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MONEY AND STOCK RETURNS: IS THERE HABIT FORMATION FOR HOLDING LIQUID ASSETS

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ABSTRACT

Assuming a utility function, which is non-separable in money and consumption, we derive a simple, non-linear asset pricing model, according to which investors' willingness to hold liquid assets in their portfolio can be described by a sort of habit formation. The parameters of the empirical model derived from our theoretical model are estimated with the Smooth Transition Regression (STR) models for the US data. The results of our econometric exercise to test the hypothesis of habit formation remain mixed, but we find evidence, which supports some existing, related attempts to explain stock returns by the liquidity of the economy relative to investors' target level for liquidity.

KEY WORDS: asset pricing models, liquidity.

JEL Classification: E44, E51, G12.

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1. INTRODUCTION

Meltzer (1999), King (2002) and Nelson (2002, 2003), among others, have recently argued that there may be important channels other than the short-term interest rate through which monetary policy affects real activity. Thus, economists should reconsider the possibility that money may have a role in the transmission mechanism of monetary policy that is independent of the short term interest rate, since the monetary policy is likely to work by changing the relative prices of a wide range of assets and interest rates, as was also argued by Milton Friedman back in the 1970's.

The current economic theory does not seem to provide any unanimous evidence about the link from liquidity of the economy to asset returns, however. Monetary portfolio models, like those of Homa and Jaffee (1971) and Hamburger and Kochin (1972), for instance, assume that a shock in money supply leads investors to substitute money for other assets, when they try to reallocate their asset portfolios. Of course, if the stock markets are assumed to be efficient, then this kind of supply effects should not be present, as it is also commonly assumed in the traditional finance literature. There is, however, some recent empirical findings (reviewed eg by Shleifer (2000) that some supply effects can be found in the asset markets. Friedman (1970) and Nelson (2003) for instance, considered the case in which the households are not willing to acquire long-term securities without an equal increase in their money holdings. Congdon (2005) considers a case in which institutional investors have a constant target for their holdings of liquid assets from their total portfolios. Accordingly, changes in the degree of liquidity of the financial markets might be reflected in asset prices if

investors tend to reallocate their portfolios as a response in changes in the degree of liquidity of the markets.

The paper at hand contributes to the literature by considering a special case of consumer's utility maximization with non-separable utility for consumption and liquidity. The paper derives an empirically testable hypothesis for the relation between asset prices, consumption and liquidity. The reduced form model of the paper predicts, first, linear relationships from the growth rates of liquidity and consumption to asset returns. The sign of the effect of consumption growth is unambiguously positive with all theoretically acceptable parameter values. The sign of the linear impact of liquidity growth depend on the degree of relative risk aversion, but with the empirically plausible assumption that the risk aversion exceeds unity, it is positive as well. Secondly, analogously to the empirical models for habit formation in consumption, our model allows for a sort of habit formation for holding liquid assets, which is shown as a non-linear relationship from liquidity to asset returns if the share of liquid assets in investor's portfolio grows above its target ratio. The sign of the non-linear effect is unambiguously positive as well, if the relative risk aversion exceeds unity. Thus, the estimable model provides a theoretically motivated model to test the hypothesis that investors try to hold a constant share of their portfolio as liquid assets. In the empirical part of the paper, the hypothesis is tested by estimating a smooth transition regression (STR) model with the US data. The estimated econometric model is always used to discuss some results of the existing literature on the relationship between liquidity and asset prices.

2. THEORETICAL MODEL

Our theoretical framework stems from the consumption based asset pricing (CCAPM) framework, originally set up by Rubinstein (1976), Lucas (1978), Grossman and Shiller (1981) and Hansen and Singleton (1983). Whereas the CCAPM literature concentrates on explaining the asset returns by the changes of the marginal utility from consumption over time, our set-up focuses on the role of the liquidity as partly determining that utility. The utility from consumption is assumed to be non-separable in money so that the marginal utility from consumption partly depends on the level of utility the consumer derives from his money holdings. Thus, the interest rate that makes the marginal utilities between two periods equal becomes a function of consumer's money holdings. Moreover, in contrast with the bulk of previous empirical studies on the relationship between liquidity and asset returns is based on linear models, the parameters of the simple asset pricing equation derived from our theoretical model are estimated using nonlinear methodology, the Smooth Transition Regression (STR) models.[2]

A central feature in our modelling approach of the relationship between the utilities from consumption and liquidity is based on an idea of habit formation for holding liquid assets. The idea is analogous to the literature on habit formation for consumption, in which consumers slowly develop habit for higher or lower level of consumption, so that the habit is usually determined by the consumption history of the representative consumer. The lower has his consumption been in the recent past, *ceteris paribus*, the higher utility does he yield from

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[2] The methodological approach is actually highly analogous to that presented in Oikarinen and Kahra (2003), in which a consumption based capital asset pricing model, augmented by an assumption of consumers with habit formation for consumption, was used to model housing returns.

his consumption today. In our set-up, we abstract from the habit formation in consumption, however, and instead focus on the possible habit formation for holding liquid assets.

A natural approach for examining the habit formation in money holdings would be to start with the utility function of the form

$$\frac{\left[c_t^\alpha (m_t - x)^{1-\alpha}\right]^{1-\gamma}}{1-\gamma},$$

where x denotes the level of habit for the money holdings. With this specification, consumer's risk aversion would be driven by the level of his money holdings relative to the habit. Although estimating directly the parameters for the model above sounds appealing, it would be somewhat problematic because the level of the habit is an unobservable variable. In addition, our hypothesis is that investors' risk aversion depends on the relative proportion of the liquid assets in investor's portfolio, rather than the absolute level of his money holdings.

Thus, we abstract from the possible habit formation for the absolute level of the money holdings, but assume that the consumer develops a habit level for the share of his portfolio that she prefers to hold in liquid assets. It is assumed that consumer's portfolio consists both of yield-providing stocks and a liquid asset, which only provides liquidity services but no return. The utility that the consumer derives from his holding of liquid assets depends on the level of his money holdings relative to an exogenously determined constant level. Since the utility function is non-separable in money and consumption, consumer's utility from holding money affect the elasticity of the intertemporal substitution of consumption, and therefore, to the required return for holding assets in the way explained in more detail below. [3]

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[3] Considering the previous literature, consumer's willingness to hold a constant share of his portfolio as liquid assets could be rationalized eg by following Nelson's (2003) reasoning along with the arguments originally put forward by Friedman and Schwartz, that in addition to providing liquidity services, money may serve a precautionary purpose as a temporary adobe for purchasing power.

