Development in and Measurement of the Real Interest Rate

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INTRODUCTION AND SUMMARY

In theory, key elements of the economy, be they savings, consumption or investments, are determined by factors such as the real rate of interest, i.e. the inflation-adjusted interest rate. In practice, however, the functional relationship is not particularly evident from Danish figures. This may be related to problems with empirical measurement of the real interest rate. In practice, the traditional measure of the real interest rate as a nominal interest rate less the current domestic inflation rate is often misleading. It is shown that significant smoothing of the price series improves predictability.

On the basis of the traditional measure of the real interest rate some economists conclude that, via higher inflation, a boom in a country which is part of a fixed-exchange-rate system will press down that country's real interest rate, thereby further stimulating the boom. This article argues that, on the contrary, high inflation has a contractive effect in a credible fixed-exchange-rate system.

Even though the traditional measure of the real interest rate was decreasing in many countries throughout the 1990s, the historical level is still quite high, viewed in international terms. This may be related to structural trends in the international propensity to save.

Reducing inflation, as well as the value of the tax deductibility of interest payments, has contributed to Denmark's positive real interest rate both before and after tax. At the same time, the spread between the real interest rates before and after tax has narrowed. In a sound economy investments can live up to the requirement of a positive real interest rate.

DETERMINING THE REAL INTEREST RATE

The real rate of interest is defined as the nominal interest rate less the expected change in the price level over the relevant horizon. The real interest rate can be interpreted as the price at which current consumption opportunities via savings can be converted into future consumption, cf. Boschen (1994). If the real interest rate is positive the future consumption made possible on the basis of today's savings will be greater than the consumption which has to be given up today in order to make savings possible. An increase in the real interest rate corresponds to a decrease in future prices relative to current prices, which makes current consumption relatively more expensive.

Central elements of the economy such as consumption, savings and investments in theory depend on the real interest rate. A high real interest rate will e.g. dampen investments, while the sign of the effect on consumption is less clear. By their nature, investment and savings decisions are forward-looking and are dependent on the expected real interest rate over the savings or investment horizon. However, there is no reliable data for expected inflation, so that in empirical work an approximation must be applied, cf. below.

If a country has a deep market for index-linked bonds, the real rate of interest can be measured directly as the yield on such bonds. However, only a few countries have such markets. In Denmark, the market for index-linked bonds is very small, and price fixing is distorted by e.g. taxation and institutional factors. The Danish market for index-linked bonds thus cannot be used to measure the behaviour-relevant real interest rate.

In the longer term, there is not only a correlation from the real interest rate to savings and investments, but also vice versa, since when resources are fully utilised the level of real interest rates is determined primarily by the ratio between investments and savings. A rising real-interest-rate level will be a consequence of an increase in planned investments, or a decrease in planned savings, or a combination thereof.

In addition to the private savings-investment balance, the real interest rate is also fundamentally dependent on net government savings. To the extent that government budgets show a deficit, the public sector absorbs private savings, which, all else being equal, will exert upward pressure on the real interest rate, and thereby supplant private investments.

In an inflationary economy the question is how inflation expectations affect the real interest rate. Taking the Fisher equation as the point of departure, it is assumed that the inflation expectations are transmitted on a one-to-one basis in the nominal interest rate, i.e. the nominal interest rate increases by 1 per cent on a 1-per-cent increase in inflation expectations. This leaves the real interest rate unaffected by the inflation expectations, cf. Box 1. This corresponds to savers being compensated for the erosion of the value of their savings attributable to the price increase.

TRANSMISSION OF INFLATION EXPECTATIONS TO THE NOMINAL INTEREST RATE Box 1

The Fisher equation decomposes the nominal interest rate (R) into a real interest rate before tax (r^{fs}) and inflation expectations (Π^e):

$$(1) \qquad R = r^{fs} + \Pi^e$$

According to this equation a 1-per-cent increase in inflation expectations will lead to a 1-per-cent increase in the nominal interest rate, equivalent to a transmission of one. This makes the real interest rate before tax independent of inflation expectations.

The mechanism in a small, open economy is that a permanently 1-per-cent higher inflation rate for given foreign inflation entails the expectation of depreciation by 1 per cent in the currency, which again is converted to an equivalent increase in the domestic nominal interest rate, i.e. a transmission of one, as in the Fisher equation.

However, certain factors may indicate that the transmission to the nominal interest rate is less than one-to-one, indicating that the real interest rate falls as expected inflation increases, even if inflation is predicted correctly. The argument is that rising inflation expectations will lead to a flight from nominal to real assets, as a safeguard against the erosion of values. This will cause the marginal product of capital, and thereby the real interest rate, to decline. Another argument leading to the same result is that rising inflation expectations reduce the real value of households' monetary claims, so that households feel poorer. This will push up savings, and push down the real interest rate for given investments. The arguments for a transmission ratio of less than one-to-one are called the Mundell-Tobin effect after Mundell (1963) and Tobin (1965). This effect must be assumed to be most relevant in the event of high expected inflation. Uncertainty of future inflation will have an equivalent effect.

