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# Money Growth, Inflation and the Business Cycle

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## INTRODUCTION AND SUMMARY

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The money stock is not normally at the forefront of most central banks' monetary-policy deliberations, despite its prominent role in large parts of the theoretical economic literature. One explanation is that the correlation between money growth and inflation has proved to be unstable, particularly in the short term. In the long term, on the other hand, money and inflation are often closely related across monetary-policy and exchange-rate regimes. So in the long term inflation is often regarded as a monetary phenomenon, even though a strong long-term correlation between money growth and inflation does not as such shed light on cause and effect in the link between money growth and inflation.

Money growth has recently been relatively strong both in Denmark and abroad. Denmark's money growth is slightly higher than the current economic conditions and interest rates would normally warrant. This may in part be attributed to the increase in bank deposits, and thus in the money stock, in connection with the higher remortgaging activity and realisation of capital gains in continuation of the large increases in housing prices.

In recent years money as an indicator of the business cycle and trends in equity and housing prices has received increased attention in the international debate. The money stock and housing prices are procyclical and are affected in the same direction by the course of long-term interest rates. Money tends to be a leading cyclical indicator since money demand reacts more quickly than economic activity to interest-rate changes. This also applies to the development in housing prices and remortgaging activity, which can amplify money demand – as described above.

This article first discusses whether money growth in Denmark is exceptionally high, followed by a review of the empirical correlation between money growth and inflation in the short and long term. In conclusion, the correlation between money, credit and housing prices over the business cycle is examined.

## DEVELOPMENT IN MONETARY AGGREGATES

The monetary aggregates applied in Denmark are described in Box 1, and the development in various monetary aggregates is shown in Chart 1.

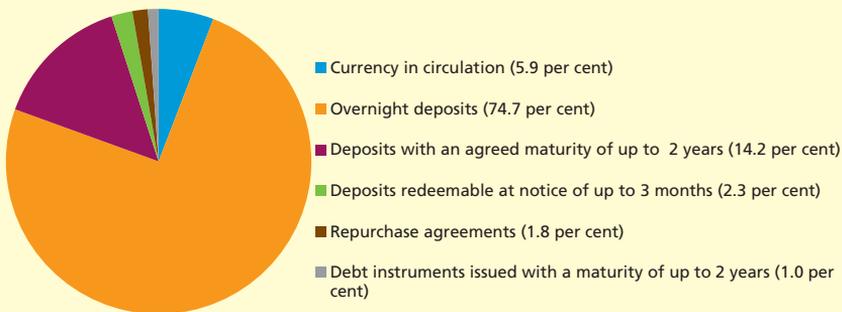
The relatively high money growth is in part attributable to technical aspects of the mortgage loans offered by banks. When granting a loan against home equity as collateral, a bank often at the same time establishes a deposit account containing the nominal loan proceeds. This entails a simultaneous increase in deposits of the same magnitude, i.e. the money stock expands. The increase in deposits is reduced as the loan proceeds are withdrawn. Excluding the effect of the banks' mortgage loans on deposits is estimated to reduce the annual money growth by a couple of percentage points.

### MONETARY AGGREGATES

Box 1

M1 is defined as the private non-bank sector's holdings of currency in circulation and overnight bank deposits. M2 is typically defined as M1 plus short-term time deposits. M3 is normally defined as M2 plus certain other deposits and holdings of short-term debt instruments. The exact definition of monetary aggregates in a Danish context appears from Danmarks Nationalbank's statistical publications. M3 amounted to kr. 798 billion at end-2005. The Chart below shows the breakdown of M3.

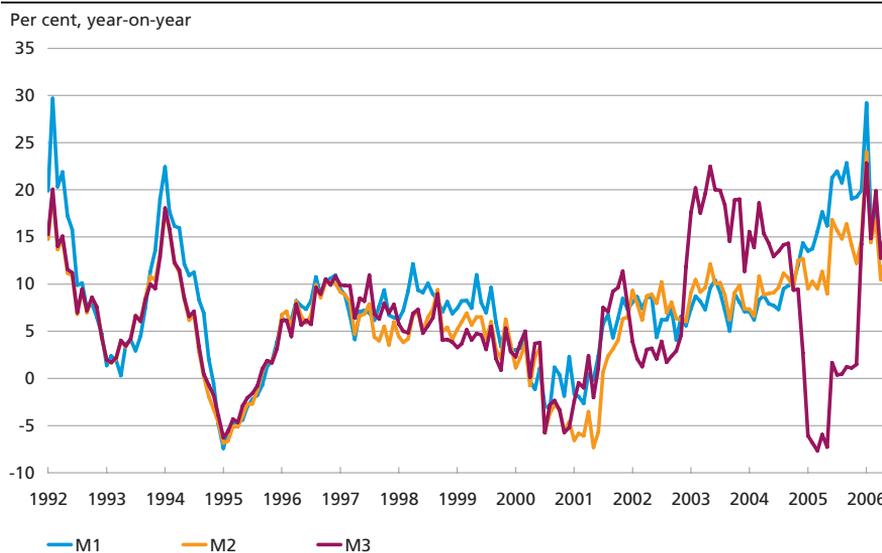
### BREAKDOWN OF M3 END-2005



In recent years, the development in M3 has been affected by issue of short-term bonds to finance adjustable-rate mortgage-credit loans. Underlying bonds with an original maturity of up to 2 years are included in M3, whereas bonds with an original maturity of more than 2 years are not included. This may entail large fluctuations in relation to M2 around the turn of the year, illustrating that the information content of M3 is often modest as far as Denmark is concerned.

