The impact of interest rates on private consumption in Germany

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I Introduction

At approximately 60 %, private consumption is, in quantitative terms, the most important component of the domestic use of gross domestic product in Germany. In order to analyse the effects which changes in the interest rate level have on the real economy, it is therefore important to know the extent to which they exert an influence on households' consumption expenditure. Nevertheless, empirical studies on this subject for Germany are somewhat thin on the ground - in contrast, say, to research on the relationship between interest rates and investment in Germany. In this context, it is not only the strength of the impact of interest rates on private consumption which is of interest but also - provided that a relationship can be proved to exist - the identification of the transmission channels through which this relation works.

The level of consumption may be interpreted as the result of a decision-making process of households over the time structure of the allocation of their income. According to popular opinion, if interest rates rise, consumption decreases, which means that an important demand component declines. In this context, reference is made to the substitution effect, by which future consumption becomes more attractive, in comparison with present consumption, as a result of changed relative prices. However, the proponents of this opinion overlook the fact that interest rate changes, besides substitution effects, also have income effects which may more than offset the substitution effects. By contrast, Keynes (1936) doubted that the interest rate really is a determinant of consumption "under normal circumstances". Instead, he focused on current income as the most important determining factor.

The budget constraint of households is a suitable starting point for answering the question of whether interest rates have an impact on private consumption. The budget constraint implies that consumption can be financed from current income, from assets or from credits. A distinction must be made between assets and credits because of the different interest

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rates involved. This outlines the three potential channels which are able to reflect an impact of interest rates on private consumption and which are to be discussed in this paper: firstly, the interest rate as a potentially relevant variable for making decisions on the use of households' income; secondly, the responsiveness to interest rate changes of the demand for consumer credits; and, thirdly, the importance of interest rates as a determinant of investment income.

This paper is structured in line with this tripartite division. The empirical analysis is confined to the relationships in western Germany. Before this, the second chapter briefly outlines the basis of consumption theory. This is followed by a detailed examination of the direct interest rate dependence of private consumption. Households' demand for consumer credits, the impact of interest rates on this demand and the relationship between private consumption and consumer credits are discussed in the fourth chapter. The fifth chapter deals with the importance of interest rates for investment income. The empirical studies are supplemented by some simulations which show how much consumption is influenced by interest rate changes and to what extent this can be attributed to the transmission mechanisms discussed earlier. The paper concludes with a summary of the most important results and an outlook on further possible avenues of research.

II Theoretical basis

1 The life cycle model and the permanent income model

Recent consumption theory is essentially based either on the life cycle hypothesis (Modigliani and Brumberg, 1952, Ando and Modigliani, 1963) or on Friedman's permanent income hypothesis (Friedman, 1957). We shall see that these two hypotheses are closely related to each other.

The interpretation of saving as present restraint in consumption in favour of higher consumption in the future suggests regarding this process as part of an intertemporal decision-making calculation. According to the life cycle hypothesis, households initially estimate their lifetime income or, as an equivalent, their wealth (and hence their overall consumption potential), and then choose their consumption as an appropriate share of this estimation for each period. Using this model, in contrast to Keynes' hypothesis, private consumption does not depend on current income but on the entire income stream, the lifetime income: the interest rate is the price of present restraint in consumption.

The stochastic implications of the life cycle hypothesis for private consumption were analysed by Hall (1978) in a paper which has since become famous. In this section, I shall describe the stochastic life cycle model which, in line with Wickens and Molana (1984), admits time-varying interest rates and prices as an extension.

Let us consider a representative household, which at the beginning of period t (and at the beginning of each subsequent period) prepares a consumption plan for the future (which, for the purpose of simplification, is regarded here as infinite), by maximising its expected life-time utility on the basis of all information available. Let the length of the periods chosen be so short that new information, which is obtained by the household during a given period, does not result in changes to the consumption plan of the same period. Let the utility function be strictly concave, separable between consumption and leisure and additively separable over time, and let it have the same functional form for all periods. Accordingly, the function to be maximised has the following form:

(1) $$\sum_{i=0}^{\infty}\prod_{s=1}^{i}(1+\delta_{t+s})^{-1}E_{t-1}U(C_{t+i})$$

In this context, C_t designates real consumption in period t, δ_t the rate of subjective time preference and E_{t-1} the expectation, conditional on the information available at the end of period t-1. For the maximisation of (1), the budget constraint is to be borne in mind, which for the period t is as follows in real terms:

(2) $$(1+r_t)A_{t-1}+Y_t-A_t-C_t=0$$

In this equation, Y designates the real labour income, which is derived from nominal labour income deflated by the price index for private consumption.[1] The real interest rate r is calculated here as nominal interest rate less inflation rate.[2] Finally, A_t designates real financial assets at the end of period t. If the household is a net debtor, A_t is negative. A perfect capital market is assumed, which means that there are no restrictions on borrowing

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1 In this model, so-called labour income comprises, apart from investment income, all components of disposable income. The term "non-investment income" would hence be more precise. In line with the designation chosen in the literature, however, the term labour income is used here and below.

2 The real interest rate r is defined by the equation $1+r=(1+i)/(1+\pi^e)$, where i designates the nominal interest rate and π^e the expected inflation rate. For "small" values of i and π^e, $r=i-\pi^e$ applies approximately. In addition, the expected inflation rate is frequently replaced by the current inflation rate.

and that the same nominal interest rate applies to deposits and credits. Let nominal income, the nominal interest rate and price level be stochastic variables, whose realisations are not known to the consumer at the end of the preceding period. The necessary first order conditions for this optimisation problem yield the following Euler equation:

$$(3) \qquad E_{t-1}U'(C_{t+i-1}) = E_{t-1}\left(\frac{1+r_{t+i}}{1+\delta_{t+i}}U'(C_{t+i})\right) \qquad \text{(for } i>0\text{)}$$

If the utility function is assumed to have the isoelastic form $U(C)=\alpha\ C^k$ with parameters α and k, presuming certainty equivalence the following equation can be derived for the conditional expectation of consumption:

$$(4) \qquad E_{t-1}C_{t+i} = E_{t-1}\left(\frac{1+r_{t+i}}{1+\delta_{t+i}}\right)^{\sigma} E_{t-1}C_{t+i-1}$$

with the intertemporal elasticity of substitution σ (= -U'/(C U") = 1/(1-k)) (see Mankiw, Rotemberg, Summers, 1985, Deaton, 1992, p. 6). The optimal path of real consumption thus obeys a first order autoregressive process. This equation can be well approximated by

$$(5) \qquad E_{t-1}\Delta \ln C_{t+i} = \sigma\left(E_{t-1}r_{t+i} - \delta_{t+i}\right)$$

A higher real interest rate level implies *ceteris paribus* a steeper optimal consumption path. This reflects the fact that the real interest rate acts as a premium for present restraint in consumption. Accordingly, a change in expectations of the future real interest rate level should bring about a parallel change in what is regarded as the optimum growth path of real consumption in the future.[3] The extent to which the growth rate of optimum consumption responds to households' changed estimations of the future real interest rate level is determined by the intertemporal elasticity of substitution (Hall, 1988). The rate of time preference is, in this case, a measure of the consumers' impatience: the higher it is, the lower the assessment of the utility of future consumption, and the flatter the consumption path. Assuming that the real interest rate expected for the future is constant, which is sometimes inferred from the assumption of efficient capital markets, and that the rate of

3 As will be shown below, it is not possible to draw the conclusion from equation (5), however, that an interest rate level which is higher at the time t+1 is associated with a simultaneously higher level of consumption .

time preference does not vary either, the optimum consumption of a representative household is described by a random walk with drift (Hall, 1978). If the rate of time preference and the expected real interest rate coincide, moreover, the conditional optimal consumption path for this household is a pure random walk.

A large number of empirical studies have been based on equation (5). This is because this relationship can be used to derive the statistically testable hypothesis that planned consumption can be fully explained by the preceding period's level and, in particular, that the income of all previous periods has no additional impact on consumption. In contrast to structural consumption functions, this equation is also immune to the so-called Lucas critique (Lucas, 1976), since only parameters of the utility function are estimated, which are invariant vis-à-vis regulative interventions of economic policy.

Nevertheless, equations (4) and (5) do not yield a full description of optimum consumption, since they merely describe the consumption path resulting from the first-order condition of the optimisation task, but not the consumption level (Wolters, 1992). Optimal consumption in period t is obtained by combining the Euler equation (4) with the intertemporal budget constraint (2). By "solving it forward" successively, assuming[4]

$$\lim_{j \to \infty} \prod_{s=0}^{j} (1 + r_{t+s})^{-1} A_{t+j} = 0$$

the budget constraint may be written as

$$(6) \qquad \sum_{j=0}^{\infty} \prod_{s=0}^{j} (1 + r_{t+s})^{-1} C_{t+j} = A_{t-1} + \sum_{j=0}^{\infty} \prod_{s=0}^{j} (1 + r_{t+s})^{-1} Y_{t+j}$$

Both sides of this equation can be interpreted as different representations of real life cycle wealth W of the consumer. The left-hand side indicates the use, and the right-hand side the origin of the funds. Analogous "forward solving" of the first order condition (3) and combining it with budget constraint (6) yields a proportionality of optimal consumption and expected wealth

4 This assumption is met if the average growth of real labour income is lower than the real interest rate expected for the future.

(7) $$E_{t-1}C_t = \left(E_{t-1}h_t\right)E_{t-1}W_{t-1}$$

with the following propensity to consume out of wealth

(8) $$E_{t-1}h_t = \left(\frac{1+E_{t-1}r_t}{1+\delta_t}\right)^{\sigma}\left[\sum_{j=0}^{\infty}\prod_{s=0}^{j}\left(\frac{\left(1+E_{t-1}r_{t+s}\right)^{(\sigma-1)/\sigma}}{1+\delta_{t+s}}\right)^{\sigma}\right]^{-1}$$

The propensity to consume out of wealth is a function of the expected future real interest rate and the rate of time preference. It may be simplified if the assumption is made that a constant real interest rate is expected for the future and that the rate of time preference is also time-invariant:

(9) $$E_{t-1}h_t = E_{t-1}\left(1+r_t\right) - E_{t-1}\left(\frac{1+r_t}{1+\delta_t}\right)^{\sigma}$$

Assuming a constant real interest rate expected for the future, the expected wealth is:

(10) $$E_{t-1}W_{t-1} = A_{t-1} + E_{t-1}\frac{1}{1+r_t}\sum_{j=0}^{\infty}\left(1+r_t\right)^{-j}Y_{t+j}$$

In the special case of the rate of time preference and the expected real interest rate coinciding, the marginal wealth propensity of consumption corresponds to the expected real interest rate. In addition, equation (7) for optimal consumption, in conjunction with the definition (10) of wealth, is then formally identical to the interpretation of the permanent income model by Flavin (1981) (see also Campbell, 1987). Accordingly, consumption is proportional to the sum of human wealth - the expected present value of the future labour income - and accumulated savings. If real labour income Y is an integrated variable of order one, it follows from the permanent income model that both real consumption and real disposable income are also integrated variables of order one and that, in addition, they are cointegrated (Stock and West, 1988).

The effects on the consumption level of a change in the expected real interest rate are:

(11) $$\frac{\partial E_{t-1}C_t}{\partial E_{t-1}r_t} = E_{t-1}h_t\frac{\partial E_{t-1}W_{t-1}}{\partial E_{t-1}r_t} + E_{t-1}W_{t-1}\frac{\partial E_{t-1}h_t}{\partial E_{t-1}r_t}$$

Since the partial derivative of expected wealth with respect to the expected real interest rate is negative, the first summand of the right-hand side of equation (11) is also negative. If the value of the intertemporal elasticity of substitution is lower than one, the second summand of the right-hand side is positive. The overall effect is indeterminate. However, if the substitution elasticity is perceptibly higher than one, the second summand is also negative, with the result that a higher real interest rate is associated with a lower current consumption level. In this case, the substitution effect is thus greater than the income effect. However, assuming this lower consumption level, the growth rates of private consumption are, in accordance with equation (5), above those rates which are regarded as optimum with a lower real interest rate.

The optimal consumption is not only a function of the expected real interest rate, however, but also depends on expected future labour income. If new information becomes available about real income and real interest rate, the household will review its optimisation plan and, if necessary, prepare a new optimal consumption plan for the future, in line with the changed set of data. Given certain assumptions on the stochastic structure of Y and r and provided that the household knows this structure, Wickens and Molana (1984) derive the following equation for the growth rate of consumption:

$$(12) \qquad \Delta \ln C_{t+1} = \alpha_0 + \sigma\, E_{t-1} r_{t+1} + \alpha_2\, \xi_t + \alpha_3\, \psi_t + u_{t+1}$$

In this equation, ξ and ψ designate the innovations - i.e. unforeseen components - of Y and r, i.e. $\xi_t = \ln Y_t - E_{t-1} \ln Y_t$ and $\psi_t = r_t - E_{t-1} r_t$, and u designates the error term, which is uncorrelated both with all variables which are available to the household at the end of the previous period and with ξ_t and ψ_t. If either ξ_t or ψ_t is different from zero, the change in private consumption - despite the fact that individuals are acting rationally - no longer satisfies the Euler equation (3) (see also Ramser, 1988). On account of the inclusion of the unforeseen components, the relationship (12) is also designated as a "surprise" consumption function (Bean, 1968, Muellbauer, 1983), although - like equation (5) - it represents only the empirical implementation of the first order condition.

2 Modifications of the life cycle and the permanent income model

In empirical studies it has often become apparent that the equations (5) and (12) for describing private consumption are incompatible with the observable data. In the literature, this incongruence between the theoretical model and the empirical data is attributed, inter alia, to households possessing incomplete information (Goodfriend, 1992, Pischke, 1995), to aggregation problems (Attanasio and Weber, 1993), to the unrealistic assumption of an infinite lifetime of the individual (Blundell, Browning and Meghir, 1994, Attanasio and Weber, 1995), and to the assumption of an unchanged form of the utility function (Attanasio and Browning, 1995). However, the most important reason for the rejection of the life cycle or the permanent income hypothesis in empirical tests is held to be households' liquidity constraints, i.e the violation of the assumption of perfect capital markets (Nicoletti-Altimari and Thomson, 1995).

Households are regarded as being subject of liquidity constraints if they are unable to satisfy their credit demand and cannot therefore realise their envisaged level of consumption. Liquidity constraints may arise, for example, as a result of the typical observable income pattern of individuals. Over time this initially has a low level (training phase), then increases more or less steadily (working phase) and, during the last phase (retirement), it is below the level of the working phase. In the first life-stage, therefore, the current income is below the average income and possibly also below the desired consumption level derived from the permanent income. If consumers have, at the same time, only a small amount of financial assets, they have to resort to borrowing in order to fulfil their consumption desires. As collateral for their borrowing they may offer the expected future income, which may be rejected by the financial intermediaries, however, owing to its uncertain nature. Difficulties in terms of borrowing may also occur if there are unexpected and substantial losses in current income, arising from unemployment, for example. These problems are a result of the uncertainty concerning the future income flow, which is represented only inadequately by the expectation value formation or the assumption of the certainty equivalence in the life cycle model and, instead, would require the inclusion of the expected variability of income. Even the possibility of a credit rationing, together with uncertainty concerning future income flows, is enough to induce households which act prudently to insure themselves and to want to hold a certain amount of liquidity reserves for precautionary reasons. They thus follow a consumption path which is geared more to past trends in their income.[5] Thus, current income (plus liquidity reserves) replaces permanent income as the relevant determinant of private consumption not only in the case of credit rationing, but also if there is a certain probability of the risk that credits will be rationed in the near future.

The permanent income model, or the life cycle model, can be nested in a more general model which allows the possibility of liquidity constraints (Campbell and Mankiw, 1989, 1990). In this model, it is assumed that a part λ of consumption is undertaken by households which are either subject to liquidity constraints or which do not wish to smooth their consumption path through borrowing. It is assumed that these households consume a constant share of their income, with the result that the change rate of their consumption is equivalent to the change rate of their disposable income: $\Delta \ln C_t = \Delta \ln YV_t$, disposable income being the sum of investment and labour income: $YV_t = r_t A_{t-1} + Y_t$. If the other households are guided by the life cycle model, one obtains approximately the following equation for the change rate of consumption:

$$(13) \quad \Delta \ln C_t = a_0 + (1-\lambda)\sigma\, E_{t-1}\, r_t + \lambda\, \Delta \ln YV_t + u_t$$

The parameter λ does not necessarily have to be constant over time, however. Thus, a change in the age structure of the population or liberalisation measures in the financial system might lead to a variable λ, for example. In an empirical study for the United Kingdom, Bayoumi (1993a, 1993b) allowed the parameter λ to vary as a function of the degree of regulation in the British financial system. In an international comparison, Jappelli and Pagano (1989) likewise estimated (a linear version of) equation (13) and found an inverse correlation between the amount of consumer credits (standardised through private consumption) and the estimated value for λ. These findings were confirmed by a similar study by Blundell-Wignall, Brown and Tarditi (1995), who estimated equation (13) using data for different periods from eight OECD countries. According to this study, there is a decline in liquidity constraints over time in the great majority of cases, with the notable exception, however, (besides Australia) of Germany, where the estimated value for λ, at 1.04, was perceptibly higher for the eigthies and the early nineties than for the sixties (λ=0.46) and the seventies (λ=0.66).

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5 See, for example, Mariger (1987), Skinner (1988), Zeldes (1989a, 1989b), Deaton (1991), Carroll (1994), Jappelli and Pagano (1994) and Hubbard, Skinner and Zeldes (1995).

