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The circulation of euro banknotes and coins in the Netherlands

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NOTES AND COMMUNICATIONS

THE CIRCULATION OF EURO BANKNOTES AND COINS IN THE NETHERLANDS

1 INTRODUCTION

In the countries of the European Economic and Monetary Union (EMU) euro banknotes and coins will be put into circulation from January 1, 2002. Seven new banknotes will be issued and eight new coins. Each EMU country is responsible for the production and distribution of its domestic euro circulation. Therefore, these countries, *in casu* central banks and ministries of finance, each draw up their own plan for this project.

It goes without saying that this task is intricate and vast: collection of the domestic currency, production, storage, and distribution of the new currency. Moreover, the future need for currency is unknown. An additional problem is that in most EMU countries the composition of the circulation will change. This is the case in the Netherlands, where currently twelve denominations in guilders circulate, consisting of six notes and six coins. These have to be replaced by fifteen euro denominations; one more banknote and two more coins. Obviously, the value of each existing denomination will not be in accordance with the value of one of the new denominations.

We unfold a methodology for indicative forecasts of the euro circulation needed in 2002. Two methods are proposed. The first method uses econometric models describing the demand for banknotes and the demand for coins. The second method starts from estimated over-the-counter payments in 2002, and calculates the required notes and coins. Sections 3 and 4 describe these two projection methods. Section 2 precedes with some descriptive statistics. Section 5 presents the euro projections for the circulation in 2002. The last section summarises.

2 SOME STATISTICS ON THE GUILDER CIRCULATION

To form an idea of the actual currency circulation in the Netherlands Figure 1 is presented. Figures 1a and 1b show the number and value of the six banknotes, whereas Figures 1c and 1d are concerned with the six coin denominations. As follows from these figures the total numbers of banknotes consist for a major

part of Dfl. 100, Dfl. 25 and Dfl. 10 notes. In value Dfl. 1,000 and Dfl. 100 domi-
nate. In the coin circulation the lowest three denominations take the largest share
in numbers, which is obvious from the point of view of pricing practice as prices
are often rounded to Dfl. 0.95, Dfl. 0.90 or Dfl. 0.50. The three highest denomi-
nations evidently dominate in value.

From growth figures (not shown here) it follows that the number of notes in
circulation is still increasing considerably, except for the Dfl. 1,000 note where
demand is declining. The demand for the Dfl. 2.5 coin has also declined over the

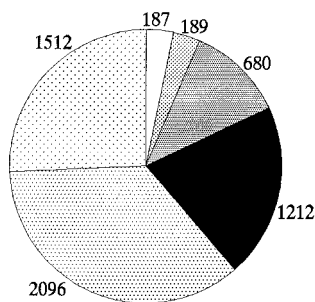**1a Number of banknotes**
(in millions, 1996)
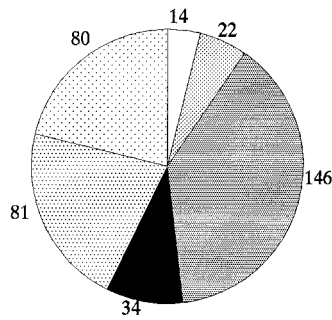
1b Value of banknotes
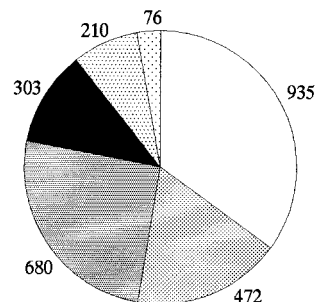(in millions of guilders, 1996)
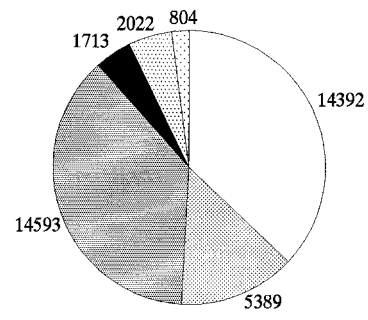
1c Number of coins
(in millions, 1996)

1d Value of coins
(in millions of guilders, 1996)

Figure 1 – Circulation of banknotes and coins

last years. The number of other coins in circulation has grown, but on average far less than notes. Noteworthy is further that the Dfl. 50 note was introduced in 1982, Dfl. 250 in 1986, and that the Dfl. 5 note was replaced by a coin in 1988.