In the following, we proceed in a standard way by deriving an Euler equation for the optimal choice of consumption from the first order conditions for maximum in the consumer's problem. Consumer's utility function is assumed to be non-separable in consumption (c_t) and real money balances (m_t), and it is presented by Equation (1) below.

$$U(c_t, m_t) = \frac{(c_t^{\alpha} m_t^{1-\alpha})^{1-\gamma}}{1-\gamma}, \text{ where } 0 \le \alpha \le 1 \text{ and } 0 \le \gamma \le \infty. \tag{1}$$

In the utility function, the consumption and real money balances are first aggregated by a Cobb-Douglas function, which is then used as an argument in a power utility function. As shown by Feenstra (1986), a utility function that is non-separable in money and consumption explains the demand for both consumption and liquidity. The holding of liquidity in these models has the motives of transaction, precautionary and speculation.[4] Parameter γ in the utility function measures the relative risk aversion of the consumer.

Regarding consumer's periodical budget constraint, she maximises her future utility wrt to his future consumption and portfolio holdings, consisting of the common stock, which is assumed to be the only interest bearing asset available, and of consumer's holdings of real money balances. Thus, the budget constraint takes the form $q_t c_t + \boldsymbol{\alpha_t} \mathbf{P_t} = y_t + \boldsymbol{\alpha_{t-1}} \mathbf{P_{t-1}}$. That is, at period t the consumer has an external income y_t and a portfolio of assets $\mathbf{P_t}$, the allocation $\boldsymbol{\alpha_t}$ of which has been decided in the previous period. The consumer may use his

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[4] Kahra (2004) provides GMM estimates for the parameters of specification (1.) with the US data.

resources to by composite consumption good c_t with price q_t and to investment in a new asset portfolio.

From the first order conditions for the optimal choice of c_t, we obtain the Euler equation, which says that marginal utilities between dates t and $t+1$ should be equal. The Euler equation can be stated in the form

$$1 = E_t \left[\frac{p_{t+1}}{p_t} \frac{q_t}{q_{t+1}} \frac{\beta c_{t+1}^{(\alpha-1)(1-\gamma)-\gamma} m_{t+1}^{(1-\gamma)(1-\alpha)}}{c_t^{(\alpha-1)(1-\gamma)-\gamma} m_t^{(1-\gamma)(1-\alpha)}} \right], \text{ where} \qquad (2)$$

the price of common stock at period t is denoted by p_t.

With the utility function non-separable in consumption and real balances, consumption and liquidity are substitutes for the consumer. Thus, the marginal utility from adding one unit of either consumption or liquidity depends on the combined holdings of both consumption and liquidity. Whether the marginal utility of consumption is decreasing or increasing function of the money balances, depends on the value of γ, the measure of relative risk aversion. If $\gamma > 1$ ($\gamma < 1$), marginal utility of consumption is decreasing (increasing) in the money holdings. In the following we only consider the case of $\gamma > 1$, which seems to be given most empirical support (see eg Meyer and Meyer 2005). Thus, the more the consumer holds liquid balances in our model, the lower is the marginal utility of consumption at a given level of consumption. Accordingly, assuming a growing path for consumption, the elasticity of intertemporal rate of substitution between consumption between dates t+1 and t becomes a decreasing function of the growth rate of the real balances.

More precisely, consumer's holdings of liquid balances affect the marginal utilities of consumption at periods t and t+1 in Eq (2) by the factor $\dfrac{m_{t+1}^{(1-\gamma)(1-\alpha)}}{m_t^{(1-\gamma)(1-\alpha)}}$. Thus, we can introduce habit formation to the model by explicitly modelling the dynamics of γ in $\dfrac{m_{t+1}^{(1-\gamma)(1-\alpha)}}{m_t^{(1-\gamma)(1-\alpha)}}$ as depending on the liquidity position of the consumer.

We start by writing the Euler equation above in the form of Eq. (3.) below.

$$1 = E_t \left[\frac{p_{t+1}}{p_t} \frac{q_t}{q_{t+1}} \frac{\beta c_{t+1}^{(\alpha-1)(1-\gamma_1)-\gamma_1} m_{t+1}^{(1-\gamma_1-\gamma_2 G(*))(1-\alpha)}}{c_t^{(\alpha-1)(1-\gamma_1)-\gamma_1} m_t^{(1-\gamma_1-\gamma_2 G(*))(1-\alpha)}} \right] \qquad (3.)$$

The effect of liquid balances to marginal utilities of consumption at periods t and t+1 in Equation (3) is now captured by $\dfrac{m_{t+1}^{(1-\gamma_1-\gamma_2 G(*))(1-\alpha)}}{m_t^{(1-\gamma_1-\gamma_2 G(*))(1-\alpha)}}$, where $\gamma_2 > 0$ and $G(*)$ is an increasing function of the share of liquid assets in consumer's portfolio, relative to the target level for that ratio. The exact functional form of $G(*)$ will be specified in more detail below. Note that only the contribution of liquid balances on the marginal utility from consumption is assumed to depend on the value of $G(*)$, however, whereas the own contribution of consumption on the marginal utility in Eq. (2), denoted by ($\dfrac{c_{t+1}^{(\alpha-1)(1-\gamma)-\gamma}}{c_t^{(\alpha-1)(1-\gamma)-\gamma}}$), remains unchanged.

In line with the idea of habit formation, it is assumed that $\gamma_2 > 0$. As $\gamma_2 G(*)$ is increasing in the share of liquid assets compared to his habit level, the total value of the measure for the relative risk aversion (γ) is increasing in that share. More intuitively, a higher level of liquidity, relative to consumer's habit level of liquidity implies a higher combined level of

utility from consumption and liquidity, given the level of consumption. Accordingly, the higher is the share of liquid assets in consumer's portfolio, the smaller is the marginal utility from an additional unit of consumption. Thus, the elasticity of intertemporal substitution substitution between dates t+1 and t consumption decreases and a higher expected stock return is needed to satisfy the Euler equation for optimal consumption. From this reasoning, it follows that the asset return should be non-linearly increasing in real money balances.