Blundell-Wignall, Browne and Tarditi (1995) regard as unrealistic the implicit hypothesis contained in equation (13) that the influence of disposable income on consumption is symmetrical; they argue that, although households which are subject to liquidity constraints also have to reduce their consumption in the event of losses in income, their consumption does not necessarily rise to the same extent in the case of an increase in income. For that reason, they split the changes in disposable income into a positive and a negative component:

$$(14a) \quad \Delta \ln YV_t^+ = \begin{cases} \Delta \ln YV_t & \text{if} \quad \ln YV_t > \ln YV_{t-1} \\ 0 & \text{otherwise} \end{cases}$$

$$(14b) \quad \Delta \ln YV_t^- = \begin{cases} \Delta \ln YV_t & \text{if} \quad \ln YV_t < \ln YV_{t-1} \\ 0 & \text{otherwise} \end{cases}$$

Equation (13) may thus be written as (see also Shea, 1995):

$$(15) \qquad \Delta \ln C_t = a_0 + (1-\lambda)\sigma E_{t-1} r_t + \lambda_1 \Delta \ln YV_t^+ + \lambda_2 \Delta \ln YV_t^- + u_t$$

with $\lambda = \lambda_1 I(\Delta \ln YV^+) + \lambda_2 I(\Delta \ln YV^-)$ and the indicator variable I, which for positive arguments assumes the value 1 and otherwise has a value of 0. A higher value of λ_2 in comparison with λ_1 could be interpreted as providing further evidence of households' liquidity constraints. Equations (13) or (15) also permit other interpretations of the parameter λ, however. Thus, (13) is analogous to the (logarithmic) Keynesian consumption function in first differences, and λ would hence have to be regarded as a function of the marginal propensity to consume.

Imperfections in the market for consumer credits may also be shown by the nominal interest rate (i) exerting an influence on private consumption. In this context, it is argued that such imperfections reflect many banks' practice of virtually constant repayment-to-current income ceilings as a criterion for loan qualification (see also Wilcox, 1989). A rising nominal interest rate and a reduction in current income alike may result in this criterion being violated. The consumption function would then be:

$$(16) \qquad \Delta \ln C_t = a_0 + (1-\lambda)\sigma E_{t-1} r_t + \gamma \Delta i_i + \lambda_1 \Delta \ln YV_t^+ + \lambda_2 \Delta \ln YV_t^- + u_t$$

The empirical analyses by Blundell-Wignall, Browne and Tarditi (1995) which are based on this equation do not show any impact of nominal interest rates for Germany in the sixties and the seventies, but do show that the change in the nominal interest rates have had a significant negative effect on the growth of real private consumption since the early eighties.

It has been assumed in the analyses hitherto that the stock of financial assets corresponds to the cumulative sum of past savings. If part of the financial assets is held in the form of debt securities or shares, however, this identity is no longer given, and the market value of the assets is a negative function of the interest rates (see Spiro, 1962, Bhatia, 1972). For example, this is taken into consideration in the IMF's econometric model Multimod, which models a part of the interest rate effects on private consumption through an appropriately defined wealth variable (Masson, Symansky and Meredith, 1990). Another approach is adopted by Deaton (1972) who modifies the life cycle model and includes the market value of assets as an additional argument in the utility function. Assets may produce utility, owing to potential liquidity constraints or uncertainty concerning future labour income, for instance. According to Deaton, the optimal consumption is then, on the one hand, proportional to permanent income and the optimal wealth is likewise proportional to permanent income, on the other hand. Empirical implementations of these (long-run) equilibrium conditions in the context of error correction models were carried out, in particular, for the United Kingdom and for Scandinavian countries.[6] In an alternative specification, Molana (1991) eliminated the permanent income and considered only consumption and wealth (excluding human wealth) in the long-run solution.

The life cycle model implicitly assumes that consumer goods produce utility for households only for a period. If this assumption is dropped, given the large number of durable consumer goods, a distinction must be made between the consumption purchases and the service flow of consumption goods (Mankiw, 1982, Bernanke, 1985). The relevant prices of durable consumer goods are then, by analogy with investment theory, the user costs. An increase in the real interest rate leads to an increase in user costs, which has a negative impact on the demand for durable consumer goods.

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6 See, for example, Hendry and von Ungern-Sternberg (1981), Drobny and Hall (1989), Favero (1993) and Brodin and Nymoen (1992), who use Norvegain data, and Berg and Bergström (1995), who use Swedish data.

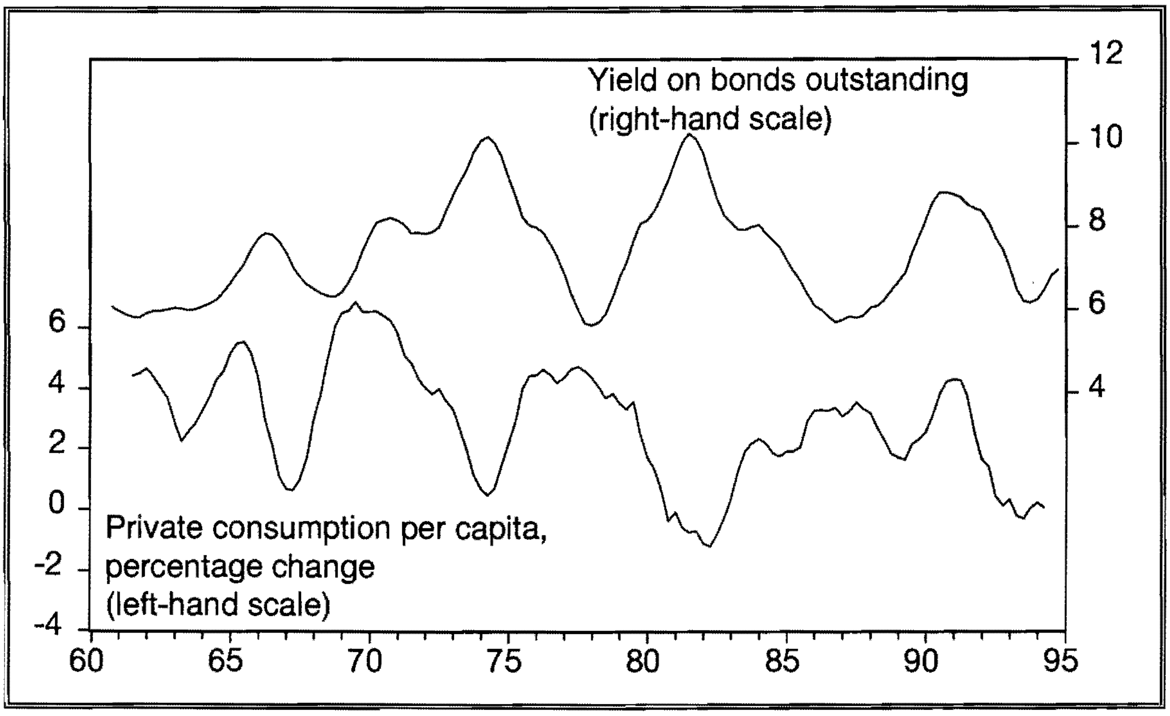
III Direct interest rate dependence of private consumption

1 Time structure of private consumption, interest rates and income

This section describes the temporal trend in private consumption, interest rates and disposable income. To ensure the better "readability" of the charts, all the time series are shown as moving averages over five quarters.

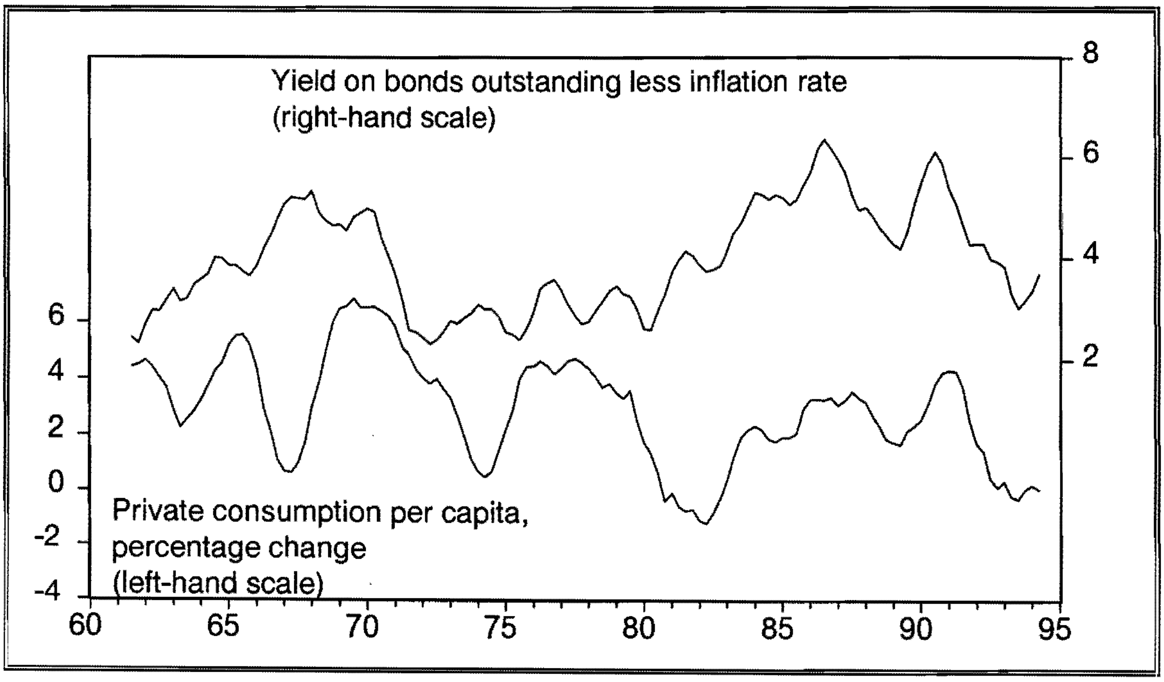
Chart 1 makes it clear that the growth rate of private consumption and nominal interest rates - depicted here as the yield on public bonds outstanding - have shown largely contrasting trends during the past 35 years. This could be assessed as an indication that the interest rate elasticity of private consumption is negative in terms of the yield on bonds outstanding and, in absolute terms, has a high value. The contrasting trend in private consumption and nominal interest rates, which was interrupted by phases of parallel movements - as in the second half of the sixties and since the end of the eighties, for example - is, however, largely a reflection of the cyclical pattern in Germany since 1960. For that reason, there is something to be said for assuming that this is a "spurious" correlation. This is because firstly, the correlation between consumption and interest rates becomes less obvious if we consider - as in the theoretical model - the real interest rates instead of the nominal interest rates, which were derived here approximately as the difference of nominal interest rates and the increase rate of the deflator for private consumption (chart 2). Secondly, as shown in chart 3, the correlations between private consumption and households' disposable income are perceptibly closer than those between private consumption and interest rates. On the one hand, pronounced income increases are associated with a perceptible expansion of private consumption expenditure; on the other hand, a moderate income trend corresponds to a subdued consumption cycle. This close correlation supports the theory that households are guided in their consumption decisions primarily by current income.

Chart 1: Private consumption (real) and yield on public bonds outstanding



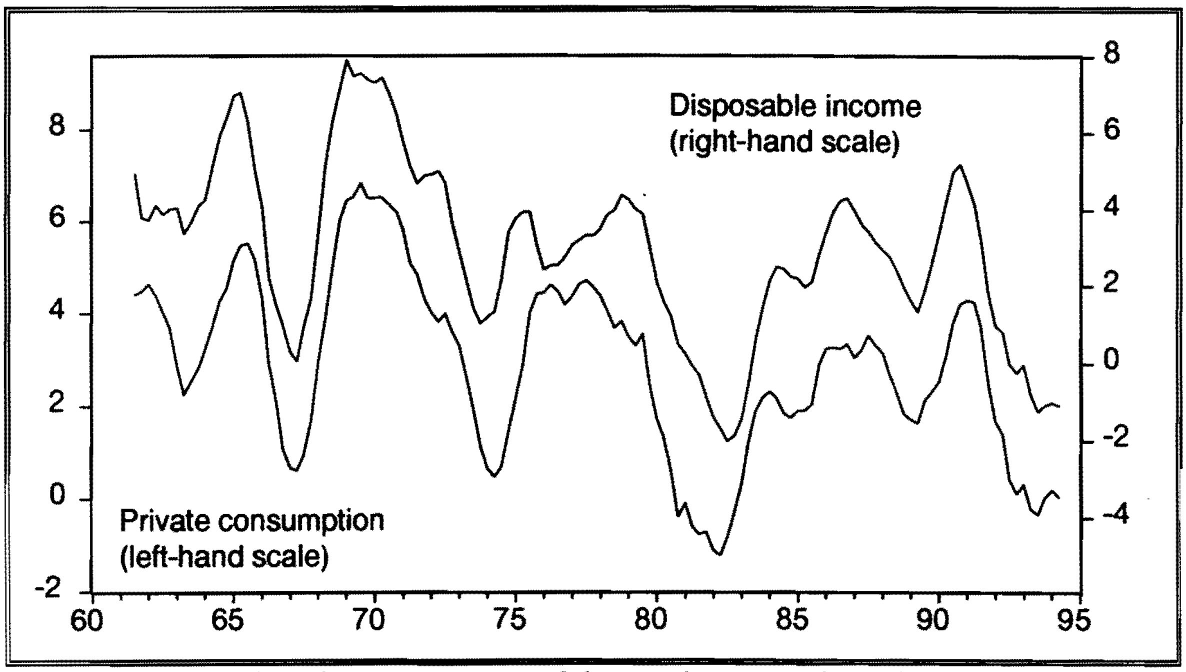
Calculated as the average of five quarters in each case.

Chart 2: Private consumption (real) and "real" yield on public bonds outstanding



Calculated as the average of five quarters in each case.

Chart 3: Private consumption and disposable income



Rate of change against the same quarter of the previous year; in each case per capita and deflated by the price index for private consumption, calculated as the average of five quarters.

2 Estimation of the intertemporal elasticity of substitution

The intertemporal elasticity of substitution measures the importance of the real interest rate for the change in consumption. It comprises the total impact of the real interest rate on the allocation of private consumption over the individual periods. It therefore comprises both the channel formed by increased borrowing and the effects of changed investment incomes. The intertemporal elasticity of substitution therefore captures the interest rate impact stemming from all three channels. An estimated value for the intertemporal elasticity of substitution may be determined either through the "surprise" consumption function (equation II.12) or from equations II.13 to II.16, which allow the possibility of households being subject to liquidity constraints. Matching the longer-term planning horizon, the empirical analysis is to be based on a long-term interest rate which acts as reference variable. Flaig (1988) estimates values between 0.4 and 1.1 for the intertemporal elasticity of substitution in Germany, depending on the specification of the "surprise" function. He uses the interest rate on savings deposits at statutory notice as the interest-rate variable, the suitability of which was questioned, however, in the discussion on his paper. By contrast, Blundell-Wignall, Browne and Tarditi (1995), using the regression II.15 were not able to establish an intertemporal elasticity of substitution significantly different from zero for Germany.

The empirical implementation of the "surprise" consumption function II.12 requires assumptions on how households form expectations of future interest rates, income and prices. In line with the approach adopted by Flaig (1988), these variables are generated through a VAR model (using the unemployment rate and the share price index as exogeneous variables). The parameters of the VAR model are estimated using data up to the time t-1, and forecast values for nominal interest rates, nominal income and prices are then derived from this for the periods t and t+1. The surprise variables are calculated finally as the difference of realised and forecast values. However, taking the yield on public bonds outstanding as the interest rate variable, neither a significant real interest rate impact nor a significant impact of the surprise variables on the change rate of private consumption emerges, irrespective of the estimation period. The use of other interest rate variables likewise produced insignificant results. The "best" results were achieved for the interest rate on savings deposits at statutory (three-month) notice. The value for the intertemporal elasticity of substitution of 0.2 estimated in this way, at a t-value of 1.6, was not significantly different from zero either, however.

It is possible that these results are due to the model assumption that households determine their consumption at the beginning of a period, which is undoubtedly an inappropriate hypothesis for quarterly data. However, alternative dating of consumption decisions also produced insignificant values for the intertemporal elasticity of substitution. The following estimation based on quarterly data for the period 1975-1994 is a typical example of this (t-values in brackets):

$$(1) \qquad \Delta \ln C_t = \underset{(1.77)}{0.0098} - \underset{(0.34)}{0.043} E_{t-1} r_t - \underset{(1.93)}{0.44} (r_t - E_{t-1} r_t) + \underset{(8.01)}{0.71} (Y_t - E_{t-1} Y_t)$$

With this equation, an estimated value of -0.043 is established for the intertemporal elasticity of substitution, which is insignificant, however. According to all the "surprise" consumption functions carried out, unexpected increases in real interest rates ($r_t - E_{t-1} r_t$) have a contractionary impact on consumption, whereas positive income surprises ($Y_t - E_{t-1} Y_t$) have a stimulating effect on private consumption. While the significance of the income variables is comparatively robust in respect of changes in specification, the t-value for the interest rate surprise variables varies very strongly, depending on the special form of the VAR model chosen for generating the expectation variables. For the main part, the parameter for the interest rate surprise variable is not statistically significant.

The strong impact of the income variable on private consumption, along with the interpretation of a revision of the expected human wealth having a commensurate impact on consumption, also permits the conclusion that households vary their consumption with current income, either by acting myopic or by being subject to liquidity constraints. The consumption functions (13), (15) and (16) of the second chapter were tested in order to verify this assumption. The results of these estimations which are based on quarterly data for the period 1975-94 have been compiled in table 1. This makes it clear that a major part of the short-term variation of private consumption is attributable to changes in real disposable income. According to equation (b), households' consumption behaviour responds largely symmetrically to income changes, whereas, according to equation (d), which contains the nominal loan interest rates as an additional regressor, income losses are associated with a disproportionate decline in consumption. However, an estimation of equation (b) without parameter restrictions likewise showed an asymmetrical reaction of consumption to income variations. The values a_2=0.700 (7.95) and a_3=0.965 (4.26) were obtained for the parameters a_2 and a_3 of the equation (t-values in brackets):

$$\Delta_4 \ln C_t = a_0 + a_1 \, E_{t-1} \, r_t + a_2 \, \Delta_4 \ln YV_t^+ + a_3 \, \Delta_4 \ln YV_t^- + u_t$$

Tests using the Kalman filter algorithm, in contrast to studies by Blundell-Wignall, Browne and Tarditi (1995), did not give any indication of time-varying parameters.

Changes in credit interest rates play a significant part in explaning private consumption. According to the estimations, an increase in the interest rate level by one percentage point would lead to a loss in private consumption of just over one-quarter per cent.

