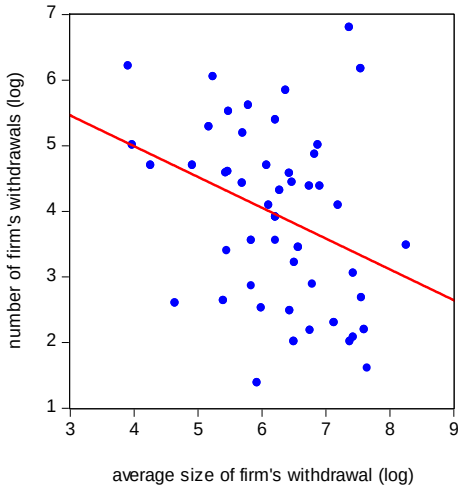
firms



households



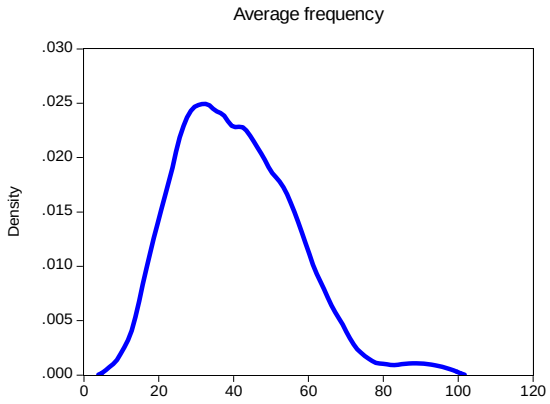
firms

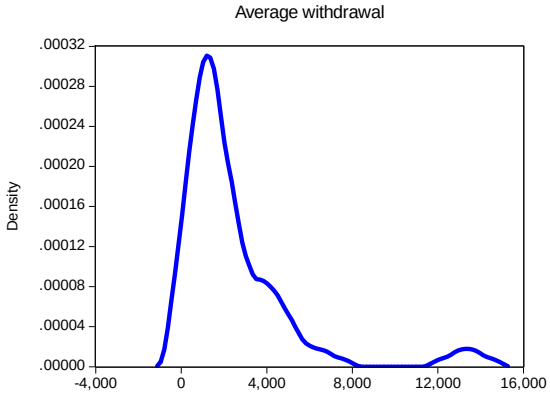


The first two graphs is based on banks' cash operators' estimates of average size of cash withdrawals (ws) and average cash withdrawal frequency of customers (n) in different bank offices. The upper panel represents households and the lower firms. (for households ws = .515 - .045*n, R^2 = 0.119 and for firms ws = 7.357+.409*n, R^2 = 0.202)) . All values represent individual bank offices. The two latter graphs represent actual values of withdrawal size and volume (number) of withdrawals in individual bank offices based on household – non-household distinction.

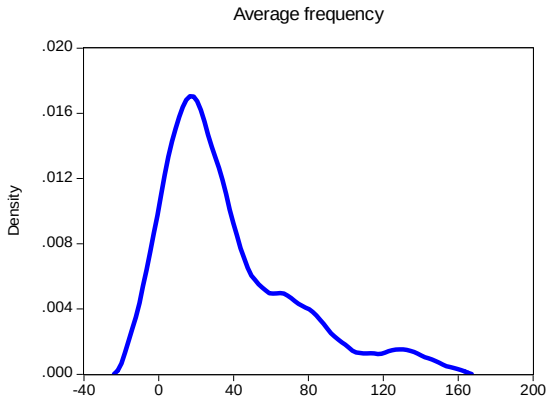
Figure 8. Banks' cash operators' estimates of average withdrawal frequencies and average withdrawal sizes

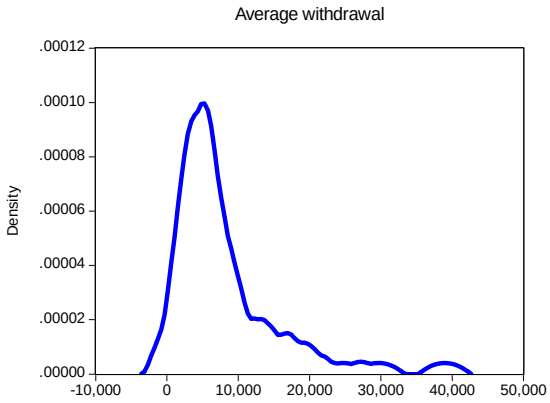
households





firms





In the questionnaires, banks' cash operators were asked to provide data on household's and firms' withdrawals and withdrawal frequencies and on operators' subjective assessment of the distribution of withdrawals in terms of size of withdrawal and frequency of withdrawal of different customers (these later data are used in the figure). All values represent individual bank offices.

8. Conclusions

The aggregate use of cash is difficult to measure accurately. However, it is important or at least interesting to follow the development of cash payments in contrast to card payments. For most euro countries, there are no estimates of the volume or value of cash payments. In this paper, we have proposed a simple calculation scheme to estimate the public use of cash by tracking the primary sources of banknote distribution to the public. We suggest that we can approximate overall cash usage by summing up the ATM and OTC distribution of banknotes. In addition we must take into account that cash can be recycled by the public. Cash can be used and recycled between households (consumers) or between companies (B2B), as both of these sectors make cash transactions within the sector. Unfortunately, we do not have any reliable data about the extent of this recycling, so we have simply assumed recycling rates for them.

Consumers most often withdraw their cash from ATMs and in some euro countries also as OTC withdrawals from banks' branches. The total value of ATM distribution of banknotes is published in the ECB statistics, but the distribution of cash to the public over the bank counters is available only for some euro countries. This complicates our estimation. As for many euro countries, OTC withdrawals of banknotes were not available, we estimated the OTC distributions estimates based on either CIT deliveries of banknotes to bank branches or NCB withdrawals of banknotes, again assuming CI or CIT recycling rates to take into account the same physical banknotes taking part in the transactions.

For the EU12 countries, our cash usage estimates have been relatively stable at around 2400 billion euro in 2007-2009. This is based naturally on the stability of ATM and OTC cash withdrawals, but it also depends on the reliability of OTC withdrawals data. For a couple of countries, the data may raise questions. For 2010, the euro area cash usage estimate shows a slight decrease. The cash usage calculations have been aggregated from country-specific data. In our calculations, we used rough assumptions of the recycling rates, as there is no current official statistics on the recirculation of banknotes. However, the ECB has already started to collect data on recycling of banknotes via NCBs from professional cash handlers in relation to the banknote recycling framework that could be used later in assessing cash recycling rates. Of course questionnaires can be used as well for calculating recycling rates.

The cash distribution estimates of cash usage were also briefly compared with the available estimates of the cash usage from Germany, Netherlands and Finland. We also compared the estimates with other measures of cash usage, combining the return frequency of banknotes with different estimates of cash holdings and cumulative net circulation. Even if the range of estimates is rather large, this study used one method for tracking the use of cash over time, which is valuable for assessing trends in the cash cycle. So the cash distribution procedure at least gives us some ground for comparing the use of cash in retail payments over the euro area.

Analyses with the questionnaire data from Finland showed that the cash cycle estimates seem to be largely consistent with the available micro data. These data suggest that there are huge differences between different households and firms in terms of cash withdrawal behaviour. Thus average values do not necessarily give a solid basis for estimating the money balances in the economy. For firms, this problem is even more obvious, as the sampling errors can be much more important. The useful thing in the survey studies is that both ATM and bank office customers can be simultaneously compared and the total money balances can be estimated more precisely.

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