3 A FIRST METHOD TO FORECAST THE EURO CIRCULATION IN 2002

3.1 *Guilder notes*

De Nederlandsche Bank started using an econometric model to explain the demand for banknotes two decades ago (e.g., Fase and Van Nieuwkerk (1976), Fase (1981a)). In this banknote model a separate equation is specified for each denomination. The model is updated and upgraded on a two-year-basis, after which forecasts are made for the banknote circulation for about five years ahead. Our forecasts for euro banknotes are also based on forecasts with this banknote model. There are six banknote denominations, thus six equations to be estimated, and each equation is estimated univariately. Explanatory variables are private consumption, interest rates, and the value of debit card payments at point-of-sale terminals (POS, for short).

Personal consumption is defined as total consumption minus living expenses, like housing rents, which are usually noit paid cash. The interest rate is included, as cash holdings imply forgone interest income on bank accounts. This will hold in particular for higher denominations, since these denominations are mainly used as a store of value. POS turnover is evidently expected to influence currency circulation. Different from debit cards, one could also consider cheques, credit cards, and prepaid cards. An indication of the value of payments by cash and other types of payment is shown in Table 1. It follows that total turnover at POS terminals was about Dfl. 1.8 billion in 1991, increasing more than 20 times over a period of five years to Dfl. 38.4 billion in 1998. This increase has been mainly at the expense of cheques, of which the value more than halved over five years, from Dfl. 33 to Dfl. 14 billion. Credit cards have become more popular, but are still not accepted everywhere and are mainly used for large amounts. Prepaid

TABLE 1 – ESTIMATED TURNOVER BY TYPE OF PAYMENT (IN BILLION GUILDERS)

	POS	Cheques	Credit cards	Prepaid cards	Cash payments[a]
1991	1.8	33	3	–	112
1996	38.4	14	8	0.01	123

[a] Cash payments of private sector excluding firms

cards were introduced a few years ago, but are not widely used.[1] Although other types of payment could be relevant to explain the demand for currency, only debit card payments are used. Other types are not used in the analysis, as reliable and sufficiently long time series are not available.

The econometric model for banknote circulation is specified as

$$CU_{it} = \alpha_i + \beta_i C_t + \gamma_i r_t + \delta_i POS_t$$

with α_i, β_i, γ_i and δ_i parameters to be estimated; i an index equal to Dfl. 1000, Dfl. 250, Dfl. 100, Dfl. 50, Dfl. 25 or Dfl. 10; t a time index in quarters from 1970 to 1996; CU_{it} the circulation by denomination (thousand notes, in natural logarithm); C_t private consumption excluding living expenses (million guilders, in natural logarithm); r_i interest rate, either long or short-term (percentages); POS_t value of payments at points-of-sale (million guilders, in natural logarithm).

The specification implies a constant consumption elasticity of the circulation and, similarly, a constant POS elasticity. In case where consumption increases (decreases) 1%, the circulation increases (decreases) *ceteris paribus* β%. A constant semi-elasticity is assumed between the interest rate and the circulation: a 1% point increase (decrease) in the interest rate implies a γ% increase (decrease) *ceteris paribus* in circulation. These are all long-term elasticities. Although only the long-term relationship is described above, the estimated model is an error-correction model, including short-term dynamics and long-term relationship. This dynamic relationship is important in order to take account of delays in the effects of explanatory variables on the banknote circulation. To adjust for seasonal effects and breaks in the series, dummy variables are included.

Table 2 reports the long-term elasticities that follow from the estimations in their final form. The consumption elasticities are all significantly different from zero. The long-term consumption elasticity decreases with the value of the denominations. This is expected, because an increase in nominal consumption induces more demand for higher denominations. The three highest denominations are significantly influenced by the interest rate, where the semi-elasticity in absolute value increases with denomination values. This supports our expectation that higher denominations are by and large used as a store-of-value. POS-turnover elasticities are significant for the banknotes Dfl. 25 up to Dfl. 250. These elasticities are small, however, which is not according to our expectations. The use of POS terminals has grown considerably and therefore, evidently, less currency is needed. One explanation for the low elasticities might be that there are not enough observations to estimate the effect of POS payments reliably, although the estimated effect is significant. Another explanation is that debit card payments mainly replace cheque payments. The circulation of Dfl. 1,000 and

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1 For a theoretical analysis of the interaction between different types of over-the-counter payments, see Folkertsma and Hebbink (1999).

