



EUROPEAN CENTRAL BANK

MONETARY, FINANCIAL INSTITUTIONS AND MARKETS STATISTICS DIVISION

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Technical notes on the historical monthly series for euro area loans and deposits to other resident sectors

1. Introduction

These technical notes explain the interpolation procedure followed to derive historical monthly time series from quarterly data, for the period January 1999 to December 2002, for euro area loans and deposits to the *other resident sectors* broken down by type of sub-sector. These historical data will not be subject to the regular monthly revision policy adopted for MFI balance sheet statistics, but to ad hoc updates triggered by larger revisions of the reported quarterly and monthly series used as reference variables in the derivation of these data.

The interpolation procedure yields a series of monthly outstanding amounts (stocks) and transactions (flows). Consequently, the growth rates are derived by using the standard procedure adopted for MFI balance sheet statistics.

The following data sources are used to derive euro area aggregates for the monthly breakdowns of loans and deposits:

- a) actual national monthly data provided by the NCBs (i.e. IT, BE, and partially DE);
- b) national monthly series by type of sector estimated by NCBs from quarterly data;
- c) national monthly series by type of sector derived by the ECB from (i) actual national monthly series with no sectoral breakdown, and from (ii) quarterly series with desired sectoral breakdown.

Procedure for the derivation of monthly series of loans and deposits for the euro area:

- Step 1: Preliminary interpolated data are obtained by the ECB for each euro area member country for which data are not available (see point c above) that satisfy the temporal constraint (i.e. end-quarter monthly values equal the corresponding quarterly values¹). This is done for stock data using Chow-Lin with AR1 errors for non-seasonally adjusted data in levels, and for

¹ The preliminary estimates do not necessarily satisfy the horizontal aggregation constraints with respect to the monthly total *other resident sectors* series.

adjustment data, which are needed to derive financial transactions, by using a proportional adjustment procedure. As indicator variables (related variables), the national monthly total amounts for the *other resident sectors* are used.

- Step 2: Final interpolated data for each country are obtained by imposing all additional required constraints to the preliminary series (horizontal constraints, breakdowns must not be larger than the corresponding totals, non-negativity of stock data).
- Step 3: Euro area data are obtained by mathematical aggregation of national data, interpolated data and actual data, where available (e.g. by using data sources a, b and c above).

2. Historical monthly stock series: the procedure in detail

Euro area monthly time series of loans and deposits vis-à-vis the *other resident sectors* are available broken down by currency, maturity and type of sub-sector ('*other financial intermediaries*' (S.123 and S.124)², '*insurance corporations and pension funds*' (S.125), '*non-financial corporations*' (S.11) and '*households*' (S.14 and S.15)³) as from reference to January 2003. These series are available for the period up to and including December 2002 at a quarterly frequency without maturity and/or currency breakdowns.

Monthly series by maturity and type of sub-sector for the period prior to January 2003 have been derived by using interpolation techniques that make use of existing information on deposits and loans available (i) at quarterly frequency by sub-sector breakdown only, and (ii) at monthly frequency by maturity breakdown for the total *other resident sectors*.

The lack of quarterly data by sub-sector and maturity breakdowns prevented the derivation of monthly data disaggregated by sub-sector and maturity, by using standard interpolation techniques. Thus the procedure consists of two phases: in the first phase, the maturity breakdowns for the quarterly series are derived; and subsequently, these series are used to derive monthly interpolated values⁴.

- Phase I: derivation of maturity breakdowns for quarterly stock series

The quarterly maturity breakdowns are derived by means of an iterative two-step algorithm. The first step can be described as follows:

$$\hat{x}_t^{m,s} = x_{t+1}^{m,s} \frac{1}{1 + \frac{x_{t+1}^{T,s} - x_t^{T,s}}{x_t^{T,s}}} \quad [1]$$

² Including financial auxiliaries (ESA 95, S.124).

³ Including non-profit institutions serving households (ESA 95, S.15).

⁴ In principle, the problems of interpolation and estimation of further breakdowns could be solved simultaneously. However, that would unduly complicate the mathematical algorithms to be applied, without any guarantee of a major improvement in the resulting estimates. For practical reasons, therefore, the two problems were treated separately.

with values computed for $m=1,2$ (denoting the two maturities to be derived) and $s=1,...,4$ (denoting the four *other resident* sub-sectors), with $x_t^{T,s}$ being the observed total maturity outstanding amount for sector s . As starting values for the iterative procedure, the actual $x_{Jan03}^{m,s}$ values are taken⁵.