It was not possible to establish a value for the intertemporal elasticity of substitution which was significantly different from zero even with these estimations. This suggests that intertemporal substitution does not play a significant role for private consumption in Germany. Attanasio and Weber (1993) have shown for the United Kingdom, however, that estimations using disaggregated data yield larger values for the intertemporal elasticity of substitution than those based on aggregated data. For a final evaluation of the relevance of the intertemporal elasticity of substitution for private consumption in Germany, it would therefore seem advisable to carry out an estimation with cohort or individual data, which would, however, go beyond the scope of this paper.

Table 1: Estimation of consumption functions

(a)	$\Delta_4 \ln C_t = a_0 + (1-\lambda)\sigma E_{t-1} r_t + \lambda \Delta_4 \ln YV_t + u_t$				
	$a_0 = 0.014$ (3.10)	$\sigma = -0.755$ (1.40)	$\lambda = 0.760$ (12.81)		
	$\bar{R}^2 = 0.678$	DW = 1.08			
(b)	$\Delta_4 \ln C_t = a_0 + (1-\lambda)\sigma E_{t-1} r_t + \lambda_1 \Delta_4 \ln YV_t^+ + \lambda_2 \Delta_4 \ln YV_t^- + u_t$				
	with $\lambda = \lambda_1 I(\Delta_4 \ln YV^+) + \lambda_2 I(\Delta_4 \ln YV^-)$ and indicator variable I				
	$a_0 = 0.014$ (3.02)	$\sigma = -0.756$ (1.34)	$\lambda_1 = 0.759$ (10.76)	$\lambda_2 = 0.752$ (3.31)	
	$\bar{R}^2 = 0.674$	DW = 1.09			
(c)	$\Delta_4 \ln C_t = a_0 + (1-\lambda)\sigma E_{t-1} r_t + \gamma \Delta_4 i_i + \lambda \Delta_4 \ln YV_t + u_t$				
	$a_0 = 0.012$ (2.93)	$\sigma = -0.643$ (1.29)	$\gamma = -0.256$ (4.05)	$\lambda = 0.770$ (14.20)	
	$\bar{R}^2 = 0.732$	DW = 1.26			
(d)	$\Delta_4 \ln C_t = a_0 + (1-\lambda)\sigma E_{t-1} r_t + \gamma \Delta_4 i_i + \lambda_1 \Delta_4 \ln YV_t^+ + \lambda_2 \Delta_4 \ln YV_t^- + u_t$				
	with $\lambda = \lambda_1 I(\Delta_4 \ln YV^+) + \lambda_2 I(\Delta_4 \ln YV^-)$ and indicator variable I				
	$a_0 = 0.011$ (4.60)	$\sigma = -0.066$ (0.39)	$\gamma = -0.299$ (4.64)	$\lambda_1 = 0.635$ (6.83)	$\lambda_2 = 1.253$ (4.87)
	$\bar{R}^2 = 0.739$	DW = 1.28			

C: real per capita private consumption, YV: real per capita disposable income, r: yield on public bonds outstanding less inflation rate, i: interest rate for current account credits, Δ_4: change against the same quarter of the previous year. Estimation period: 1975/1 - 1994/4. t-values in brackets.

So far, the present analysis has explained only the short-term dynamics of private consumption, whereas potential long-run relationships between consumption, disposable income and real interest rates have not been taken into consideration. This will be dealt with in the following two sections. The longer-term relationships will be analysed in the next section and, following this, the fourth section will examine the linking of long-term equilibrium relationships with short-term dynamics in the context of so-called error correction models.

3 Long-run relationships between consumption, interest rates and income

The longer-term relation between economic variables can be examined by using the methods of cointegration analysis. A precondition for a stable long-run relationship between variables is that they have the same order of integration. Evidence concerning the order of integration can be derived from the augmented Dickey Fuller test (ADF test) (Dickey and Fuller, 1981). The ADF test tests the null hypothesis that the characteristic polynomial of the data generating process has a (real-value) unit root, which means that the time series has a stochastic trend. We consider private consumption and income variables per capita at 1991 prices, income being deflated by the index for private consumption. The test is based on quarterly data, which have generally been available for the old Länder since 1968. As private consumption and the income variables show a pronounced seasonal

Table 2: ADF unit root tests for the real economic variables

Variable		Test specification	t-value
Private consumption	Level	C,S,4	- 1.81
	1st difference		- 3.24 **
Disposable income	Level	C,S,4	- 1.47
	1st difference		- 2.97 **
Mass income	Level	C,S,4	- 2.06
	1st difference		- 5.27 ***
Private withdrawals and income from financial assets	Level	C,S,3	- 0.17
	1st difference		- 3.34 **
Households' saving ratio	Level	C,S,1	- 3.14 **
	1st difference		- 7.72 ***
Net financial assets	Level	C,S,4	- 1.62
	1st difference		- 1.79
	2nd difference		- 5.90 ***
Net financial assets (at market prices) [1]	Level	C,S,4	- 1.56
	1st difference		- 2.15
	2nd difference		- 5.39 ***

Test period: 1975:1 - 1994:4. All variables - with the exception of the savings ratio - in logs and per capita. Comparison of the t-values with the critical values of MacKinnon (1991). ***/**/*: significant at the 1% /5% /10% level. Specification: C = constant, S = seasonal dummies, 1, 3, 4: number of lags in the test equation.

[1] Net financial assets at market prices differ from net financial assets in that debt securities and shares are included at their market value, and not at their nominal value.

pattern, the test equation of Dickey and Fuller is expanded by the inclusion of seasonal dummies, which implies an unchanged seasonal structure over time.

As shown in table 2, it may be assumed both for private consumption and for households' disposable income that their change rates are stationary and that they are therefore (both taken logarithmically) integrated processes of order 1 (i.e. I(1) variables). The components of disposable income, i.e. mass income, on the one hand, and private withdrawals and income from financial assets, on the other hand, are probably also I(1) variables.

By contrast, according to the ADF test the saving ratio of households is a stationary variable. This result may also be interpreted to show that consumption and disposable income are (both taken logarithmically) co-integrated and satisfy the following long-run relationship:

(2) $\ln C = \alpha + \ln YV$

Accordingly, in the long-run equilibrium, private consumption (C) grows at the same rate as disposable income (YV). If this growth rate is designated as g and the equilibrium savings ratio, which is then also constant, as s (s=(YV-C)/YV), then real net financial assets likewise grow at rate g in the dynamic growth equilibrium. This is because the nominal net financial assets A^n satisfies the relationship $A_t^n = A_{t-1}^n + s \cdot YV_t^n$, with the nominal disposable income YV^n. If both financial assets and disposable income are deflated by the index for private consumption P, the following difference equation is yielded for real net financial assets: $A_t = (1+\pi_t)^{-1} \cdot A_{t-1} + s \cdot YV_t$, with the inflation rate $\pi = P_t / P_{t-1} - 1$. The equilibrium path of real assets is then:

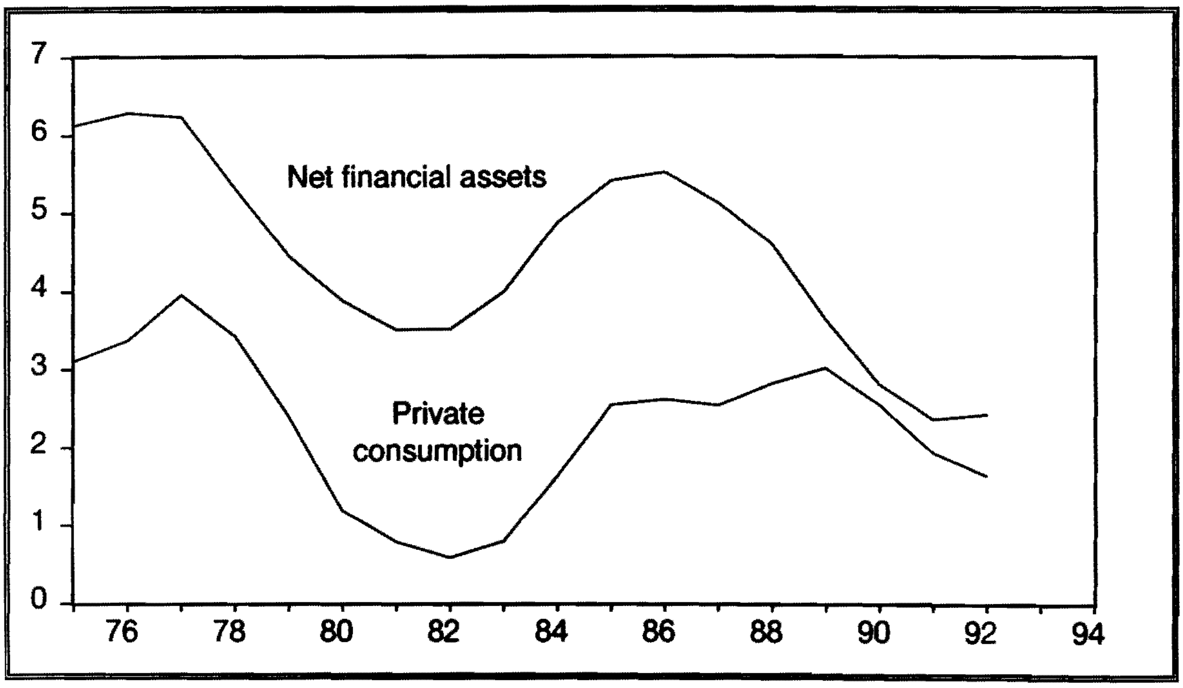
(3) $$A_t = \frac{s(1+g)(1+\pi)}{(1+g)(1+\pi)-1} YV_t + \frac{1}{(1+\pi)^t}\left(A_0 - \frac{s(1+g)(1+\pi)}{(1+g)(1+\pi)-1} YV_0\right)$$

If the initial conditions are ignored, the following relationship between assets and households' consumption is obtained in the long-run equilibrium:

(4) $$\frac{A}{C} = \frac{s}{1-s} \frac{(1+g)(1+\pi)}{(1+g)(1+\pi)-1}$$

As an alternative to equation (2), therefore, the long-run behaviour of private consumption could also be described through the relationship to assets. The ADF test suggests, however, that net financial assets are (taken logarithmically) an integrated process of order 2. An explanation of this might be that the relationship between assets and private consumption was perceptibly below the equilibrium value according to equation (4), particularly in the sixties. If the average savings ratio for the period between 1960 and 1994 is considered along with the average inflation rate and the average change rate of consumption or income, the optimum relationship of assets and consumption according to equation (4) would be about 2 ½ on an annual basis. Using the average savings ratio and the growth rates for the period 1975-95, there is, in fact, an optimum assets consumption relationship of 3, owing to the low nominal growth of consumption. In the first half of the sixties, however, the relationship was, in actual fact, lower than 1. In 1994, the relationship of consumption and assets was, by contrast, already about 2. During the time the adjustment path is followed, there is a higher change rate of assets, which declines over time, however, and becomes closer to the average increase rate of private consumption (see also chart 4).

Chart 4: Private consumption and net financial assets



At 1991 prices, change against previous year, calculated as the average of 5 years.

The analysis of the stochastic structure of the expected real interest rates initially requires assumptions concerning the expected inflation rate. If it is assumed that households form their price expectations rationally, the expected inflation rate for the next period $\pi_t^e = E_{t-1}(\pi_t)$ deviates from the realised inflation rate π_t by an error term u_t, the expectation value of which is zero and which is uncorrelated with all the variables of the previous periods:

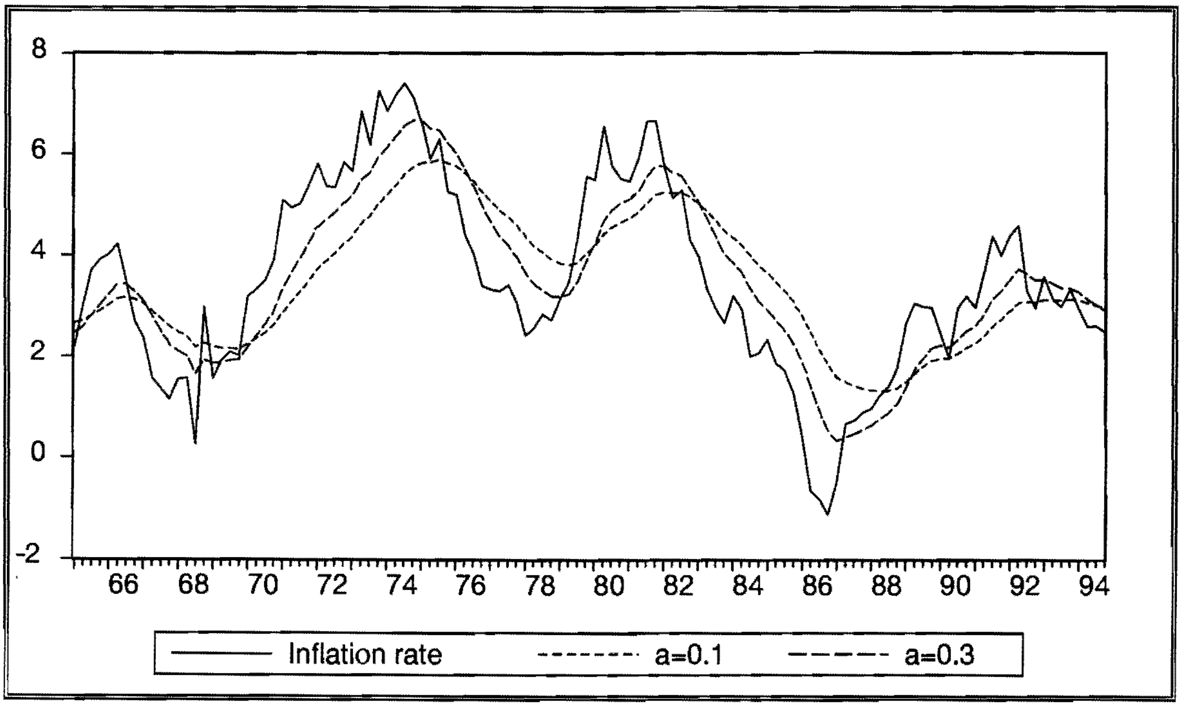
(5) $$\pi_t^e = \pi_t + u_t$$

As an alternative, a model of adaptive expectation can be taken as the basis, in which households use the forecasting error of the past as a corrective:

(6) $$\pi_t^e = \pi_{t-1}^e + \alpha\left(\pi_{t-1} - \pi_{t-1}^e\right) \qquad \text{where} \qquad 0 \le \alpha \le 1$$

The higher the damping coefficient α, the stronger the expectation error from the current period flows into the expectation formation for the coming period. If α has the value 1, the current inflation rate will also be expected in the next period (static expectations). In the other extreme case (α=0), it is assumed that the inflation rate will be constant over time, which would imply that the real interest rate corresponds to the nominal interest rate less a constant. As shown in chart 5, the adaptive expectation model adjusts quite well to the inflation rate, even with a damping coefficient of α=0.3 (albeit, according to equation (6), with a time lag of one quarter), unsystematic or irregular fluctuations of the inflation rate not being reconstructed by the expectation model.

Chart 5: Inflation rate and adaptive expectations (with α=0.1 or α=0.3)



In this chapter, we are considering the yield on fixed-rate public bonds outstanding as an interest rate variable. As shown in table 3, according to the ADF test, the hypothesis of non-stationarity of the yield on bonds outstanding can be rejected at the 5 % level. By contrast, for the inflation rate, measured by the index for private consumption, the hypothesis of a unit root cannot be rejected, although it is theoretically implausible. Accordingly, the real interest rate, as a linear combination of a I (1) and a I (0) variable, should likewise be non-stationary. However, the ADF test rejects the non-stationarity hypothesis, assuming rational or static price expectations. Even in the case of adaptive price expectations, with a damping coefficient α=0.3, the null hypothesis of a unit root is rejected at the 10 % level for the real interest rate. A reason for these inconsistencies in the test results might be the low power of the ADF test. For that reason, stationarity tests were carried out for inflation rates and interest rates as a supplement and for validating the results.

Table 3: ADF unit root tests for inflation rate and yield on bonds outstanding

Variable	Test-specification	t-value Level	t-value 1st differences
Inflation rate (deflator of private consumption)	C,1	- 2.30	- 5.30 ***
Yield on public bonds outstanding			
- nominal	C,1	- 2.95 **	- 5.38 ***
- real, with price expectation hypothesis			
rational	C,1	- 2.78 *	- 7.30 ***
static	C,1	- 3.05 **	- 6.19 ***
adaptive (α=0.1)	C,1	- 2.31	- 5.40 ***
adaptive (α=0.2)	C,1	- 2.38	- 5.73 ***
adaptive (α=0.3)	C,1	- 2.60 *	- 5.96 ***

Test period: 1975:1 - 1994:4. Comparison of the t-values with the critical values of MacKinnon (1991), ***/**/*: significant at the 1%/5%/10% level.
Specification: C=constant, 1: number of lags in the test equation.

Stationarity tests test the null hypothesis that the available data have been generated by a stationary process against the alternative that the data generating process is non-stationary. Thus, compared with the unit root tests, the null hypothesis and the alternative hypothesis are exchanged. Stationarity tests were developed, inter alia, by Kwiatkowski, Phillips, Schmidt and Shin (1992) and by Bierens and Guo (1993). The derivation and the functional form of the relevant test statistics are explained in the annex.

The KPSS test statistics of Kwiatowski et al. require a weighting function for a consistent estimation of the "long-run" variance of the partial sums of the deviations from the average value. Kwiatkowski et al. propose the Bartlett window and recommend the value l=7 for the parameter of the Bartlett window, given a time series of 80 observations.

The KPSS test confirms the result of the ADF test, according to which the nominal yield on bonds outstanding is stationary. The stationarity hypothesis cannot be rejected at the 5 % level for the inflation rate either. It is especially notable, above all, that the real yield - irrespective of the specification of price expectations - seems to have a stochastic trend according to the KPSS test, which is incompatible with the stationarity properties of the inflation rate and the nominal interest rate, provided it is assumed that the inflation rate is generated by a stationary process.

