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THE INTEREST RATE ELASTICITY OF AGGREGATE CONSUMPTION: A TIME VARYING PARAMETER APPROACH*

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The aim of this note is to examine whether the empirically documented positive interest rate elasticity of aggregate consumption in Finland is an artefact due to the previously widespread credit rationing. The aim is carried out using a novel time varying parameter approach and data from the period 1960—1989. The empirical evidence lends further support for a positive interest rate elasticity of aggregate consumption. The elasticity seems to have increased over time, especially in recent years. To some extent, this mirrors a gradual easening up of credit rationing, which has been particularly rapid in recent years.

1. Introduction

Is the interest rate elasticity of private consumption positive, zero, or negative? Theoretically, it can be any of these. However, a commonly held belief, which enjoys some international empirical support, is that the elasticity is negative.[1] Empirical evidence for the Finnish economy is mixed.[2] Given that consumption constitutes 3/4 of GDP in Finland, knowledge of the sign of the interest rate elasticity of consumption is of paramount importance.

Recently, the commonly held belief that the interest rate elasticity of consumption is negative has been challenged. Sheshinski & Tanzi (1989) have pointed out that the sign of the elasticity of aggregate consumption is a function of the age distribution of the population. Moreover, a large fraction of financial wealth is typically held by elderly persons.[3] These are individuals who can be expected to have a very high marginal propensity to consume because of their low average life expectancy. Hence, an increase in the interest rate which results in higher income for the elderly could substantially increase their consumption. This may overwhelm the increase in saving of younger people, making the interest rate elasticity of aggregate consumption positive.

* *I am indebted to two anonymous referees for helpful comments.*

[1] *While the empirical literature employing international data is huge, the results are mixed. See Smith (1990) for a survey of such empirical work. A negative elasticity is found by a number of authors reviewed by Smith (op.cit.) and by Mankiw (1982), Muellbauer (1982), Blinder & Deaton (1985), Clements (1985), Terza et al. (1985) and Mankiw (1986).*

[2] *Using Finnish data, mixed results are obtained by Koskela & Virén (1982a-d). Negative elasticities are documented by Koskela & Virén (1985) and Tarkka et al. (1990).*

[3] *Evidence of the wealth position of the elderly is presented by Beach et al. (1988) for Canada, by Sheshinski & Tanzi (1989) for the U.S. and by Vilmunen & Virén (1991) for Finland.*

In fact, a positive elasticity is found in a recent study by Kostiainen & Starck (1990) for Finland, and it appears to be congruent with the experience of some other countries as well (Koskela (1990)).

Nevertheless, the estimated positive interest rate elasticity may in the Finnish case be an artefact in at least the following sense. Up to the mid-1980s, credit rationing was widespread and highly binding, thus downplaying the role of the price of credit quite considerably. Hence, there is a possibility that the estimated sign and magnitude of the interest rate elasticity reflects other factors than what is aimed at. It is only during the last few years of liberalized credit markets that the interest rate may have served its conventional role in the household decision process. In particular, the possibility that the elasticity has been negative during the last few years offers an alternative hypothesis worthy of investigation.

2. *A Time Varying Parameter Approach*

Trying to assess the possible changes in the interest rate elasticity of consumption through fixed parameter techniques is probably futile in the Finnish case since the easening up of credit constraints has occurred only very recently. More generally, the use of a constant parameter consumption function in the study of Finnish consumption behavior may be inappropriate because of the following reasons.

Firstly, a major structural change occurred in the mid-1980s involving the deregulation of the market for household loans. This would tend to enhance the interest rate sensitivity of aggregate consumption (Montiel (1986)). Secondly, the age distribution of the population has been gradually changing toward an oldening of the population. This would tend to raise the value of the interest rate elasticity of aggregate consumption (Sheshinski & Tanzi (1989)). Thirdly, during the period of credit rationing, a rise in the interest rate could have had a stronger impact on aggregate consumption than a fall in the interest rate (Jackman & Sutton (1982)).

Since there are reasons to believe that the interest rate elasticity of aggregate consumption has not been constant over time, we relax the restriction that the elasticity be constant over the estimation period. In particular, we adopt a time varying parameter approach, which allows us to assign at each point in time the value to the elasticity which is most congruent with the data. The model of consumption behavior we will be working with is an observation equation of the form

$$(1) \quad y(t) = x(t)\Xi(t) + z(t)\phi + v(t)$$

where $y(t)$ is the endogenous variable at time t, $x(t)$ is a k1-dimensional vector of explanatory variables, $\Xi(t)$ is the corresponding vector of time varying parameters, $z(t)$ is a k2-dimensional vector of explanatory variables, ϕ is the corresponding vector of fixed parameters and $v(t)$ is a white noise error term. The vector of time varying parameters $\Xi(t)$ is not directly estimated. Instead, it is modelled by a set of k1 transition equations (one transition equation for each component of $x(t)$). The transition equations take the form of a multivariate extended autoregressive model with the i:th equation taking the form

$$\begin{aligned}(2) \quad \Xi(i)(t) = {} & \xi(i)(1,1)\Xi(1)(t-1) + \ldots + \\ & \xi(i)(1,m1)\Xi(1)(t-m1) + \\ & \xi(i)(2,1)\Xi(2)(t-1) + \ldots + \\ & \xi(i)(2,m2)\Xi(2)(t-m2) + \ldots + \\ & \xi(i)(k1,1)\Xi(k1)(t-1) + \ldots + \\ & \xi(i)(k1,mk1)\Xi(k1)(t-mk1) + \\ & \zeta(i)(1)q(1)(t) + \ldots + \\ & \zeta(i)(p)q(p)(t) + \zeta(i)(m) + \\ & e(i)(t)\end{aligned}$$

where ξs are fixed parameters, m1, m2, ..., mk1 denote the orders of the autoregressions, ζs are fixed parameters, $q(n)$s are driving terms, $n = 1,\ldots,p$, $\zeta(m)$ is a constant and $e(t)$ is a white noise error term.