For our empirical application of testing the theoretical hypothesis outlined above, we need a more easily estimable equation than the Euler equations above. Thus, we start by writing Equation (3.) in logarithmic form:

$$1 = E_t\left[\beta\exp(\log\frac{p_{t+1}}{p_t} - \log\frac{q_{t+1}}{q_t} + [(\alpha-1)(1-\gamma_1)-\gamma_1]\log(\frac{c_{t+1}}{c_t}) + (1-\alpha)(1-\gamma_1-\gamma_2 G)\log(\frac{m_{t+1}}{m_t}))\right]$$
$$(4)$$

Assuming that the growth rates of the asset prices and real money balances follow conditional log-normal distribution, we may use the rule $E[\exp(X)] = \exp\left[E(X) + \frac{1}{2}V(X)\right]$ to get, after taking logarithms:

$$E_t\left[\log\frac{p_{t+1}}{p_t}\right] = -\log\beta + \exp\left\{E_t\left[\log\frac{q_{t+1}}{q_t} - [(\alpha-1)(1-\gamma_1)-\gamma_1]\log(\frac{c_{t+1}}{c_t}) - [(1-\alpha)(1-\gamma_1-\gamma_2 G)]\log(\frac{m_{t+1}}{m_t})\right] - \right.$$
$$\left.\frac{1}{2}V_t\left[(\log\frac{p_{t+1}}{p_t} - \log\frac{q_{t+1}}{q_t} + [(\alpha-1)(1-\gamma_1)-\gamma_1]\log(\frac{c_{t+1}}{c_t}) + [(1-\alpha)(1-\gamma_1-\gamma_2 G)]\log(\frac{m_{t+1}}{m_t}))\right]\right\}$$

(5)

Finally, denoting the real return of the asset i ($\log \dfrac{p_{t+1}^{j}}{p_{t}^{j}} - \log \dfrac{q_{t+1}}{q_{t}}$) by R_{t+1}^{j}, ($\log \dfrac{m_{t+1}}{m_{t}}$) by

Δm_{t+1} and ($\log \dfrac{c_{t+1}}{c_{t}}$) by Δc_{t+1}, we may specify our model as a mixture of an ARCH-M model

(since the last RHS term is -½ times the variance) and a smooth transition (STR) model for

the expected returns for asset i:

$$R_{t+1} = -\log \beta + b_1 \Delta m_{t+1} + d \Delta c_{t+1} + (b_2 \Delta m_{t+1}) G(\varphi, r; s_{t+1}) - \frac{1}{2}\sigma_t^2 \qquad (6),$$

where $b_1 = (\alpha - 1)(1 - \gamma_1)$, $b_2 = (1 - \alpha)\gamma_2$, and $d = (1 - \alpha)(1 - \gamma_1) + \gamma_1$.

Signs of the linear regression coefficients b_1 and d depend on the values of the structural

parameters of the utility function, so that b_1 is negative (positive) if $0 \le \gamma_1 \le 1$ ($\gamma_1 \ge 1$), and d

is positive for all theoretically plausible values for α and γ_1. If our assumption of habit

formation holds, the non-linear coefficient b_2 should be positive.

As already noted, the value of γ in the factor $\dfrac{m_{t+1}^{(1-\gamma)(1-\alpha)}}{m_{t}^{(1-\gamma)(1-\alpha)}}$ may vary between γ_1 and $\gamma_1 + \gamma_2$,

depending on the value of $G(*)$. The structural parameters γ_1, γ_2 and α can be easily

identified from the estimated values for b_1, b_2 and d. The linear part of γ, that is, γ_1, which

alone determines the contribution of consumption to the marginal utility of consumption, is

obtained from $\gamma_1 = b_1 + d$. The non-linear part of γ, which is assumed to only affect the

utility from liquidity services, is simply given by $\gamma_2 G(*) = \dfrac{b_2}{1 - \alpha} G(*)$. In calculating the

value of parameter α, which tells the relative weight between consumption and monetary

services in the utility function, we impose the restriction that α is determined purely by the

linear part of the model. This makes it possible to identify the value of $\gamma_2 G(*)$. Thus, the

value of α is given by $\alpha = \dfrac{1-d}{1-d-b_1}$.

The transition function $G(\varphi, r; s_t)$ is assumed to be of the logistic form of

$G(\varphi, r; s_t) = \{1 + \exp[-\varphi(s_t - r)]\}^{-1}$, where r is the threshold value for the transition variable

s_t. As noted, the more the value of the transition variable exceeds its threshold value, the

larger grows the transition function G(*), the value of which is limited between 0 and 1,

however.

The transition speed is determined by parameter φ , also estimated from the model.[5] The

location parameter of the STR model denoted by r, in turn, is the empirical counterpart for the

target share of the liquidity in consumer's portfolio. The wider is the gap between the target

level and investor's actual money balances, the higher value gets his risk aversion and

subjective discount factor parameters in the utility function.

Thus, we have ended up with an asset pricing equation with the first differences of

consumption and real money balances as explanatory variables. Unlike the linear models,

however, our framework includes an additional non-linear part: The higher is the liquidity

position of the representative consumer compared to his habit level, the more the utility from

his money holdings decrease the marginal utility from an additional unit of consumption. As

consumer's intertemporal substitutability of consumption decreases, he requires a higher

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[5] Also other specifications for the logistic function are possible, but the value of G is bounded between 0 and 1 in all of the specifications.

return to compensate postponed consumption. As the common stock is the only interest-bearing asset in the model the increased liquidity simply imply higher stock returns.

There is also an obvious advantage with our STR specification compared to nonlinear models that assume discrete changes between different states, since it allows for a continuum of different levels for the risk aversion among the investors, instead of the value of γ being limited to only two extreme states. The continuum of states implied by the model also allows that the agents may have different targets for their money holdings.

3. DATA

Equation (6) is estimated using quarterly time-series data from the US over the sample period of 1952:1 – 2004:1. As the stock return series we have used the total return of the S&P 500 composite index, obtained from the Bloomberg database. Constructing the index is based on an assumption that the dividends are re-invested. Some of the observations in the stock return series, unfortunately, were missing and these observations were estimated by interpolating. The monetary variables of the study are calculated using data on asset holdings by the household sector, computed by the Federal Reserve Board and published in the Flow of Funds sector balance sheets. The money variable (M_t) is a sum of demand deposits and currency. The transition variable of our STR model, in turn, is constructed as a ratio of the money variable and the total asset holdings of the household sector. Consumption is measured by the personal consumption expenditures less durables, which is constructed by summing up consumption expenditures on nondurable goods and services. The consumer price index (CPI) series are the consumer price index for all consumers. The series for consumption and the consumption price index were provided by the FRED database

published by the Federal bank of St. Louis. The time series of the logarithmic growth rates of consumption and liquidity are plotted in Figure I.1 in Appendix I.

Selecting the transition variables for the estimation of the STR model was constrained by some technical difficulties in the estimation procedure. The number of observations of the transition variable in the neighbourhood of the location parameter (r) was not always large enough to allow the ML procedure to converge in reasonable parameter values. It was, however, possible to construct two series to be used as the transition variables. Our first candidate as a transition variable (s_t) for the STR model was simply the share of investor's liquid balances from his total portfolio ($s_t = \dfrac{m_t}{B_t}$).

The series are plotted in Figure I.2 in Appendix I. It is seen that the series have shown a downward sloping trend during our whole sample period so that if our hypothesis that the households attempt to hold a constant fraction of their portfolios as liquid assets is to be true, then this ratio at least has been in a gradual decrease during our whole sample period. When the stationarity of s_t was examined using formal unit root tests, the series appeared to be borderline cases between a trend-stationary process and a unit root process around a linear trend. One of the statistical assumptions behind the STR models is the stationarity of the transition variable, which suggests removing the deterministic trend from the series of the transition variable before estimation. Accordingly, by removing a HP-filtered trend from the series of the share of liquid balances of investor's portfolio, we constructed a new transition variable series: the deviations of the growth rate of the liquid balances from their trend

($s_t = \dfrac{m_t}{B_t} - trend_t$).