Equation [1] assumes that the *one-period development* in $x_t^{m,s}$ can be approximated with disregard to the specific maturity considered. Note that the specific maturity is not disregarded in terms of the *level* of $\hat{x}_t^{m,s}$. The application of [1] will in general produce values that do not add up to the observed total *other resident sectors* for any given maturity ($\sum_{s=1}^4 \hat{x}_t^{m,s} \neq x_t^{m,T}$). Discrepancies with respect to the totals are then corrected in the second step of each iteration by delivering a set of reconciled values $\hat{\hat{x}}_t^{m,s}$. This is done by solving the quadratic minimisation problem:

$$\text{Min} \sum_{m,s} \left(\hat{\hat{x}}_t^{m,s} - \hat{x}_t^{m,s} \right)^2 \quad [2]$$

subject to

$$\sum_{s=1}^4 \hat{\hat{x}}_t^{m,s} = x_t^{m,T}, m=1,2 \quad \text{and} \quad [3]$$

$$\sum_{m=1}^2 \hat{\hat{x}}_t^{m,s} = x_t^{T,s}, s=1,...,4. \quad [4]$$

In practice, one of the restrictions in [3] and [4] must be dropped, as any given restriction in [3] and [4] can be derived as a linear combination of the rest.

Once the problem [2] to [4] has been solved⁶ for $\hat{\hat{x}}_{Dec02}^{m,s}$, a further iteration is performed to solve for $\hat{\hat{x}}_{Nov02}^{m,s}$, repeating the two steps formed by [1] and [2] to [4] and performed utilising $\hat{\hat{x}}_{Dec02}^{m,s}$ as a proxy for the unobserved $x_{Dec02}^{m,s}$ in the RHS of [1]. This two-step backward iteration is repeated for all time periods for which the further breakdown estimates are required. The application of the second step of the procedure should not produce negative estimates; non-negativity is then ensured by setting any

⁵ Goodness-of-fit tests computed by comparing the iterative estimates with actual data for those countries for which such data was available showed that an alternative choice of starting values (e.g. based on averaging $x_t^{m,s}$ over the first quarter of 2003 or during that first year) implied a poorer performance of the method.

⁶ The problem has a well-known solution, and can be shown that the solution to the constrained quadratic minimisation problem laid out in [2] to [4] has the form $\hat{\hat{X}}_t = \hat{X}_t - \hat{X}_t' \hat{X}_t' G' (G \hat{X}_t' \hat{X}_t' G')^{-1} (G \hat{X}_t - h_t)$ where $\hat{X}_t' = (\hat{x}_t^{1,1} \dots \hat{x}_t^{1,4} \hat{x}_t^{2,1} \dots \hat{x}_t^{2,4})$ is a vector containing the first-step estimates, and $G \hat{\hat{X}}_t = h_t$ is the matrix representation of the system of linear restrictions [3] and [4].

negative values of the solution for $\hat{x}_t^{m,s}$ to zero and repeating the reconciliation step of the procedure until there are no negative values⁷.

- Phase II: derivation of monthly interpolations from quarterly stock series

The interpolation methods ensure the derivation of monthly data that are consistent with the existing quarterly ones. This means that a temporal (vertical) constraint, according to which derived monthly data with reference to end-quarter periods equal the corresponding quarterly values, is implicitly satisfied by the interpolated data.

However, the loans and deposits series are structured around two breakdowns: (i) the maturity breakdown and (ii) the sectoral breakdown. Therefore, the additivity (horizontal) constraints between series that represent the total phenomenon and those that represent their breakdowns must also be respected. In addition to these, some constraints arise due to the nature of the data: (iii) stocks data are positive by definition, and (iv) breakdowns must not be larger than the corresponding totals.

The standard Chow-Lin method with AR1 errors (Chow-Lin, 1971⁸; Fernandez, 1981⁹; Litterman, 1983¹⁰) is used to derive temporally disaggregated (monthly) time series from temporally aggregated (quarterly) series of loans and deposits. The method makes use of indicators available at a monthly frequency, which are related to the variable to be interpolated. The estimated relationship between the indicators and the variables at the lower frequency (quarterly) is exploited, together with the values of the indicators at the higher frequency (monthly), to obtain monthly values of the variables to be interpolated. However, the interpolated values obtained from this procedure do not satisfy the horizontal aggregation constraints (i) and (ii). Therefore, in the second step these constraints are imposed by means of a proportional adjustment (Di Fonzo, 1990¹¹) where the discrepancy is distributed according to the weight of each sub-sector on the total *other resident sectors*¹².

3. Historical monthly transactions series: the procedure in detail

In line with international statistical standards, flows (transactions) in MFI balance sheet statistics are derived by taking the difference between stock positions at two end-month reporting dates and by removing the effect of changes in stocks not due to financial transactions (i.e. "non-transactions-

⁷ These sub-iterations within the second step of the procedure were not required very often and convergence usually followed after a maximum of three sub-iterations.

⁸ Chow, G. C. and Lin, A. (1971), "Best Linear Unbiased Interpolation, Distribution and Extrapolation of Time-Series by Related Series" Review of Economics and Statistics, 53, pp. 372-375.

⁹ Fernandez, R. B. (1981), "A Methodological Note on the Estimation of Time-Series" Review of Economics and Statistics, 63, pp. 471-476.

¹⁰ Litterman, R. B. (1983), "A Random Walk, Markov Model for the Distribution of Time Series" Journal of Business and Economic Statistics, 1, pp. 169-173.