Maximum likelihood estimation of the parameters of (1) and (2) is a computationally formidable task, yet it is feasible if one is willing to consider parsimonious transition equations. The estimation problem is solved by writing the model in state space form, making it possible to apply the Kalman filter in an iterative search through the parameter space. An EM algorithm (see Dempster et al. (1977) and Watson & Engle (1983)) is used to move quickly to the neighborhood of the solution, and the Gauss-Newton algorithm is used to obtain final convergence. The maximum likelihood solution is refined further by use of the Kalman smoother on the entire span of historical data. The (inverse of the) Fisher information matrix obtained from the Gauss-Newton iterations yields asymptotically valid standard errors for the estimated parameters.

The observation equation (1) will be operationalized both in level and error correction form, and total as well as nondurable consumption will be considered. Different specifications are considered in order to gauge the size of the parameter variation caused by specification uncertainty.[4]

The transition equation (2) will be modelled as a random walk driven by an indicator of the prevalence of credit rationing. In this case, equation (2) simplifies to

$$\Xi(t) = \xi\Xi(t-1) + \zeta q(t) + e(t) \tag{3}$$

where Ξ stands for the interest rate elasticity of consumption and q is an indicator of the prevalence of credit rationing. This specification will allow the interest rate elasticity of consumption to drift over time reflecting, inter alia, the degree of credit rationing. In addition, feedback between changes in the interest rate and income elasticities will be considered. Such interaction may be expected along with an easening up of liquidity constraints.

3. *Empirical results*

3.1 The prevalence of credit rationing

Casual inspection indicates that credit rationing was widespread and binding during the 1960s and certainly nonnegligible also during the 1970s and the first half of the 1980s. In 1987 – 1988 credit to households soared, and the active marketing strategies of creditors suggest that credit was not rationed during the last years of our sample period. However, casual observations are arguable qualitative statements unsuitable for quantitative research. In this section, our aim is to produce a quantitative estimate of the prevalence of credit rationing in Finland during the last three decades. Our time varying approach is novel, and to the best of our knowledge, it has previously been applied neither to the Finnish case nor abroad.

Our approach begins by estimating the share of the population which is facing binding liquidity constraints at each point in time using an Euler equation framework. As it is well known, this can be done by specifying the observation equation (1) as a weighted average of a consumption rule for consumers who are not subject to liquidity constraints and that of consumers who are liquidity constrained (see e.g. Jappelli & Pagano (1989)). Specifically, assume that the optimal consumption plan of nonconstrained consumers is given by the Euler equation

$$E[\{c_{t+1}/c_t - [(1+r_{t+1})\beta]^{\sigma}\} \mid I_t] = 0 \tag{4}$$

where E[.] is the expectations operator, c is consumption, r is the real rate of interest, $\beta = 1/(1+\delta)$ is a discount factor where $\delta \leq r$ is the constant rate of subjective time preference, σ is the elasticity of intertemporal substitution and I is the information set of the consumers.

The liquidity constrained consumers are assumed to be rule-of-thumb consumers who simply consume a constant fraction of current income each period. Hence, their consumption rule is

$$E[\{c_{t+1}/c_t - y_{t+1}/y_t\} \mid I_t] = 0 \tag{5}$$

where y is disposable income. Consumption in the aggregate is obtained by weighting equations (4) and (5) by the proportion of aggregate consumption in the two categories of consumers

$$E[\{c_{t+1}/c_t - \lambda y_{t+1}/y_t - (1-\lambda)[(1+r_{t+1})\beta]^{\sigma}\} \mid I_t] = 0 \tag{6}$$

where λ, $0 < \lambda < 1$, denotes the fraction of aggregate consumption that accrues to liquidity constrained households. Log-linearizing yields

[4] *In general, parameter variation may be caused also by omitted variables, proxy variables, incorrect functional form, aggregation and changes in policy rules. Hence, some portion of the estimated parameter variation will undoubtedly merely be a reflection of these issues.*