Our second candidate for the transition variable for stock returns was the first difference of the share of liquid balances of the total portfolio, that is, $s_t = \Delta \dfrac{m_t}{B_t}$. With this alternative specification, it is assumed that the households avoid sudden _changes_ in the shares of liquid assets of their total portfolios. Thus, we then ask, whether the consumers form a habit rather to the change instead of the level of the share of liquid assets in their portfolios. Both series selected as the transition variables, labelled henceforth transition1 and transition2, are plotted in Figure I.3 in Appendix I.

4.   RESULTS

4.1. Statistical properties of the model

As noted, our STR model specification (6) for asset returns includes an ARCH term. Statistical properties of purely autoregressive STR models with GARCH errors (STAR-GARCH) has been examined by Chan and McAleer (2002) who found the QMLE estimates of these models to be consistent and asymptotically normal. Because of the problems with estimating the STAR-GARCH models, reported eg by Lundbergh and Teräsvirta (1999), van Dijk et al. (2002) and Chan and McAleer (2002, 2003), however, we ended up with estimating standard STR models with constant variances[6]. After the specification (6) was estimated for both of our two alternatives for the transition variable, the model was evaluated

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[6] Lundbergh and Teräsvirta (1999), van Dijk et al. (2002) have shown that the convergence of the quasi-maximum likelihood estimator is sensitive on initial values. Chan and McAleer (2002) suggest, based on their Monte Carlo experiment, that the QMLE estimates of the GARCH components of the STAR-GARCH models are sensitive on the model specification, while Chan and McAleer (2003) show that the estimation results are not robust to the algorithm used in the estimation.

in terms of remaining autocorrelation in residuals, using tests suggested by Teräsvirta (1996). Since the tests clearly suggested remaining autocorrelation for both of the estimated equations, the model (6) was re-specified by adding one lag of dependent variable as an additional explanatory variable. As seen in Tables II.1 and II.2 in Appendix II, the null hypothesis of no autocorrelation in the residuals is clearly maintained after the lagged stock returns are added into the estimated models.

Because the sample period is rather long, more than 50 years, it is possible that there has been structural breaks in the relation between money and stock returns. Thus, the constancy of the coefficients of the growth rate of consumption and liquidity over time was examined using the test suggested by Teräsvirta (1996) with the null hypothesis of no structural change in parameter values over the sample period. The results of the tests are reported in Tables II.3 and II.4 in Appendix II. As it is seen, the null hypotheses of parameter constancy clearly could not be rejected for either of the two specifications of the model, the p-values of the test statistics equalling or exceeding 0.5 in all slightly differing variants of the tests.

The estimated models were also tested for remaining non-linearity, using the test suggested by Teräsvirta (1996). The null hypothesis of the test is that the linear variables of the estimable model – the growth rate of consumption and the lagged stock returns - do not have any additional non-linear effect on stock returns. The results of the tests, carried out for several slightly different specifications for the nature of non-linearity, are reported in Tables II.5 – II.8 in Appendix II. In some cases the test actually rejects the null hypothesis of no additive non-linearity, suggesting that the linear variables of the model might also affect stock prices in a non-linear way.

From theoretical point of view, the non-linear component of consumption growth could naturally be given the same interpretation as the growth rate of money, namely that there is habit formation in consumption. The growth rate of consumption could in principle be incorporated into the model in two different ways. Firstly, it could be included into the non-linear part of our original specification (6.) Alternatively, a STR model with two transition functions – one for both the growth rate of money and the growth rate of consumption - could be estimated. The first of the specifications would, however, restrict the non-linear effect of both liquidity and consumption to share the same transition dynamics, including the same transition variable (the share of liquid assets in consumers' total portfolio). An attempt to estimate the latter of the two specifications was made, however, using the growth rate of consumption as the transition variable, following the specification of Kahra and Oikarinen (2003). Estimating the specification with two transition functions turned out to be computationally not feasible, however, as the model did not converge with the relatively few observations of our data.

All in all, although we may omit some valuable information by restricting the non-linear effect from consumption growth, the main purpose of our estimation exercise becomes still fulfilled, as the residuals of the model show no autocorrelation so that the estimated coefficients of the models still should be unbiased.

4.2. Estimation results

The estimated parameter values are shown in Table 1 below. Figures III.1 and III.2 in Appendix III show the values of the transition function against time, as well as the actual and fitted values of the stock returns.

Table 1. Estimated parameter values with their t-values.

Parameter	Stock returns/ Transition1	Stock returns/ Transition2
$-\log \beta_1$	-0.01689 (-0.99)	-0.02499 (-1.76)
b_1	-0.0179 (-0.165)	-0.824 (-2.96)
b_2	0.411 (2.2)	1.26 (4.07)
d	2.71 (2.26)	2.64 (2.27)
α	1.01	2
γ_1	2.69	1.62
γ_2	-38.6	-1.24777
φ	299 (0.296)	6.54 (2.04)
r	0.000434 (4.41)	-0.00181 (-7.29)
rr(-1)	0.117 (1.62)	0.101 (1.45)
σ_i^2	0.00558	0.00517

It can be seen that the estimates for the parameter triplet (b_1, b_2, d) mostly take statistically significant values in both specifications. The coefficients of the consumption growth are positive, as expected. The linear effect of liquidity growth on asset returns is negative in both specifications, which is in contrast with the predictions of our theoretical model. The non-linear effect of liquidity is of the right sign – positive – however.

Regarding the structural parameters of the model, we first consider the value α. The estimated values for α in the cases of the two transition variables considered are 1.01 and 2. In the first case the value of α is very near unity, which would in fact imply that money plays no role at all in the utility function. Since the estimate for α was calculated as a product of several estimated coefficients of equation (6.) and the covariance matrix between the coefficient estimates was not available, the standard errors for the estimate of α could not be calculated. Thus, the hypothesis of $\alpha = 1$ could not be formally tested. In the second case, the estimate for α, in turn, was far beyond the upper bound of unity implied by theory.

The parameter values of most interest to us are the values of γ_1 and γ_2, the linear and non-linear components of the measure for the relative risk aversion. The linear component γ_1 ($= b_1 + c$) takes a value above unity in cases of both transition variables used in estimations. The estimates for γ_1 also sound plausible in light of previous studies. In Kahra (2003), for instance, the estimates for γ_1 were ranging between 2.06 and 2.67 (with monthly data) or between 0.23 and 4.63 (with quarterly data), depending on the instrument variable set used in the GMM estimation procedure.