Dfl. 10 notes is not affected by POS turnover; the former probably because POS payments do not often concern transactions of more than Dfl. 1,000; the latter probably because for small transactions Dfl. 10 notes are still used.

TABLE 2 – LONG-TERM (SEMI-)ELASTICITIES OF BANKNOTE CIRCULATION

Denomination	Private consumption	Short-term interest rate	POS turnover
Dfl. 1,000	0.95	−0.097	0
Dfl. 250	0.92	−0.033	−0.034
Dfl. 100	0.89	−0.018	−0.039
Dfl. 50	0.75	0	−0.040
Dfl. 25	0.66	0	−0.047
Dfl. 10	0.52	0	0

In order to forecast circulation in 2002, assumptions concerning exogenous variables have to be made.[2] Consumption growth is assumed to be 4.75% in 1997, 4.25% in 1998 and 5.25% thereafter. Turnover at POS is assumed to grow 22% in 1997, gradually decreasing to 3.75% in 2002. For the whole period, the short-term interest rate is assumed to remain constant at 3.25%.

3.2 *Guilder coins*

Fase (1981b) estimates a forecasting model for coin circulation in the Netherlands. For our purpose of projecting the circulation of euro coins, a model is estimated that slightly differs from the model for banknotes in the previous subsection. An important difference with previous models for coin circulation is that substitution among coins, and among banknotes and coins, is taken into account by a simultaneous estimation of all denominations. The econometric model for coin circulation is represented by

$$\Delta y_t = A \Delta y_{t-1} + B \Delta x_t + \epsilon_t,$$

where Δ is the first-difference sign, y_t is a vector of circulation growth rates of all twelve guilder denominations, x_t is a vector containing private consumption including living expenses, POS payments (in logarithm), short-term interest rate, seasonal dummies and step-dummies, and ϵ_t is a disturbance term. The model is a VARIX(1,1) model, in which A and B are matrices to be estimated. In order to make forecasts, the same assumptions concerning exogenous variables are made as in the banknote model.

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2 The forecasts reported here date from August 1997, so they reflect assumptions from that period.

3.3 *Conversion from guilder forecasts to euro forecasts*

Conversion from our guilder forecasts to euro forecasts requires some specific assumptions. The new currency has a larger number of denominations, which also differ from guilders in their value per denomination. We distinguish two assumptions. First, each guilder denomination is exchanged for one or two euro denominations of about the same value. In this case, almost certainly the number of guilder notes and coins will differ from the number of euro notes and coins. Alternatively, the total number of guilder banknotes and coins could be kept equal. Evidently, the total circulation value remains unchanged in both cases.

In order to keep the denominational composition of euro currency as close as possible to the guilder composition, we chose the first assumption mentioned. An additional assumption is needed for the denominations EUR 200, EUR 0.20 and EUR 0.01. These are denominations for which no equivalent guilder denomination exists. We will assume that these currencies are returned for guilder denominations that are close in value related. We maintain a guilder-euro exchange rate of Dfl. 2.22.

Table 3 contains the conversion assumptions. The first line indicates that 80% of Dfl. 1,000 notes are assumed to be converted to EUR 500 notes and 20% to EUR 200 notes. Similarly, 20% of Dfl. 250 notes changes into EUR 200 notes and the rest into EUR 100 notes. It is expected that the smallest euro coin will be required in larger amounts, since the current practice of rounding payments to Dfl. 0.05 multiples will no longer exist. Therefore, it is assumed that Dfl. 0.05 coins are converted to EUR 0.02 and EUR 0.01 coins in a 60%–40% relation.