## ANNUAL GROWTH IN VARIOUS MONETARY AGGREGATES

Chart 1



Note: Monthly data. Latest observation is June 2005.

Source: Danmarks Nationalbank.

Money demand in Denmark has been examined a number of times in recent years.<sup>1</sup> If the monetary aggregates have taken an unusual course recently compared to the estimated money demand, this may indicate that the previous results no longer apply. Money demand is generally explained by the volume of transactions, expressed in terms of nominal domestic demand, and the remuneration of money compared to other claims, calculated as the difference between the rate of interest for deposits with banks and the 10-year government bond yield. The higher the transaction need and the higher the remuneration of money compared to other placements, the greater the money demand.

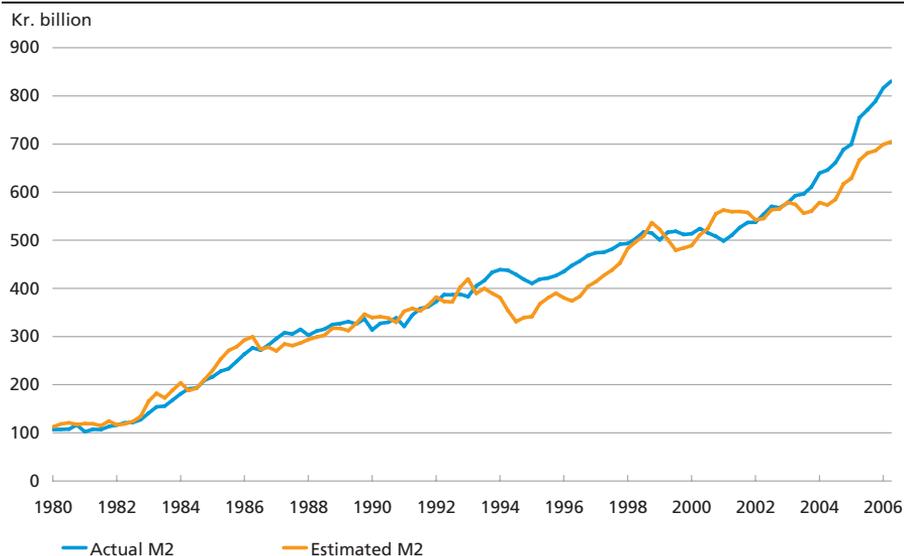
In general, the developments in the actual money stock and in the estimated long-term money demand are in line with each other.<sup>2</sup> However, since 2003 the money stock has increased slightly more than warranted by the estimated long-term relation, cf. Chart 2. A similar temporary deviation was observed during the upswing in the 1990s, cf. the section on the business cycle, money, credit and housing prices below.

<sup>1</sup> Cf. Allan Bødskov Andersen (2004), Money Demand in Denmark 1980-2002, Danmarks Nationalbank, *Monetary Review*, 3rd Quarter. Compared to previous surveys of money demand by Niels Lynggård Hansen (1996), Money Demand in Denmark, Danmarks Nationalbank, *Monetary Review* 3rd Quarter, and by Anders Møller Christensen and Hugo Frey Jensen (1987), Money Demand in Denmark 1975-86 (in Danish), *Nationaløkonomisk Tidsskrift*, Vol. 125, No. 2, interest rates in Germany (the euro area) and foreign-exchange gains are no longer significant. This can be taken to indicate that the stability of inflation and exchange rates has resulted in a high degree of homogeneity in return expectations in Denmark and the euro area.

<sup>2</sup> The long-term relation is given by  $m = \beta + y + 6,5 \cdot r$ , where  $m$  is (the natural logarithm of) money,  $\beta$  is a constant,  $y$  is (the natural logarithm of) nominal domestic demand, and  $r$  is the difference between the deposit rate and the 10-year government bond yield.

## ACTUAL AND ESTIMATED MONEY DEMAND

Chart 2



Note: Quarterly data. Latest observation is 2nd quarter 2006. Estimated M2 is determined on the basis of the long-term model in Allan Bødskov Andersen (2004), *Money Demand in Denmark 1980-2002*, Danmarks Nationalbank, *Monetary Review*, 3rd Quarter.

Source: Danmarks Nationalbank.