Table 4: KPSS stationarity tests for inflation rate and yield on bonds outstanding

Variable	Parameter (l) for Bartlett window		
	5	7	9
Inflation rate (deflator of private consumption)	0.428 *	0.347 *	0.299
Yield on public bonds outstanding			
- nominal	0.112	0.094	0.086
- real, with price expectation hypothesis			
rational	0.628 **	0.520 **	0.445 *
static	0.670 **	0.558 **	0.481 **
adaptive (α=0.1)	0.624 **	0.505 **	0.437 *
adaptive (α=0.2)	0.673 **	0.545 **	0.470 **
adaptive (α=0.3)	0.684 **	0.558 **	0.481 **

Test period: 1975:1 - 1994:4. Comparison of empirical values with critical values by Kwiatkowski et al. (1992), ***/**/*: significant at the 1%/5%/10% level.

As an alternative to the KPSS test, the stationarity hypothesis can be verified by means of the four test statistics developed by Bierens and Guo (1993), which all converge towards the Standard Cauchy distribution under the null hypothesis of stationarity. As part of a simulation study, Lob (1994) showed that it is reasonable to use tests II and III by Bierens and Guo. Test II, given a finite sample range, has the tendency to reject the null hypothesis even if it is correct, whereas test III has the property of very frequently maintaining the null hypothesis, even if it is wrong. If, therefore, test II maintains the stationarity hypothesis, it can be assumed that the time series examined are really stationary. If test III rejects the stationarity hypothesis, the necessary degree of difference formation has not yet been achieved.

The Cauchy tests, the results of which are summarised in table 5, also suggest that the yield on bonds outstanding is stationary. The stationarity hypothesis cannot be rejected for the inflation rate either. For the real interest rate, Cauchy test II rejects the null hypothesis only if adaptive expectations and a small damping coefficient are assumed, whereas Cauchy test III does not reject the stationarity hypothesis for any of the time series under examination here.

Table 5: Cauchy stationarity tests for inflation rate and yield on bonds outstanding

Variable	Test II (unilateral)	Test III (bilateral)
Inflation rate (deflator of private consumption)	0.865	0.874
Yield on public bonds outstanding		
- nominal	0.867	0.600
- real, with price expectation hypothesis		
rational	0.472	0.938
static	0.465	0.929
adaptive (α=0.1)	0.035 **	0.564
adaptive (α=0.2)	0.080 *	0.749
adaptive (α=0.3)	0.198	0.839

Test period: 1975:1 - 1994:4. Tabulated values: probability that a Cauchy-distributed random variable exceeds the observed values of S_2 or $|S_3|$. ***/**/*: significant at the 1%/5%/10% level.

From the results of the three tests which were carried out on the order of integration of inflation rates and yield on bonds outstanding, it is possible to conclude that the yield on bonds outstanding is stationary and that there is also some evidence for the stationarity of the inflation rate. Accordingly, we shall assume below that the real interest rates are also stationary variables. For modelling the relationship between interest rates and private consumption, it follows from these "assumptions" that the real interest rates and private consumption cannot be cointegrated. Thus, although interest rates can influence the short-run dynamics of private consumption, in the long run consumption is determined by other variables.

In the second chapter, reference was made to the fact that it follows from the permanent income hypothesis that consumption and disposable income are cointegrated if "non-labour income" has a stochastic trend. Below, the question of whether there is a linear cointegration relationship between the logs of consumption and income will be examined. If there is cointegration, this would mean that the levels of consumption and income also have a stable long-run relationship, albeit (apart from exceptions) a non-linear one.

Table 6: Long-run regressions with consumption and income

(1) $\ln C = \underset{(0.012)}{1.020} \cdot \ln YV + \text{constant} + \text{seasonality}$

ADF statistics for the residuals: - 4.07 ***

(2) $\ln C = \underset{(0.037)}{0.694} \cdot \ln YM + \underset{(0.012)}{0.289} \cdot \ln YG + \text{constant} + \text{seasonality}$

ADF statistics for the residuals: - 4.27 ***

(3) $\ln C = \underset{(0.008)}{0.717} \cdot \ln YM + (1 - 0.717) \cdot \ln YG + \text{constant} + \text{seasonality}$

ADF statistics for the residuals: - 4.12 ***

Estimation period: 1975:1 - 1994:4, C: private consumption, YV: disposable income YM: mass income, YG: profit and investment income, real and per capita in each case. Standard error in brackets. ADF statistics with one lag in the test equation. ***: significant at the 1 % level.

Table 6 summarises the results of the long-run regressions between consumption, on the one hand, and different income variables, on the other. According to the ADF test for the residuals of the long-run regression, consumption and disposable income are cointegrated. The long-run elasticity of consumption in terms of disposable income is very close to the theoretically expected value of 1. Private consumption is also cointegrated with the components of disposable income, i.e. mass income as well as income from profits and investment income. Even if the sums of the elasticities are restricted to the value 1, the cointegration relationship is maintained, according to the ADF test for the residuals. These results are confirmed by an analysis of the seasonally adjusted time series using the Johansen method (Johansen, 1988, 1991). The resulting normalised cointegration vectors are of similar magnitude.

According to the ADF test for the residuals of the long-run regression, consumption and households' financial assets are not cointegrated. In addition, the coefficient in respect of assets, at just under 0.5, deviates perceptibly from 1: the value which would have to be expected in a long-run growth equilibrium.

4 Estimation of error correction models

Error correction models make it possible to link short-run dynamics with the long-run equilibrium relationships. The deviations from the long-run equilibrium are included in the estimation equation as the so-called error correction term (ECT) for explaining the dynamics of private consumption. If the operational sign of the parameter in respect of this ECT variable is negative, existing disequilibria are reduced over time. Owing to the pronounced seasonal pattern of private consumption and the income variables, the error correction terms - contrary to the proposal made by Engle and Granger (1987) - are not modelled as a simple lag but as the average of the four figures from the previous quarters.

In the error correction models, the long-run relationship between private consumption and disposable income was initially included with the theoretical elasticity 1. The results of these estimations are shown in table 7. Alternatively, the deviations from the equilibrium relationship between consumption, mass income and income from profits and investment are tested as ECT variables. Table 8 contains the results of these estimations.

For constructing the real interest rates, rational price expectations were assumed in a first variant, whereas a second variant was based on an adaptive price expectation model. The "best" estimation results for adaptive price expectations were achieved with a damping coefficient of $\alpha=0.2$. In addition, in some estimations asymmetrical reactions of consumption to income changes were admitted. For income expectations, we assumed an adaptive pattern (see also Karmann and Nakhaeizadeh, 1988). This reflects the high share in the change in consumption which is attributable to households subject to liquidity constraints or households with a short effective planning horizon.

In the vast majority of the models, the error correction term proved to be significant: according to Kremers, Ericsson and Dolado (1992), this can be regarded as an indication of a cointegration relationship of the variables from the long-run equation. However, this significance could only be achieved if the inflation rate was included as an additional regressor. The parameter values in respect of the ECT term suggest that existing disequilibria are reduced relatively quickly. In addition, the estimations bear out the assumption that households adjust their consumption faster to the new income situation if there is a decline in real income than if their income expands. According to all the estimations presented here, the short-term income elasticity of private consumption in Germany exceeds 0.5.

According to table 7, the semi-interest-rate elasticities are greater in terms of amount on the assumption of rational price expectations than they are on the hypothesis of adaptive price expectations. However, the interest rate impact on private consumption is statistically significant only if an adaptive price expectation process is assumed.

It is interesting to note that the disaggregated model, using mass income as well as profit and investment income, shows perceptibly lower short-term income elasticities in comparison with the model approach which uses aggregated income (table 8). However, the information gain from disaggregation of disposable income is less than initially assumed. This disaggregation was motivated by the hypothesis that it is, in particular, the short-term consumption behaviour of those households which obtain their income mainly from enterpreneurial activities and assets which deviates perceptibly from that of the other households. Since profit and investment income accounts for around one-third of disposable income, and is hence about half as high as mass income, the coefficients in respect of the variable YG in table 8 should be less than half as high as the coefficients in respect of the variable YM. This is generally not the case, however.

In the model variants which use disaggregated income on the assumption of rational price expectations, too, the short-term semi-interest-rate elasticities are higher than they are on the hypothesis of adaptive expectations. When comparing the estimated results, it is also striking that the short-term semi-interest-rate elasticities in the equations which use disaggregated income (table 8), are perceptibly higher, at values between 0.3 and 0.4, than in the aggregated model (table 7), according to which, on the assumption of adaptive expectations, the semi-interest-rate elasticities were estimated to be lower than 0.2.

Table 7: Error correction models with disposable income

Dependent variable: $\Delta_4 \ln C_t$				
Explanatory variables	Estimation			
	(a)	(b)	(c)	(d)
$\sum_{i=1,4}(\ln C_{t-i} - \ln YV_{t-i})/4$	-0.499 (3.76)	-0.509 (3.71)	-0.461 (3.45)	-0.477 (3.49)
$\Delta_4 \ln C_{t-1}$	0.438 (4.69)	0.426 (4.48)	0.411 (4.30)	0.390 (4.01)
$\Delta_4 \ln YV_t$	0.732 (9.13)		0.700 (8.88)	
$\Delta_4 \ln YV_{t-1}$	-0.396 (3.81)		-0.327 (2.99)	
$\Delta_4 \ln YV_t^{(+)}$		0.652 (6.66)		0.608 (6.32)
$\Delta_4 \ln YV_{t-1}^{(+)}$		-0.342 (2.91)		-0.273 (2.28)
$\Delta_4 \ln YV_t^{(-)}$		1.019 (4.73)		1.029 (4.83)
$\Delta_4 \ln YV_{t-1}^{(-)}$		-0.571 (2.48)		-0.483 (2.07)
$i_t - \pi_t$	-0.232 (1.90)	-0.220 (1.79)		
$i_t - \pi_t^{e,a}$			-0.174 (2.22)	-0.180 (2.26)
π_t	-0.320 (3.23	-0.321 (3.13)	-0.236 (2.83)	-0.246 (2.88)
Constant	-0.049 (2.49)	-0.049 (2.53)	-0.049 (2.57)	-0.049 (2.58)
$\bar{R}^2$	0.787	0.787	0.791	0.793
DW statistics	2.19	2.23	2.16	2.19

Estimation period: 1975:1 - 1994:4; C: private consumption, YV: disposable income, at 1991 prices and per capita in each case, i: yield on bonds outstanding, π: inflation rate, $\pi^{e,a}$: expected rate of inflation given adaptive expectations with α=0.2; (+) bzw. (-): positive or negative component; Δ_4: difference against the same quarter of the previous year; t-values in brackets.

Table 8: Error correction models with mass income and profit and investment income

Dependent variable: $\Delta_4 \ln C_t$						
Explanatory variable	Estimation					
	(a)	(b)	(c)	(d)	(e)	(f)
ECT	-0.355	-0.437	-0.355	-0.380	-0.425	-0.373
	(2.76)	(3.48)	(2.71)	(3.13)	(3.50)	(3.06)
$\Delta_4 \ln C_{t-1}$	0.240	0.434	0.244	0.256	0.406	0.246
	(3.14)	(4.47)	(3.08)	(3.63)	(4.26)	(3.41)
$\Delta_4 \ln YM_t$	0.342	0.471		0.331	0.410	
	(5.98)	(5.55)		(6.13)	(5.05)	
$\Delta_4 \ln YM_{t-1}$		-0.255			-0.167	
		(2.68)			(1.81)	
$\Delta_4 \ln YM_t^{(+)}$			0.327			0.261
			(3.84)			(3.22)
$\Delta_4 \ln YM_t^{(-)}$			0.348			0.465
			(2.05)			(2.89)
$\Delta_4 \ln YG_t$	0.194	0.222		0.195	0.211	
	(7.26)	(8.30)		(8.00)	(8.50)	
$\Delta_4 \ln YG_{t-1}$		-0.084			-0.067	
		(2.61)			(2.06)	
$\Delta_4 \ln YG_t^{(+)}$			0.180			0.171
			(5.37)			(5.68)
$\Delta_4 \ln YG_t^{(-)}$			0.268			0.304
			(2.48)			(3.00)
$i_t - \pi_t$	-0.420	-0.387	-0.419			
	(3.01)	(2.72)	(2.96)			
$i_t - \pi_t^{e,a}$				-0.346	-0.282	-0.368
				(4.41)	(3.40)	(4.56)
π_t	-0.358	-0.330	-0.351	-0.239	-0.212	-0.244
	(3.41)	(3.17)	(3.27)	(3.19)	(2.85)	(3.19)
Constant	0.195	0.229	0.196	0.198	0.215	0.200
	(3.17)	(3.82)	(3.14)	(3.47)	(3.78)	(3.49)
$\bar{R}^2$	0.751	0.777	0.745	0.778	0.788	0.779
DW statistics	1.72	2.23	1.71	1.85	2.20	1.81

YM: mass income; YG: profit and investment income, real and per capita in each case; $ECT = \sum_{i=1,4} (\ln C_{t-i} - 0.717 \ln YM_{t-i} - 0.283 \ln YG_{t-i}) / 4$; for other variables see table 7. Estimation period: 1975:1-1994:4.

If one tries to classify the estimations of tables 7 and 8 on the basis of their quality, the equations with adaptive price expectations - at least when measured against the adjusted determination coefficient - are superior to the equations with rational price expectations. Owing to their parsimonious parametrisation and the fact that test results are satisfactory overall, equations (c) and (d) from table 7 are the most convincing ones. The semi-interest-rate elasticity of private consumption in respect of the yield on public bonds outstanding would then have to be located at the lower edge of the range between 0.2 and 0.4.

What is the impact, according to these equations, of the interest rate shocks on the trend in private consumption? The assumption that interest rates are stationary variables is tantamount to stating that deviations of the real interest rates from their equilibrium value can only be of a temporary nature. According to the estimated semi-interest-rate elasticity, temporary shocks lead to a temporary contraction of consumption, which fades away over time, however, with the result that, after a while, it no longer has an adverse impact on consumption. How quickly the stimulus loses in importance is determined mainly by the size of the parameter of the error correction term. The time structure of the effects of temporary interest rate shocks on private consumption will be analysed more closely in chapter VI.

What is unsatisfactory about the estimations presented in this section is the inclusion of the inflation rate as an explanatory variable in the regression model.[7] Deaton (1977) explains the significance of the inflation rate by stating that consumers misinterpret unanticipated changes of the inflation rate as relative price changes. According to him, this is due to the fact that they do not purchase the same bundle of goods in all periods, and therefore consider only the prices of those goods which they wish to acquire in the period concerned. He also points out that in many applications it was possible merely to establish a significant impact of nominal interest rates - not, however, of real interest rates - on consumption (Deaton, 1992). This is confirmed here. If the real interest rate is replaced in the error correction models by the nominal interest rate and the inflation rate is dispensed with as an autonomous regressor, the estimation results are, on the whole, quite satisfactory. The consumption equations presented here would hence be overparametrised.

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7 See also the estimation function of Davidson, Hendry, Srba and Yeo (1978) for the United Kingdom, which likewise contains the inflation rate as an explanatory variable.

Another explanation of the significant impact of the inflation rate on private consumption is given by von Ungern-Sternberg (1981). He argues that a rise in the inflation rate reduces the real value of private financial assets, which is interpreted by the consumers as "negative income" and affects consumption expenditure accordingly (see also Siegel, 1979, Jump, 1980 and Muellbauer and Lattimore, 1995). According to this view, it would be wrong to calculate real investment income, and hence also real disposable income, in the usual way by deflating nominal incomes by the price index for private consumption. This view was also put forward by Hicks (1950), who defines the income of an individual as "the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning" (ibid., p. 172). The United Nations' revised system of national accounts (SNA) of 1993 is also based on this definition of real income (Lützel, 1993). We shall examine the empirical relevance of this argument below.

Let YV designate real disposable income, which is calculated on the basis of nominal disposable income by deflating it by the price index for private consumption; let A be real net financial assets of households, likewise deflated by the price index for private consumption, and let π^e be the inflation rate expected (or perceived) by individuals: the income of households, which is available for consumption purposes and simultaneously leaves expected real assets constant, may then be given by:

(7) $$YV_t^* = YV_t - \pi_t^e \cdot A_{t-1}$$

As the income variable for the equation, von Ungern-Sternberg (1981) proposes a slightly different representation with the additional parameter κ:

(8) $$YV_t^* = YV_t - \kappa \cdot \pi_t^e \cdot A_{t-1}$$

The parameter κ should be significantly different from zero and be about 1. For the empirical examination, the restriction $\kappa=1$ was imposed in the first estimation.. In the second estimation, κ was additionally estimated as part of the error correction models. These parameters were estimated using the non-linear least square method on account of the associated non-linear parameter restrictions. Table 9 summarises the estimations results using this newly defined income variable for equation (c) of table 7; table 10 contains the regression results for error correction model (e) of table 8.

Table 9: Error correction models with corrected disposable income

Explanatory variable / parameter	Dependent variable Variable: $\Delta_4 \ln C_t$ Equation (a)		Equation (b)	
$\sum_{i=1,4}(\ln C_{t-i} - \ln YV^*_{t-i})/4$	-0.261	(3.74)	-0.331	(3.44)
$\Delta_4 \ln C_{t-1}$	0.414	(4.34)	0.387	(4.01)
$\Delta_4 \ln YV^*_t$	0.632	(8.62)	0.706	(9.04)
$\Delta_4 \ln YV^*_{t-1}$	-0.341	(3.60)	-0.319	(3.04)
$i_t - \pi^{e,a}_t$	-0.283	(2.97)	-0.226	(2.58)
Constant	-0.008	(1.44)	-0.027	(2.31)
κ	1		0.458	(2.31)
$\bar{R}^2$	0.768		0.783	
DW statistics	2.15		2.17	

Estimation period: 1975:1 - 1994:4; t-values in brackets.

First of all, it is notable that the error correction terms are significant as a result of the newly defined income variables, even disregarding the inflation rate as an autonomous regressor. Expanding the estimations by using the inflation rate did produce any non-significant results for them. Furthermore, it is immediately noticeable that if the share κ is estimated, this is significantly different from 0, but also significantly different from 1. The fact that the restriction $\kappa=1$ is waived, moreover, improves the explanatory power of the regression.

