

ELECTRONIC MONEY, CURRENCY DEMAND AND SEIGNORAGE LOSS IN THE G10  
COUNTRIES

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SUMMARY

In this study we estimate the effect of electronic money on currency circulation and central bank seignorage in the Group of Ten countries. We consider different stages in the acceptance of electronic money. First, we use three methods to estimate the partial effect of prepaid cards. Second, we include other types of electronic money which may eventually eliminate transaction balances. Third, in the long run dishoarding may occur as well, eliminating currency completely. Measured by opportunity cost, in the near future seignorage loss due to prepaid cards is expected to be rather limited, around 0.1 % of GDP. Eventual replacement of all transaction balances in the case of an overall use of electronic money would reduce seignorage by 0.2% of GDP in the Netherlands to 0.4% of GDP in Italy. An even larger seignorage loss would result in the long run, up to 0.7% of GDP, if hoarded banknotes would disappear as well.

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# ELECTRONIC MONEY, CURRENCY DEMAND AND SEIGNORAGE LOSS IN THE G10 COUNTRIES

## 1 INTRODUCTION

In this paper the impact of the use of electronic money on currency demand and its possible consequences for seignorage loss in the G10 countries is estimated. Electronic money considered here includes multi-purpose prepaid cards as well as other electronic transactions used in Internet-payments (e-cash) and EFTPOS (debit) payments. Strictly speaking the latter category does not involve additional financial assets, besides the currently available demand deposits. However, like prepaid card payments, electronic transfers are made, replacing cash turnover and consequently currency demand. For this reason we use a broad definition of electronic money and include EFTPOS payments in our analysis.

In chapter 2 we determine the possible reduction in the amount of notes and coin outstanding due to increased use of electronic money. First, we spend the largest part of our analysis on the near future when prepaid cards become accepted widely. The effect of prepaid cards on currency circulation is estimated in three different ways, two of which generate rather similar results. Then, the possible effects of other types of electronic money, like EFTPOS and e-cash, are taken into account. Unlike with prepaid cards, there is no indication of any limit to the use of EFTPOS or e-cash payments. This makes it more difficult to assess the specific effects of these types of electronic money. For the current situation, however, we give an indication of the reduction in currency demand due to EFTPOS-payments. The combined results of all types of electronic money are considered in the long term situation, when transaction balances are entirely replaced by electronic money. Finally, we look at the ultimate case, when currency is eliminated completely, due to additional dishoarding of banknotes. In chapter 3, we compute the loss of seignorage following from each of the considered stages in the expected reduction in currency circulation. Chapter 4 summarizes and assesses the main conclusions.

## 2 MEASURING THE DECREASE IN CURRENCY CIRCULATION

### 2.1 Estimation of prepaid card effect

Up to now, multi-purpose prepaid cards have been used mainly in pilot projects (Gruber, 1996). In the absence of experiences with nation-wide use of these cards, we can only roughly estimate their effects on currency circulation by making certain assumptions. To get an impression of the sensitivity of the estimated effects with respect to these assumptions, we consider three different estimation methods. In all estimates it is assumed that prepaid cards are loaded directly from bank accounts without the use of banknotes. As far as banknotes are used for this purpose, their circulation will decrease less than indicated by our computations.

#### 2.1.1 Method 1: average value on prepaid cards

A first measure of the reduction in note and coin circulation is computed from the expected value on prepaid cards that will eventually be in use. Implicitly, this approach assumes complete substitution of currency by prepaid cards up to the value that follows from the number of cards and the average value held on a card, which neglects the possibility that prepaid cards replace demand deposits. The value held on a card may depend, among other things, on the maximum value up to which cards can be loaded. For the number of prepaid cards, we use the total population. This figure may be an overestimation as it includes persons (young children and elderly people) which will not use these cards. On the other hand, a substantial number of people will probably get accustomed to the use of more than one multi-purpose card (BIS, 1995b). The average amount held on prepaid cards is estimated at USD 100, which is approximately the equivalent of the amount of cash kept in wallets or at home for transaction purposes, according to surveys held in the US (Avery *et al.* 1996) and in the Netherlands (Boeschoten, 1995), respectively.