## MONEY AND INFLATION

Inflation can be regarded as a monetary phenomenon in the long term. The long-term correlation between money growth and inflation is often described using the quantity equation, cf. Box 2. However, the correlation between money growth and inflation has proved to be unstable. Furthermore, monetary development is to a high degree beyond the control of the central bank. These factors have contributed to the diminishing focus on the money stock, although money growth, together with growth in lending, plays an important role in the ECB's monetary-policy strategy.<sup>1</sup> In a small open economy like Denmark, with a fixed exchange rate and liberalised capital flows, the money stock is solely determined by the demand for money. In the larger countries, money is only rarely directly included in the macroeconomic models applied by e.g. central banks.<sup>2</sup>

In Denmark, a negative correlation between inflation and money growth in the short term has often been observed, cf. the left-hand side of Chart 3. This applied particularly in the period 1983-85 when money

<sup>1</sup> Cf. Otmar Issing's foreword in ECB (2003), *Background studies for the ECB's evaluation of its monetary policy strategy* and ECB (2004), *The monetary policy of the ECB*.

<sup>2</sup> Cf. Mervyn King (2002), *No money, no inflation – the role of money in the economy*, Bank of England, *Quarterly Bulletin*, Summer, for a discussion of the role of money in economic models.

## MONEY GROWTH AND INFLATION

Box 2

The correlation between money growth and inflation is normally based on the quantity equation<sup>1</sup>:

$$M \cdot V = P \cdot Y$$

where M is money stock, V is the velocity of money, P is the price level and Y is the volume of real transactions, e.g. approximated as real GDP or real domestic demand. This is a definition equation whereby the volume of nominal transactions in the economy in a given period (the right-hand side) equals the money stock (the quantity of money) multiplied by the velocity. The equation defines the velocity of money. If nominal income is kr. 100 and money stock is kr. 20, the velocity is 5 (times per year).

In terms of growth the quantity equation says that the sum of real demand and inflation equals the sum of money growth and the change in the velocity.

$$\Delta M + \Delta V = \Delta P + \Delta Y$$

where  $\Delta$  indicates a change in a variable.

Without further assumptions the quantity equation is just a definition of the velocity of money, V, and does not contain any indication of the causal links between money and inflation.

If the velocity is fairly constant, the quantity equation says that for a given rate of growth in real income, inflation will be determined by the change in money. In practice, however, the velocity is not stable and it depends on e.g. financial innovation and the opportunity costs of holding money. Structural and temporary shifts in money demand mask the characteristics of money as an indicator of price development. The correlation between money and prices is also affected by changes in supply conditions, e.g. in connection with increased international price competition and productivity growth. For these reasons it has turned out to be difficult to apply the quantity equation directly.

<sup>1</sup> This is described in more detail in e.g. Deutsche Bundesbank (2005), *The relationship between money and prices*, *Monthly Report*, January, and ECB (2004), *The monetary policy of the ECB*.

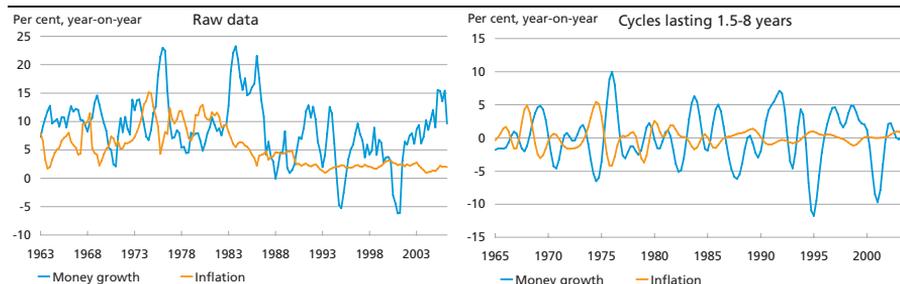
demand rose strongly, whereas inflation declined. Part of the explanation is that the transition to a fixed-exchange-rate policy in 1982 was gradually gaining credibility, thus reducing devaluation and inflation expectations in Denmark. This resulted in a considerable decrease in long-term interest rates and a narrowing of the spread between long-term and short-term interest rates. This resulted in simultaneously growing interest in deposits and declining inflation.<sup>1</sup>

One way of analysing the development in money and inflation over various horizons is to break down the development in money and in prices into different cyclical components, i.e. the short term of 1.5-8 years, the medium term of 8-20 years, and the long term of 20-40 years, cf. Box 3. To a high degree the very short-term waves for cycles lasting less than 1.5 years represent noise. The part of inflation and money growth

<sup>1</sup> Cf. Dan Knudsen (1988), *Causes and Effects of Development in Money Supply*, Danmarks Nationalbank, *Monetary Review*, February.

## MONEY GROWTH AND INFLATION IN THE SHORT TERM

Chart 3



Note: Quarterly data. The monetary aggregate is M2, and inflation is CPI-based. Money growth and inflation are broken down into frequency bands using the Christiano-Fitzgerald filter.

Source: Statistics Denmark and Danmarks Nationalbank.

that moves in short-term waves, i.e. high-frequency fluctuations, often displays negative correlation. This also applies to business cycles lasting 1.5 to 8 years, cf. the right-hand side of Chart 3.