In a small open economy with a credible exchange-rate target, it can be argued that the externally-determined factor is the nominal interest rate, rather than the real interest rate. An inflation rate which deviates temporarily from that of the currency anchor will in this case directly impact the measured domestic real interest rate if the current price-increase level is used to calculate the real interest rate. However, inflation expectations will typically be determined by the inflation rate of the currency anchor, which in Denmark's case is the euro area, and not by the current domestic inflation. The actual real interest rate which is relevant to the behaviourial relations is thus different from the initial measure of the real interest rate. *Ex post* calculations of the real interest rate applying actual domestic inflation can thus be misleading. Indeed, Danmarks Nationalbank's work on the Mona model has shown that it is difficult to satisfactorily include a real interest rate as a determinant in equations to explain the development in consumption and investments, cf. Christensen and Knudsen (1992). However, the real interest rate is partly included in the cash-price relation for owner-occupied homes. In the slightly longer term, inflation in Denmark and the euro area will tend to converge, thereby reducing the measurement error from using the domestic price-increase rate to calculate the real interest rate.

Even though in theory the expected real interest rate as part of the user cost determines whether an investment project is undertaken, in practice importance is often attached to the nominal interest rate. Part of the background is that while the nominal interest rate is known at the time of investment, at any rate in the case of financing at a fixed interest rate, as a general rule the development in prices during the investment's pay-back period will be uncertain. This behaviour may also reflect the formation of expectations whereby high inflation at the time of investment is expected to be redressed via contractive economic-policy measures. This type of behaviour e.g. characterised Denmark in the first part of the 1980s on the transition from a high to a low-inflation regime, when the real interest rate rose concurrently with investments, while the nominal interest rate was falling, cf. Christensen and Knudsen (1989). Unexpected changes in the price-increase rate can cause the actual realised return to differ considerably from expectations when the investment was initiated. This deviation can be positive or negative, but in all circumstances entails that the backward-looking real interest rate is irrelevant to investments in Denmark.

According to the Walters criticism[1] of a monetary union, and thereby indirectly also of a fixed-exchange-rate policy, a boom in one country in the union or fixed-exchange-rate area will cause that country to have higher price increases than the rest of the union, and thereby a lower real interest rate. This further amplifies the boom, and therefore has a procyclical effect, cf. Walters (1986) and Østrup (2000). However, this is not reflected in Danish experience. In practice, the expansive effect is moderated by the fact that high inflation generates expectations of contractive economic measures among the population and the business sector, just as competitiveness typically deteriorates in a fixed-exchange-rate regime, resulting in falling exports. On the other hand, low inflation and thereby a higher real interest rate will have an expansionary impact via e.g. increased competitiveness and thereby also exports.

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[1] After Margaret Thatcher's economic advisor Alan Walters.

INTERNATIONALISATION OF THE DETERMINATION OF THE REAL INTEREST RATE

In the period from 1960 until today both goods and financial markets have undergone extensive liberalisation. This tends to equalise the real interest rates of different countries. Previously, the markets were generally more segmented. An illustrative historical example is the case of Denmark prior to the development of national financial markets in the last part of the 19th century. This followed a long period during which interest rates were typically lower on Zealand, Funen and the smaller islands of Denmark than in western Jutland, cf. Glud (1951). This was due to variations in the savings-investment balances of the various regions of Denmark. In fertile farming areas with high yields savings as a ratio of the investment requirement were high, resulting in relatively low nominal and real interest rates, while the reverse was the case in the more barren areas of western Jutland. This reflects how the segmented financial markets prevented savings from being channelled from areas with a savings surplus to areas with a savings deficit. To a certain degree

EQUALISATION OF REAL INTEREST RATES ACROSS COUNTRIES AND REGIONS — Box 2

Two conditions must be fulfilled for the equalisation of variations in real interest rates across national borders. In the financial markets the open interest-rate parity must be sustained. According to the latter, an investor will require the same yield on two otherwise identical securities denominated in different currencies. This is to say that the foreign interest rate must be equivalent to the domestic rate, adjusted for the change in the exchange rate:

$$1) \qquad R^{abroad} = R^{domestic} + \Delta E$$

where R = nominal interest rate and ΔE = change in exchange rate.

On the goods markets the relative purchasing-power parity must be sustained. According to the latter, the exchange rate in one country will depreciate equivalent to the additional price increase (adjusted for the relative development in productivity) in that country compared to abroad. This correlation between exchange rate and relative inflation can be written as:

$$2) \qquad \Pi^{abroad} = \Pi^{domestic} + \Delta E$$

where Π = inflation.

Inserting equation 2) in 1) gives:

$$R^{abroad} - \Pi^{abroad} = R^{domestic} - \Pi^{domestic}$$

$$3) \qquad r^{abroad} = r^{domestic}$$

where r = the real interest rate.

this segmentation between markets still exists between countries today. See Box 2 for an exposition of the theoretical conditions for uniform real interest rates across countries and regions.

Despite the greater integration of the financial markets there is still a surprisingly strong correlation between savings and investment levels in each country. In a fully integrated world a country's investments would be expected to be financed from the total global savings, see Feldstein and Horioka (1980). One reason that this does not seem to be the case may be that in many countries balance on the current account of the balance of payments is a political objective. This makes it politically unacceptable for an excessive proportion of the country's investments to be financed by foreign savings to a sustained degree. This is equivalent to a sustained current-account deficit, and thereby increasing foreign debt[1]. With regard to portfolio investments too, there is a clear tendency to invest funds predominantly on a national basis.

THE INTERNATIONAL DEVELOPMENT IN THE REAL INTEREST RATE

As stated above, one of the key problems presented by empirical calculation of a real interest rate is that the nominal interest rate is to be adjusted by the inflation expectations, and not by the current inflation rate. The derivation of inflation expectations can take place on a more or less sophisticated basis. In the following an HP filter[2] is applied. This makes the assumption that the inflation expectations only change with a certain time lag. It is important to be aware that applying the HP filter does not solve the fundamental problem related to measuring inflation expectations.