Table 1 Results of value on prepaid cards method

	Population 1994 (millions)	Value on prepaid cards		Total currency as percentage of GDP 1994
		Billions of USD	As percentage of currency circulation	
Belgium	10.1	1.0	7	5.7
Canada	29.0	2.9	13	4.0
France	57.8	5.8	11	3.9
Germany	81.3	8.1	5	7.6
Italy	57.1	5.7	9	6.2
Japan	125.0	12.5	3	9.9
Netherlands	15.3	1.5	7	6.8
Sweden	8.7	0.9	8	5.0
Switzerland	7.0	0.7	3	9.2
United Kingdom	58.3	5.8	16	3.5
United States	259.0	25.9	6	6.0

The results in Table 1 show a moderate prepaid card effect on currency circulation, varying from less than 3% of currency circulation in Japan and Switzerland to 16% in the United Kingdom. The reason for these inter-country discrepancies is the strongly differing importance of the currency circulation in the various countries. Thus, in the United Kingdom, where total currency amounts to only 3.5% of GDP, the impact of prepaid card use is relatively, though not absolutely, much more substantial than in Japan and Switzerland, where currency still plays a major role in cash transactions and as a means of hoarding.

#### 2.1.2 Method 2: value of lower denominations

A second way to estimate the reduction in currency due to the use of prepaid cards is to assume that these cards will replace lower value denominations in particular. This approach has been applied by Wenninger and Laster (1995) for the US and by the BIS (1995a) for the G10 countries. Both studies assume, for the sake of simplicity, that all lower denominations will eventually disappear from circulation. By doing so the method overestimates the prepaid card effect on currency circulation, since lower denominations may still be needed for payments of large value cash transactions. Moreover, the results strongly depend on the denominational structure of the note and coin circulation and may

be distorted from this point of view. Therefore, estimates on the basis of this lower denominations method should be interpreted as rough approximations of the upper value of the currency circulation reduction due to the use of prepaid cards.

Indeed, the results in Table 2, which are based on the replacement of all denominations with a face value of up to USD 25, show considerably stronger effects than those which result from the prepaid card value method in Table 1. In Canada and in the United Kingdom, countries with relatively low currency figures but a low value of the highest denomination, the results suggest a decrease in currency circulation of about 50%. This is about three times as high as the corresponding estimates using the prepaid card value method. In the case of Japan and the United States the estimated effects are even five times as high. For Japan this is due solely to the very low upper limit of the banknote range. According to the underlying estimation method, this implies that a large share of the circulation is affected by the prepaid card, even if part of it will be used for higher value payments. For the United States the considerably higher estimate is due to the low upper limit of the banknote range in combination with the fact that, according to estimates by Porter (1993), over two-thirds of the US currency stock may

Table 2 Results of value of lower denominations method

	Total currency outstanding	Value of denominations < USD 25	
		billions of USD	as % of currency circulation
Belgium	13.6	1.5	11
Canada	21.7	9.3	43
France	52.5	13.6	26
Germany	162.0	18.0	11
Italy	62.5	4.9	8
Japan	466.6	58.3	12
Netherlands	23.5	2.9	12
Sweden	10.2	2.2	22
Switzerland	24.6	2.8	11
United Kingdom	36.1	18.4	51
United States	403.8	134.9	33

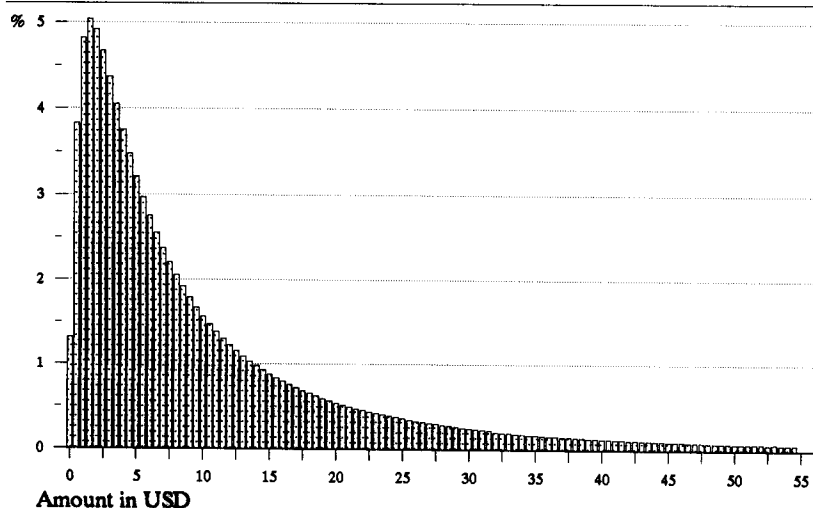
Source: BIS (1995b); converted at year-end USD exchange rates