The semi-interest-rate elasticity increases as a result of the income correction in the equations using disposable income (table 9, compared with table 7), whereas the semi-interest-rate elasticity decreases in the case of a disaggregated analysis of incomes (table 10, compared with table 8). The outcome is that the estimated semi-interest-rate elasticities have largely drawn closer to each other, as a result of treating inflation losses on financial assets as "negative" income.

Table 10: Error correction model with corrected investment income

Dependent variable: $\Delta_4 \ln C_t$				
Explanatory variable / parameter	Equation (a)		Equation (b)	
$\frac{1}{4}\sum_{i=1,4}(\ln C_{t-i} - \beta_1 \ln YM_{t-i} - (1-\beta_1)\ln YG^*_{t-i})$	-0.361	(3.68)	-0.622	(4.83)
$\Delta_4 \ln C_{t-1}$	0.391	(4.03)	0.338	(2.53)
$\Delta_4 \ln YM_t$	0.370	(4.46)	0.416	(5.16)
$\Delta_4 \ln YM_{t-1}$	-0.254	(2.43)	-0.246	(2.48)
$\Delta_4 \ln YG^*_t$	0.138	(7.70)	0.144	(8.33)
$\Delta_4 \ln YG^*_{t-1}$	-0.053	(2.65)	-0.043	(2.18)
$i_t - \pi_t^{e,a}$	-0.227	(2.53)	-0.242	(2.08)
Constant	0.154	(3.86)	0.289	(4.91)
β_1	0.822		0.749	(43.62)
κ	1		0.390	(2.53)
$\overline{R}^2$	0.758		0.780	
DW statistics	2.22		2.25	

Estimation perid: 1975:1 - 1994:4; $YG^*_t = YG_t - \kappa \cdot \pi^e_t \cdot A_{t-1}$; t-values in brackets.

It may be stated as a conclusion of this section that incomes, in addition to the long-term impact, have a perceptible short-term impact on consumption expenditure. Moreover, a significantly negative interest rate impact is shown in most cases. The semi-interest-rate elasticity is likely to be between 0.2 and 0.4, the majority of the estimations showing a lower value than 0.3.

5 Analysis of the components of private consumption

It may be assumed that not all components of private consumption are equally responsive to interest rate changes, but that, instead, the interest rate impact affects only certain groups of goods. This section analyses which components are responsive to interest rate changes. Disaggregated data on private consumption are provided by the Federal Statistical Office using four different categories: by delivery areas, by durability and value of the goods, by purpose of use, and by groups of goods (Federal Statistical Office, 1995). In the two sub-sections below, we shall consider the disaggregation of consumption by purpose of use, and by durability and value of the goods.

5.1 Private consumption by purpose of use

The composition of private consumption by purpose of use has changed perceptibly over the past 35 years - as is shown in table 11. In particular, there has been a marked decline in the share of food, beverages and tabacco. The portions of their budget which households spend on clothes and shoes, and on household appliances have likewise declined over time. On the other hand, there has been a disproportianate increase in expenditure on the use of dwellings. Expenditure on transport and communications increased perceptibly as a share of consumption expenditure, especially in the sixties. The disproportionately large increase in spending on personal goods was due almost solely to the expansion of expenditure on services provided by credit institutions and insurance companies (for a definition of the components, see also Hamer and Müller-Nagell, 1963).

Table 11: Structure of private consumption by purpose of use

Purpose of use	Year				
	1960	1970	1980	1990[1]	1994[1]
Food, beverages, tobacco	37.2	30.0	24.9	22.1	19.7
Clothing, shoes	11.6	10.3	9.4	8.3	7.6
Housing[2]	9.9	12.4	13.9	16.5	19.1
Energy (excluding petrol)	3.0	3.9	5.6	4.0	3.9
Household appliances	11.5	10.1	10.1	9.4	9.3
Goods for health care and hygiene	4.9	4.6	4.8	5.3	5.6
Goods for transport and communication	9.0	14.0	14.9	17.2	16.8
of which: motor vehicles	2.4	3.9	3.9	5.8	5.2
Goods for education, entertainment, leisure	8.5	11.3	10.5	10.4	10.2
Personal goods	4.4	4.7	6.1	7.0	7.9
Domestic purchases of households	100.0	100.0	100.0	100.0	100.0

At current prices; shares in %. 1 Old Länder. 2 Including owner-occupied dwellings.

The shifts in the structure of private consumption are explained generally by the different price developments of the components (price elasticities) or by the different income elasticities. Oberheitmann and Wenke (1994) made a detailed breakdown in examining private consumption and showed that those types of expenditure which tend to be part of basic needs (food, clothes, repair services) have a comparatively low income elasticity, whereas up-market goods are characterised by relatively high income elasticities. According to an analysis of non-durable consumer goods by Hansen (1985), who uses annual data for the period between 1960 and 1980, all product groups with the exception of "food, beverages and tabacco" and "housing" possess comparatively high own-price elasticities, but only low cross-price elasticities.

However, the above-mentioned studies fail to discuss the potential impact of interest rates on the components of private consumption. In order to examine this question, this paper will estimate, firstly, disaggregated consumption functions, which, in terms of their basic structure, correspond to the aggregated consumption functions in the previous section. Secondly, the linear expenditure system of Deaton and Muellbauer (1980a) - augmented by including an interest rate variable - will be examined empirically. Both approaches have certain drawbacks. Disaggregated consumption functions require the validity of specific separability conditions; in linear expenditure systems, the components of private consumption are specified as ratios, with the result that conclusions on the interest rate sensitivity of individual components can only be drawn indirectly from the changes in the composition of consumption expenditure caused by interest rate variations.

The specification of the disaggregated consumption function was based on the hypothesis that the change of the component i of private consumption ($\Delta \ln C_i$) is a function of changes in real income ($\Delta \ln YV$), the expected real interest rate ($i-\pi^{e,a}$), the relative price change rate of the component i ($\pi_i-\pi$), and the lagged endogenous variables. Households' budget constraint is captured via the error correction term, which is specified as the deviation of overall consumption from its equilibrium value, thus linking the individual expenditure categories to each other:

(9)
$$\Delta_4 \ln C_{i,t} = \alpha_0 + \sum_{k\geq 1} \beta_k \Delta_4 \ln C_{i,t-k} + \sum_{k\geq 0} \gamma_k \Delta_4 \ln YV_{t-k} + \phi_1\left(i_t - \pi_t^{e,a}\right) + \phi_2\left(\pi_{i,t} - \pi_t\right) + \lambda \sum_{i=1,4}\left(\ln C_{t-i} - \ln YV_{t-i}\right)/\,4$$

A significant impact of real interest rates at the 5 % level could be shown only for three of the nine components. Accordingly, the real interest rate, with an estimated semi-interest-rate elasticity of 1.1, has a restraining effect on expenditure on transport and communications, which is not surprising in view of the frequently used possibility of instalment financing in the case of purchases of new motor vehicles; it likewise has a negative effect (semi-elasticity: 0.1) on expenditure on training, entertainment and leisure, which also include expenditure on phono equipment, and, at a semi-elasticity of 0.3, on expenditure on personal goods. Calculated roughly, an estimation of the semi-interest-rate elasticity for the total consumption of households in Germany can be derived from the disaggregated estimates by weighting with the various shares. If those components which have a significant interest rate impact are included in the calculation, the (short-term) semi-elasticity for 1994, for example, would be just over one-fifth, which would confirm the estimations of the aggregated consumption functions in the previous section.

The expenditure system of Deaton and Muellbauer (1980a), including a real interest rate variable, may be represented as:

$$(10) \quad w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{i,j} \ln p_j + \beta_i \ln \frac{C^n}{P} + \psi_i \, r^e \qquad (i=1,...n)$$

In this context, C^n designates the total nominal consumption expenditure, p_j the price index of the commodity j, r^e the expected real interest rate, and w_i the budget share of the commodity i, with the result that the following holds: $\Sigma w_i = 1$. Let P be the price index for the total expenditure, as defined by Stone (1959):[8]

$$(11) \quad \ln P = \sum_{i=1}^{n} w_i \ln p_i$$

The parameters α, β, γ and ψ have to meet the following conditions:

$$(12) \quad \gamma_{i,j} = \gamma_{j,i} \quad \text{(Symmetry)} \qquad \sum_{j=1}^{n} \gamma_{i,j} = 0 \quad \text{(Homogeneity)}$$

$$\sum_{i=1}^{n} \alpha_i = 1 \qquad \sum_{i=1}^{n} \beta_i = 0 \qquad \sum_{i=1}^{n} \psi_i = 0 \qquad \sum_{i=1}^{n} \gamma_{i,j} = 0 \quad \text{(Adding up)}$$

8 Alston, Foster and Green (1994) have shown that the approximation of the theoretically adequate index through the index used by Stone has scarcely any influence on the estimated values for the price and income elasticities of the expenditure system (see also Ng 1995).

The income elasticities of the components are $E_i=1+\beta_i/w_i$, the compensated own-price elasticities $E_{ii}=w_i+\gamma_{ii}/w_i-1$, and the compensated cross-price elasticities $E_{ij}=w_j+\gamma_{ij}/w_i$. The semi-interest-rate elasticities are calculated as: $E_{zi} = \psi_i/w_i + \partial \ln C^n/\partial r^e$.

For estimating the linear expenditure system, the categories "housing" and "energy" were combined, with the result that a distinction is made between eight purposes of use overall. The large-scale purchases, especially of higher-quality durable consumer goods by east German households in western Germany in 1990-91, partly obscured the structural trend. The end of the estimation period was therefore set at 1989. Table 12 contains the estimated income, own-price and semi-interest-rate elasticities for 1989. In calculating the semi-elasticity, the second summand, which reflects the impact of interest rates on total expenditure, was dispensed with. Assuming that this is likely to be between 0.2 and 0.3, in line with the estimations presented in the previous section, the table value would have to be reduced accordingly.

Table 12: Estimated elasticities for 1989

Purpose	Income elasticity	Own price elasticity	Semi-interest rate elasticity
Food, beverages, tobacco	0.469	-0.124	0.65
Clothing, shoes	0.676	-0.526	0.64
Housing and energy	0.970	-0.066	0.61
Household appliances	0.313	-1.151	-0.45
Goods for health care and hygiene	1.145	-0.316	0.21
Goods for transport and communication	1.536	-1.523	-0.53
Goods for education, entertainment, leisure	1.973	0.745	-1.73
Personal goods	4.035	-0.448	-0.42

Estimation period: 1962 - 1989. Semi-interest rate elasticity calculated as ψ_i/w_i.

Income and own-price elasticities show the expected operational signs and magnitudes. Exceptions to this are the very high income elasticity of personal goods, which reflects the steep increase over time in this expenditure category, and the positive own-price elasticity of goods for education, entertainment and leisure. The low income elasticity of household appliances might be an indication of saturation tendencies.

Negative semi-interest-rate elasticities are shown in the following groups of products: household appliances, transport and communications, education, entertainment and leisure, and personal goods. The estimated results of the disaggregated consumption function are hence confirmed for the three last-named categories. For these three categories, the parameter ψ_i for the interest rate variable is significantly different from zero; this does not apply to the household appliances category, however. It is surprising that expenditure on education, entertainment and leisure goods, according to the estimations, is perceptibly more responsive to interest rate changes than expenditure on transport. Alternative estimations which vary the estimation period show that this is caused, above all, by the inclusion of the sixties. If the start of the estimation period is defined as the first half of the seventies, the sequence changes, and expenditure on transport and communications becomes the category which is the most responsive to interest rate changes.

5.2 Private consumption by durability

The structural shifts in the composition of private consumption stated in the previous section also become manifest when private consumption is broken down by durability. Unfortunately, data for Germany are only available for the years since 1980. As shown in table 13, there was a dramatic fall in the share of non-durable consumer goods, in particular, over the past 15 years, whereas expenditure on the use of dwellings and on other services rose appreciably in importance. By contrast, the share of high-quality durable consumer goods (for example, motor vehicles, furniture, electrical devices) remained relatively constant.[9]

Table 13: Structure of private consumption by durability

Item	Year			
	1980	1985	1990 [1]	1994[1]
Non-durable goods	40.0	38.9	35.1	32.7
Semi-durables	16.9	15.2	15.5	14.4
High-quality durables	12.1	11.2	13.4	12.4
Housing	13.9	16.1	16.5	19.1
Repairs	2.5	2.4	2.7	2.7
Other services	14.5	16.1	16.8	18.8
Domestic purchases of households	100.0	100.0	100.0	100.0

At current prices, shares in %. 1 Old Länder

9 High-quality durable consumer goods are characterised by the fact that they are "long-lived" (in Germany: at least five years) and of "high quality" (Schäfer and Bolleyer 1993).

The disaggregation of private consumption according to the durability of goods makes it possible to distinguish between the service flow of durables and the expenditure on durables. It is hence possible to resolve the formerly tacit assumption that goods provide utility only in the period in which they are purchased. A demand system for consumer durables developed by Hansen (1984) will be presented and examined empirically below (see also Deaton and Muellbauer, 1980b, p. 97ff., Hansen, 1993).

Let there be the following relationship between the purchases (e) and the stock (B) of a durable i:

$$(13) \qquad e_{i,t} = B_{i,t} - (1-\mu_i) \cdot B_{i,t-1} \qquad\qquad (i=1,...n)$$

μ_i designating the depreciation rate which is assumed to be constant. Non-durable goods are characterised by a depreciation rate of 1. The (nominal) budget equation can then be formulated as:

$$(14) \qquad Y_t^n + i_t A_{t-1}^n = \Delta A_t^n + \sum_{i=1}^{n} p_{i,t}\left(B_{i,t} - (1-\mu_i) B_{i,t-1}\right)$$

In this equation, Y^n stands for the (nominal) labour income, i the nominal interest rate, A^n the nominal portfolio of financial assets and p_i the price of the commodity i.

By linking this budget equation with a utility function or, equivalently, a cost function, it is possible to establish a demand system for durable goods. Hansen (1984) derives the following generalised expenditure system from a cost function which was specified in line with the generalised Leontief production function of Diewert (1971):

$$(15) \qquad p_{i,t}^* B_{i,t} = \sum_{j=1}^{n} \alpha_{ij} \sqrt{p_{i,t}^* p_{j,t}^*} + \beta_i \left[\sum_{k=1}^{n} p_{k,t}^* B_{k,t} - \sum_{k=1}^{n} \sum_{j=1}^{n} \alpha_{kj} \sqrt{p_{i,t}^* p_{j,t}^*} \right] + \varepsilon_{i,t} \qquad (i=1,...n)$$

with parameters α and β, which are subject to the following restrictions:

$$(16) \qquad \alpha_{ij} = \alpha_{ji} \quad \text{(Symmetry)} \qquad\qquad \sum\nolimits_j \beta_j = 1 \quad \text{(Adding-up)}$$

as well as the user costs p*:

(17) $$p^*_{i,t} = p_{i,t} - (1-\mu_i)\frac{p_{i,t+1}}{1+i_{t+1}}$$

The user costs, by analogy with the neo-classical investment theory, give the costs of holding one unit of a durable for a given period. Higher interest rates also raise the user costs of durable goods. The user costs of non-durable goods are, by contrast, independent of the interest rate level and correspond to the prices of the goods.

In this model, the elasticities of expenditure on commodity i with regard to the user costs of commodity j can be written as:

(18) $$\frac{\partial \ln e_i}{\partial \ln p^*_j} = \frac{1}{e_i}\left\{ (B_j - \alpha_{jj})\beta_i \frac{p^*_j}{p^*_i} + \alpha_{ij}\sqrt{\frac{p^*_j}{p^*_i}} - \frac{\beta_i}{p^*_i}\sum_{k\neq j}\alpha_{ij}\sqrt{p^*_k p^*_j} \right\}$$

Hansen (1984) expanded this demand system by interpreting financial assets formally as the (n+1)th durable good. Financial assets then have a depreciation rate of μ=0. The "purchases" of this commodity are thus the changes in the real net financial assets:

(19) $$e_{n+1,t} = \frac{A_t}{P_t} - \frac{A_{t-1}}{P_{t-1}} = \frac{1}{P_t}(A_t - (\pi_t + 1)A_{t-1})$$

with the price index P for the total expenditure and the inflation rate π. If the concept of user costs is transferred formally to financial assets, the following is obtained:

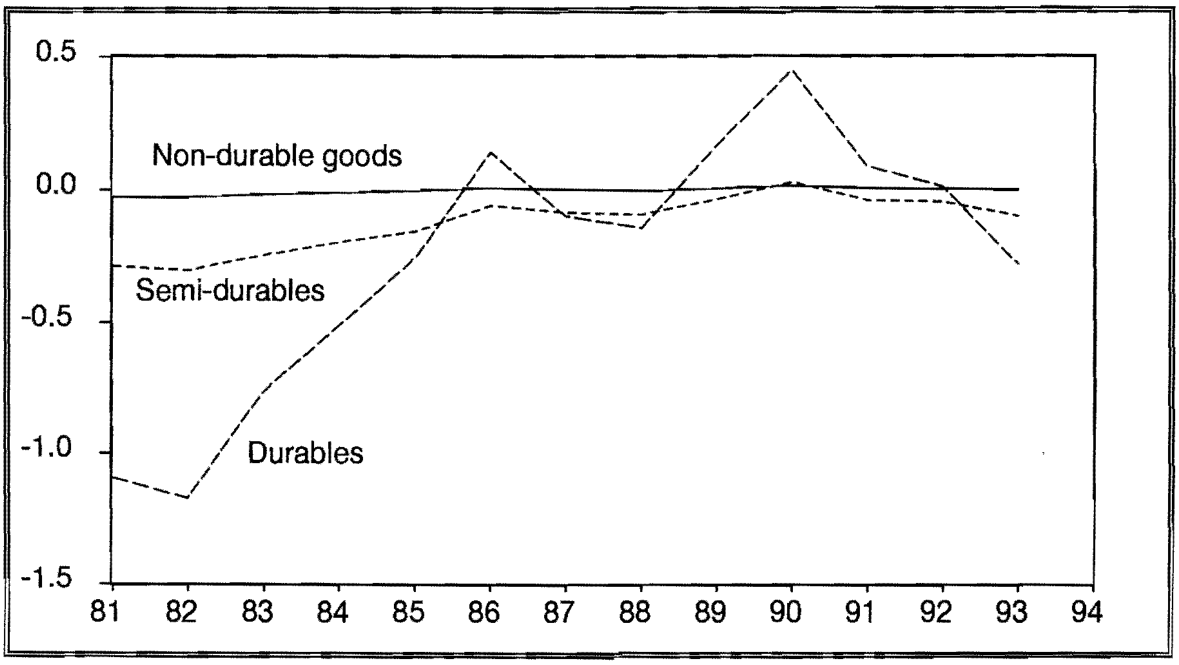
(20) $$p^*_{n+1} = P\frac{i_{t+1} - \pi_{t+1}}{1+i_{t+1}}$$

The "user costs" of the financial assets are therefore the discounted real interest rates.