The nonlinear component of the utility from monetary holdings in Eq (3), γ_2 ($= b_2 / (1 - \alpha)$), gets a negative value in both specifications, which contradicts the restriction the habit formation implies for the value of γ_2 in our model. In the first specification, the negative value may, however, only result from the inaccuracy in estimating α: The estimate for α was very slightly above unity, while an α below unity would imply a positive value for γ_2. Although the sign of γ_2 is at least unclear, the large absolute value of the estimate of γ_2 at least implies a rather strong non-linear dynamics for the effect on liquidity on the asset

returns. The value of γ $(= \gamma_1 + \gamma_2 G(\cdot))$ fluctuates in the range beginning from 2.69 and ending to estimates with absolute values at the level of 35. In the case of our second transition variable, $\gamma_1 + \gamma_2 G(\cdot)$ ranges from 1.62 to 0.37, as the share of liquid assets increases, which violates our hypothesis of habit formation. Because of the implausible estimate for α, the results have to be considered with considerable caution, however, so that in light of our simple empirical exercise it is difficult to decisively either accept or reject our hypothesis for habit formation.

The adjustment dynamics of the transition between the regimes was driven by the transition function $G(\varphi, r; s_t)$. The parameters of the function include φ, which determines the speed of adjustment and r that tells the threshold value for the transition variable. The estimates for the former of the variables took values of 299 in the case of transition variable 1 and 6.54 in the case of transition variable 2, respectively. The speed of adjustment described by φ actually seems to take a statistically significant value only when the second of out alternative transition variables was used. As noted by Teräsvirta (1996), however, the parameter φ does not follow normal distribution, and accordingly, our estimation procedure does not provide us with reliable inference for that parameter.

Although the estimates for the threshold values (r) took statistically significant values in cases of both transition variables, the estimated size of the estimates were practically zero in both cases. Thus, in the case of the detrended share of liquid assets from the total asset portfolio as the transition variable, the model implies that the non-linear part of γ starts to increase immediately as the share of liquid assets in their portfolios increases above its trend. Likewise, when the change in the growth rate of the liquidity was used as the transition variable, the model implies that the more rapidly the share of liquid assets from their

portfolios grow, the lower value γ gets. The values of the transition function $G(\varphi, r; s_t)$ are plotted in Figures III.1 and III.2 in Appendix III. As it can be seen, the dynamics of the STR model here actually does not show any smooth transition between different regimes. Instead, the system seems to by constantly fluctuating between two clearly separated regimes.

Finally, the estimates for the logarithm of the subjective discount factor β, which is obtained from the constant term of the estimated equation, differ statistically from zero in both specifications, getting values of 0.01689 and 0.02499. For β itself, this implies values between 0.975 and 0.984, depending on the specification of the model. A priori, the value of β should be positive and in the previous studies by eg Kahra (2003), the subjective discount factor was estimated to be fluctuating between 0.965 and 1. The estimate for our ad hoc increment to the model, that is, the coefficient for the lagged stock return. levelled around 0.1 irrespectively of the transition variable used.

All in all, the discussion above shows that mainly because of the problems in estimating α, our empirical exercise seems to fail to either strongly support or reject the predictions of our theoretical model for the habit formation. The coefficient values of the estimated model (b_1, b_2, d) can, however, still be discussed in light of the previous studies on the relationship between stock returns and liquidity. Note, first, that only in the case of "Transition2" as the transition variable, all the reduced form coefficients enter economically and statistically significantly into the model. Regarding the sign of the estimate for b_1 in this case, our results are in line with some recent studies that have argued, both on theoretical and empirical grounds, that increasing liquidity in the economy should rather dampen than increase the equity returns (see eg Gallagher and Taylor (2002) and Heimonen (2004)). The estimated negative sign of the reduced form coefficient for the growth rate of money could be

interpreted as supporting the reasoning of Gallagher and Taylor and Heimonen, according to which the increased liquidity increases the future inflation and inflation expectations, which in turn, dampens equity prices through its negative impact on aggregate supply.

The estimated positive sign of the non-linear effect from liquidity to the stock returns (b_2) apparently contradicts this reasoning, since if the explanation holds, then it would be expected that as the liquidity of the economy grows, the inflationary pressures induced by expanding the liquidity of the economy should become stronger, not weaker.

An alternative approach for the relationship between money and stock returns have been suggested by Friedman (1970), Nelson (2003) and Congdon (2005), who have argued that consumers or institutional investors may not be willing to increase their holdings in any return yielding assets without an equal increase in their holdings of liquid assets. In contrast with our theoretical considerations based on the habit formation for liquidity, the argument is based on assumed supply effects in the financial markets. Accordingly, if the central bank feeds investors needs for liquidity, this may have positive liquidity effects in the prices of long-term securities. Our estimated positive non-linear impact from liquidity to the stock returns, after the share of liquid balances in investor's portfolio has exceeded it's threshold level, can be interpreted as a supporting this kind of reasoning.

5. CONCLUSIONS

It has been argued lately that economists should reconsider the possibility that money may have a role in the transmission mechanism of monetary policy that is independent of the short

term interest rate, since the monetary policy is likely to work by changing the relative prices of a wide range of assets and interest rates. Friedman (1970), Nelson (2003), and Congdon (2005), for instance, argue that consumers or institutional investors may not be willing to increase their holdings in return yielding assets without an equal increase in their holdings of liquid assets. To discuss these questions, this paper has developed and empirically tested a simple model, which predicts in a non-linear relationship from the degree of liquidity of the economy to stock returns. The model is based on a version of the consumption based CAPM, in which consumers' utility function is non-separable in consumption and monetary services. The form of the utility function implies that the optimal path of consumption partly depends on consumer's holdings of liquid assets relative to his constant target level of liquidity.

Thus, we can derive a simple empirical, non-linear asset pricing model, according to which investors' willingness to hold liquid assets in their portfolio can be described by a sort of habit formation. The higher is the share of liquid assets in consumer's portfolio, the smaller is the marginal utility from an additional unit of consumption. Accordingly, higher expected return is needed to satisfy the Euler equation for optimal consumption, and it follows that asset returns become non-linearly increasing in real money balances.

The structural parameters (most importantly, the measure for the risk aversion of holding liquid assets) of the Euler equation were identified from the reduced form parameters estimated with a Smooth Transition Regression (STR) models for the US data. As transition variables of the STR model, we used two alternative measures for the share of liquid balances in investor's portfolio. Mainly because of the problems in accurately estimating α, however, the results regarding the parameter of most interest to us, the non-linear component of the coefficient of risk aversion, were puzzling in light of our hypothesis of habit formation. Thus,

our empirical exercise seems to fail to either strongly support or reject the predictions of our theoretical model.