be held abroad 1). Consequently, the lower denominations method overestimates the effect of prepaid cards on currency demand in the US, unless the foreign demand for US currency is affected in the same way as in the US. This does not seem very plausible, given the countries where US currency is held and the motives underlying these holdings. In the case of Germany and Switzerland, the other two countries with a high external currency demand, the discrepancy between results of the two estimation methods is considerably smaller, due to the presence of high value banknote denominations, which are also used abroad.

### 2.1.3 Method 3: currency needed for payments

A third, more advanced, method of assessing the prepaid card effect on currency circulation is based on estimates of the need for notes and coin for lower value payments which probably will be replaced by prepaid card payments. For this purpose we use a frequency distribution of cash payments, obtained from an expenditure survey among Dutch

Figure 1 Frequency distribution of payments



1) The estimated decrease of 33% is considerably higher than the reduction of 13% computed by Wenninger and Laster (1995). The reason for this is that here, in view of an expected wider use and in view of comparability with method 3, an upper limit of USD 25 has been chosen instead of the USD 10 assumed by Wenninger and Laster. Besides, the results do not change when we assume an upper limit of USD 20, as assumed by the BIS (1995a).

households (Boeschoten and Fase, 1989). Extensive evaluation of the survey results suggests that the outcomes are reasonably representative for the Netherlands. This frequency distribution is fitted to a lognormal distribution, which appears to be the most adequate distribution from a statistical point of view. The average payment is USD 13, while the modal payment is USD 1.70. A more detailed description of the survey and the fitted distribution of cash payments can be found in Boeschoten and Fase (1989) and Bos (1993). The resulting distribution (Figure 1) bears some uncertainty as it is based on survey results concerning only one country. However, the results of Virén (1994) show a comparable frequency distribution for Finland, suggesting a more general validity of the distribution, which is roughly confirmed by survey results of Perdrix (1994) for France.

The distribution has been applied to all G10 countries, in order to calculate the percentage share of notes and coin that is needed for low value payments. All calculations are based on frequencies of cash payments up to USD 550. Up to USD 55 payment amounts are rounded to multiples of the smallest coin. Above USD 55 payment amounts are rounded

Table 3 Results of need for currency method

	Percentage decrease in need for currency		Percentage decrease in circulation			Currency circulation in 1994 in billion USD		Decrease in circulation in billion USD		
	Notes	Coin	Notes	Coin	Total	Notes	Coin	Notes	Coin	Total
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Belgium	47	87	7	87	10	13.0	0.6	0.9	0.5	1.4
Canada	50	89	34	90	37	20.2	1.5	6.9	1.3	8.3
France	44	88	19	88	23	49.2	3.3	9.4	2.9	12.3
Germany	44	88	8	88	12	152.4	9.6	11.4	8.4	19.8
Italy	51	90	13	90	14	61.4	1.1	7.9	1.0	8.9
Japan	34	88	5	88	10	429.0	26.0	22.3	22.9	45.2
Netherlands	43	85	7	86	12	22.1	1.4	1.5	1.2	2.7
Sweden	45	88	32	86	34	9.8	0.4	3.1	0.3	3.4
Switzerland	44	88	5	88	11	23.0	1.6	1.2	1.4	2.6
United Kingdom	43	87	23	87	36	28.9	7.2	6.7	6.2	12.9
United States	40	88	17	88	22	382.0	21.8	65.3	19.2	84.5

Explanatory note: All payments below USD 25 are assumed to be paid by prepaid cards. For EU-countries, columns 1-5 are based on Bos (1993).



to multiples of the local currency. The numbers of notes and coin necessary to carry out each payment are calculated by assuming that a payment is performed in the most efficient manner, *i.e.* using a minimum number of notes and coin and allowing for change, given the country's available denominations (Boeschoten and Fase, 1989) 2). Although it is clear that not all payments are performed in this manner, this assumption is the least sensitive to smoothing of the frequency distribution of payments .