Four groups of products are formed for the empirical implementation of this model: nondurables, semi-durables, durables and savings. The group of non-durable goods, which have a depreciation rate of 1, comprises non-durable consumer goods, repairs and other services. To establish the depreciation rates of semi-durables and durables, it was assumed that the average life of semi-durables is 2 years, whereas the average life of durables is 7 years. The stock of durables were taken from the paper by Schäfer and Bolleyer (1993), the initial stock of semi-durables was estimated on the basis of the average life and the average rate of change (Hansen, 1984).

Since expenditure system (15) describes an equilibrium, a partial adjustment process was modelled for the estimation, in which the adjustment parameter must have the same value in all equations of the system for reasons of consistency. The estimations are based on quarterly data which, however, are available only since 1980. A shortening of the estimation period to exclude the years after German unification from the sample because the "structural" trend in the series was obscured to a great extent by special effects, particularly in 1990 and 1991 (purchases by east German households in western Germany), did not appear reasonable, owing to the fact that there would then be only a small number of degrees of freedom in the estimation. In fact, according to a trial estimation, most of the parameter estimates were not significant. The estimations and the resulting income and price elasticities cannot be interpreted meaningfully in many cases even if the total period of 15 years is used, however. Plausible results were obtained mainly for the elasticities of the three groups of commodities with regard to the "user costs" of financial assets (discounted real interest rates).

Chart 6: Elasticities with regard to the "user costs" of financial assets



As shown in chart 6, the interest rate elasticity of the non-durable consumer goods (including repairs and other services) is almost zero. In the first half of the eighties, the elasticity of semi-durables is around -0.3, but declined steadily towards zero up to 1990, and since that time has again shown slightly negative values. The shape of the elasticity curve of high-quality durables is especially interesting in terms of the real interest rates. As expected, these show negative values, but for some years the correlationship seems to be positive. The cause of the positive value in 1986 is the approximately 30 % increase in households' real expenditure on motor vehicles. The briskness of car sales was attributable, firstly, to the substantial decline in mineral oil prices, which perceptibly expanded the real income scope of households and also made the use of motor vehicles cheaper. A second contributory factor is likely to have been tax incentives granted for low-pollutant motor vehicles. The second phase, which shows a non-negative dependence of demand for consumer durables on the user costs for financial assets, reflects the boom in demand that occurred in the wake of the German unification process. Perhaps these two events explain why Kaehler and Korn (1995, pp. 106-112) were unable to establish interest rate effects on the purchase of durables on the basis of different consumption functions. Owing to the shortness of the estimated period, even the results presented here should be interpreted with a certain degree of caution, however.

IV Interest rates, consumer credits and private consumption

1 Structure of and trend in consumer credits

In the third chapter, it was shown that expenditure on transport and communications, expenditure on education, entertainment and leisure, and (probably), expenditure on household appliances are responsive to interest rate changes among the components of private consumption expenditure, broken down by purpose of use. To a significant extent, these categories comprise high-quality durable consumer goods, which are often financed by credits. This is confirmed by the results of the Income and Expenditure Survey (EVS), in which households were questioned about the purposes of use of newly raised credits. This showed that consumer credits were most frequently raised for the purpose of purchasing private cars, the share of such purchases even increasing over time (table 14). Purchases of household furniture and appliances were, in a considerable number of cases, financed by credits, whereas only a small number of holiday trips, at least until 1983 (more recent figures are not available), were financed by borrowing.

In this paper, we define consumer credits, in line with the borrowers statistics, as the credit extended by credit institutions to "employees and other individuals", excluding housing loans. This definition provides "a reliable overall picture of borrowing for the purpose of consumption" (Deutsche Bundesbank, 1993, p. 20). There has been a perceptible increase

Table 14: Purpose of use of newly raised credits

in %	1973	1978	1983
Purchase of cars	34.8	38.5	42.9
Purchase of furniture	23.9	15.0	18.5
Other acquisitions	31.7	21.7	20.5
Holiday trips	4.4	4.2	3.0
Other	27.7	38.9	28.7

Multiple indications possible.
Source: Federal Statistical Office, Subject-Matter Series 15, Vol. 2, various years.

in consumer credits in the past 25 years, both in absolute terms and in relation to disposable income or private consumption. Whereas the relationship to disposable income was just under 7 % in 1970, it was more than twice as high, at almost 17 %, in 1994 (see table 15). On an international comparison, the indebtedness of households in Germany is still quite low. In parallel with increased recourse to consumer credits, the resulting interest rate burden on households rose, too; households now have to spend roughly 2 % of their disposable income on this.

Table 15: Longer-term trend in consumer borrowing

Year	Consumer credits		Interests on consumer credits	
	DM billion	as % of disposable income	DM billion	as % of disposable income
1970	29.7	6.9	3.34	0.8
1975	56.2	8.1	6.41	0.9
1980	130.7	13.4	13.19	1.4
1985	179.5	15.1	17.67	1.5
1989	232.9	16.5	19.46	1.4
1991	295.0	15.6	29.53	1.6
1994	363.2	16.8	40.50	1.9

From 1991: Including new Länder and East Berlin.
Sources: Deutsche Bundesbank; Federal Statistical Office, Subject-Matter Series 18.

In terms of redemption modalities, consumer credits can be broken down into instalment credit and non-instalment credit. Among the non-instalment credits, an important sub-group is formed by the personal credit lines (debit balances on wage, salary, pension accounts), which have accounted for a relatively constant share in consumer credits since 1970 (between 11 % and 14 %). Shifts have occurred between instalment and non-instalment credit. Thus, the share of instalment credit fell from 51 % at the end of 1980 to 44 % in 1994.

As an alternative to the redemption modalities, consumer credit can also be classified by its maturity. Here, it emerges that there has been a marked decline in both the share of short-term credits (up to and including one year) and the share of medium-term consumer credits (more than one year and less than four years) (see table 16). Long-term loans, by contrast, now account for almost two-thirds of all consumer credits. This preference for longer-term obligations has probably tended to result in a declining sensitivity of households to variations of short-term interest rates.

Information on how many households raised consumer credits is contained in the Income and Expenditure Survey (EVS) carried out every five years by the Federal Statistical Office. The EVS provides detailed data on the households' credit obligations, broken down according to the age of the reference person, household size, social status and household net income.[10] The respective remaining debt is shown as well, which comprises outstanding interest rate payments besides the credit volume to be redeemed.

Table 16: Structure of consumer credits by maturity

Year	short-term	medium-term	long-term
1970	33.2	44.9	21.9
1975	32.6	40.5	26.9
1980	27.7	28.7	43.6
1985	29.0	21.1	50.0
1990	23.3	18.4	58.3
1994	20.4	15.4	64.2

From 1991: Including new Länder and East Berlin; end of year level; shares in %.

[10] In contrast to the definition chosen in this paper, the EVS do not define personal credit lines as consumer borrowing.

According to the data provided by the EVS, around one-sixth of all households had credit obligations during the past 20 years.[11] Although it is not possible to ascertain a clear trend in the share of households with credit obligations, it seems to have been higher since the beginning of the eighties than in the seventies. As expected in accordance with the life cycle hypothesis, the age group up to 35 years accounts for the highest share of households with credit obligations. The share decreases steadily with the age of the reference person: Fewer than one-fifth of households with a reference person of at least 65 years old have credit obligations in connection with private consumption.

Table 17: Households' credit commitments by age of reference person

Age	1973	1978	Year 1983	1988	1993[1]
			Households with credit commitments[2]		
Total	16.0	14.6	17.2	19.7	17.6
under 35	29.7	30.1	33.9	33.5	27.0
35 to 45	22.2	21.5	25.2	30.9	26.8
46 to 55	16.2	16.1	18.8	22.8	21.5
55 to 65	10.1	10.2	11.6	13.9	12.2
65 and above	4.7	4.1	4.1	5.0	4.1
			Remaining debt per household with consumer credits[3]		
Total	9 400	10 500	11 800	12 800	10 700
under 35	8 300	11 100	10 200	11 000	10 100
35 to 45	10 100	11 500	13 100	14 500	11 000
45 to 55	10 400	10 400	13 700	14 700	12 200
55 to 65	10 900	8 800	12 900	11 800	10 900
65 and above	7 600	7 400	8 400	10 300	7 000

1 Old Länder. 2 In terms of all households of the age group concerned. 3 DM; at 1991 prices, rounded to amounts of DM 100.
Sources: Federal Statistical Office, Subject-Matter Series 15, vol. 2, various years; Euler (1995); Guttmann (1995).

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11 Households with a particularly high income (in 1993, a monthly household net income of more than DM 35,000) have not been included in these statistics.

According to the data provided by the Income and Expenditure Survey, the average remaining debt per household arising from consumer credits rose, deflated by the price index for private consumption, by a total of 36 % between 1973 and 1988 whereas it declined again perceptibly between 1988 and 1993 (table 17). When analysing this intertemporal comparison of average residual debt, it should be borne in mind, however, that the EVS are merely a sample survey and that the credit obligations shown in the table are based on data provided by the respondents and are therefore certainly not as reliable as the data recorded in the borrowers statistics (table 15), according to which there has been no ascertainable decline in obligations during the past few years. The highest average remaining debt from consumer credits is not to be found among the young households, but, rather, according to most of the surveys, among the households with a reference person who is between 45 and 55 years of age. However, there is only a weak overall correlation with age for the remaining debt.

An analysis of income stratification shows that the share of households with credit obligations is higher in the above-average income brackets than in the below-average income brackets. The average remaining debt rises, in terms of its absolute amount, as a function of income. The picture is reversed if the remaining debt is related to the annual income, however. Households with lower income have a higher indebtedness in relationship to their income than do households with higher incomes. The classification of the household net income can be used to state the approximate ratio of the remainig debts to the average household net income of the sample. Accordingly, this ratio was 4 1/2 % in 1973, 5 ½ % in 1983, 7 % in 1988 and again 4 ½ % in 1993. These figures, particularly for the most recent surveys, are significantly below the ratios derived from the borrowers statistics and the national accounts, even if it is borne in mind that the EVS do not cover current account credits, and that households with a very high income are not included in the sample. It may thus be assumed that the credit obligations are like the assets figures distinctly underrepresented in the EVS data record.

2 Impact of interest rates on the demand for consumer credits

According to the permanent income hypothesis, households do not restrict their consumption in the event of an income loss which is deemed to be of a temporary nature; instead, they either resort to savings or raise credits to maintain their desired consumption level. Another reason for the raising of consumer credits is the purchase of durable consumer goods which are utilised for more than one period. The interest rate on consumer credits is a relevant variable in decision-making for both borrowing motives. Regarding the maturity of the credits, the hypothesis appears plausible that households resort to personal credit lines or other short-term credits if there are temporary losses of income, whereas maturities compatible with durability, i.e. medium-term or long-term forms of financing, tend to be chosen for purchases of longer-term durable consumer goods. This assumption is corroborated by simple correlation analyses according to which there appears to be no, or only a weak, correlation between the growth rate of short-term consumer credits and the growth rate of private consumption, both in terms of the aggregate and in terms of components, disaggregated by durability or purpose of use, whereas a strongly positive correlation exists between private consumption on the one hand and medium-term and long-term consumer credits on the other.

According to the unit root tests, the consumer credits can be regarded as integrated time series of first order (see table 18). The test results show that the stochastic structure of long-term consumer credits has a special feature in that a significant value was estimated for the coefficient of the time trend in the test equation, reflecting the sharp increase in long-term credits.

Table 18: ADF unit root tests for consumer credits

Consumer credits		Test specification	Test period	
			1971:1 - 1989:4	1971:1 - 1994:4
Total	Level	C,S,4	- 1.79	- 1.88
	1st difference		- 2.81 *	- 3.19 **
Short-term	Level	C,S,4	- 1.79	- 2.06
	1st difference		- 2.81 *	- 3.20 **
Medium-term	Level	C,S,4	- 2.10	- 2.29
	1st difference		- 3.21 **	- 3.75 ***
Long-term[1]	Level	C,S,T,4	- 2.67	- 2.64
	1st difference		- 3.51 **	- 4.07 ***

Consumer credits per capita, logarithmic, deflated by the price index for west German private consumption; "unification jump" taken into consideration by including dummy variables. ***/**/*: significant at the 1 %/5 %/10 % level according to MacKinnon (1991); C=constant, S=seasonal dummies, T=time trend, 4=number of lags in the test equation.
1 One additional dummy for the fourth quarter of 1980.

It was not possible to find a cointegration relationships between consumer credits and private consumption. If disposable income or, alternatively, mass income and profit and investment income are added as additional variables, there is one and only one cointegration relationship. This long-term log-linear relationship could therefore be interpreted to mean that households finance a certain share of their consumption through credits. However, this result proved not to be robust in respect of variations of the estimation period. For that reason, in the estimations we are disregarding consumer credits in the long-run equation.

If personal credit lines and other short-term credits are raised chiefly for bridging short-term discrepancies between income flows and desired consumption, it is unlikely that deviations of the consumption-income relationship from its equilibrium path will provide any additional explanation if the changes in consumption and income are included in the estimation for explaining the change rate of short-term credits. Estimations of such equations confirmed the over-parametrisation, and the long-term relation between consumption and income was, for that reason, dispensed with as an explanatory variable. Versions which included so-called "income surprises" in the estimation, instead of growth differentials of income and consumption, produced non-significant parameter estimators, which was in keeping with earlier studies (Deutsche Bundesbank, 1993).

The interest rate for current account credits of less than DM 1 million is used here as an interest rate variable (i) to cover credit costs. For the estimation period 1975-94, we obtain the following on the basis of quarterly data for the (real) short-term consumer credits KS (t values in brackets):

$$\Delta_4 \ln KS_t = \underset{(20.02)}{0.846}\,\Delta_4 \ln KS_{t-1} + \underset{(3.01)}{0.514}(\Delta_4 \ln C_t - \Delta_4 \ln YV_t) - \underset{(2.96)}{0.294}(i_t - \pi_t^{e,a}) + \underset{(3.0)}{0.026}$$

$$\overline{R}^2 = 0.862 \qquad DW = 1.69$$

Since consumer credits from the second quarter of 1990 also comprise the credits of east German credit institutions, an attempt was made to counter this statistical break either by using dummy variables or, alternatively, by using data for unified Germany for real private consumption (C) and real disposable income (YV). None of these two approaches was able to improve the quality of the estimation. The estimation also proved to be comparatively robust in respect of variations of the estimation period.

The estimated equation confirms the conjecture that higher credit interest rates tend to have a restraining effect on demand for short-term consumer credits and hence also affect consumer demand. The semi-interest-rate elasticity of credit demand, at 0.3 %, is not very high, however.

For explaining the medium-term and long-term consumer credits, we assume that these are raised mainly in connection with the purchase of durable consumer goods. As data for durable consumer goods have been available only since 1980, we initially tentatively consider overall private consumption and also consider those consumption components which have a high share in durable consumer goods. Another determinant considered is the equilibrium relationship between consumption and income. The correlation between this equilibrium relationship and the demand for consumer credits could be negative if one agrees with the argument that, given a weakening of the income trend, the gap is closed by resorting to credits for maintaining the previous level of consumption (Wenke, 1993, 1994). Alternatively, it is also conceivable, however, that in the case of equilibrium deviations consumption is adjusted to new income conditions - perhaps with a certain time lag - which leads to a slackening in credit demand. As is shown by the estimations in table 19, the last-mentioned argument is probably more relevant, particularly for long-term lending. In addition to the long-run consumption-income relationship, short-term fluctuations of private consumption have significant effects only on medium-term consumer credits.

Long-term consumer credits are perceptibly more responsive to interest rate changes than credits with medium-term maturity. This result suggests that durable consumer goods which are financed by long-term credits, such as private cars, are often for the purpose of replacing older goods of the same type. If the real interest rate is felt to be high, the "replacement investment" can therefore be postponed. The behaviour of so-called car credit banks for some years, which has been to offer low-interest-rate credits for the purchase of new motor vehicles, has probably tended to sever the link between demand for motor vehicles and "normal" credit interest rates to some extent.

If medium-term and long-term consumer credits are combined, the estimated parameter values are always situated between the corresponding estimated values for the individual components. The short-term and long-term semi-interest-rate elasticities of credit demand would hence be just under ¾ and around 2 ¾, respectively. The extent to which this affects private consumption depends on the elasticity of private consumption with regard to consumer credits. This issue will be dealt with in the next section.

Table 19: Estimation of credit demand functions

Explanatory variables	Dependent variable: $\Delta_4 \ln K$ Medium-term credits	Long-term credits	Medium and long-term credits
ECT_{t-1}	-0.146 (1.60)	-0.275 (2.53)	-0.207 (2.25)
$\Delta_4 \ln K_{t-1}$	1.339 (16.90)	0.808 (24.27)	0.737 (23.52)
$\Delta_4 \ln K_{t-2}$	-0.566 (8.15)		
$\Delta_4 \ln C_t$	0.380 (3.55)		0.342 (3.23)
$i_t - \pi_t^{e,a}$	-0.351 (2.81)	-1.035 (7.64)	-0.722 (5.96)
Constant	0.004 (0.54)	0.061 (5.11)	-0.038 (4.62)
D804		0.079 (4.24)	0.035 (2.60)
D902944	0.009 (1.92)	0.021 (3.38)	0.016 (3.55)
$\bar{R}^2$	0.964	0.935	0.944
DW statistics	2.32	2.20	1.55

Estimation period: 1975:1 - 1994:4; K: consumer credits, C: private consumption, YV*: disposable income (corrected), real and per capita in each case; i: interest rate on current account credits, $ECT_{t-1} = \sum_{i=1,4}(\ln C_{t-i} - \ln YV^*_{t-i}) / 4$; $\pi^{e,a}$: expected inflation rate given adaptive expectation with α=0.2; D804: dummy variable for fourth quarter of 1980; D902944: dummy variable=1 from second quarter of 1990. t-values in brackets.