TABLE 3 – ASSUMED CONVERSION FROM GUILDERS INTO EUROS

	EUR 500	200	100	50	20	10	5	2	1	0.50	0.20	0.10	0.05	0.02	0.01
Dfl. 1,000	0.8	0.2													
250		0.2	0.8												
100			1												
50				1											
25					1										
10						1									
5							1								
2.50								1							
1									0.8	0.2					
0.25										0.2	0.8				
0.10												1			
0.05														0.6	0.4

4 A SECOND METHOD TO FORECAST THE EURO CIRCULATION IN 2002

As an alternative method, the euro circulation in 2002 is projected by means of the value of over-the-counter cash payments and calculating the required notes and coins for those payments. This method consists of several steps.[3] First, the frequency distribution of cash payment values is estimated from expenditure surveys among Dutch households. Adjusted for inflation and converted to euros, this gives the number of cash transactions for each transaction value, from EUR 0.01 (the smallest coin) to EUR 500 (the largest note). A more detailed description of the surveys and fitted distribution can be found in Bos (1993), and Boeschoten and Fase (1989).

Next, for each transaction, the number of notes and coins needed by denomination is calculated. It is assumed that payments are performed in the most efficient manner, i.e., using a minimum of notes and coin allowing for change (Cramer (1983 and 1986), Boeschoten and Fase (1989)). Summation over denominations gives the turnover of each euro denomination that is required for the over-the-counter cash payments in 2002. Finally, these turnover values should be converted to circulation values. Ideally, this would require assumptions on unknown variables such as circulation velocities, hoarding, losses in circulation, and the share of cash transactions that is not included in private over-the-counter payments. However, we take a short-cut by calculating each euro denomination's circulation from its turnover using comparable turnover-circulation ratios for guilder denominations, using the actual guilder circulation in 1996. To achieve this, we estimate turnover of guilder denominations in 1996, using the procedure described above.

5 PROJECTIONS FOR THE EURO CIRCULATION

It is likely that forecasts obtained with the two described methods will appear to be too high. The actual use of cash in 2002 may be lower, due to the widespread introduction of electronic money, like multi-purpose prepaid cards. This factor is not taken into account in the econometric models described in previous sections, as no reliable time series are available yet to estimate this effect. However, Boeschoten and Hebbink (1996), and Hebbink (1997) present estimates of the use of electronic money for several scenarios, one of which we use here. Our coin circulation forecast for 2002 does not incorporate another significant factor, namely the loss of coins in circulation. Percentages of coins lost in circulation are estimated by Bos (1994) for each coin denomination. A main result of this study is that small coins and low-value coins are lost more than large and high-value coins.[4]

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3   An extensive description of this method is given in Hebbink (1997).
4   As far as we know, only one foreign study on the calculation of loss in circulation percentages exists, i.e., Goldin (1985) for coins issued in Israel during 1960–1979.

TABLE 4 – ASSUMED REDUCTION OF CIRCULATION

Dfl.	More electronic money	Fewer losses in circulation	More electronic money and fewer losses in circulation
1,000	0	0	0
250	0	0	0
100	0	0	0
50	10	5	14
25	42	10	48
10	42	10	48
5	40	10	47
2.50	38	20	50
1	40	30	58
0.25	43	40	66
0.10	43	55	74
0.05	43	50	72

Explanation: In the third column the reduction of Dfl. 50, for example, equals 14%, calculated as $(1 - (1 - 0.10)(1 - 0.05) = 0.14$. The electronic money effects are from Hebbink (1997); the loss percentages are from Bos (1994).

Table 4 reports the percentages applied to the banknote and coin circulation by denomination. The second column shows the percentage reductions due to the use of electronic money, the third column the reduction due to loss in circulation and the fourth column gives the combined effect of electronic money and losses. It appears that electronic money as well as loss in circulation mainly affect the smaller notes and coins.