On the other hand, the signs of the estimates of the reduced form parameters of the model support some previous, although tentative, explanations for the observed relationship between liquidity and stock returns: Gallagher and Taylor (2002) and Heimonen (2004), among others, have argued both on theoretical and empirical grounds, that increasing liquidity in the economy should rather dampen than increase the equity returns. Our results regarding the linear relationship between the stock returns and the growth rate of money support the view above, according to which the increased liquidity increases the future inflation and inflation expectations, which in turn, dampens equity prices through its negative impact on aggregate supply. Our estimated positive non-linear impact from liquidity to the stock returns can also be interpreted as providing empirical support for the arguments by Friedman (1970), Nelson (2003) and Congdon (2005), cited above, although the theoretical underpinnings of these papers differ from our model.

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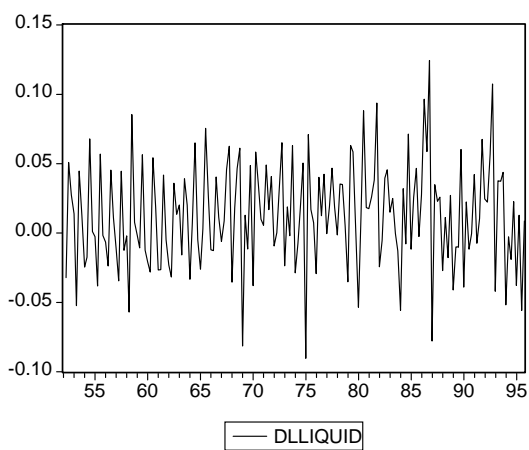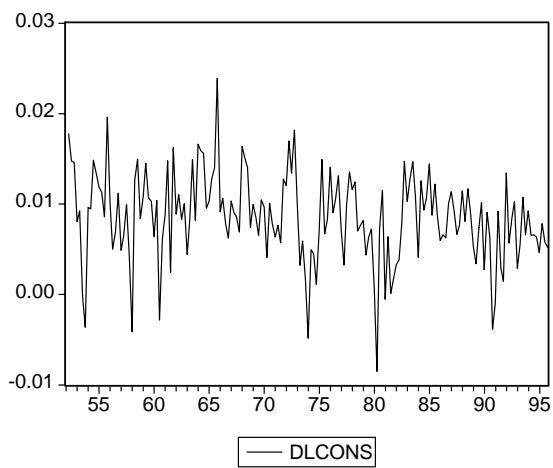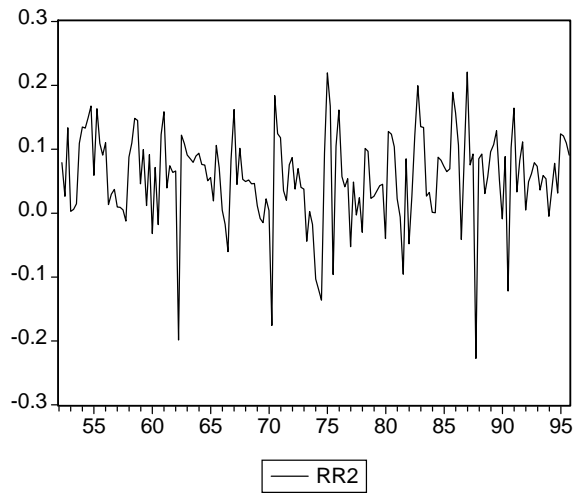**Inefficient Markets. An Introduction to Behavioral Finance.**

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APPENDIX I

Figure I.1. The quarterly stock returns and the growth rates of consumption and liquidity.

RR2 refers to the series of stock returns, DLCONS to the first difference of consumption in logarithms and DLLIQUID to the first differences of money growth in logarithms.