Since the results of the Income and Expenditure Survey show that the majority of consumer credits are raised for acquiring cars and household appliances, it might be assumed that these purposes of use display a close correlation with the demand for consumer credits. The study carried out by Wenke (1993), which uses an in-depth breakdown of groups of products, confirms this assumption. However, these correlations are blurred if the goods are combined to form groups. Thus, the estimated impact (measured by elasticity) of expenditure on goods of transport and communications on the demand for medium-term credits is not higher than the impact of the aggregate. Surprisingly, it was not possible to establish that expenditure on transport and communications has any significant impact on the demand for long-term consumer credits.

3 Relationship between consumer credits and private consumption

The previous section analysed the impact of private consumption on the demand for consumer credits. This showed, firstly, that changes in private consumption have a positive effect on the growth rate of consumer credits. Secondly, a consumption level which is too high in comparison with income has a restraining effect on the credit demand. This relationship was interpreted to mean that households adjust their consumption to changes in their income situation and reduce their credit demand accordingly, either because the share of durable consumer goods (financed by credits) is reduced or because the gap between consumption and income thereby becomes smaller and the necessity to borrow becomes less urgent as a result. Since borrowing increases the financial resources available for consumption purposes, credits, in turn, might influence private consumption. Accordingly, the change in consumer credits would have to be included in the aggregated consumption functions as an additional regressor, for example.

If consumer credits are included in the consumption function, the following interdependent two-equation-system appears for the simultaneous explanation of private consumption (C) and consumer credits (K) (see also Wenke, 1993):

$$C = f_1(K, i^l, \ldots) \qquad \text{and} \qquad K = f_2(C, i^k, \ldots)$$

This system of equations contains two interest rates, i^k and i^l, as explanatory variables; the interest rate in the credit demand function measures the costs of borrowing, whereas the interest rate in the consumption equation captures the opportunity costs. For the empirical implementation, consumption function (a) from table 9 was expanded by including the change rate of medium-term and long-term consumer credits. The specification of the credit demand functions has been taken over from the previous section.

The estimations for this system of equations have been compiled in table 20. The parameters were estimated by three-stage least squares. The explanatory power of the consumption function increases if consumer credits are included as an additional regressor, although the coefficient, given an estimated elasticity of just under 0.05 %, is statistically significant only at the 10 % level. In this consumption function the semi-interest-rate elasticity decreases slightly from 0.28 to 0.23 by including credits as an additional regressor. Both phenomena allow the following interpretations. The semi-interest-rate elasticities shown in the error correction models of the third chapter reflect not only the importance of interest rates for the allocation of disposable income between consumption and savings but also capture the impact of interest rates which affects consumption through the credit demand of households. By including the credit variables, these two effects can be separated. However, this approach has the drawback that credit and interest rate are highly correlated with each other, which may result in insignificant parameters if both variables are included in the consumption function as explanatory variables.

Table 20: System estimation of credit demand and private consumption

Explanatory variables	Consumption function Dep. variable: $\Delta_4 \ln C_t$		Credit demand function Dep. variable: $\Delta_4 \ln K_t$	
$\Sigma (\ln C - \ln YV^*)_{t-i}$	-0.252	(3.81)	-0.210	(2.39)
$\Delta_4 \ln C_t$			0.331	(3.27)
$\Delta_4 \ln C_{t-1}$	0.312	(2.91)		
$\Delta_4 \ln K_t$	0.048	(1.79)		
$\Delta_4 \ln K_{t-1}$			0.739	(24.69)
$\Delta_4 \ln YV^*_t$	0.601	(8.42)		
$\Delta_4 \ln YV^*_{t-1}$	-0.306	(3.35)		
$i_t^l - \pi_t^{e,a}$	-0.231	(2.42)		
$i_t^k - \pi_t^{e,a}$			-0.725	(6.26)
Constant	-0.010	(1.96)	-0.039	(4.84)
$\bar{R}^2$	0.773		0.944	
DW statistics	1.99		1.65	

Estimation period: 1975:1-1994:4; estimation with 3SLS, credit demand function contains two additional dummy variables (see table 19): K: medium and long-term credits; i^l: yield on public bonds outstanding; i^k: interest rate on current account credits. t-values in brackets.

V Interest rates, investment income and private consumption

1 Trends in private financial assets and investment income

We have seen that disposable income is a major determinant for explaining private consumption. Investment income is a component of disposable income which becomes increasingly important over time. Interest rate changes, lead *ceteris paribus* to a change in investment income, which, in accordance with the elasticity of consumption with regard to investment income, is reflected in a positive correlation between interest rates and private consumption. In this chapter, an attempt will be made to estimate this effect in quantitative terms.

The gross financial assets of households have increased much more sharply than disposable income over the past 30 years. Whereas the assets-income ratio was about 1 in the sixties, at the beginning of the nineties assets were twice as high as income. Hence, the share of investment income in the disposable income of households rose as well.[12] Whereas this share came to no more than just over 5 % in 1970, in 1992 every tenth D-Mark of disposable income stemmed from financial assets (table 21). However, it must be borne in mind that investment income is shown in the national accounts before deduction of direct taxes (Dorow, 1974).

There have been considerable shifts within the category of financial assets. For example, whereas savings deposits accounted for around two-fifth of financial assets at the end of 1970, their share had declined to less than 20 % by 1992 (table 22). On the other hand, there was a disproportionate increase in time deposits (including savings bonds) and in debt securities. Between 1970 and 1992 the share of time deposits almost quadrupled, and the share of debt securities almost tripled. These shifts from savings deposits, which generally bear low rates of interest, to components which bear higher interest rates can also be interpreted to mean that households are becoming increasingly aware of yield aspects when compiling their portfolios.

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[12] In the definition used for the national accounts, investment income also contains net rent and income from licences, patents, etc. (Dorow 1974). This income came to just over DM 2 billion in 1988, or roughly 2 % of investment income, income from licences and rents being appreciably less than DM 1 billion (Schüler and Spies 1991).

Table 21: Trends in investment income

Year	Gross financial assets at market prices in DM billion	Disposable income in DM billion	Investment income in DM billion	Investment income as % of disposable income
1970	524.3	432.3	23.4	5.4
1975	962.9	696.2	41.1	5.9
1980	1483.5	975.0	73.0	7.5
1985	2214.7	1188.2	109.4	9.2
1990	3005.2	1548.4	152.4	9.8
1992	3551.5	1785.3	186.8	10.5

Sources: Deutsche Bundesbank (1994): Results of financial accounts for western Germany, 1960 to 1992; Federal Statistical Office: Subject-Matter Series 18, Series 1.3.

A comparison of the yield on financial assets, calculated implicitly from financial assets (of the previous year) and investment income, with the yield on public bonds outstanding reveals a parallel movement of these two variables (see chart 7). The fluctuations of the yield on financial assets are perceptibly lower than those of the yield on bonds outstanding, since households do not shift their total assets in the case of market rate changes. The spread between the yield on bonds outstanding and the yield on financial assets declined nevertheless, which also corroberates the hypothesis that households' investment strategy has become increasingly more yield-conscious.

Chart 7: Yield on financial assets and yield on public bonds outstanding

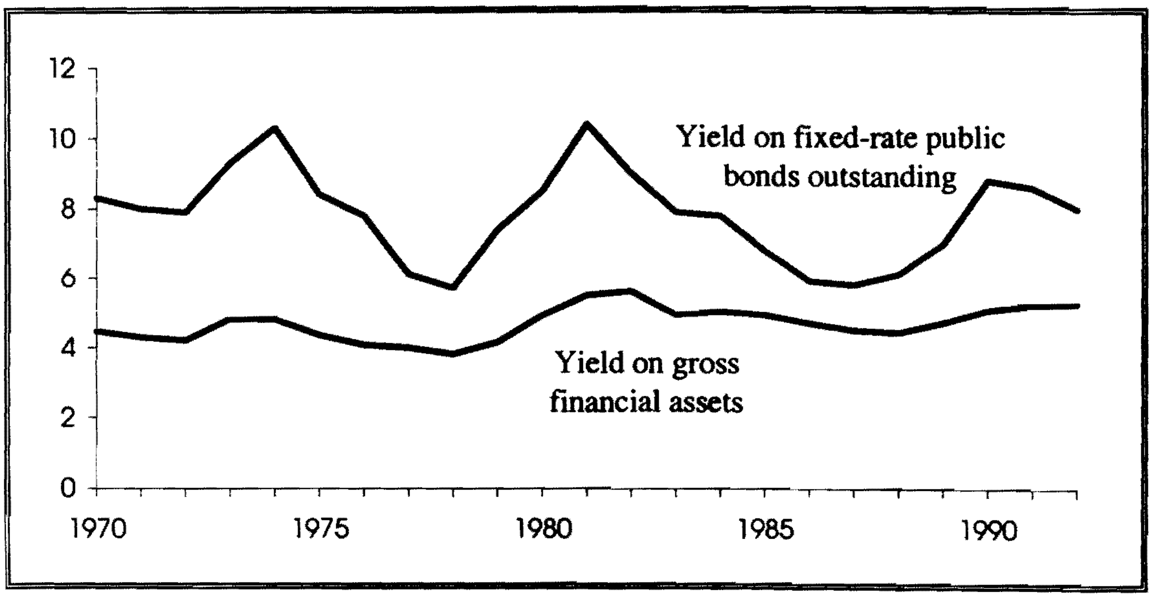

Table 22: Structure of households' gross financial assets (shares in %)

Year	Financial assets at banks							Financial assets at		Financial assets in		Other assets
	Cash and sight deposits	Time deposits (incl. savings bonds)			Savings deposits			Building associations	Insurance enterprices	Debt securities	Shares	
		Total	short-term	long-term	Total	at statutory notice	at agreed notice					
1970	10.6	2.7	1.5	1.2	39.1	23.1	16.0	7.5	14.8	7.7	11.3	6.2
1971	10.6	3.1	1.6	1.5	39.2	22.8	16.4	7.6	14.8	8.1	10.6	6.1
1972	10.5	3.8	2.0	1.8	39.1	22.1	17.0	7.7	14.8	8.3	9.9	6.0
1973	9.8	6.3	4.0	2.4	37.5	20.4	17.1	8.1	15.1	8.6	8.4	6.1
1974	9.6	7.0	4.2	2.7	37.9	21.2	16.7	8.1	15.4	8.8	6.9	6.4
1975	9.4	5.0	1.7	3.3	40.1	22.8	17.3	7.8	15.1	9.1	7.3	6.3
1976	9.1	5.4	1.5	3.9	39.4	22.6	16.8	7.6	15.2	10.7	6.3	6.4
1977	9.2	6.3	1.6	4.7	38.0	22.8	15.2	7.4	15.3	11.4	5.9	6.4
1978	9.4	6.9	1.8	5.1	37.3	22.7	14.6	7.4	15.8	10.5	6.0	6.7
1979	9.1	8.7	2.9	5.8	35.4	21.6	13.8	7.4	16.2	11.1	5.1	7.0
1980	8.6	10.6	4.1	6.4	33.2	20.6	12.7	7.3	16.6	11.5	4.8	7.5
1981	7.8	12.4	5.7	6.7	30.5	18.9	11.6	7.1	17.1	13.3	4.1	7.6
1982	7.6	12.3	5.6	6.7	29.9	19.0	10.9	6.7	17.4	14.3	4.0	7.7
1983	7.6	11.7	4.7	7.0	29.5	19.4	10.1	6.5	17.9	14.1	5.0	7.8
1984	7.3	11.8	4.6	7.2	28.3	18.6	9.7	6.0	18.3	15.4	5.1	7.8
1985	7.0	11.5	4.4	7.1	27.6	18.1	9.5	5.5	18.6	15.0	7.0	7.7
1986	7.1	11.3	4.2	7.1	27.9	18.3	9.6	5.1	19.2	13.9	7.6	7.8
1987	7.5	11.4	4.0	7.3	28.4	18.8	9.6	4.8	20.3	14.1	5.6	8.1
1988	7.8	10.5	3.6	6.9	27.1	18.4	8.7	4.5	20.6	15.0	6.5	8.0
1989	7.5	11.6	4.9	6.8	24.5	16.6	7.9	4.3	20.9	15.5	7.4	8.2
1990	7.7	12.8	5.9	6.9	22.6	15.0	7.6	4.1	21.3	16.7	6.4	8.5
1991	7.5	13.3	6.6	6.6	20.7	13.9	6.8	3.9	21.1	19.3	6.0	8.3
1992	8.0	13.2	7.1	6.1	19.4	13.1	6.4	3.7	21.2	20.9	5.2	8.4

2 Interest rates and investment income

This section analyses the relationship between interest rates and households' financial assets income. There is the following definitional equation between (nominal) financial assets income (YGV^n), financial assets yield (ig) and (nominal) gross financial assets (A^n):

$$(1) \qquad YGV_t^n = ig_t \cdot A_{t-1}^n$$

This equation can hence be used to derive the yield on financial assets implicitly from the empirically measured financial assets income and the empirically measured gross financial assets portfolios. For estimating the responsiveness of investment income to market rate changes, the implicit yield on financial assets, defined in equation (1), is represented as a function of the market interest rates, the structure of the portfolio also having to be taken into consideration.

In a first step, a hypothetical yield on financial assets (ih) is constructed for this purpose, which is a function of different market interest rates and of the structure of households' financial assets. In a second step, the empirical yield on financial assets (ig) is regressed on this hypothetical variable. The hypothetical yield on assets proposed here is defined as:

$$(2) \qquad ih_t = a_{t-1}^{se} \cdot i_t^{se} + a_{t-1}^{tk} \cdot i_t^{tk} + a_{t-1}^{tl} \cdot \sum_{j=0}^{k_1} q_{1j} \cdot i_{t-j}^{tl} + a_{t-1}^{wp} \cdot \sum_{j=0}^{k_2} q_{2,j} \cdot i_{t-j}^{wp}$$

In this equation, a^{se} designates the share of savings deposits, a^{tk} the share of short-term time deposits, a^{tl} the share of long-term time deposits, and a^{wp} the share of debt securities in the gross financial assets of households. Furthermore, in this equation, i^{se} designates the interest rate on savings deposits, i^{tk} the interest rate on short-term time deposits, i^{tl} the interest rate on savings bonds, and i^{wp} the yield on public bonds outstanding. In addition, this equation takes into consideration the fact that a major part of longer-term investment bears a fixed interest rate. For that reason, the calculation also includes the long-term interest rates of the previous periods. It is assumed that the age structure of the portfolio of longer-term time deposits and debt securities can be described by a geometrical lag distribution, where the average "age" of the time deposits and savings bonds is two years and the average "age" of the debt securities is five years. The weights q_1 or q_2 are calculated, therefore, using

$$(3) \qquad q_{1,j} = \frac{\theta_1 \cdot (1-\theta_1)^j}{1-(1-\theta_1)^{k_1+1}} \qquad \text{and} \qquad q_{2,j} = \frac{\theta_2 \cdot (1-\theta_2)^j}{1-(1-\theta_2)^{k_2+1}}$$

The assumptions concerning the average "age" result in the following values, if quarterly data for θ_1 and θ_2 are used: θ_1=0.12 and θ_2=0.05. The summation limits are defined as k_1=20 or k_2=40, which means that longer-term time deposits and savings bonds are included in the calculation only up to the age of five years and that the maximum age of the fixed-rate bonds considered here is ten years.

The following estimated values are calculated on the basis of the quarterly data for the period 1975-92:

$$(4) \qquad ig_t = \underset{(4.38)}{0.963} + \underset{(4.69)}{0.558} \cdot ih_t + \underset{(4.16)}{0.455} \cdot ig_{t-1}$$

$$\overline{R}^2 = 0.915 \qquad DW = 1.08$$

The estimation has a high explanatory power, although the Durbon Watson statistic suggest autocorrelation in the residuals. But alternative specifications did not lead to any improvement in these statistics either. The approach of adding a first-order autoregressive specification of the error process to the regression model, which is often found in the literature in such a case (using, for example, the procedure developed by Cochrane and Orcutt (1949)), without this being supported on any theoretical grounds, was not adopted for more general considerations (see particularly Mizon, 1995).

The estimated parameters have the theoretically expected operational signs and magnitudes. If the structure of gross financial assets in 1992 is taken as a basis, the financial assets yield, according to this equation, would increase by one-half percentage point over the longer term given an increase of one percentage point in all market rates. The constant covers, inter alia, the proceeds of other interest-bearing paper, which were not taken into consideration here and whose yields over time fluctuate far less, such as interest credited on sight deposits and financial assets invested in building associations and insurance companies.

To what extent are market rate changes reflected in financial assets income? Taking the structure of 1992 as a basis again, the assumed increase in all market rates of one percentage point would raise financial assets income by DM 18 billion per year, or just under 10 %, over the longer term. The disposable income of households would then rise by 1 %, and there would also be a perceptible increase in private consumption. These figures show that the contractionary effects of higher interest rates are accompanied by an expansionary stimulus arising from the higher investment income which should not be disregarded.

VI Simulation studies

The previous chapters analysed different channels through which interest rates can exert an influence on private consumption, in particular, the impact of interest rate changes on demand for consumer credits and the importance of the interest rate level for investment income. Additional influence factors, above all, the influence of interest rates on the breakdown of current income into consumption and savings, were accommodated in the consumption function through an interest rate variable. The aim of this chapter is both to quantify the individual effects over time and to estimate the overall effect of interest rate changes on private consumption. It would seem reasonable to use models simulation instruments for this purpose, which allow, in particular, a formal breakdown of the interest rate impact into its individual components.