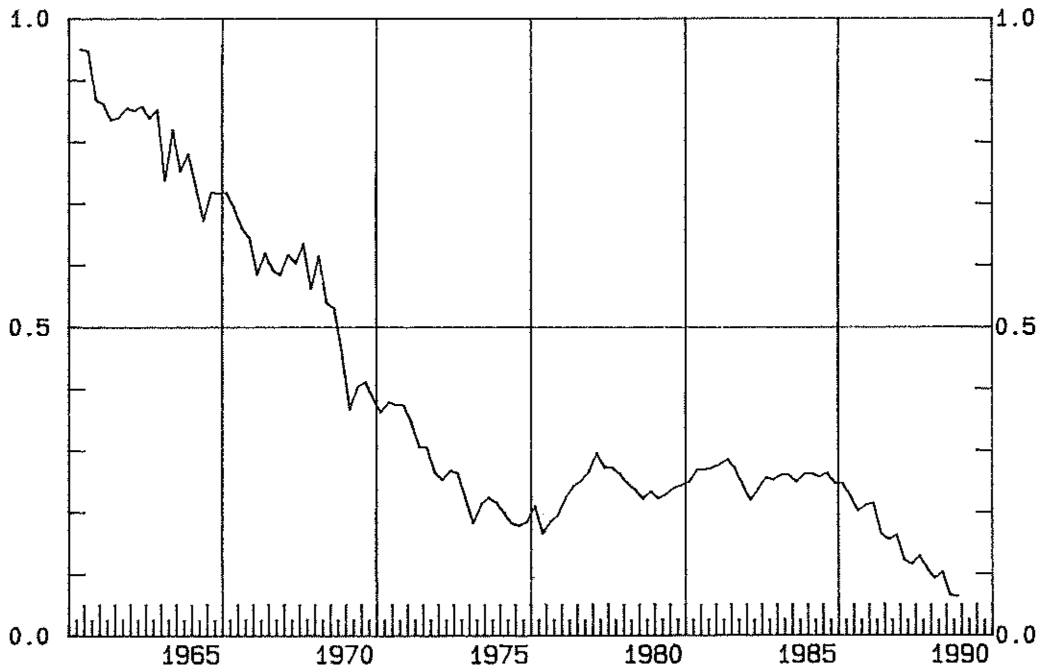

Figure 1. Fraction of consumption accruing to individuals facing binding liquidity constraints.

(7) $\Delta c_t = \alpha_0 + \alpha_1 r_t + \lambda \Delta y_t + u_t$

where Δ denotes a logarithmic first-difference, $\alpha_0 = (1-\lambda)\sigma(\ln\beta + \upsilon/2)$ where υ denotes the constant variance of the (assumed) normal distribution of the bracketed expression in equation (6), $\alpha_1 = (1-\lambda)\sigma$ and u is an error term made up of the forecast errors in c, y and r.

Equations (6) and (7) were estimated from Finnish data by Kostiainen & Starck (1990) under the assumption of parameter constancy. For the sample period 1960 – 1988, a significant λ of the order of magnitude 0.3 was obtained. We now relax the assumption of a constant λ, and estimate this parameter using the time varying parameter model outlined in section 2. Specifically, let the observation equation (1) be specified as the Euler equation (7), and the transition equation (2) for λ as a random walk driven by the growth rate of consumption. Nondurable private consumption and the real interest rate on new bank credit are employed as c and r, respectively. We use seasonally adjusted quarterly Finnish data spanning the period 1960Q1 – 1989Q4. All data are, were suitable, in real per capita logarithmic form. The estimation result is displayed in Figure 1.

Our estimate of the incidence of credit rationing features characteristics broadly congruent with casual observation. Around 3/4 of the households were, on average, subject to binding liquidity constraints during the 1960s according to the estimation result. During the 1970s, the share of liquidity constrained consumers falls to roughly 1/3, around which it stays throughout the first half of the 1980s. In 1986, the share of liquidity constrained consumers starts to fall again, approaching zero at the end of our sample period.[5] This easening up of credit constraints in the late 1980s is in accordance with the

[5] *While the estimated decline in λ is quantitatively significant, it is also statistically significant. The Watson-Davies test (see Watson & Engle (1985)) rejects the constancy of λ at a marginal significance level of 0.005. The weight of the growth of consumption in the transition equation is estimated to be −0.334.*

Figure 2. The interest elasticity of aggregate consumption estimated from level specifications.

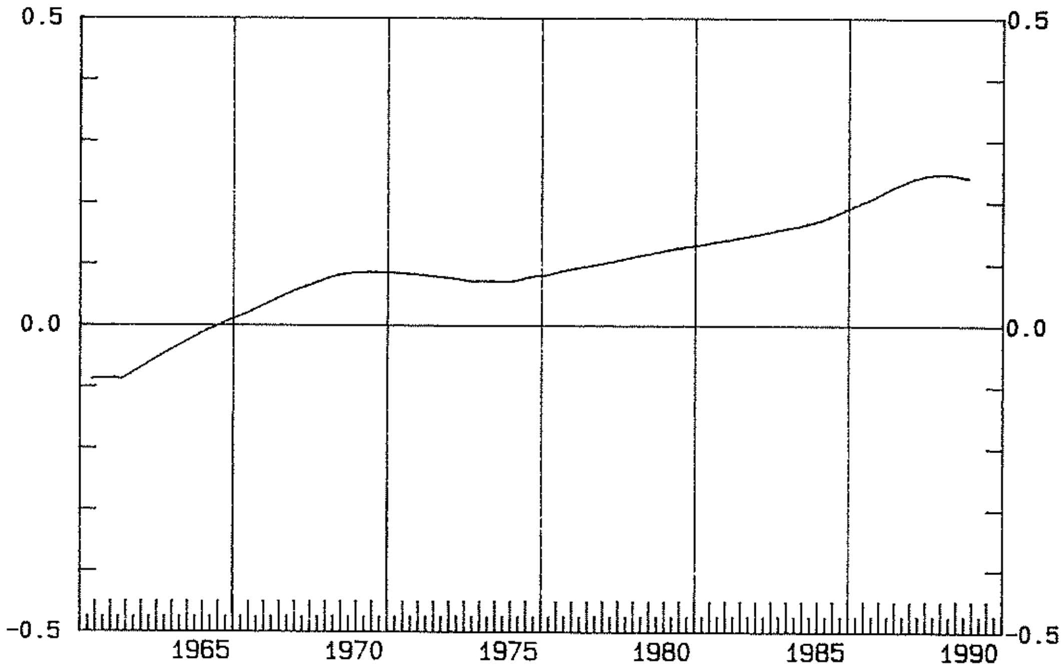

Figure 2a. Total consumption.