For a longer horizon, money growth and inflation are more closely linked. However, divergent developments are often observed in the

## DETERMINATION OF CYCLICAL COMPONENTS IN TIME SERIES

Box 3

Movements in a time series can generally be taken to comprise a trend and a cyclical component, where the latter is the deviation from the trend. The cyclical component, corresponding to economic business cycles, is typically defined for cycles lasting from 1.5 to 8 years.

The cyclical component is extracted from an economic time series using a filter. In technical terms the filter is often based on spectral analysis. The central element of the analysis is that time series can be regarded as the sum of periodical functions with different frequency fluctuations. The periodical cosine and sine functions are used in the spectral analysis to divide time series into different frequencies. In two popular filters developed by Baxter and King (1999) (BK) and Christiano and Fitzgerald (2003)<sup>1</sup> (CF) the cyclical components for a given frequency band are calculated as a moving average of the observations in the time series.

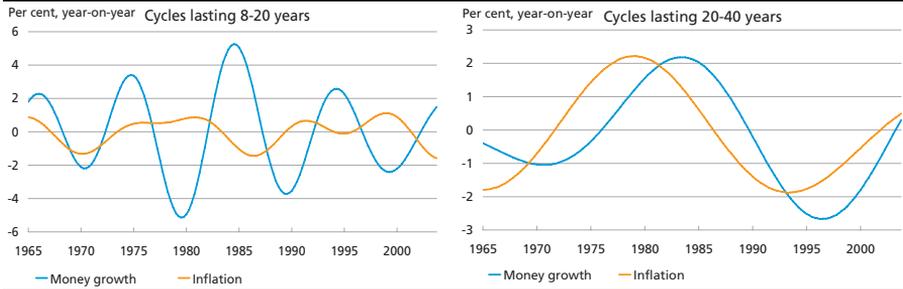
The BK filter applies fixed, symmetrical weights in the calculation of the moving average. The typical number of observations for an economic cycle is 12 on each side. This requires quarterly data for three years on each side.

The CF filter provides for time-varying weights, and the moving average is not necessarily symmetrical. The first and last two years are excluded here since the determination of the filtered data is less accurate close to the end points of the time series.

There are no significant differences between the two filters as regards the frequency bands for economic cycles. The CF filter is most useful for cycles with a low frequency (long cycles). This article applies the BK filter when focusing on business cycle frequencies and the more complicated CF filter when focusing on longer cycles.

<sup>1</sup> Lawrence J. Christiano and Terry J. Fitzgerald (2003), The band-pass filter, *International Economic Review*, Vol. 44, No. 2 and Marianne Baxter and Robert G. King (1999), Measuring business cycles: Approximate band-pass filters for economic time series, *The Review of Economics and Statistics*, November, 81(4).

**MONEY GROWTH AND INFLATION IN THE MEDIUM AND LONG TERM** Chart 4

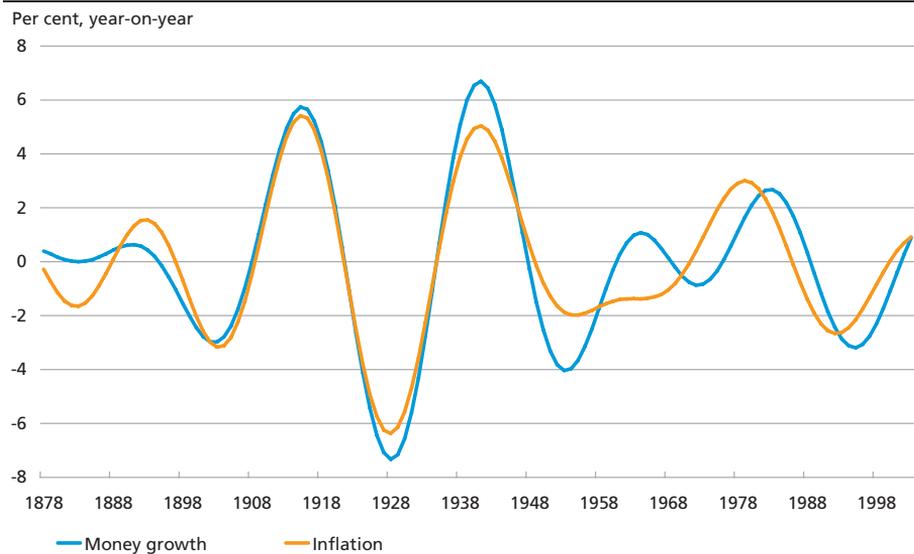


Note: Quarterly data. The monetary aggregate is M2, and inflation is CPI-based. Money growth and inflation are broken down into frequency bands using the Christiano-Fitzgerald filter.  
 Source: Statistics Denmark and Danmarks Nationalbank.

frequency area equivalent to 8-20-year cycles, cf. the left-hand side of Chart 4. For the very low frequencies, i.e. 20-40-year cycles, the correlation between money growth and inflation is high, cf. the right-hand side of Chart 4. Money does not seem to lead inflation in the long term, however.