The econometric model comprises a consumption function, a credit demand function and a function for explaining the yield on private financial assets. The model is augmented by a number of definitorial equations, such as those for disposable income and for households' financial assets. In this model, interest rate changes affect disposable income via investment income. Changes in the financial assets portfolio due to interest rate variations are also taken into consideration by including a definitorial equation for financial assets. Table 23 provides a summary of the model's equations. The advantage of an analysis using this model, compared with a study which uses a macroeconometric model for the whole economy, is that it includes only the effects of interest rate changes on private consumption, which are to be counted among the decision-making factors of households. Other effects, such as potential effects on employment with matching implications for wage income, are deliberately disregarded in this way. In the simulation, the impact of interest rate shocks on price trends is also disregarded.

Table 23: The econometric model

1. **Private consumption, real**

$$\Delta_4 \ln C_t = \beta_{10} + \beta_{11} \sum\nolimits_{i=1,4} (\ln C_{t-i} - \ln YV^*_{t-i}) / 4 + \beta_{12} \Delta_4 \ln C_{t-1} + \beta_{13} \Delta_4 \ln K_t$$
$$+ \beta_{14} \Delta_4 \ln YV^*_t + \beta_{15} \Delta_4 \ln YV^*_{t-1} + \beta_{16} \left(i^{wp}_t - \pi^{e,a}_t \right)$$

2. **Consumer credits, real**

$$\Delta_4 \ln K_t = \beta_{20} + \beta_{21} \sum\nolimits_{i=1,4} (\ln C_{t-i} - \ln YV^*_{t-i}) / 4 + \beta_{22} \Delta_4 \ln K_{t-1} + \beta_{23} \Delta_4 \ln C_t$$
$$+ \beta_{24} \left(i^k_t - \pi^{e,a}_t \right) + \beta_{25} DUM804_t + \beta_{26} DUM902944_t$$

3. **Yield on financial assets**

$$ig_t = \beta_{30} + \beta_{31}\, ih_t + \beta_{32}\, ig_{t-1}$$

4. **Hypothetical yield on financial assets**

$$ih_t = a^{se}_{t-1} \cdot i^{se}_t + a^{tk}_{t-1} \cdot i^{tk}_t + a^{tl}_{t-1} \cdot \sum_{j=0}^{k_1} q_{1j} \cdot i^{tl}_{t-j} + a^{wp}_{t-1} \cdot \sum_{j=0}^{k_2} q_{2,j} \cdot i^{wp}_{t-j}$$

5. **Financial assets income, nominal**

$$YGV^n_t = ig_t \cdot A^n_{t-1} \cdot 0{,}25$$

6. **Financial assets, nominal**

$$A^n_t = A^n_{t-1} + \left(P_t \cdot Y_t + YGV^n_t - P_t \cdot C_t \right)$$

7. **Disposable income, real**

$$YV^*_t = Y_t + YGV^n_t / P_t - \pi^{e,a}_t \cdot \left(A^n_{t-1} / P_{t-1} \right)$$

Exogenous variables

Y	Non-investment income, real
P	Deflator of private consumption
$\pi^{e.a}$	Expected inflation rate
a	Shares of households' financial assets (se: saving deposits, tk: short-term time deposits including savings bonds, tl: long-term time deposits including savings bonds, wp: debt securities)
i	Nominal interest rate (wp: yield on public bonds outstanding, k: rate for current account credits, se: rate on savings deposits, tk: rate on short-term time deposits,. tl: rate on savings bonds)
q	Weights, see equation (3) in chapter V.

Parameter estimation values

See table 20 and equation (4) in chapter V.

In the simulation study, it is assumed that a temporary shock has an effect on the (nominal) interest rate level. After one year, the interest rates return to their level arising from the basic simulation. Since different interest rate variables are included in the model, which were characterised in the past both by different levels and by a differing variability, the changes in the individual interest rates triggered by the hypothetical shock were "normalised". The simulation experiment assumes that for the period of one year the yield on public bonds outstanding is one percentage point, the interest rate for current account credits 1.67 percentage points, the interest rate for savings accounts 0.70 percentage point, the short-term time deposits 1.5 percentage points and the interest for savings bonds 1 percentage point above the figure yielded by the reference simulation. The effects of this shock on private consumption can be described by the deviations from the basic simulation.

The results of this simulation study are summarised in table 24. The overall effect of temporary interest rate changes on private consumption was additionally broken down into three components. The "direct impact" comprises those effects which result from a variation of the interest rate variable i^{wp} in the consumption function. The credit cost channel indicates the effects on private consumption, which result from a change of the interest rate for current account credits in the credit demand function. Finally, the investment income channel comprises the impact of interest rate changes on private consumption, which operates through the yield on financial assets and the changes which this brings about in financial assets income and disposable income.

According to the simulation study, the consumption level given a one-year interest rate shock, would be lower for four years than in a situation where no interest rate shock had occurred. Following this, there would, however, be slight expansionary effects for some years. This is because financial assets from the year in which higher interest rates applied have higher proceeds in the following years as well. Over time, however, this effect would wane; in line with the long-run relation between consumption and disposable income which is integrated into the model and the hypothesis that temporary interest rate variations do not have any longer-term effects, this would result in households' consumption expenditure returning to the level of the basic simulation over the long run.

In respect of the contractionary effects of higher interest rates, in the year of the interest rate shock the "direct impact" outweights the effects arising from the higher credit costs. In the following years, the credit cost channel would then predominate. What it is not very plausible is that the deviations from the basic solution should be greater for this transmission channel in the second year than in the year of the interest rate shock. Instead of such a time pattern, which is formally a result of the lag structure in the consumption and in the credit demand function, it would have been to be expected that the restraining effects on private consumption are most pronounced in the first year owing to the higher credit costs.

Table 24: Effects of a temporary interest rate shock on private consumption

Year	Effect through			total effect
	direct impact	credit costs	investment income	
1	- 0.27	- 0.14	0.23	- 0.18
2	- 0.21	- 0.21	0.19	- 0.23
3	- 0.13	- 0.17	0.15	- 0.14
4	- 0.07	- 0.11	0.12	- 0.05
5	- 0.03	- 0.06	0.10	0.00
6	- 0.01	- 0.03	0.07	0.03
7	0	- 0.01	0.06	0.04

Interest rate shock in year 1; deviation of real private consumption from the basic solution in %.

According to the simulation study, a consumption level that is approximately 0.4 % lower in comparison with the reference trend is to be expected in the first two years on account of the two contractionary effects. It must be borne in mind, however, that about one-half of this retarding impact on consumption is offset by the changed investment income. On balance, therefore, the short-term semi-interest rate elasticity of private consumption is likely to about 0.2 %. It was largely possible to confirm these results by means of simulations using alternative models which contained other specifications of the consumption function, but in some cases the overall effects were lower (between 0.1 % and 0.15 %).

The simulation studies make it clear that the responsiveness of private consumption in Germany to interest rate changes has been overestimated on the basis of the estimated semi-interest-rate elasticities of the consumption function - even taking into consideration the interest rate effects arising from the raising of consumer credits. This is because an important aspect, i.e. the impact of interest rates on financial assets income, was not taken into account. It is likely that this channel will gain even greater importance in future, as the share of investment income in disposable income increases.

VII Summary and conclusion

In Germany, interest rates play only a secondary role in explaining the development of private consumption. According to the estimations and simulation studies presented in this paper, the semi-interest-rate elasticity is probably about 0.2 if the income effect is taken into consideration. The simulation studies indicate that the substitution effect exceeds the income effect in the first few years after an interest rate shock. The substitution effects persist for a longer time than the income effects, however, with the overall result that there are, in fact, slightly positive interest rate effects on private consumption after a few years.

Stationarity tests and unit root tests suggest that interest rates in Germany - both in nominal and in real terms - are stationary variables, whereas private consumption has a stochastic trend. Accordingly, interest rates can influence only the short-run dynamics of consumption; the long-term trend of private consumption is determined by other variables. Thus, private saving, too, as a mirror image of private consumption, is not interest-rate-elastic over the long term.

In particular, it was not possible to establish a value significantly different from zero for the intertemporal elasticity of substitution. However, the conclusion should not be drawn from this that intertemporal substitution has no relevance for consumption in Germany. Rather, an analysis of this question should be based on microeconomic data, as has been shown by studies for other countries. Using macroeconomic consumption functions, values between 0.2 and 0.4 were established for the short-term semi-interest-rate elasticity. However, it has to be borne in mind that these figures capture only the substitution effects but fail to cover the income impact which operates in the opposite direction; an impact which offsets a considerable part of the substitution effect. A major part of the substitution effects of interest rate changes is probably effected through changed credit costs, since the demand for consumer credits responds highly sensitively to interest rate changes.

The analysis of disaggregated private consumption has shown that expenditure on transport and communications are the components of private consumption which are particularly responsive to interest rate changes. Furthermore, negative interest rate effects could also be shown for expenditure on education, entertainment and leisure, and for the demand for personal goods. The results for the demand for household appliances, on the other hand, were not clear-cut. The examination of the groups of goods classified by durability showed an influence of real interest rates only for durable consumer goods - which should be interpreted with a certain amount of caution, however, owing to the shortness of the observation period; the interest rate impact "disappeared" for some years (1986 and at the beginning of the nineties).

The results of the disaggregated analysis are corroberated by figures from the Income and Expenditure Survey, according to which a major part of consumer credits are raised for acquiring motor vehicles, furniture and making other purchases. The increasing preference for longer-term obligations probably tended to result in households becoming less and less responsive over time to short-term interest rate fluctuations. However, this is offset by the households' higher indebtednes in terms of consumer credits in relationship to disposable income.

For monetary policy, the empirical results presented in this paper permit the conclusion that a change in central bank interest rates is not an appropriate instrument for stimulating or restraining the level of private consumption. This is true in view of the comparatively low overall responsiveness to interest rate changes alone; moreover, this largely relates to longer-term interest rates, for which it is by no means certain that the direction, let alone the scale, of their movements are in line with short-term interest rates, which are largely determined by the central bank.

It has not been possible in this paper to describe in appropriate detail all the aspects which are of relevance for the relationship between interest rates and private consumption. We have already mentioned the possibility of augmentation with cohort or micro data analyses, with which due account can be taken of the heterogeneity of economic agents and of the unequal distribution of income and assets (Fortin, 1995, Jappelli, 1995). The demand of households for residential property would undoubtedly also be a rewarding avenue of research. In contrast to our approach and the sector definition of the national accounts, this would have to include residential property in both the utility function and the budget constraint of households (Miles, 1992, Pain and Westaway, 1994). Finally, from a methodological point of view, the application of more recent econometric procedures should be considered, such as the inclusion of seasonal cointegration relationships in the estimations (Boswijk and Franses, 1995, Franses and Paap, 1995, Harvey and Scott, 1994). Dealing with these subjects will be a matter for future research activity.

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Annex: Stationarity tests

Stationarity tests test the null hypothesis that a time series can be interpreted as the realisation of a stationary stochastic process against the alternative hypothesis that the characteristic polynomial of the data-generating process has a unit root. The null hypothesis and the alternative hypothesis are thus interchanged in comparison with the ADF tests. Test statistics on the stationarity hypothesis were developed, inter alia, by Kwiatkowski, Phillips, Schmidt and Shin (1992), and by Bierens and Guo (1993).

The KPSS test by Kwiatkowski, Phillips, Schmidt and Shin, in its simplified variant, assumes that the time series y consists of the sum total of a random walk (r) and a stationary error (ε):

(A1.1) $$y_t = r_t + \varepsilon_t$$

(A1.2) $$r_t = r_{t-1} + u_t$$

Let the random variables u_t be iid$(0,\sigma_u^2)$. In this model, the stationarity hypothesis is equivalent to $\sigma_u^2 = 0$. For constructing the test statistic, the partial sums S_t of $e_t = y_t - \bar{y}$ are needed:

(A1.3) $$S_t = \sum_{i=1}^{t} e_i$$

A consistent estimator for the "long-run variance"

(A1.4) $$\sigma^2 = \lim_{T\to\infty} T^{-1} E\left(S_T^2\right)$$

is given by

(A1.5) $$s^2(k) = \frac{1}{T}\sum_{t=1}^{T} e_t^2 + \frac{2}{T}\sum_{s=1}^{k} w(s,k) \sum_{t=s+1}^{T} e_t e_{t-s}$$

In which w(s,k) is a weighting function. For w Kwiatkowski et al. propose the Bartlett window: w(s,k) = 1- s/(k+1). By including the second summand in (A1.5), quite general forms of the temporal dependence of the process e can be admitted. For the consistency of

$s^2(k)$, it is necessary, however, for k to grow along with the growing size of the sample, e.g. $k = o(\sqrt{T})$. The KPSS test statistic is defined as:

(A1.6) $$\hat{\eta} = \frac{1}{T^2}\sum_{t=1}^{T} S_t^2 / s^2(k)$$

Under the null hypothesis, the test statistic converge to a Brownian bridge. As $\hat{\eta}$ is of the order $O_p(T/k)$ under the alternative hypothesis, the test is an upper tail test and the test statistic is, moreover, consistent.

For finite samples, the power of the test depends on the sample size (T) and the bandwidth k. In a simulation study, Kwiatkowski et al. show that if one assumes that e is a first-order autoregressive process with a positive autocorrelation, the null hypothesis for "small" k is wrongly rejected too frequently. On the other hand, a "too great" k impairs the power of the test. Kwiatkowski et al. propose the value $\lfloor 8(T/100)^{1/4} \rfloor$ for k, $\lfloor x \rfloor$ indicating the largest integer not greater than x. With the choice of k, the KPSS test thus contains a subjective element. It is therefore advisable to calculate the test statistics for different values of k.

The test statistics on the stationarity hypothesis developed by Bierens and Guo (1993) are free from subjective elements. Here we present two of the total of six test statistics. Bierens and Guo combine several estimators, the amounts of which measure the deviation from the stationarity hypothesis in such a way that they obtain test statistics whose distributions are asymptotically independent of the variance of the error process. Under the stationarity hypothesis, all the test statistics converge in distribution to a random variable which is distributed standard Cauchy.

The null hypothesis $y_t = \mu + u_t$ is tested against the alternative $\Delta y_t = u_t$, u_t being a strong mixing process. Let $\hat{\alpha}$ be the least squares estimator for α of the model $y_t = \mu + \alpha y_{t-1} + u_t$ and $\hat{\beta}$ the least squares estimator for β in the model $y_t = \mu + \beta t + v_t$. Furthermore define:

$$c = \sqrt{\frac{(T+1)T(T-1)}{12}}$$

$$\hat{\xi} = \frac{1}{T}\sum_{t=1}^{T} y_t - \frac{1}{\lfloor T/2 \rfloor}\sum_{t=1}^{\lfloor T/2 \rfloor} y_t$$

Using the transformations of the estimators

$$\hat{\gamma} = 2c\hat{\beta} - \sqrt{3T}\hat{\xi}$$

$$\hat{\zeta} = \left[1 - e^{-\left[\sqrt{T}(1-\hat{\alpha})\right]^4}\right]\sqrt{T}\hat{\xi} + e^{-\left[\sqrt{T}(1-\hat{\alpha})\right]^4} \cdot \frac{\hat{\gamma}}{T}$$

the test statistic (Cauchy test II) is defined as

(A1.7) $$S_2 = \frac{\hat{\gamma}}{\hat{\zeta}}$$

Under the stationarity hypothesis, S_2 has an asymptotic standard Cauchy distribution, under the alternative hypothesis, S_2/T converges in probability to 1:

(A1.8) $$\operatorname*{plim}_{T\to\infty} \frac{S_2}{T} = 1$$

The test is an upper tail test and the null hypothesis is rejected if S_2 exceeds a critical value.

For constructing Cauchy test III, an estimator is needed for the variance of the process u:

(A1.9) $$\hat{\sigma}_u^2 = \frac{1}{T-1}\sum_{t=2}^{T}(y_t - y_{t-1})^2$$

The test statistic of the Cauchy test III is defined as

(A1.10) $$S_3 = \frac{\hat{\gamma}}{\sqrt{T}\hat{\xi}}\left(1 + \frac{\hat{\xi}^2}{\hat{\sigma}_u^2}\right)$$

Under the null hypothesis, S_3 likewise converges in distribution to a standard Cauchy distributed random variable, under the alternative hypothesis, S_3/T converges in distribution to the product of two jointly normally distributed random variables. Test III is a two-sided test. According to Lob (1994), a non-symmetrical distribution of the critical mass increases the power of the test.

Simulation studies by Bierens and Guo (1993), and Lob (1994) showed that, given a finite sample size, test II has the tendency to reject the null hypothesis even if it is correct. By contrast, test III has the property of very frequently retaining the null hypothesis even if it is wrong. If test II retains the stationarity hypothesis, it can hence be assumed that the time series examined is actually stationary. If test III rejects the stationary hypothesis, the necessary degree of difference formation has not yet been achieved.

The following papers have so far been published:

May	1995	The Circulation of Deutsche Mark Abroad	Franz Seitz
June	1995	Methodology and technique for determining structural budget deficits	Gerhard Ziebarth
July	1995	The information content of derivatives for monetary policy – Implied volatilities and probabilities	Holger Neuhaus
August	1995	Das Produktionspotential in Ostdeutschland *	Thomas Westermann
February	1996	Sectoral disaggregation of German M3	Vicky Read
March	1996	Monetary aggregates with special reference to structural changes in the financial markets	Michael Scharnagl
March	1996	The impact of interest rates on private consumption in Germany	Hermann-Josef Hansen
May	1996	Market Reaction to Changes in German Official Interest Rates	Daniel C. Hardy
May	1996	The role of wealth in money demand	Dieter Gerdesmeier

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August	1996	Intergenerative Verteilungseffekte öffentlicher Haushalte – Theoretische Konzepte und empirischer Befund für die Bundesrepublik Deutschland *	Stephan Boll
August	1996	Der Einfluß des Wechselkurses auf die deutsche Handelsbilanz *	Jörg Clostermann
October	1996	Alternative specifications of the German term structure and its information content regarding inflation	Sebastian T. Schich
January	1997	Reserve Requirements and Economic Stabilization	Ulrich Bindseil

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