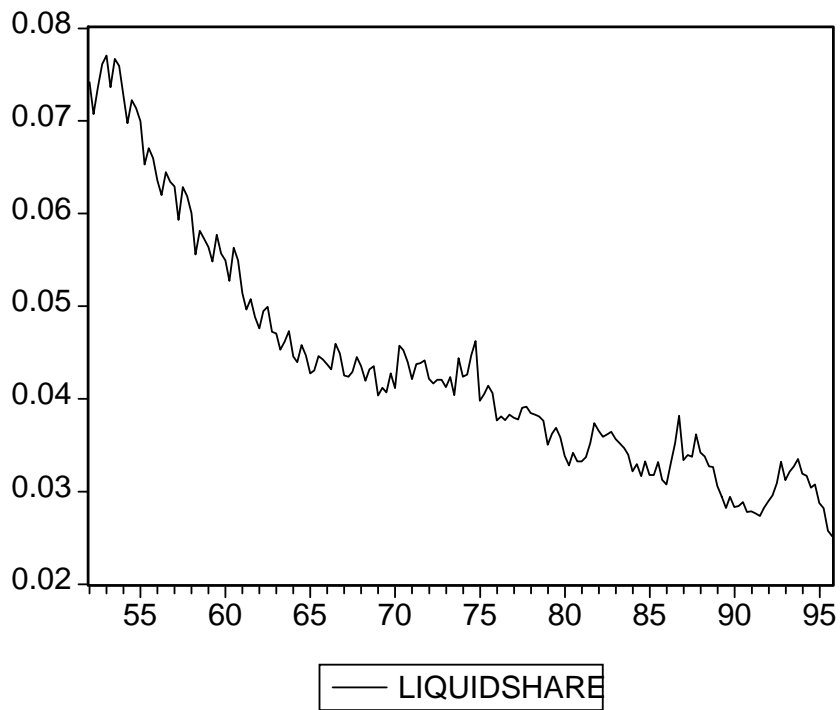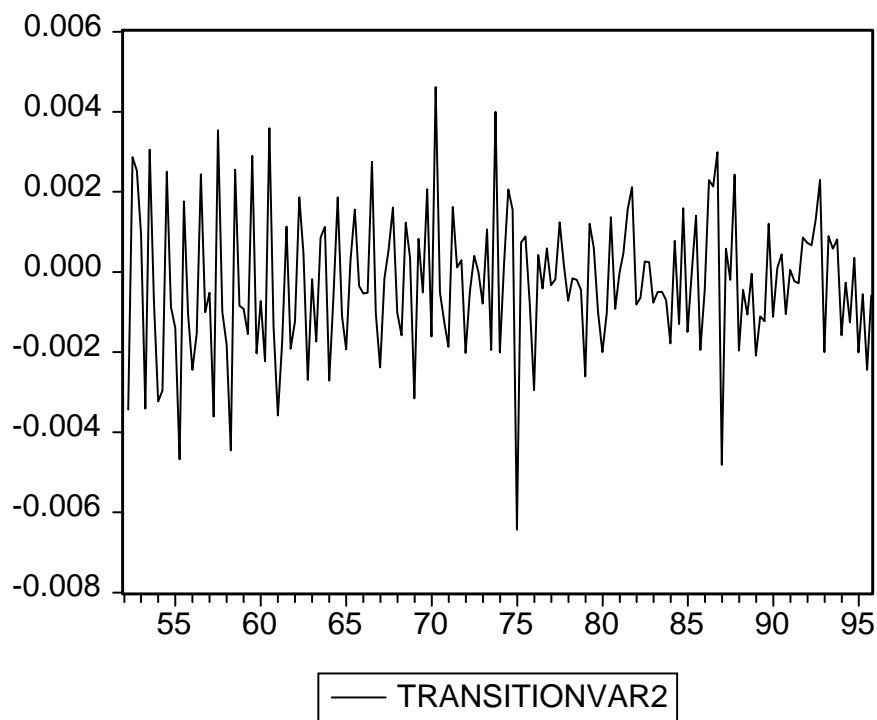**Figure I.2.** The share of liquid assets from investor's total portfolio.
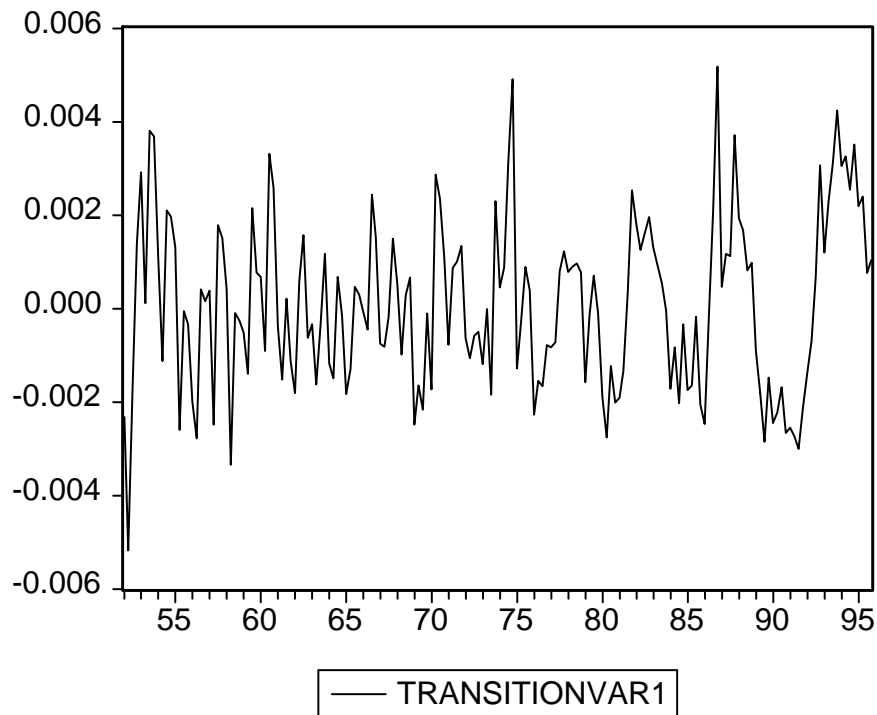
Figure I.3. The transition variables $\dfrac{m_t}{B_t} - trend_t$ (above) and $\Delta \dfrac{m_t}{B_t}$ (below).

TRANSITIONVAR1

TRANSITIONVAR2

APPENDIX II

Results of specification tests

Tests of no remaining autocorrelation: Transition1			
Nr of lags	F-stat.	df1/df2	p-value
1	0.00176	1/199	0.967
2	0.469	2/198	0.626
3	0.489	3/197	0.691
4	0.519	4/196	0.722
5	0.430	5/195	0.827
6	0.362	6/194	0.902

Table II.1

Tests of no remaining autocorrelation: Transition2			
Nr of lags	F-stat.	df1/df2	p-value
1	0.241	1/199	0.624
2	0.724	2/198	0.486
3	0.668	3/197	0.573
4	0.537	4/196	0.709
5	0.429	5/195	0.828
6	0.356	6/194	0.905

Table II.2

Test for parameter constancy: Transition1			
Test	F-stat.	df1/df2	p-value
LM3	0.666	6/194	0.677
LM2	0.387	4/196	0.817
LM1	0.464	2/198	0.630

Table II.3

Test for parameter constancy: Transition2			
Test	F-stat.	df1/df2	p-value
LM3	0.841	6/194	0.539
LM2	0.403	4/196	0.806
LM1	0.695	2/198	0.500

Table II.4

Tests of no additive non-linearity: Transition1, dlliquid		
F-stat	df1/df2	p-value
0.776	3/200	0.509
0.00931	1/200	0.923
0.54	1/201	0.463
1.79	1/202	0.182

Table II.5

Tests of no additive non-linearity: Transition2, dlliquid		
F-stat	df1/df2	p-value
12	3/200	2.91 e-7
4.17	1/200	0.042
25	1/201	1.22e-6
5.64	1/202	0.02

Table II.6

Tests of no additive non-linearity: Transition1, dlcons, rr(-1)		
F-stat	df1/df2	p-value
1.67	6/194	0.13
1.13	2/194	0.324
0.986	2/196	0.375
2.88	2/198	0.0582