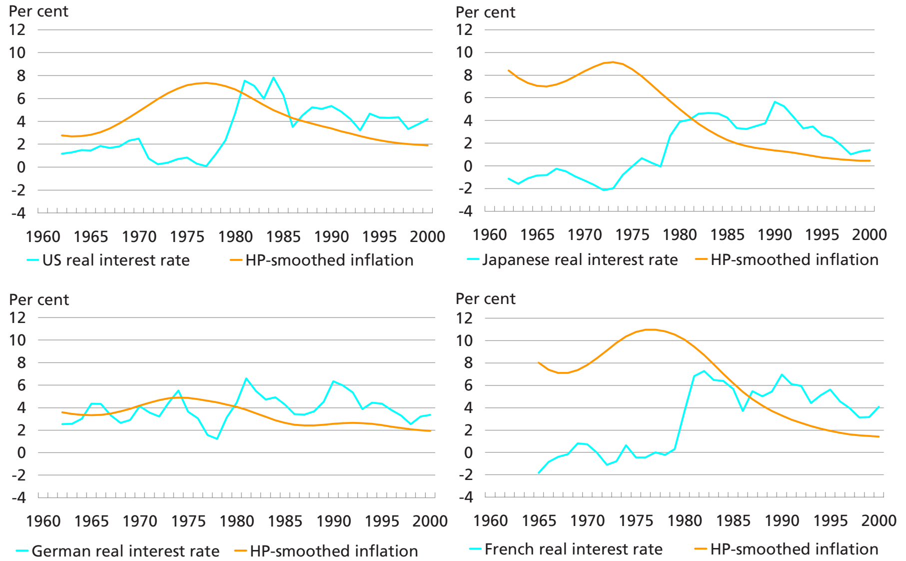
By their nature, investments are forward-looking. When business enterprises plan their investments, the expected long-term real interest rate therefore determines whether a project is worth executing. Many of the households' savings decisions also have a long-term view, such as pension savings. The long-term real interest rate is therefore relevant to the assessment of the economic effects of the real interest rate. In the following, the long-term real interest rate is defined as the interest rate on a 10-year government bond, less the HP-smoothed current inflation rate.

Like the preceding decades, the 1960s were characterised by internationally segmented financial markets with various types of credit restrictions and administrative control of the level of interest rates. A case in

1 See Obstfeld and Rogoff (2000) for an attempt to explain the correlation between savings and investments at national level by the existence of transaction costs.

2 See appendix.

REAL INTEREST RATE AND INFLATION Chart 1



Note: Calculated on the basis of 10-year bond yields and consumer-price inflation. On smoothing λ =100 is applied.

point is the rationing of bond issues in Denmark. International capital flows were also subject to extensive restrictions. On the other hand, goods prices could be fixed more freely, with hardly any restrictions at all. It must therefore be assumed that the real interest rate was artificially low in many countries in the 1960s. In the decades that followed a gradual liberalisation took place, which also involved international capital flows. For example, the overall development in the real interest rate has many common characteristics in the different countries from 1970 onwards, cf. Chart 1.

The boom of the 1960s resulted in an accelerating price-increase rate, and probably also expectations of higher future inflation. The strong leap taken by oil prices in 1973 amplified this process. The subsequent drop in inflation was not accompanied by an equivalent decline in the long-term nominal interest rate. The result was a strong increase in the real interest rate, which remained high during the 1980s and the beginning of the 1990s. In Germany, the real interest rate rose strongly around 1990 in the wake of reunification. It thus turned out to be surprisingly difficult in many countries to bring the nominal interest rate down to the lower inflation level. This may be related to the fact that inflation expectations were difficult to subdue after the high-inflation period. For a long time, there were fears of a return to high inflation.

During the past decade the real interest rate has fallen, especially in the euro area where nominal interest rates and inflation, and thereby also the real interest rates of the different member states, have converged towards the German level. In terms of the development in interest rates, not only nominal, but also real convergence has taken place. This should be viewed in the light of the EMU process which has e.g. ensured considerable budget consolidation, resulting in lower budget deficits. At the same time, inflation has been brought down. As a result of sounder fiscal policy and generally more appropriate economic policy private investments are less suppressed by government consumption. Moreover, the development in inflation is subject to less uncertainty, giving more stable expectations of low inflation. The EU member states that faced the greatest budget and debt problems at the beginning of the 1990s have seen the strongest decreases in long-term real interest rates as a consequence of the EMU process. These member states are Italy, Finland and Ireland in particular.

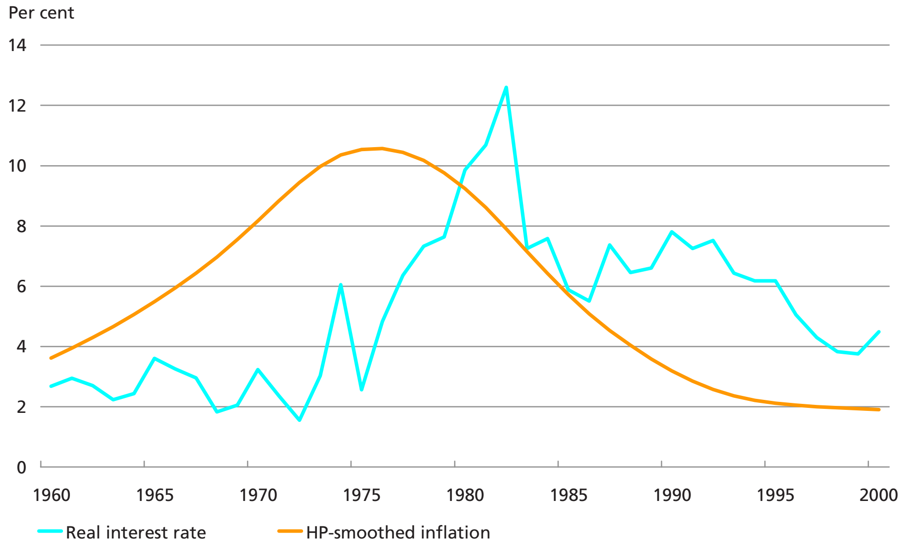
The greater the degree of integration of the financial markets, the smaller the significance of the budget balances of the individual countries. On the other hand, other countries' budgetary positions become more important, and the real interest rate is influenced by the aggregated budget balance. Free capital flows also facilitate the financing of a budget deficit, thereby reducing the disciplinary effect of the financial markets. As a consequence, decision-makers show more interest in co-ordinating economic policy in a formal, binding framework such as the Stability and Growth Pact within EMU.