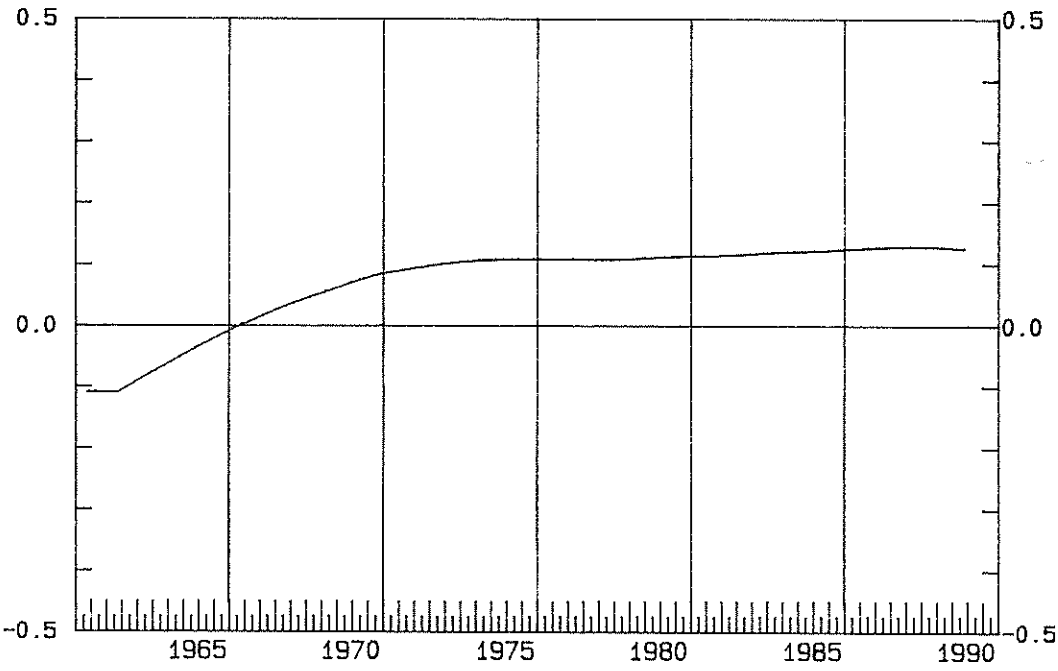

Figure 2b. Nondurable consumption.

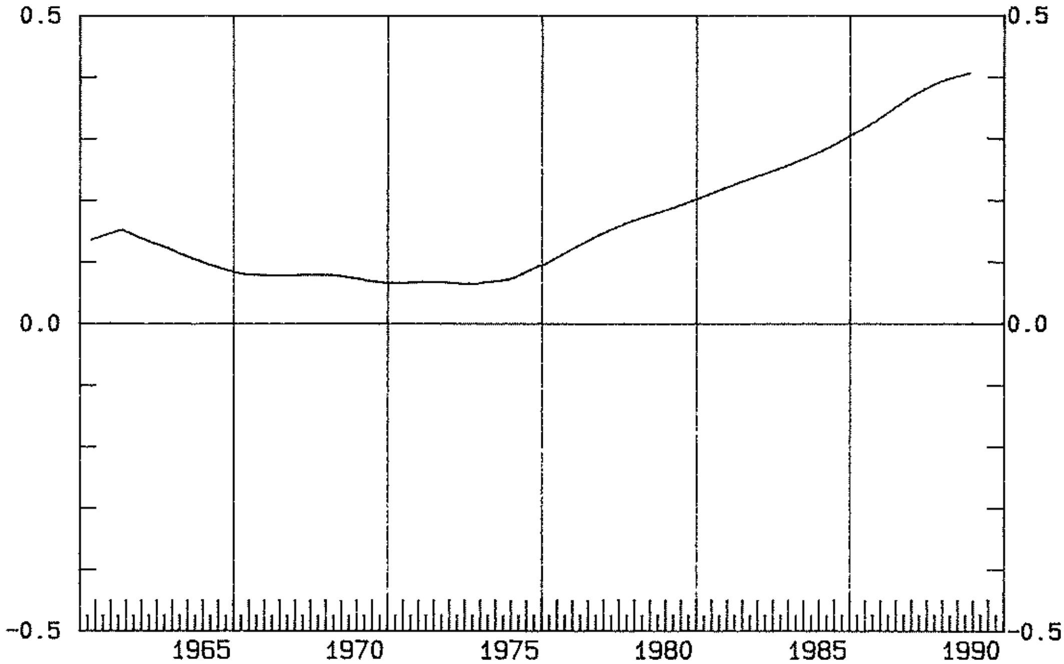

Figure 2c. Total consumption, elasticity interaction.