Next, the effect of prepaid cards on currency circulation has been computed by assuming that all former cash payments below USD 25 are carried out by means of prepaid cards. The first two columns of Table 3 present the percentage effects on the numbers of notes and coin needed for transaction purposes 3). These effects can only be applied directly to outstanding circulation if all denominations have the same turnover rate. The turnover rates differ, however, by denomination and especially between notes and coin, as notes are used much more frequently and coins are hoarded or lost more often. Therefore, columns 3 and 4 present computed effects of prepaid cards on actual circulation, assuming that circulation of each denomination shrinks by the same proportion as the number of transactions carried out using that denomination. This procedure duly takes into account the importance of higher denominations in the value of the banknote circulation.

The results in column 4 show that in all countries considered, coin circulation will be reduced by the use of prepaid cards by more than 85%. This figure is even higher if adjusted for the fact that a considerable part of issued coin is not in circulation any longer due to loss, hoarding, disappearance abroad etc. 4). The remaining circulation is mainly needed as change for higher value cash payments.

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2) These calculations use an algorithm which is inspired by Cramer (1983). More detailed information is available on request.

3) Given by  $100(1 - \frac{\sum_{j=25}^{550} [f_{ij} n_{ij}]}{\sum_{j=0}^{550} [f_{ij} n_{ij}]})$ , with  $n_{ij}$  = number of coin  $i$  for amount  $j$ ,  $f_j^{j>25}$  = frequency of amount  $j$ .

4) In the Netherlands about 25% of the value and 57% of the number of coins is not in circulation any longer (Bos, 1994). Comparable loss figures were found for the United Kingdom (De Glanville, 1970).

The decrease in note circulation is, at least in percentages, considerably lower than in the case of coin (column 3).

The computed effects for total currency circulation (column 5 and 10) are, generally speaking, remarkably similar to those computed by means of the value of lower denominations method, though for most of the countries they show somewhat lower effects. The only exceptions are Italy and Sweden, where the computed reduction of currency is nearly two times as high as the reduction which follows from the previous method. This is probably due to the fact that, given the banknote range, a considerable part of the denominations above USD 25 is affected by the use of prepaid cards as well.

## 2.2 Effect of EFTPOS-transactions

The present impact of electronic payment transfers on currency demand can be roughly approximated from the value of EFTPOS-transactions. The relative size of these transactions differs widely among the G10 countries. Thus, EFTPOS is relatively unimportant in Canada and the United States, where credit cards are the dominating non-cash payments medium. On the other hand, in Belgium and France, EFTPOS-transactions amount to 5.4% and 6.4% of GDP, respectively. Moreover, in all countries the importance of this kind of electronic transfer is increasing.

The impact of EFTPOS-transactions on the currency circulation so far is estimated in Table 4, by assuming a transactions velocity of cash balances of 30 times a year, which follows from survey results for the Netherlands 5). The reduction in currency demand due to EFTPOS-transactions may be derived by dividing the value of these transactions by this velocity. As evident from the last column of Table 4, the use of

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5) Boeschoten (1995). Avery *et al.* (1986) find a velocity of 54 times a year for the US, which may be an overestimation, due to neglected bottom cash inventories (Boeschoten, 1992).

Table 4 Effect of actual EFTPOS use on currency circulation

	Value of EFTPOS transactions 1994		Reduction in currency due to EFTPOS use in 1994 a)	
	Billion USD	%GDP	Billion USD	%
Belgium	12.9	5.4	0.43	3.2
Canada	6.8	1.2	0.23	1.0
France	86.9	6.4	2.90	5.5
Germany	6.7	0.3	0.22	0.1
Italy	3.8	0.4	0.13	0.2
Japan	0.1	0.0	0.00	0.0
Netherlands	7.9	2.3	0.26	1.1
Sweden	6.2	3.0	0.21	2.0
Switzerland	2.9	1.1	0.10	0.4
United Kingdom	.	.	.	.
United States	5.5	0.2	0.52	0.1

a) assuming a transactions velocity of currency of 30 times a year.

EFTPOS has only reduced currency demand by more than 5% in France. Moreover, these figures probably overestimate the reduction in currency, as part of the EFTPOS-transactions replace other non-cash payments, like cheque and credit card payments.