Unlike Europe, the USA saw no drop in the real interest rate in the 1990s. This is the result of two contradictory trends. There was considerable budget consolidation, as in the EU, which pulled down the real interest rate, but this was offset by high growth and growth prospects right up to the end of 2000. The trend during the 1990s was for convergence of real interest rates not only within the EU, but also between the EU and the USA, which both had a real interest rate of approximately 4 per cent at the end of the decade. In contrast, Japan has a strongly falling real-interest-rate level of less than 2 per cent as a consequence of the deep and sustained recession in that country for the last 10 years.

DEVELOPMENT IN THE DANISH REAL INTEREST RATE

In a description of the Danish real interest rate, as from 1960 four periods can be identified. During the boom up to the first oil crisis inflation and the nominal interest rate were rising. This resulted in a by and large constant real-interest-rate level of 3 per cent, cf. Chart 2. Then came a period with an accelerating real interest rate up to the peak in 1982. The background is the build-up of inflation expectations triggered

DANISH REAL INTEREST RATE AND INFLATION Chart 2



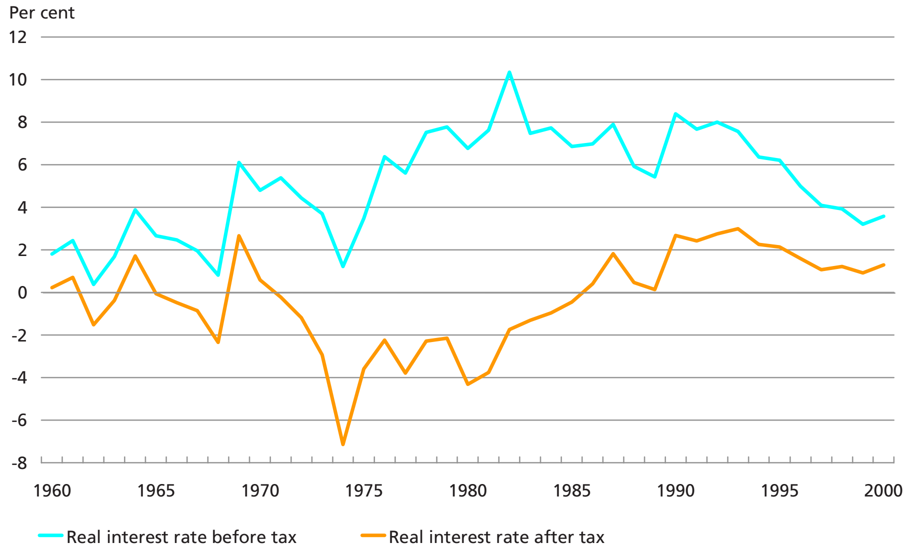
Note: The basis is a 10-year government-bond yield and consumer prices.

in the 1970s by the two oil-price surges and less appropriate economic policy. This caused the nominal interest rate to rise strongly, even though current inflation was falling in the latter part of the period. In the 1980s, after economic policy was restructured in 1982 with a declared fixed-exchange-rate policy, the real interest rate stabilised at around 7 per cent, also a historically high level in international terms. Despite the ongoing decline in current inflation, it proved to be extremely difficult to press the inflation expectations out of the system. The expected real interest rate, on which economic agents actually act, was thus lower than the actual measure of the real interest rate, cf. the previous discussion on the problems of when the real interest rate is significant in the behaviour equations.

During the boom in the 1990s, when inflation stabilised at a low level, the drop in the nominal interest rate also caused the real interest rate to fall to just over 4 per cent at the millennium rollover. Meanwhile, the spread between the nominal and the real interest-rate levels narrowed in step with falling inflation.

Taxation of capital income inserts a wedge between investment returns and the real interest received by the households, which in the final analysis own the capital stock. Business enterprises will focus on the real interest rate before tax in their investment calculations, since this is the interest rate to be paid, whereas the real interest rate after tax affects the households' consumption and savings decisions.

DANISH REAL INTEREST RATE BEFORE AND AFTER TAX Chart 3



Note: Calculated on the basis of a 10-year government-bond yield, consumer prices and the rate of taxation of capital income.

In the Danish case, the real interest rates respectively before and after tax have taken very different courses over the past 40 years, cf. Chart 3. The advantageous opportunities to deduct nominal interest expenditure in taxable income, together with high inflation, and thereby a high inflation component in nominal interest rates, meant that the real interest rate after tax was negative for many taxpayers in the 1970s and early 1980s. This coincided with a high and increasing real interest rate before tax. The interest rate can be said to have been high and low at the same time. Business enterprises' productive investments were hit by the high real interest rate before tax, while the households benefited from the low real interest rate after tax, which stimulated consumption and housing investments. The households were also favoured by savings in pension schemes for which yields were untaxed up to the beginning of the 1980s. These factors contributed to low growth and substantial macroeconomic imbalances during the period, including a sustained current-account deficit, and as from 1976, a government deficit and high unemployment.