Table II.7

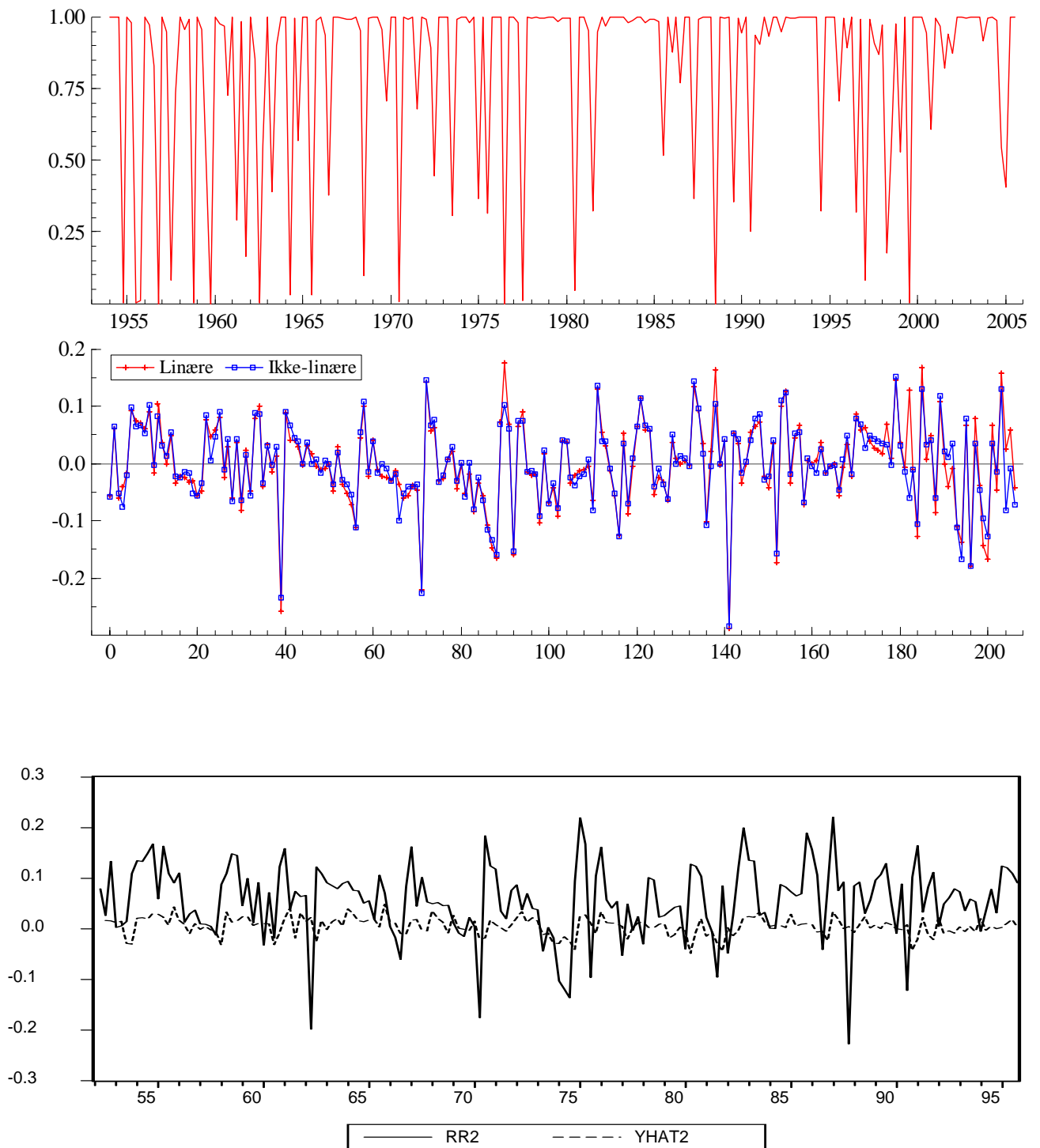| Tests of no additive non-linearity: Transition2, dlcons, rr(-1)		
F-stat	df1/df2	p-value
5.82	6/194	1.36e-5
0.105	2/194	0.9
1.04	2/196	0.356
16.5	2/198	2.45e-7

Table II.8

APPENDIX III

Figure III.1
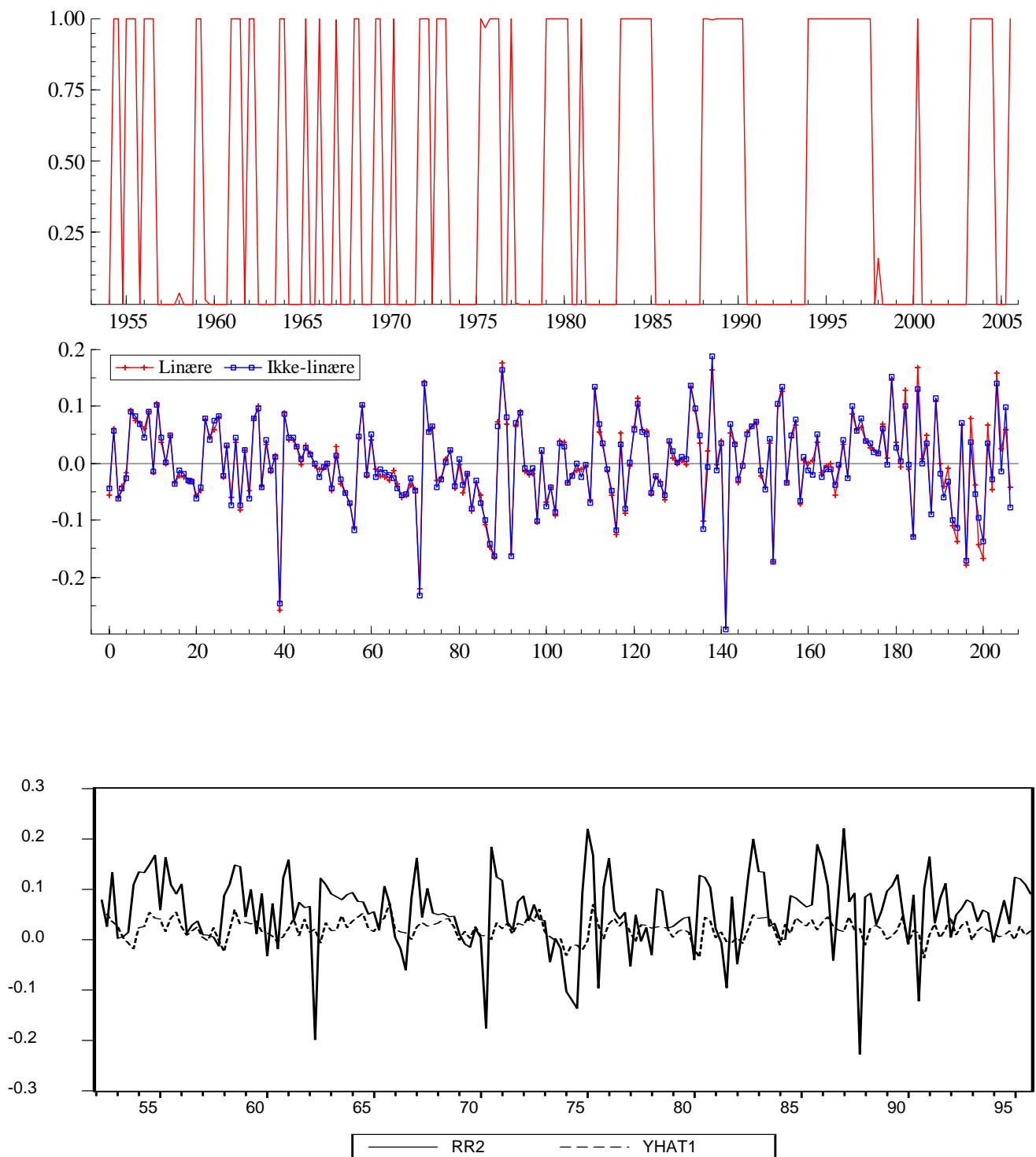
The values of the transition function for stock returns with $s_t = \dfrac{m_t}{B_t} - trend_t$ as the transition variable (the figure above) and the actual and fitted values of the stock returns

Figure III.2.

The values of the transition function for stock returns with $s_t = \Delta \dfrac{m_t}{B_t}$ as the transition variable (the figure above) and the actual and fitted values of the stock returns.