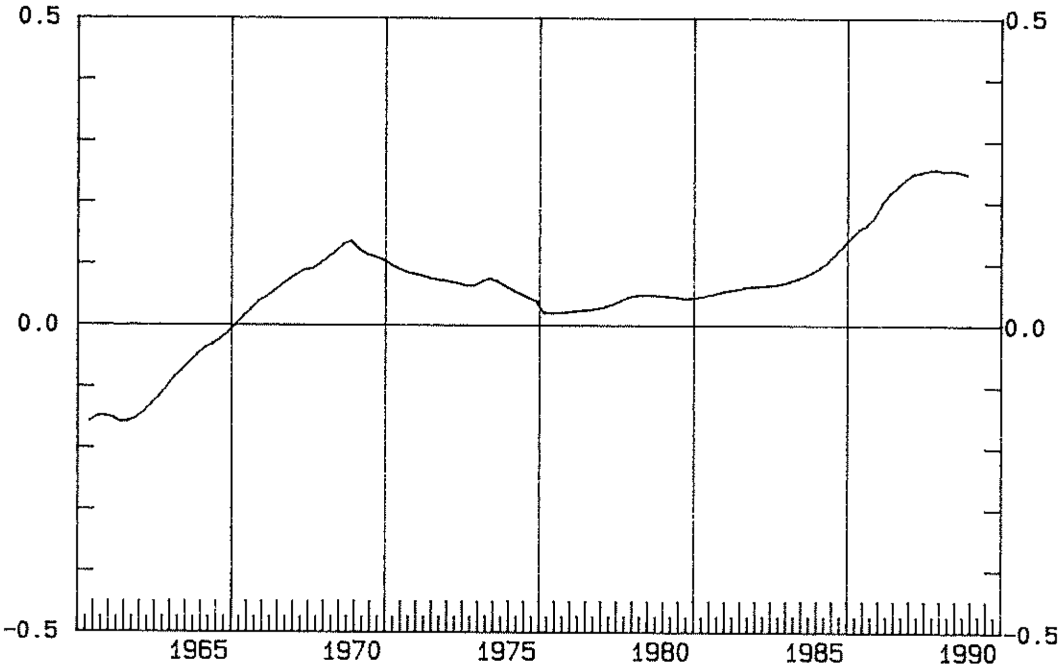

Figure 2d. Nondurable consumption, elasticity interaction.

Finnish experience (see e.g. Lehmussaari (1990)).

The estimate of λ should be viewed as a proxy because of the reasons spelled out in footnote 4. Moreover, it is unknown to what extent our estimation method takes into account the endogenous formation of expectations of r and y. To the extent to which this is a problem, λ will be inconsistent and biased upward. Furthermore, unavoidable issues involving measurement errors and the use of (poorly) seasonally adjusted data may distort the estimate. Moreover, the estimated Euler equation did not perform well as a specification (this is a standard feature of Euler equations). The coefficient of multiple determination corrected for degrees of freedom was 0.007 and the Ljung & Box (1978) test for autocorrelation revealed a departure from the null hypothesis of no autocorrelation at a marginal significance level of 1×10^{-6}.

The estimated incidence of credit rationing $\hat{\lambda}$ will in the next section be used in a consumption function framework as a driving variable in the transition equation for the interest rate elasticity of aggregate consumption. The need to work with two different equations describing consumption arises because of the following reasons: The share of consumption accruing to liquidity constrained households can, given our data, be estimated from an Euler equation, but not from a consumption function. The interest rate elasticity of consumption, on the other hand, can be estimated from a consumption function, but not from an Euler equation (in which the coefficient of the interest rate is interpreted as the coefficient of relative risk aversion and/or the elasticity of intertemporal substitution). Note that the two equations do not represent rivalling models for consumption, nor are they mutually exclusive. An Euler equation is a theoretical first-order condition for an optimal consumption plan whereas our consumption function is an empirical approximation to the unknown data generating process for consumption.

3.2 *The interest rate elasticity of aggregate consumption*

The consumption functions employed to estimate the interest rate elasticity were specified through sequential simplifications of unrestricted autoregressive distributed lag models for consumption. These models include levels, differences and linear combinations of consumption, income and the real rate of interest and constants. Fixed parameter estimates of the final models are given in the Appendix. We note that the models are statistically adequate, and that the interest rate elasticity is estimated to be significantly positive in all cases. Moreover, total private consumption is more interest rate sensitive than consumption of nondurables. Level specifications — not surprisingly — outperform error correction specifications in terms of explanatory power.

Turning to estimation of the time varying interest rate elasticity, we begin by examining elasticities estimated from consumption functions in levels. It is perhaps worth emphasizing, that estimates from these level specifications are asymptotically equivalent to estimates from the error correction specifications to be examined later. In other words, although our variables contain common unit roots (Kostiainen & Starck (1990)), transformation to stationary form is unnecessary asymptotically (Sims et al. (1990)). However, as pointed out earlier, examination of the robustness of the estimate of the time varying interest rate elasticity to the specification from which it is estimated seems mandatory, as the exact form of the consumption function is very much an unresolved issue.

In level specifications, we operationalize the observation equations as models A1 and A2 of the Appendix, and the transition equations as random walks driven by our estimate of the incidence of credit rationing $\hat{\lambda}$. Corresponding estimates of the interest rate elasticity for total consumption and for consumption of

[6] *The general flavor of our conclusions was found to be robust to how the transition equation is operationalized (random walks, random walks with drifts, AR-processes etc.). The findings of Starck (1987) and Kostiainen & Starck (1990) suggest that the general conclusions may be robust to many alterations of the observation equation as well. In particular, the operationalization of r would seem to be of negligible importance as would the importance of other variables than those included in the current analysis. Including $\hat{\lambda}$ in the observation equation never yielded statistically significant results (subject to the caveat stemming from the generated regressor-problem; see Pagan (1984)).*

Figure 3. The interest elasticity of aggregate consumption estimated from error correction specifications.