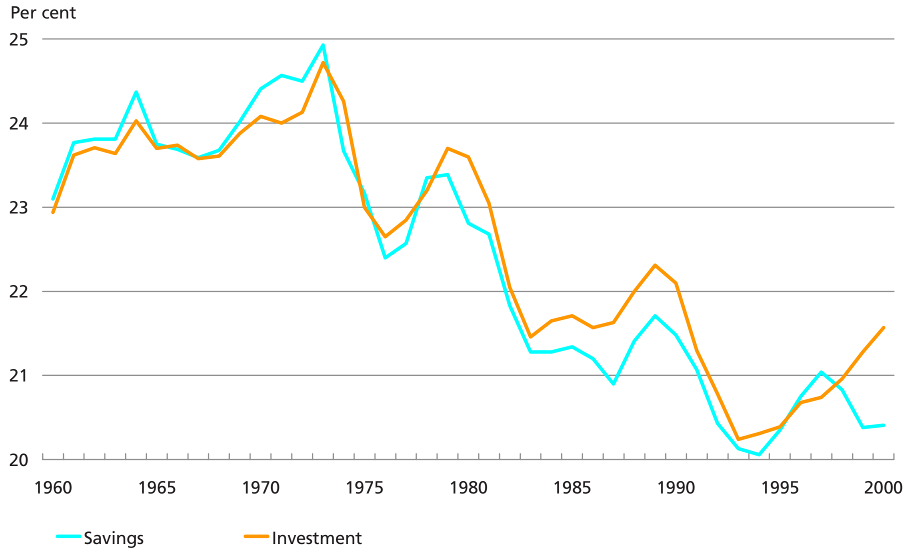
The nominally based taxation system led to a number of distortions of savings and investment decisions. The higher the inflation rate, the greater the distortions. In an ideal situation, business enterprises' investment planning will take no account of taxation, i.e. the required return on an investment project must as a minimum be equivalent to the real interest rate. Since inflation tends to reduce the required return in relation to the real interest rate it introduces a subsidy element which can make otherwise unprofitable investments profitable in micro-economic, but not necessarily macroeconomic, terms. The higher the inflation rate, the lower the required return in relation to the real interest rate. In principle, this is because there is a full tax-deduction right for the inflation component of the nominal interest rate, even though the inflation gain on the capital stock is recognised as income as it occurs. The conclusion is that high inflation distorts investments. Negative real interest rates are only preferable in situations where an economy is struggling to get out of deep recession. In a sound economy, investments will be required to fulfil a positive real interest requirement, and in the long term it is not advisable to promote investments with the help of tax-related distortions. See Pedersen and Wagener (2000) for further discussion.

IS THERE A RISING REAL INTEREST TREND?

While the decline in long-term real interest rates in the 1990s is specific to the EU and attributable to the EMU process, and while also disregarding Japan, the question remains of why the international level of real interest rates is still rather high in historical terms, and also when measured in terms of the long-term real growth in the economy. Is there an underlying upward trend for the level of real interest rates? This is indicated by certain structural courses. Considering the proportions of GDP made up by savings and investments, both ratios have shown a declining trend during the last 30 years, cf. Chart 4. The combination of falling savings and investment ratios, together with an increase in the level of real interest rates, indicates that declining savings have been the force driving this development. Both private and public savings have been declining, with the public sector accounting for the greatest decline, thereby exerting pressure on the savings-investment balance. In the mid-1970s, government debt was approximately 40 per cent of GDP, but during the next 20 years it rose to almost 70 per cent of GDP by the mid-1990s. Since then, disregarding Japan, the debt ratio has been constant or moderately falling.

The ratios are calculated for the OECD area, which is relatively closed to external factors and to only a moderate degree, in certain periods, has drawn in savings from outside the area i.e. runs a current-account deficit. The decline in the investment ratio conceals decreases in business and government investments, as well as housing investments, with the latter accounting for the greatest decrease.

SAVINGS AND INVESTMENT RATIOS IN THE OECD AREA | Chart 4



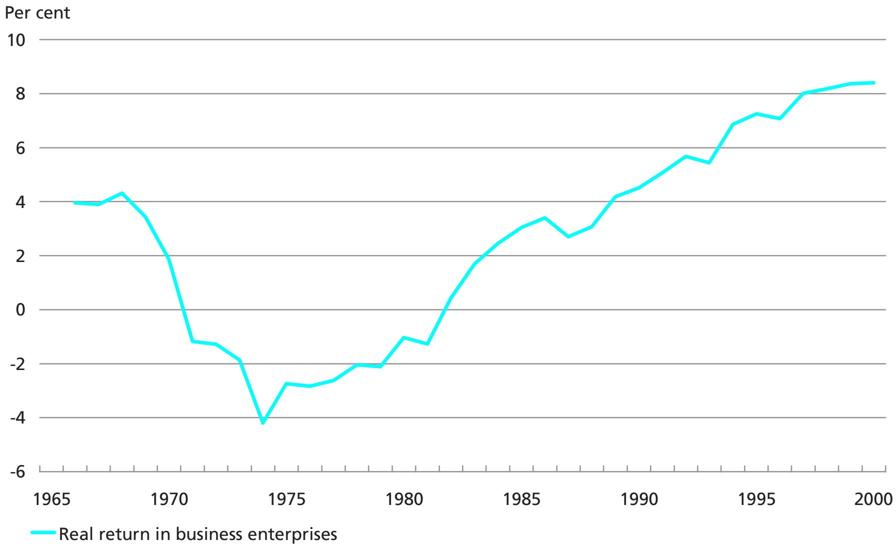
Note: Savings and investment in the OECD area as a percentage of GDP.