Viewed over a very long period across various monetary-policy regimes, there is also close long-term correlation between money growth

**MONEY GROWTH AND INFLATION FOR CYCLES LASTING 20-40 YEARS** Chart 5



Note: Annual data. The breakdown of money growth and inflation into frequency bands is made using the Christiano-Fitzgerald filter.  
 Source: Statistics Denmark, Danmarks Nationalbank, Erling Olsen (1962), *The Economic History of Denmark since 1750* (in Danish), G.E.C. GADs Forlag, and Kim Abildgren (2004), Nominal and real effective krone rate indices for Denmark 1875-2002, Danmarks Nationalbank, *Working Papers*, No. 13.

and inflation, cf. Chart 5.<sup>1</sup> Similar results for the connection between money growth and inflation in the short and long term also apply for other countries.<sup>2</sup> The long-term correlation is difficult to apply in practice, however. A technical problem is that determination of the trend in the last observations in filtered data is uncertain.

The above analysis does not as such provide a basis for conclusions as to the direction of the causality between money growth and inflation. In a Danish context, money growth is determined by demand and, like inflation, influenced by economic activity and interest-rate levels, among other factors. The most obvious interpretation of the long-term correlation between money growth and inflation is therefore that it reflects the influence of a common set of factors.

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## THE BUSINESS CYCLE, MONEY, CREDIT AND HOUSING PRICES

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Financial variables such as lending by banks and mortgage-credit institutes to households and non-financial corporations can be used as early indicators of economic development since lending data for a given quarter is published before GDP data. Lending by banks is the largest counterpart of money in the banks' balance sheets and in general, monetary and credit growth follow the same course, i.e. that of GDP, cf. Chart 6. However, the developments in money and credit vary during a business cycle. An impression of the cyclical relation between money and credit can be gained by calculating the correlation between the cyclical component of real GDP on the one hand and the cyclical component of money and credit at various dates on the other.<sup>3</sup> More specifically, the correlation between real GDP and values of lending and money in the 8 preceding quarters, the current quarter and 8 subsequent quarters is calculated.

Chart 7 shows the correlation between GDP on the one hand and money and credit on the other. The correlation between GDP and values of money and credit in the preceding quarters is shown in the left-hand side of the Chart, while the correlation between GDP and values of credit and money in the subsequent quarters is shown in the right-hand side.

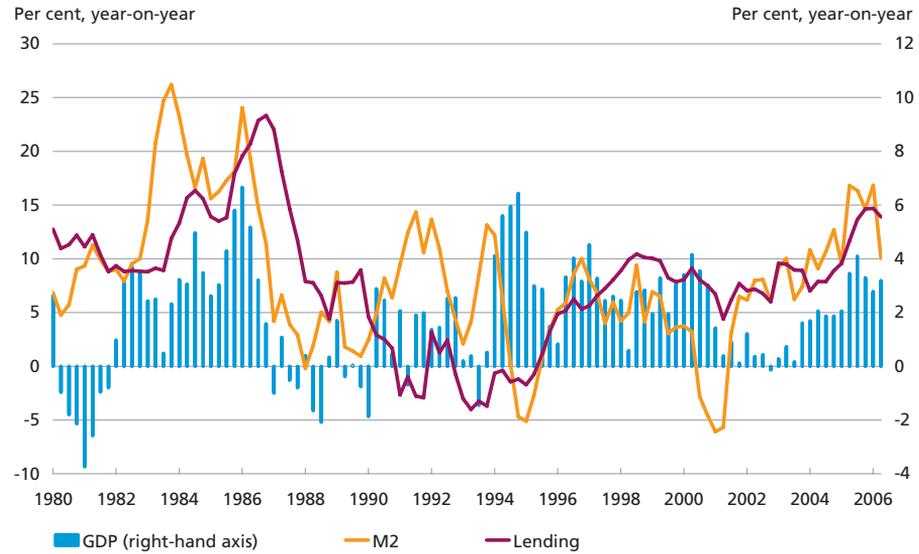
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<sup>1</sup> Cf. Kim Abildgren (2005), Interest-rate development in Denmark 1875-2003 – A Survey, *Nationaløkonomisk tidsskrift*, Vol. 143, No. 2, November, for an overview of monetary-policy and exchange-rate regimes since 1875.

<sup>2</sup> Cf. Lawrence J. Christiano and Terry J. Fitzgerald (2003), Inflation and monetary policy in the twentieth century, Federal Reserve Bank of Chicago, *Economic Perspectives*, 1Q, Luca Benati (2005), Long-run evidence on money growth and inflation, Bank of England, *Quarterly Bulletin*, Autumn, and ECB (2004), Monetary analysis in real time, *Monthly Bulletin*, October.