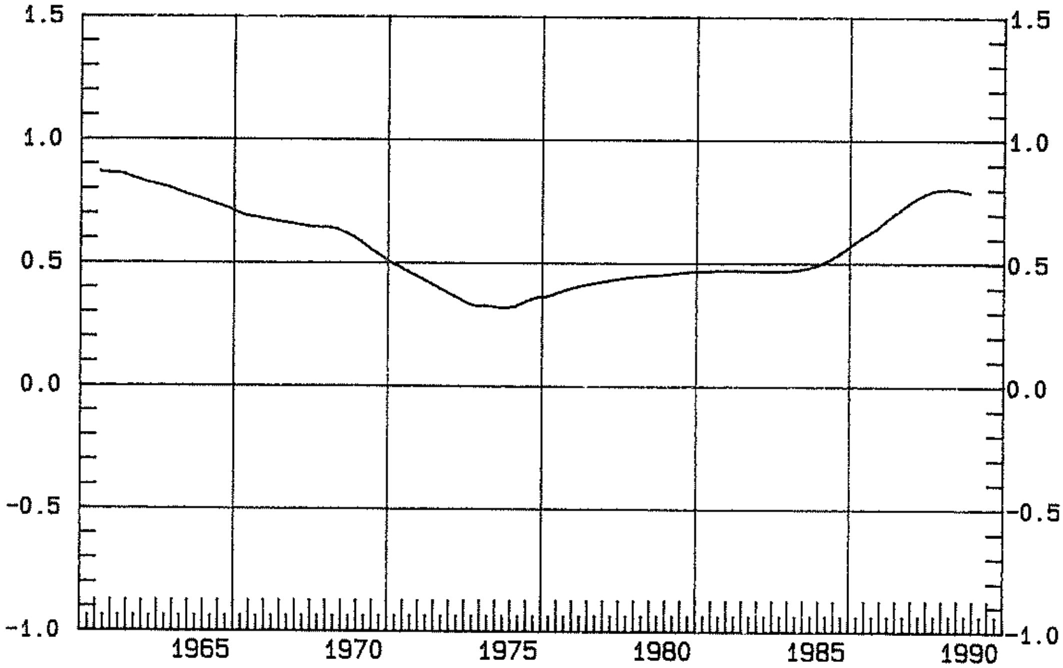

Figure 3a. Total consumption.

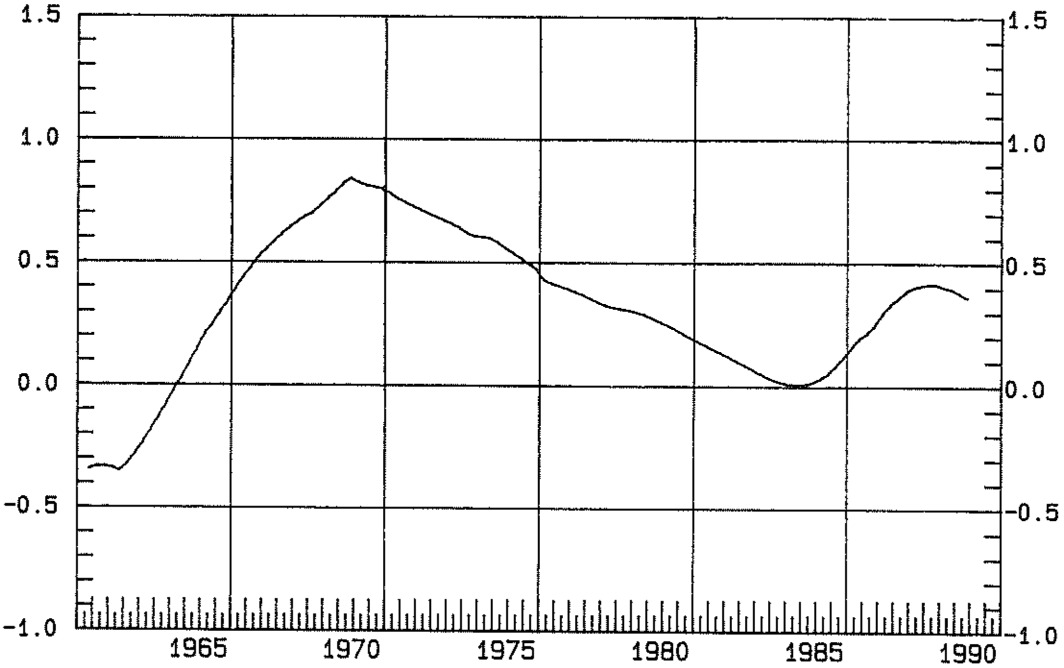

Figure 3b. Nondurable consumption.