The declining trend for the savings ratio can be attributed to several causes. The liberalisation of the financial markets means that credit restrictions affect fewer people, thereby reducing involuntary savings, e.g. larger free mortgageable values than home-owners would prefer. In addition, depreciation rates for fixed assets have increased in step with the introduction of new technology (shorter lifetimes for the capital stock). The ongoing expansion of the welfare states, with greater social-security provision, has eliminated some of the incentives to save up for one's old age and possible periods of illness, etc. Moreover, growing government deficits have not been fully offset by higher private savings. The latter effect was reversed in the 1990s, however, through greater budget consolidation.

In a more forward-looking perspective, a decline in the propensity to save must be expected in step with the ageing of the populations of many OECD countries. In practice, the 40- to 60-year-olds account for the greatest proportion of savings, while the older age groups typically draw on their savings.

Finally, the method of measuring the savings ratio may present problems. By the traditional national accounts method net worth gains are not included in incomes, since they do not increase current output, and are thus merely a type of inflation. If the income concept is amended to also include capital gains, or perhaps only realised capital gains, the decrease in the savings ratio will be less drastic. This applied especially in

REAL RATES OF RETURN FOR DANISH BUSINESS ENTERPRISES Chart 5



Note: The rate of return is calculated as residual income compared to the value of the capital stock less the increase in the HP-smoothed GDP deflator.

the 2nd half of the 1990s, when stock prices rose significantly in many countries. Reference is made to Peach and Steindel (2000) for a discussion of the USA.

Besides a decrease in the savings ratio the historically high real interest rate may be related to higher returns on investments. In fact, business enterprises' real rate of return, calculated on the basis of the national accounts as residual income as a ratio of the value of the capital stock, less the increase in the GDP deflator, has actually shown a rising trend, cf. Chart 5. The rate of return has been rising since the mid-1970s. This increase is an international phenomenon for which one underlying explanation may be increasing capital productivity. However, it is also true that new technology, including IT, has reduced the lifetime of the capital stock, i.e. increased the real-economic rate of depreciation. It follows that the increase in gross rates of return has not necessarily been followed by an equivalent increase in net rates of return.

MORE ON THE PRACTICAL CALCULATION OF THE REAL INTEREST RATE

Theoretical literature often assumes that returns on different assets are generally identical, making it possible to define a single real rate of interest. In practice, there can be significant variations in e.g. the costs of private and government borrowing, and as regards equity capital or external financing. With regard to the latter, business enterprises' capital costs are not only determined by the bond yield, which can be seen as an indicator of the costs of external financing, but also by the costs of equity. One indicator is the development in stock prices. Equity capital typically entails a risk premium compared to external financing.

For analytical purposes it may be appropriate to consider real interest rates for sub-indices of general price indices. To assess the yield on e.g. an investment in an oil well, it can be relevant to calculate a real interest rate for natural resources, whereby the development in the expected oil price is used as the deflator in the calculation of real interest. In the same way, a real interest rate deflated by the expected development in the housing price can be calculated. The development in these sub-price indices can differ considerably from the general price development. In practice, the real interest rate is by no means a clearly definable concept.

Another issue is how inflation should be defined in cases where a broadly based inflation measure is required. The reference literature differs on the ideal measure of inflation. According to Alchian and Klein (1973) an ideal measure of inflation measures the changes over time in the costs of acquiring a lifetime's consumption in current prices. This means that the price index in principle must contain both the period's consumption and expected prices of future consumption. As the prices of future benefits are not directly observable, one way of including prices of future consumption in our inflation measure could be to include asset prices. An asset is a claim on future consumption, while the asset price can be perceived as the rediscounted value of the future benefits. This is a means of including price expectations in the price index.

Interpreting the real interest rate as the exchange ratio between present and future consumption also makes it clear that assets and any capital gains on those assets are decisive to the households' opportunities for intertemporal substitution.

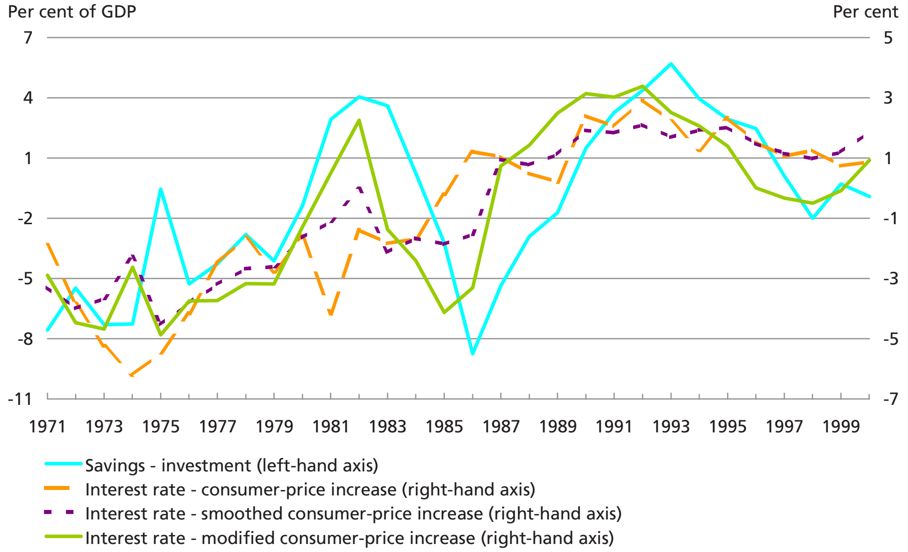
Including asset prices in the inflation measure does present problems, however. There can be problems in determining their weighting, and moreover, asset prices are typically more volatile than most goods prices, which presents the risk of invalidating the entire price index. This particularly applies to the inclusion of shares, which are far more volatile than goods prices, or human capital, which is not directly measurable. In practice, the discussion concerning asset prices in the consumer-price index is in essence a matter of the inclusion of the price of owner-occupied homes.