<sup>3</sup> The cyclical component of a variable can be regarded as the percentage deviation from the moving average or the trend. The correlation pattern in Danish economic cycles is analysed further using corresponding methodology in Frank Øland Hansen and Dan Knudsen (2004), Correlation Patterns in Danish Economic Cycles (in Danish), *Nationaløkonomisk tidsskrift*, Vol. 142, No. 3 and Frank Øland Hansen (2005), Covariation in Danish Economic Cycles (in Danish), Danmarks Nationalbank, *Working Papers*, No. 25.

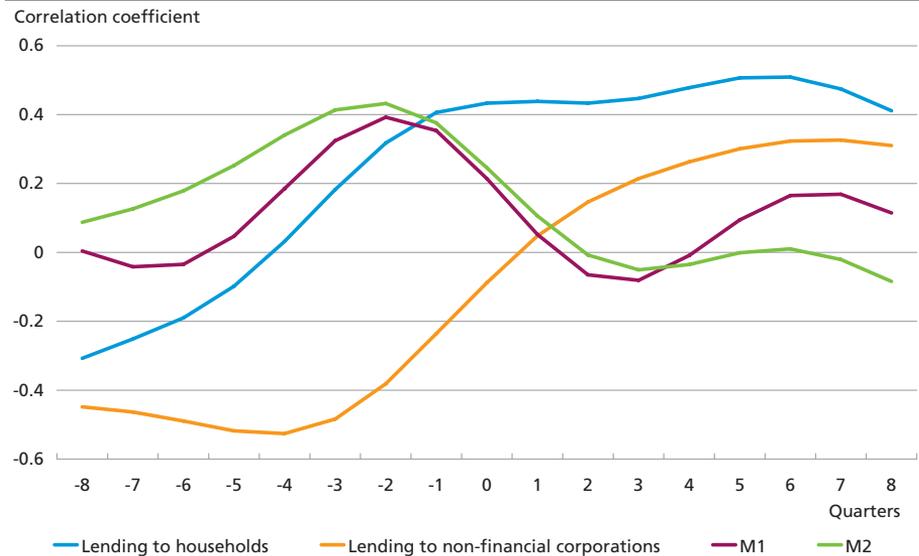
ANNUAL GROWTH IN REAL GDP, M2 AND CREDIT Chart 6



Note: Quarterly data. Lending is lending to households and non-financial corporations.  
 Source: Statistics Denmark and Danmarks Nationalbank.

High cyclical values of money tend to precede high cyclical GDP values. The correlation then declines to a negative level. In overall terms, credit

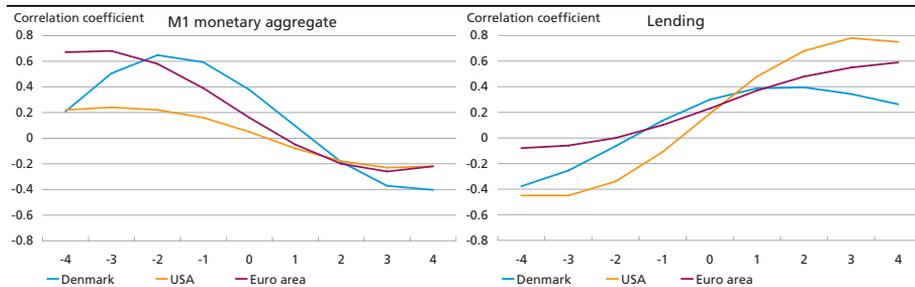
CORRELATION BETWEEN REAL GDP AND THE VALUE OF MONEY AND CREDIT IN PRECEDING, CURRENT AND SUBSEQUENT QUARTERS Chart 7



Note: Based on quarterly data for the period 1980-2005. The cyclical component is calculated using the Baxter-King band-pass filter, including cycles with a duration of 6-32 quarters in the cyclical component. A symmetrical moving average with 12 observations on each side is used.  
 Source: Statistics Denmark and Danmarks Nationalbank.

**CORRELATION BETWEEN REAL GDP AND THE VALUES OF MONEY AND CREDIT IN PRECEDING, CURRENT AND SUBSEQUENT QUARTERS IN DENMARK, THE USA AND THE EURO AREA**

Chart 8



Note: For Denmark based on quarterly data for the period 1971-2005. For the USA and the euro area based on data for the period 1970-2001. The cyclical component is calculated using the Baxter-King band-pass filter, including cycles with a duration of 6-40 quarters in the cyclical component. A symmetrical moving average with 8 observations on each side is used.

Source: Anna-Maria Agresti and Benoît Mojon (2001), Some stylised facts on the Euro area business cycle, ECB, *Working Paper No. 95*, and Danmarks Nationalbank.

shows the opposite correlation pattern. To begin with, the correlation between the cyclical component of GDP and preceding values of the cyclical component of credit is negative. Hereafter it increases. The USA and the euro area show similar cyclical correlation patterns for money and credit, cf. Chart 8.<sup>1</sup>

In an upswing, lending to households will typically begin to increase before lending to non-financial corporations, cf. Chart 7. Lending to non-financial corporations will typically begin to rise at a rather late stage of the upswing since the necessary expansion of the capital stock that is crucial to continued economic growth can at first be financed from own funds generated from higher earnings. Increased lending is thus only required after this point.<sup>2</sup>

### The significance of interest-rate developments

There is positive correlation between money growth and growth in lending on the one hand and housing price increases on the other. The explanation for the positive correlation between the development in money, credit and housing prices is that the variables are typically procyclical and tend to move in the same direction on a shift in long-term interest rates.