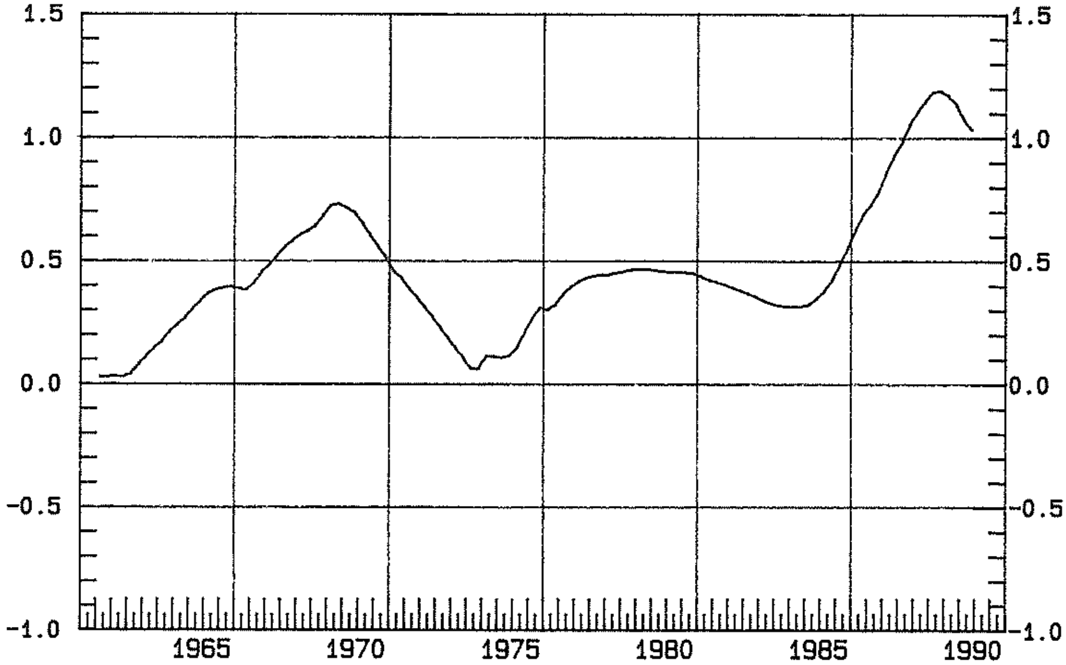

Figure 3c. Total consumption, elasticity interaction.

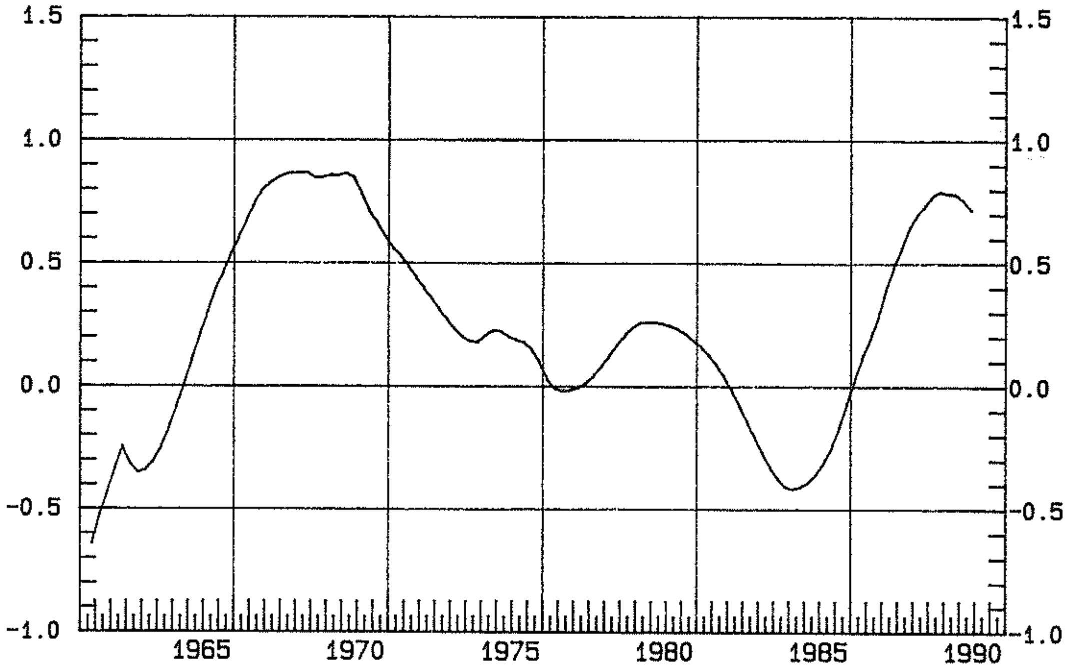

Figure 3d. Nondurable consumption, elasticity interaction.

nondurables are shown in Figures 2a and 2b. In Figures 2c and 2d corresponding estimates allowing for interaction between the interest and the income elasticities are shown.

The estimates of the interest rate elasticity of aggregate consumption displayed in Figure 2 show a positive, albeit small, elasticity which has increased somewhat in recent years. Although the estimates differ slightly across specifications, it would be hard to reconcile the findings with a view that the interest rate elasticity is negative (arguably with the exception of the first half of the 1960s). In particular, the empirical results give no support for the view that the interest elasticity has been negative in recent years.

The time varying estimates are in line with the constant parameter estimates also in the sense that total consumption emerges as more interest rate sensitive than nondurable consumption. Moreover, the interest elasticity seems to have increased more in the case of total consumption than in the case of nondurable consumption. Allowing for interaction between developments in the interest rate and income elasticities of consumption tends to bring out the changes in the interest rate elasticity more clearly while preserving the general flavor of the results.

Turning to error correction specifications, we operationalize the observation equations as models A3 and A4 of the Appendix, and the transition equations, again, as random walks driven by our estimate of the incidence of credit rationing $\tilde{\lambda}$. Corresponding estimates for total consumption and consumption of nondurables are shown in Figures 3a and 3b. In Figures 3c and 3d corresponding estimates allowing for interaction between the interest and the income elasticities are shown.