¹¹ Di Fonzo, T. (1990), "The Estimation of M Disaggregate Time Series when Contemporaneous and Temporal Aggregates Are Known", Review of Economics and Statistics, 72, pp. 178-82.

related" factors or adjustments). Even though, generally, the difference in stocks accounts for the largest share in the derivation of flows, monthly adjustments are also derived from quarterly adjustments and then used to compute historical monthly transactions.

As for the stocks, the problem faced in the derivation of monthly adjustment series is that these monthly data should simultaneously (i) comply with the relevant quarterly figures and (ii) satisfy balance sheet constraints. The derivation of monthly adjustment series (reclassifications and other revaluations) from quarterly data requires the distribution of the adjustments occurred within the quarter and recorded at end-quarter, over the three months of the quarter, on the condition that the sum of the three monthly adjustments equals the quarterly figure (*'temporal aggregation'* constraint). Since no monthly information is available on adjustments data disaggregated by sub-sector to be used as *anchor* in such distribution, and given the highly irregular nature of adjustments data, a proportional adjustment procedure¹³ is followed to derive the monthly values¹⁴. Such an approach uses the information on monthly reclassifications and revaluations by currency and/or maturity for the total sector (*'anchor series'*), and distributes them to the sub-sectors according to the quarterly adjustments data available by sub-sector (*'distribution series'*).

¹² The interpolation is implemented using Matlab procedures.

¹³ See Di Fonzo (1990).

¹⁴ In general, these two adjustments are reported for specific dates. For instance, in the cases of changes in the statistical reporting schemes, reclassifications are sent for a specific date. Similarly, once the P&L account and/or the annual accounts are approved, the write-offs are reported. For most of the countries the historical data for write-offs/write-downs were reported quarterly, biannually or annually.

Loans – Historical monthly series (stocks)¹

Loans by maturity and sub-sector, total currency to the domestic area and to other euro area member countries			
Sub-sector	Loans up to 1 year	Loans between 1 and 5 years	Loans above 5 years
Other financial intermediaries	M.U2.N.A.A20.F.1.U2.2210.Z01.E		
Insurance corporations & pension funds	M.U2.N.A.A20.F.1.U2.2220.Z01.E		
Non-financial corporations	M.U2.N.A.A20.F.1.U2.2240.Z01.E	M.U2.N.A.A20.I.1.U2.2240.Z01.E	M.U2.N.A.A20.J.1.U2.2240.Z01.E
Households			
- Consumer credit	M.U2.N.A.A21.F.1.U2.2250.Z01.E	M.U2.N.A.A21.I.1.U2.2250.Z01.E	M.U2.N.A.A21.J.1.U2.2250.Z01.E
- Housing loans	M.U2.N.A.A22.F.1.U2.2250.Z01.E	M.U2.N.A.A22.I.1.U2.2250.Z01.E	M.U2.N.A.A22.J.1.U2.2250.Z01.E
- Other purposes	M.U2.N.A.A23.F.1.U2.2250.Z01.E	M.U2.N.A.A23.I.1.U2.2250.Z01.E	M.U2.N.A.A23.J.1.U2.2250.Z01.E

1. Monthly series of transactions have '4' in the 7th dimension of the series key. Monthly series of annual growth rates have 'i' in the 7th dimension of the series key and 'A' in the last dimension.

Deposits – Historical monthly series (stocks)¹

Deposits by sub-sector, total currency to the domestic area and to other euro area member countries		
Sub-sector	Overnight deposits	Repurchase agreements
Other financial intermediaries	M.U2.N.A.L21.A.1.U2.2210.Z01.E	M.U2.N.A.L24.A.1.U2.2210.Z01.E
Insurance corporations and pension funds	M.U2.N.A.L21.A.1.U2.2220. Z01.E	M.U2.N.A.L24.A.1.U2.2220. Z01.E
Non-financial corporations	M.U2.N.A.L21.A.1.U2.2240. Z01.E	M.U2.N.A.L24.A.1.U2.2240. Z01.E
Households	M.U2.N.A.L21.A.1.U2.2250. Z01.E	M.U2.N.A.L24.A.1.U2.2250. Z01.E
Deposits by maturity and sub-sector, total currency to the domestic area and to other euro area member countries		
Sub-sector	Deposits with agreed maturity up to 2 years/above 2 years	Deposits redeemable at notice up to 3 months/above 3 months
Other financial intermediaries	M.U2.N.A.L22.L/H.1.U2.2210.Z01.E	M.U2.N.A.L23.D/E.1.U2.2210.Z01.E
Insurance corporations and pension funds	M.U2.N.A.L22.L/H.1.U2.2220. Z01.E	M.U2.N.A.L23.D/E.1.U2.2220. Z01.E
Non-financial corporations	M.U2.N.A.L22.L/H.1.U2.2240. Z01.E	M.U2.N.A.L23.D/E.1.U2.2240. Z01.E
Households	M.U2.N.A.L22.L/H.1.U2.2250. Z01.E	M.U2.N.A.L23.D/E.1.U2.2250. Z01.E

1. Monthly series of transactions have '4' in the 7th dimension of the series key. Monthly series of annual growth rates have 'i' in the 7th dimension of the series key and 'A' in the last dimension.