Figures 2 and 3 show banknote and coin projections for the case where the effects of electronic money and loss in circulation are taken into account. The euro forecasts are shown along with the guilder forecasts, where 'EUR 1st' and 'EUR 2nd' denote our two alternative forecasting methods. Similar to the current circulation, the forecasted Dfl. 100 note and Dfl. 0.10 coin dominate the guilder circulation (in numbers). As discussed before, the distribution of the euro circulation is kept in line with the guilder circulation. In numbers the euros exceed the guilders. One main cause is the asumption made for the conversion of the Dfl. 0.05 coin, of which 60% is converted to EUR 0.02 and 40% to EUR 0.01. The EUR 0.01 forecast, which is now even higher than the EUR 0.02, would be reduced if instead of a 60:40 key, 80:20 was chosen, for example. Furthermore, the forecasts for EUR 200 and EUR 0.20 are smoothly in between the EUR 100 and EUR 500, and EUR 0.10 and EUR 0.50, respectively. From this point of view the euro forecasts seem nicely balanced.
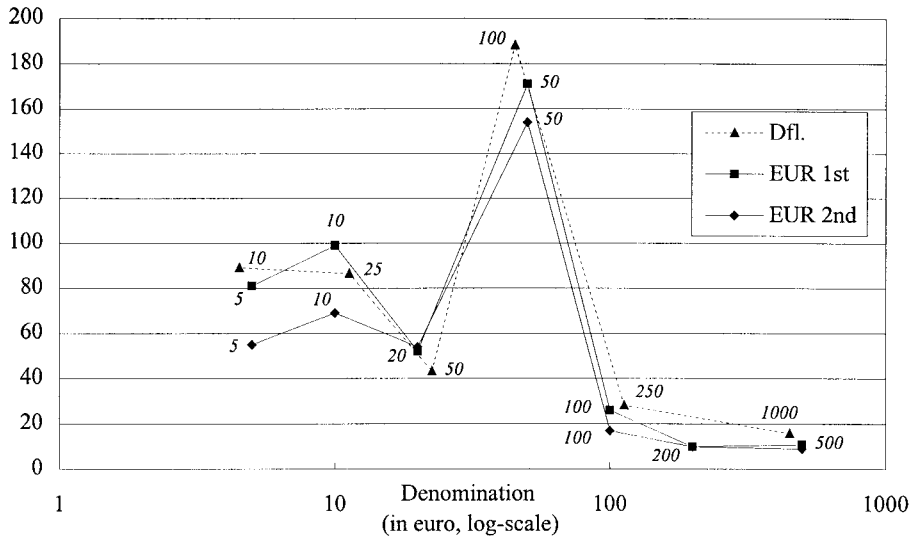
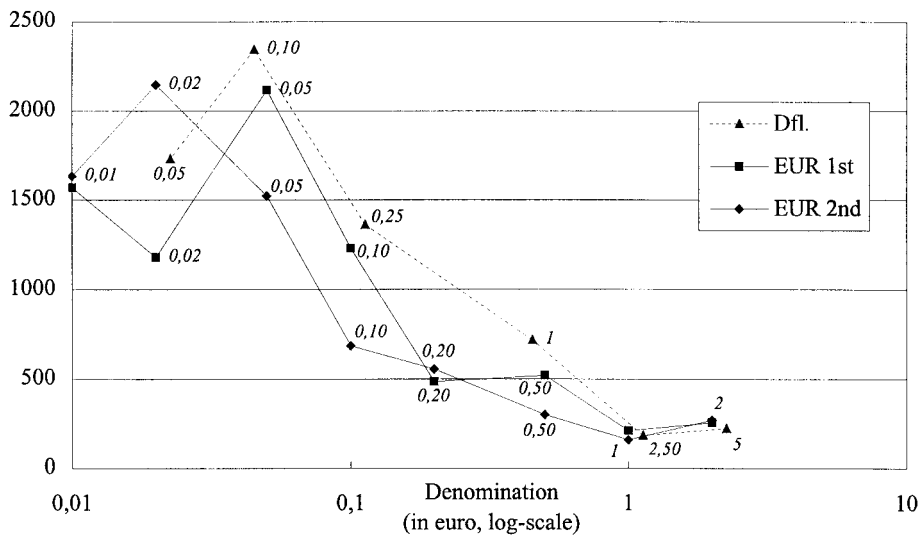Figure 2 – Banknote-circulation forecasts (millions)

Figure 3 – Coin-circulation forecasts (millions)

6 SUMMARY AND CONCLUSION

Two methods to obtain projections for the euro circulation in the Netherlands in 2002 are described. The first forecasting method derives euro currency forecasts from guilder forecasts. The second method forecasts the frequency distribution of

over-the-counter payment values in the Netherlands and derives the required euro currency for those payments. Both methods take into account the effects of more electronic money and fewer losses in circulation.

The two alternative projections for the euro circulation were actually carried out as an experiment. They may serve as a basis for the production of new currency in a country like the Netherlands, which is only a small part of 'euro-land' and the aggregate euro circulation. The final policy decisions on the euro circulation needed in 2002 are of course based on more factors than those considered in this short note. However, it may make clear that this is not a trivial exercise.

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