The estimates of the interest rate elasticity of aggregate consumption displayed in Figure 3 show a positive albeit relatively variable elasticity. Both the size and changes over time of the estimated elasticities are markedly larger than when estimated from level specifications. Nevertheless, the estimation results are again very hard to reconcile with a view that the elasticity has been negative. In particular, the elasticity unanimously seems to have increased during the period of rapid credit expansion in recent years.

The time varying estimates based on error correction specifications are in line with the constant parameter estimates also in the sense that total consumption emerges as more interest rate sensitive than nondurable consumption. Allowing for interaction between developments in the interest rate and income elasticities of consumption again tends to bring out the changes in the interest rate elasticity more clearly while preserving the general flavor of the results. This shows up in the error correction estimates e.g. in the very low interest rate elasticity during the period 1973 – 1975 when the demand for credit was exceptionally strong in Finland.

It should be recalled that the differences in estimates of the interest rate elasticity across specifications, and, in the case of the fairly big fluctuations in the estimates based on error correction specifications, caution against interpreting the estimates too literally. The estimates are most probably distorted by a number of factors as discussed above. Nevertheless, all time varying consumption functions were adequate in the sense of having clean residuals and reasonable explanatory power (level specifications outperformed error correction specifications in terms of explanatory power). All in all, our findings point toward a positive, over time increasing interest rate elasticity of aggregate private consumption — not toward a negative elasticity as often thought.[6]

4. Conclusions

The aim of this note has been to examine whether the empirically documented positive interest rate elasticity of aggregate consumption in Finland is an artefact due to the previously widespread credit rationing. Namely, when credit was heavily rationed, the price of credit i.e. the interest rate may have been of no, or of very little, concern for consumers. Hence, estimates of the interest rate elasticity may be imprecise and/or proxying for other factors when based on data from the period of widespread credit rationing. It is only during the last few years, when credit markets have been liberalized, that one could hypotheticize that the elasticity has been negative.

The aim was carried out using a time varying parameter approach and quarterly data from the period 1960 – 1989. A time varying parameter approach has not been applied to the topic previously. The empirical evidence lends further support for a positive interest rate elasticity of aggregate consumption. The elasticity seems to have increased over time, especially in recent years. To some extent, this mirrors the gradual easening up of credit rationing, which has been particularly rapid in recent years.

Our finding of an increasingly positive interest rate elasticity of aggregate consumption runs counter to fairly commonly held beliefs about this elasticity. The implications of our findings — if believable — for monetary policy are also startling. However, we do not claim to having presented conclusive evidence on these matters. We merely wish to point out an interesting salient feature of the Finnish experience which merits further study.

It should be stressed, however, that our empirical findings are compatible with economic theory. A positive interest rate elasticity is compatible with a life cycle model of consumption in which the aggregate interest rate elasticity depends on the age distribution of the population. If a large fraction of financial wealth is held by the elderly — as in Finland — the interest rate elasticity of aggregate private consumption may be positive.

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Appendix

FIXED PARAMETER (OLS) ESTIMATES OF CONSUMPTION FUNCTIONS

Total consumption, levels

(A1) $$c_t = \underset{(5.87)}{1.44} + \underset{(5.78)}{0.314}y_t + \underset{(3.32)}{0.110}r_t + \underset{(12.7)}{0.682}c_{t-1} + \hat{\varepsilon}_{A1,t}$$

$\bar{R}^2 = 0.997 \quad LB = 0.045$

Nondurable consumption, levels

(A2) $$c_t = \underset{(5.81)}{1.44} + \underset{(5.69)}{0.318}y_t + \underset{(2.54)}{0.090}r_t + \underset{(4.11)}{0.356}c_{t-1} + \underset{(2.57)}{0.213}c_{t-2} + \hat{\varepsilon}_{A2,t}$$

$\bar{R}^2 = 0.992 \quad LB = 0.224$

Total consumption, error correction form

(A3) $$\Delta c_t = \underset{(5.68)}{6.75} + \underset{(4.51)}{0.280}\Delta y_t + \underset{(3.49)}{0.475}r_t - \underset{(-5.65)}{1.47}(c_{t-1} - 1.003y_{t-1}) + \hat{\varepsilon}_{A3,t}$$

$\bar{R}^2 = 0.244 \quad LB = 0.063$

Nondurable consumption, error correction form

(A4) $$\Delta c_t = \underset{(6.27)}{7.05} + \underset{(3.29)}{0.233}\Delta y_t + \underset{(2.75)}{0.386}r_t - \underset{(-6.25)}{2.08}(c_{t-1} - 0.753y_{t-1}) - \underset{(-2.28)}{0.187}\Delta c_{t-1} + \hat{\varepsilon}_{A4,t}$$

$\bar{R}^2 = 0.371 \quad LB = 0.364$

The estimation period is 1961Q2 – 1989Q4. t-ratios are displayed in parentheses. $\bar{R}^2$ is the coefficient of multiple determination corrected for degrees of freedom. LB is the Ljung & Box (1978) test for autocorrelation (based on 14 lags). Marginal significance levels are given for LB. The cointegrating parameters of the error correction terms were estimated by OLS from static cointegrating regressions. These estimates are superconsistent (Stock (1987)) with desirable small sample properties (Phillips & Hansen (1990)). Note that the t-statistics for the coefficients of the real interest rate variable are valid (Sims et al. (1990)).