Given the growth potential of these EFTPOS transactions, it may be of great interest to indicate the potential future impact of EFTPOS-transactions. Unlike with prepaid cards, there is no indication of any maximum value for the use of EFTPOS or other types of electronic payments media like e-cash. Ultimately, a situation may result in which all lower amounts up to a certain level are paid by prepaid cards, while all higher value transactions are paid by other forms of electronic money. This would eliminate currency balances used for transactions purposes completely or nearly completely. The size of this combined effect of prepaid cards and other electronic money is dealt with in the next section.

### 2.3 Total potential effect of electronic money

The separate effects on currency demand of prepaid cards and other forms of electronic money like EFTPOS cannot simply be tallied up. Prepaid card payments may substitute for lower value EFTPOS-payments, which would reduce the total effect. However, as mentioned before, the combination of prepaid cards, EFTPOS and other kinds of electronic money like e-cash may eventually replace transactions cash balances completely. Thus, the potential, combined reduction of the currency circulation due to electronic money is approximately equal to the total amount of cash which is used for transactions purposes. The other part of cash balances, currency which is hoarded, is, at least in first instance, not affected by the use of electronic money. Transactions balances have been computed by subtracting the amount of currency in hoards derived from estimates by Boeschoten (1992) from total currency circulation, by using 1994 figures 6). It is beyond the scope of this study to go into an extensive evaluation of the results. The relative importance of transaction balances compared to hoarding seems to depend on a number of factors, including the tax level, the size of the black economy, the value of the highest banknote denomination, institutional arrangements and - last but not least - the state of the payment system. Generally speaking, the estimates suggest that on average at least one-third of currency circulation is hoarded.

The part of currency circulation used for transaction purposes, which potentially can be replaced by electronic money, appears to differ substantially per country (Table 5). However, as a percentage of GDP the inter-country discrepancies are less extensive, ranging from 2.8% of GDP in Canada up to 4.2% of GDP in Italy (third column). Exceptions are Germany and especially Switzerland, which show higher figures, probably due to foreign use of German and Swiss currencies. All in all the results suggest a transactions demand for cash of about 3% of GDP to 4% of GDP, which might eventually be replaced by electronic money.

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6) Estimates of currency hoarding are derived from life time figures of banknotes. Anderson (1977), Virén (1993) and Van Hove and Van Vuchelen (1994) find comparable hoarding estimates for the United States, Finland and Belgium, respectively.

Table 5 Potential total effect of electronic money

	Total transaction balances			Reserve balances	
	Billions USD	% of total circulation	% of GDP	Billions USD	% of GDP
Belgium	9	63	3.6	0.1	0.0
Canada	15	70	2.8	0.4	0.1
France	40	77	3.0	1.5	0.1
Germany	104	64	4.8	28.7	1.3
Italy	42	67	4.2	56.8	5.6
Japan	.	.	.	30.4	0.7
Netherlands	10	42	2.9	11.2	3.2
Sweden	7	68	3.4	0.2	0.1
Switzerland	15	62	5.6	3.2	1.2
United Kingdom	36	100	3.5	3.4	0.2
United States	263	65	3.9	30.8	0.5

Explanatory note: for Japan no hoarding estimates are available; Reserve balances on basis of 1994 figures (BIS, 1995b).

In the longer run, currency hoards (mainly kept in higher denominations) may also be affected by the use of electronic money. As far as new technology provides a safe and anonymous electronic store of value, possibly with interest, it would be more efficient to shift these hoards to electronic balances. After wide-spread acceptance of electronic money in all kinds of transactions, it may even become less attractive and to some extent suspect to use large-denomination notes. Therefore, one may expect that in the long run, when electronic money becomes the main payments medium, currency hoards will be reduced, either by converting them into deposits or by spending or investing them. This would mean that, ultimately, all or at least the major part of currency circulation would disappear.

Apart from outstanding currency, reserve balances of banks at the central bank may also be affected by the use of electronic money. These reserve holdings may be reduced if electronic money is issued outside the banking system or if banks reduce their required or free reserves due to a lower demand for deposit money. However, central banks in the European Union have restricted the issue of electronic money to credit institutions. Moreover, some central banks pay interest on reserve balances, which means that a reduction of cash reserves would have no or

only minor consequences for seignorage. This holds, for instance, for central banks in Italy and the Netherlands, where reserve balances are by far the highest (Table 5). Also, changed central bank policy, in view of increased international competition among commercial banks, has contributed to a reduction of reserve balances. Therefore, it is difficult to form any expectation about the change in these balances and hence about its possible effect on seignorage income due to the extended use of electronic money.