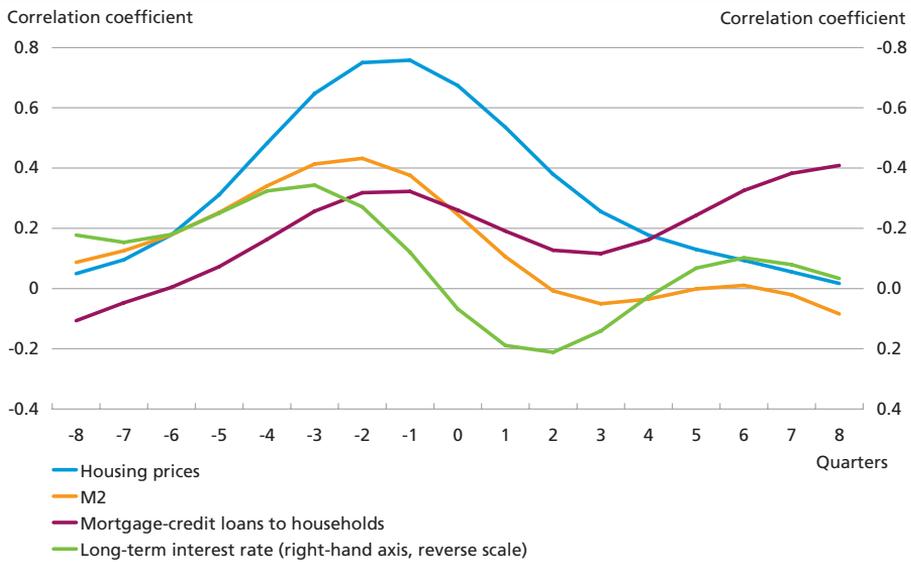
Money stock and housing prices tend to react early in an upswing. Part of the explanation can be that housing prices and money typically react more quickly than domestic demand to movements in long-term interest

<sup>1</sup> Cf. Carl E. Walsh (1998), *Monetary theory and policy*, The MIT Press, chapter 1 for a similar analysis of US data.

<sup>2</sup> Cf. Jens Verner Andersen, Hanne Lyngesen and Erik Haller Pedersen (1999), Credit Expansion During Two Booms, Danmarks Nationalbank, *Monetary Review*, 2nd Quarter.

CORRELATION BETWEEN REAL GDP AND VALUES OF M2, HOUSING PRICES, MORTGAGE CREDIT, AND LONG-TERM INTEREST RATES IN PRECEDING, CURRENT AND SUBSEQUENT QUARTERS

Chart 9



Note: Based on quarterly data for the period 1980-2005. The cyclical component is calculated using the Baxter-King band-pass filter, including cycles with a duration of 6-32 quarters in the cyclical component. A symmetrical moving average with 12 observations on each side is used. The cyclical component indicates the percentage deviation from the trend, but for the long-term interest rate the deviation in percentage points.

Source: Statistics Denmark and Danmarks Nationalbank.

rates. The upswings at the beginning of the 1980s and in the 1990s were thus both preceded by a significant drop in the long-term interest-rate level. The upswing that began in 2003 also coincided with falling interest rates, from an already low level. Chart 9 illustrates the generally close cyclical correlation between housing prices and long-term interest rates. Money demand was stimulated in connection with the sharp decline in long-term interest rates at the beginning of the upswings in both the 1980s and the 1990s since the spread between long-term and short-term interest rates also narrowed.

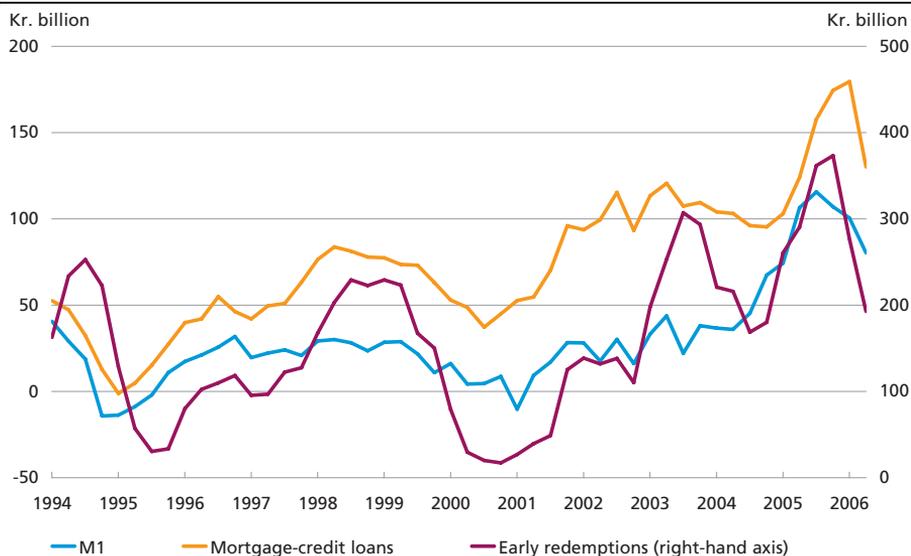
### The significance of housing prices and mortgage financing