There are two fundamental approaches to the practical calculation of consumer-price indices: the consumption approach and the expenditure approach. The first approach is based on households' consumption in a given period, not over a lifetime. By this approach the purchase of capital goods, such as an owner-occupied home, should not be included. On the other hand, the yield on the capital goods during the period, i.e. the housing service or rental value, is included, and can be perceived as the households' production for own consumption. The price of the housing service in the period is calculated, or imputed, and is thus not a market price, nor is any monetary transaction involved. This is the Danish method of calculating the housing item of the consumer-price index. As the price of the housing service is calculated, it is clear that this index gives no information concerning the future inflation on the capital goods. Despite the inclusion of the price of an asset, housing, the forward-looking perspective is not involved after all.

By the expenditure approach the change in the price of consumer goods at the time of payment, irrespective of the time of consumption, is measured. Again, only payments in a given period are considered. For goods and services besides housing the Danish consumer-price index adheres to the expenditure approach, and is thus a hybrid between the two main methods. The consistent method of involving owner-occupied homes by the expenditure approach is to include households' net purchase of homes in the period, i.e. new construction for own account plus net purchases from other sectors. Transactions between households concerning existing homes net out. By this approach, transactions at market prices involving monetary exchanges are included. This avoids imputed prices and is the method being considered for the inclusion of owner-occupied homes in HICP, which so far has excluded owner-occupied homes. In practice, the weighting given to the housing item is significantly lower by the expenditure approach compared to the consumption approach. For Denmark, the reduction is by half. Pedersen (1998) compares the two methods of calculating the price index. The conclusion is that, in practice, the difference is limited.

The method of including the housing item in the price index by the expenditure approach theoretically makes this price index more suitable for calculation of the real interest rate. However, one problem is that only the prices for the net supply of homes are included. The households must be expected also to react to changes in prices of the existing housing stock. As an alternative, a real interest rate based on a price index can be defined to include both consumer prices and home prices as cash prices. If home prices are rising, this generally reflects positive expectations of the economy, which affects consumption decisions as well as housing construction. Chart 6 presents the covariation between the private savings surplus and a real interest rate which includes cash

SAVINGS SURPLUS AND REAL INTEREST RATE Chart 6



Note: A real interest rate after tax is used, since this determines consumption and housing investments. The modified consumer-price increase is defined as 0.8*(smoothed consumer-price increase) + 0.2*increase in house prices. To avoid duplicate calculation, the housing item is drawn out of the consumer-price index before smoothing. λ = 100 is applied to smoothing.

prices for owner-occupied homes. The covariation is clearly greater than for the simple real interest rate.

The Chart also shows the difference between a real interest rate which is only deflated by the consumer-price increase, and a real interest rate where the deflator is based on an HP-smoothed price-increase rate. The significance of smoothing the price series is discussed in more detail in the Appendix. It is concluded that smoothed price series are better at capturing the behaviour-relevant inflation, so they offer a better explanation of savings and investment behaviour than the actual series.

APPENDIX

It is not immediately possible to measure the inflation expectations of households and business enterprises as they make microeconomic decisions. It can be argued that expected inflation does not mirror the actual increase in consumer prices. Below it is sought to arrive at an expression of inflation which makes the resulting real interest rate a good indicator for the development in the total private savings balance, i.e. private savings less investment. In other words, an expression of expected inflation is required that can be applied to a simple equation for the change in the private savings balance.

$$\Delta SI = a_1 SI_{-1} + a_2((1-t_{-1})R_{-1} - E\Delta p_{-1}) + a_3$$

where SI is the private savings surplus, savings less investment, as a ratio of private income, R is the nominal bond yield, t is the tax rate for capital income and $E\Delta p$ is the expected increase in consumer prices. The footer -1 indicates preceding year.

The equation shows that the savings balance improves if it is low compared to the real interest rate after tax. In principle, the propensity to save and invest can also affect the real interest rate, but in a small, open economy with externally-determined financial factors the dominating correlation must be that a higher real interest rate causes the savings surplus to increase.

Box 3 presents the results of five regressions with various expressions of expected inflation. Equation 1 is estimated entirely without the inflation term, i.e. the nominal interest rate determines the savings balance. In equation 2 the conventional real interest rate is used, i.e. deflated by the current price increase. In both cases there are problems with the significance of the interest term, cf. the low t values, and especially with the real interest rate calculated on the basis of the current price increase. It is concluded that neither the nominal interest rate nor a conventional real interest rate is a particularly good indicator of the savings balance.