### 3 CONSEQUENCES FOR SEIGNORAGE

Seignorage can be measured in several ways (Gros, 1989; Rovelli, 1994). Like the BIS (1995a), instead of total monetization, we use the nowadays more appropriate definition based on opportunity costs,

$$S = iA \tag{1}$$

with  $S$  being the amount of seignorage received by the central bank per year,  $i$  the nominal interest rate and  $A$  central bank assets. This definition can be extended by

- subtracting interest payments by the central bank on bank reserves
- subtracting costs of managing seignorage
- differentiating between interest rates
- including excess monetization

If central bank assets equal the monetary base ( $H$ ) and if reserves ( $R$ ) remain unchanged, then

$$\Delta S = i\Delta H = i(\Delta C_u - \Delta C_o) \tag{2}$$

with  $C_u$  and  $C_o$  being the amount of currency and coin in circulation, respectively. Additionally, bank reserves may be reduced if non-banking institutions are allowed to issue electronic money. Then

$$\Delta S = i(\Delta C_u + \Delta R - \Delta C_o) \tag{3}$$

In Table 6 we compute the opportunity cost measure of seignorage foregone due to a widespread use of electronic money, using the long-term interest rate. On average this rate may slightly overestimate the yield on the central bank financial assets, due to restrictions that hold with respect to liquidity, and the type of assets and currencies.

The estimates of seignorage reduction due to the expected use of prepaid cards clearly differ, depending on which of the three estimation methods for currency reduction has been used. As mentioned in the evaluation of these methods, reduction in seignorage estimated by method 2, based on complete elimination of lower denominations, is rather similar to the result of method 3, based on the need for currency. Generally, these results are considerably higher than seignorage reduction estimated by method 1, based on the average value on prepaid cards. On the whole, seignorage loss due to the use of prepaid cards may range between about 0.05% of GDP and 0.15% of GDP.

The combined effects from the use of electronic money for lower value payments (by means of prepaid cards) and higher value payments (by means of other types of electronic money like EFTPOS) are estimated to be substantially higher. Eventual replacement of all transactions cash balances in the case of such an overall use of electronic money would imply a loss of seignorage ranging from 0.20% of GDP in the Netherlands to 0.44% of GDP in Italy. Ultimately, currency hoards may disappear too. In that case, seignorage from currency may be reduced to zero. This would imply a loss of seignorage ranging from about 0.3% of GDP in Canada and the United Kingdom, where cash is already less important, to 0.5% of GDP and more in countries like Italy and Germany, which are still rather cash-oriented. Possible seignorage loss from a reduction in central bank reserve balances due to increased use of electronic money is included in Table 6 only as a reminder, in view of the underlying uncertainties. In general, this component of seignorage loss is, if evident at all, expected to be rather small. Moreover, in Italy and the Netherlands, there will be hardly any seignorage loss in this respect, since in these countries central banks are paying interest on these balances.