The characteristics of money as a leading indicator for GDP can also be related to the development in asset prices. In general, changes in asset prices may influence money since they may give rise to reallocation between assets or between consumption and savings.<sup>1</sup> This may entail placing deposits with banks at varying maturities. In particular, rising housing prices may lead to realisation of capital gains on housing either

<sup>1</sup> Cf. ECB (2005), Money and uncertainty, *Monthly Bulletin*, October, for a more detailed analysis of the effects of equity prices on money demand. See also Laurence H. Meyer (2001), *Does money matter?*, Federal Reserve Bank of St. Louis, *Review*, September/October, Vol. 83, No. 4.

## ANNUAL GROWTH IN M1 AND MORTGAGE CREDIT AND EARLY REDEMPTIONS

Chart 10



Note: Moving sum of 4 quarters. Latest observation is 2nd quarter 2006.

Source: The Copenhagen Stock Exchange and Danmarks Nationalbank.

in the form of supplementary borrowing in connection with conversion of mortgage-credit loans or in relation to purchase and sale of homes.<sup>1</sup> The realised capital gains can be (temporarily) placed as bank deposits, causing the money stock to expand, before they are used for consumption or residential investments, or are placed in other financial assets. Chart 9 illustrates the close cyclical correlation between housing prices, money and mortgage-credit loans to households.

The strong growth in housing prices and the high volume of conversions, which was supported by the introduction of new home-financing products,<sup>2</sup> may explain part of the recent discrepancy between actual and estimated money demand. The correlation between M1 and early redemptions is shown in Chart 10.

Similarly, money demand in the early 1990s, when actual money demand was also somewhat higher than estimated money demand, may have been supported by the liberalisation of mortgage-credit legislation

<sup>1</sup> Cf. Roger W. Ferguson, Jr. (2005), *Asset Prices and Monetary Liquidity*, The Seventh Deutsche Bundesbank Spring Conference, Berlin, Germany, 27 May, for a discussion of the correlation between developments in housing prices, mortgage borrowing and money. In Athanasios Orphanides and Richard D. Porter (2001), *Money and inflation: the role of information regarding the determinants of M2 behaviour*, Board of Governors of the Federal Reserve System at the ECB (2001) *Monetary Analysis: Tools and applications*, special remortgaging issues in the USA that affect monetary development are discussed.

<sup>2</sup> Cf. Lars Jul Hansen and Jesper Ulriksen Thuesen (2006), *Trends in Mortgage-Credit Financing: the Market and its Players*, and Lars Risbjerg (2006), *Trends in Mortgage-Credit Financing: Household Consumption*, Danmarks Nationalbank, *Monetary Review*, 1st Quarter.

in the early 1990s, which enhanced the access to supplementary borrowing and reintroduced 30-year annuity loans. The subsequently falling interest rates triggered substantial conversion activity.<sup>1</sup>

Money and credit are some of the indicators used by the ECB to gain information on potential financial imbalances. Such information is relevant to the ECB's monetary policy, as financial imbalances may have a destabilising effect on economic activity and thus on price developments. In an international context too there is now more focus on the role of money and credit as indicators of the course of equity and housing prices and the derived effects on economic activity. In particular it is considered whether money and credit can be applied as indicators of an imminent peak in housing and equity markets, that may be succeeded by a recession.<sup>2</sup> Other surveys point out that growth in housing prices and real investments are good indicators of an upswing which may potentially be followed by a recession.<sup>3</sup>

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<sup>1</sup> Cf. Niels Lynggård Hansen and Erik Haller Pedersen (2003), *Reasons for the Upswing in 1993-94, How Significant Was Fiscal Policy?*, Danmarks Nationalbank, *Monetary Review*, 3rd Quarter.

<sup>2</sup> Cf. Carsten Detken and Frank Smets (2004), *Asset price booms and monetary policy*, ECB, *Working Paper*, No. 364, ECB (2002), *Asset price bubbles and monetary policy*, *Monthly Bulletin*, April, and Roger W. Ferguson, Jr. (2005), *Asset Prices and Monetary Liquidity*, The Seventh Deutsche Bundesbank Spring Conference, Berlin, Germany, 27 May.

<sup>3</sup> Cf. Jean-Claude Trichet (2005), *Asset price bubbles and monetary policy*, Mas Lecture, Singapore, 8 June.