The current increase in consumer prices is too volatile to give a good picture of expected inflation, but it is not advisable either to completely eliminate an expression of inflation. A compromise method is to smooth the price series to eliminate some of the volatility. An HP filter, cf. Hodrick and Prescott (1997), is used for this purpose. The HP filter calculates a centred moving average of the price series. It can be chosen how much the fluctuations are to be dampened by setting a dampening factor called λ (lambda), which can assume values from

FIVE EQUATIONS WITH DIFFERENT RESULTS FOR EXPECTED INFLATION Box 3

(1) Nominal interest rate:

$\Delta SI = -0.23\ SI_{-1} + 0.68\ (1\text{-}t_{-1})\ R_{-1} - 0{,}039$ SE = 0,037
(2.0) (1.5) (1.5)

(2) Real interest rate with current price increase:

$\Delta SI = -0.33\ SI_{-1} + 0.35\ ((1\text{-}t_{-1})\ R_{-1} - \Delta p_{-1}) - 0.0008$ SE = 0,038
(2.5) (1.0) (0.1)

(3) Real interest rate with increase in smoothed price series, $\lambda = 100$:

$\Delta SI = -0.51\ SI_{-1} + 1.13\ ((1\text{-}t_{-1})\ R_{-1} - \Delta p\_HP100_{-1}) - 0.0004$ SE = 0,034
(3.8) (2.8) (0.1)

(4) Real interest rate with increase in smoothed price series, $\lambda = 3000$:

$\Delta SI = -0.60\ SI_{-1} + 3.62\ ((1\text{-}t_{-1})\ R_{-1} - \Delta p\_HP3000_{-1}) - 0.0008$ SE = 0,025
(6.3) (6.1) (0.2)

(5) Real interest rate with 0.54 Δp_HP100+0,025 as expected inflation:

$\Delta SI = -0.60\ SI_{-1} + 3.78\ ((1\text{-}t_{-1})\ R_{-1} - 0.54\ \Delta p\_HP100_{-1} - 0.025)$ SE = 0,024
(6.2) (6.5) (6.1) (5.0)

Note: Estimated for the period 1972-2000 on the basis of annual data. SI is the private savings surplus as a ratio of private income, t is the tax rate for capital income, R is the average bond yield and Δp is the logarithmic change in the consumption deflator. The filtration included the deflator back to 1948, and estimates up to 2007.

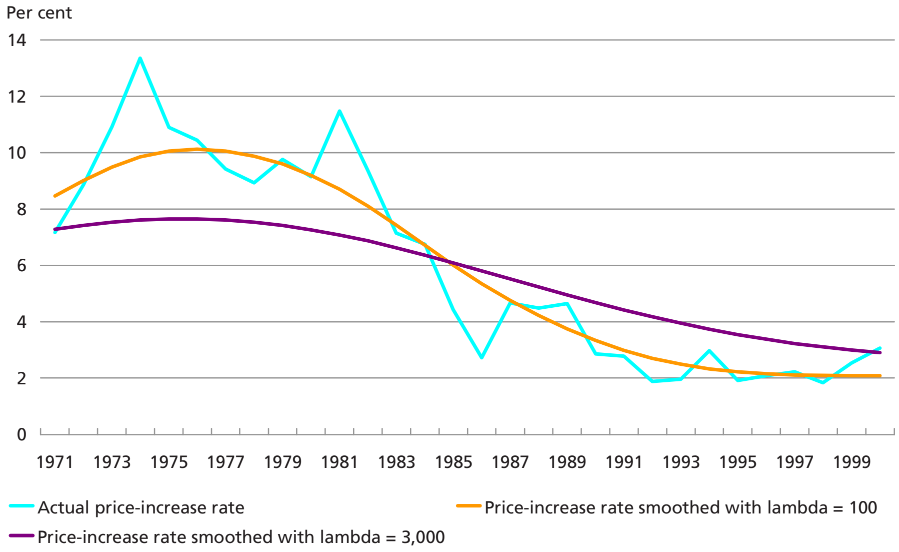
zero to infinite. For λ equal to zero there is no smoothing, and the result is the original series. For λ equal to infinite the result is a linear trend. Often, λ equal to 100 is chosen for annual figures. This standard choice also improves the relation, cf. equation 3 of the Table.

This is not the best choice, however. Trying out several different dampening factors leads to the result that the spread of the relation is minimised at a high λ of around 3,000. There is a clear decrease in the spread and increase in the real interest rate's significance from equation 3 to equation 4 of the Table.

Actual and smoothed price increases are shown in Chart 7. A dampening factor of 100 gives relatively short-term fluctuations in the actual price increase, which are smoothed out. Apart from this the curve retains its course. The greatest smoothed-out "price spikes" are in the period with the highest oil-price increases during the 1970s. It seems reasonable that households and investors did not act as though these high price increases would continue, just as the oil-price increases were related to the decrease in real incomes and activity which was not conducive to increased consumption and investment.

In view of the high dampening factor of 3,000 the filtered price series is flattened and the difference in average price increases between the

PRICE-INCREASE RATE WITH THREE DEGREES OF SMOOTHING Chart 7



Note: The deflator for private consumption is used.

1970s and 1990s is significantly less than in the case of the two other price curves.

An alternative to applying a high dampening factor of 3,000 is to release the coefficient to the price-increase rate. In equation 5 the nominal interest rate and inflation after smoothing are included separately with λ equal to 100. It is seen that the spread and significance level correspond to equation 4. Equation 5 illustrates that the free coefficient to the price increase corresponds to basing the real interest rate on $0.54\Delta p\_HP100_{-1}$ + 0.025 as the measure of expected inflation. This is to say that actual changes in the price-increase rate have half their impact on the behaviour-relevant inflation. This dimension resembles the increase in the price series with a high dampening factor, cf. Chart 7.

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