Table 6 Potential seignorage reduction due to electronic money

	From transactions balances due to			From reserve balan- ces	From hoar- ding	Total from cur- rency	
	prepaid cards		electronic money in general (including prep. cards)				
	estimation method						
	1	2	3				
Billions of USD							
Belgium	0.08	0.11	0.11	0.66	(0.00)	0.38	1.04
Canada	0.25	0.80	0.71	1.31	(0.03)	0.55	1.86
France	0.43	1.02	0.92	3.03	(0.11)	0.91	3.94
Germany	0.56	1.24	1.37	7.15	(1.98)	4.03	11.18
Italy	0.61	0.51	0.94	4.43	(6.02)	2.19	6.62
Japan	0.55	2.56	1.99	.	(1.34)	.	20.53
Netherlands	0.11	0.20	0.19	0.69	(0.77)	0.94	1.63
Sweden	0.08	0.21	0.33	0.66	(0.01)	0.31	0.97
Switzerland	0.04	0.14	0.13	0.76	(0.16)	0.47	1.23
United Kingdom	0.48	1.50	1.06	2.96	(0.19)	-	2.96
United States	1.84	9.58	6.00	18.67	(2.19)	10.00	28.67
As percentage of total potential seignorage from currency							
Belgium	7	11	11	63		37	100
Canada	13	43	38	70		30	100
France	11	26	23	77		23	100
Germany	5	11	12	64		36	100
Italy	9	8	14	67		33	100
Japan	3	12	10	.		.	100
Netherlands	7	12	11	42		58	100
Sweden	8	22	34	68		32	100
Switzerland	3	11	11	62		38	100
United Kingdom	16	51	36	100		0	100
United States	6	33	21	65		35	100
As percentage of GDP							
Belgium	0.03	0.05	0.05	0.28	(0.00)	0.16	0.44
Canada	0.05	0.15	0.13	0.24	(0.01)	0.10	0.34
France	0.03	0.08	0.07	0.22	(0.01)	0.07	0.29
Germany	0.03	0.06	0.06	0.33	(0.09)	0.19	0.52
Italy	0.06	0.05	0.09	0.44	(0.60)	0.22	0.66
Japan	0.01	0.06	0.04	.	(0.03)	.	0.44
Netherlands	0.03	0.06	0.05	0.20	(0.22)	0.27	0.47
Sweden	0.04	0.10	0.16	0.33	(0.01)	0.15	0.48
Switzerland	0.01	0.05	0.05	0.28	(0.06)	0.18	0.46
United Kingdom	0.05	0.14	0.10	0.28	(0.02)	-	0.28
United States	0.03	0.14	0.09	0.28	(0.03)	0.15	0.43

Explanatory note: it has been assumed that seignorage on coin is collected by the central bank.



As far as seignorage on prepaid cards is concerned, commercial banks may gain initially after deduction of the costs involved in these cards. However, given growing international competition in the banking sector, one may expect this seignorage to erode quickly, due to either interest payments on these cards or to other arrangements.

#### 4 CONCLUDING REMARKS

In this paper we have estimated the possible impact of electronic money on currency demand and seignorage. Seignorage loss due to the use of prepaid cards *per se* is expected to be limited, as long as these cards are used only for small value payments. The eventual effect strongly depends on the degree of acceptance of these cards, on the amount up to which they are used for payments and on the maximum value stored on these cards. The estimated seignorage reduction is rather similar for two of the three estimation methods used. These two methods give substantially stronger effects compared to the first method which assumes a certain average amount per prepaid card. The difference may be explained from efficiency gains. Nevertheless, the impact of prepaid cards for low value payments on currency demand is expected to be limited.

Seignorage may be affected noticeably, however, by the combined use of electronic money for small value payments (by means of prepaid cards) and large value payments (by means of other types of electronic money). Such an overall use of electronic money would eventually result in a complete or almost complete elimination of transactions cash balances. This would imply a seignorage loss of between 0.2% of GDP and 0.4% of GDP. An even larger seignorage loss of between 0.3% of GDP and 0.7% of GDP would result if currency hoards would disappear as well. This could be caused by the unusual character of cash payments, especially with large denominations, in a world where transactions are largely paid electronically.

The underlying analysis is static, in the sense that it describes a number of stages and the long-term situation, where countries could end up when prepaid cards and electronic transferring are generally accepted and fully in use. It does not describe how this situation will be reached. This depends on a number of critical factors, including technological development, risks of loss and fraud, possible credit facilities and, especially, costs and tariffs. It is to be expected that the substitution process of e-money for currency will come about like a usual product cycle, following a logistic or s-curve. This means that after attainment of a critical mass of participants and point of sale terminals, replacement of cash will strongly gain momentum due to networking effects and taper off when payment possibilities are nearly fully used. Given experience with, for instance, the introduction of salary-accounts and cheques in the Netherlands in the mid-1960s, this process could take between five and ten years, though in a situation of increased international competition a shorter period is certainly conceivable.

All in all, the results indicate that it may be somewhat misleading to consider the seignorage effects of prepaid cards separately from the effects of other forms of electronic money, including EFTPOS and e-cash. There is no clear dividing line between the use of various electronic payments media. Due to technological progress and increasing possibilities to combine them, the dividing line is expected to become even less clear. Therefore, and because of mutual substitution effects, it is preferable to consider the effects of various forms of electronic money simultaneously.

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