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Indexed deposits
and price expectations

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INDEXED DEPOSITS AND PRICE EXPECTATIONS

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Expectations are an illustrative example of auxiliary concepts used in theories going beyond observational regularities. Though theoretical concepts of this kind sometimes confront us with the dilemma of their elimination so as to arrive at connections between directly observable variables, it is generally agreed that they provide us with a deeper and heuristically fruitful understanding of the phenomena under study (see e.g. Tuomela, 1973). Inflationary expectations are also an example of the way how such auxiliary concepts make theories more open and capable of growth as they start to live a "life of their own". As the role of expectations in influencing the rate of inflation has recently been emphasized, there have been several attemps to arrive at observable time series for price expectations (Turnovsky, 1970; Turnovsky and Wachter, 1972; Knöbl, 1974; Carlson and Parkin, 1975; Paunio and Suvanto, 1975). This has also made it possible to test various hypotheses concerning the formation of expectations, which had previously to be tested together with other hypotheses with the help of "reduced form equations".

I Derivation of the expected rate of inflation

Finland's extensive experience of indexation also includes indexed deposits, which were introduced in 1955 (for the Finnish history with indexation see e.g. Suviranta, 1960; Bank of Finland, 1967; Puumanen, 1967, 1973; Mukherjee and Orlans, 1974). The principal on these accounts was tied to the cost of living index either to the extent of 50 or 100 per cent but they bore interest at a lower rate than the corresponding ordinary deposits. After the inflationary period in 1956-1958 the popularity of index deposits diminished until they became tax-free in May 1964. This, in combination with accelerating inflation, contributed to their attractiveness and their share in total deposits rose to and remained permanently at a higher level until they, together with most forms of index clauses, were abolished as part of the Stabilization Agreement concluded in 1968. During the same period there also existed so-called "high interest" deposits, which - except for the interest rate and the index linkage - had terms similar to those of the index deposits, e.g. a minimum deposit time of one year and a minimum deposit sum.

It is generally considered that inflationary expectations are reflected in relative prices of financial and real assets and in the rate of interest on financial assets (see e.g. Parkin, 1975, p. 252). Without any further constraints, however, the identification of the effects of expectations is difficult because of several other intervening variables and because of the dynamic nature of the adjustment process. In cases where prices or interest rates are fixed, for some reason or other, changes in expectations should be reflected in a more simple way in the asset distribution, which then can be used to obtain independent information on the expected rate of inflation. In the following we will estimate a series for the expected rate of inflation as a function of the share of index deposits in the sum of index deposits (the rate of interest on which was fixed in real terms) and "high interest" deposits (the rate of interest on which was fixed in nominal terms). We thus make the simplifying assumption that the choice concerning the relative size of these two similar asset forms can be separated from the choice concerning their combined share in the portfolio. As the yield on non-indexed and indexed accounts was uncertain in real or nominal terms, respectively, it is easily seen that this separability assumption is a rather strong one if we are not only interested in expected returns but also allow for risk minimizing behaviour. In order to eliminate the effects due to different tax treatment of the two forms of accounts, we will in the following confine ourselves to the period May 1964-February 1969. The relative share of deposits tied 50 per cent to the cost of living index was small during the period of investigation. As depositing money on these accounts was practically equivalent to placing one half of it on the 100 per cent indexed accounts and the other half on the "high interest" accounts, we have simply divided deposits on the 50 per cent accounts between the other two account forms. Allocation of wealth on these three forms of accounts as a simultaneous choice offers an interesting area of future research.

We have used for the calculation of the relative shares the new amounts deposited each month, instead of the existing stocks. A considerable proportion of these one-year deposits was renewed and as a part of the renewing was automatically carried out by the banks, we have not included the renewed deposits in the series. The relative shares calculated on the basis of the existing stocks and on the basis of new deposits are compared in Figure 1. The series for new deposits are not available on a nation-wide basis. The series used here were kindly placed at our disposal by Kansallis-Osake-Pankki (the largest commercial bank in Finland) and they represent about one fifth of the total deposits on the corresponding accounts. The series based on the existing stocks is calculated using the total stocks as given in the national statistics. The considerable difference between the two series is to a large extent due to the minimum deposit time of one year which makes the relative shares of the existing stocks adapt with a time lag to the "desired" marginal distribution.

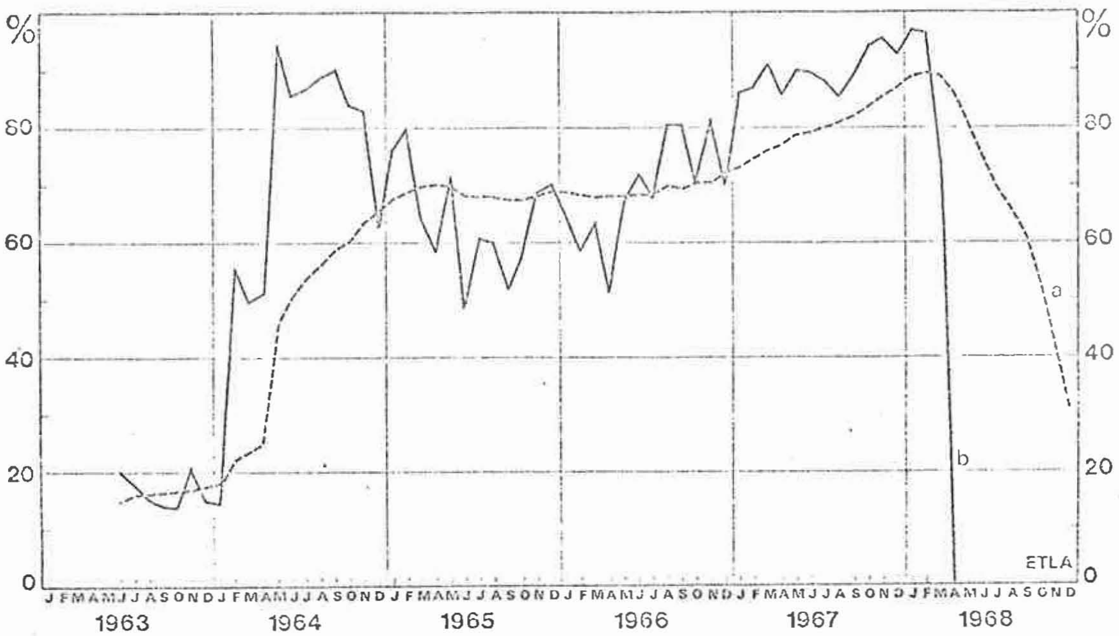

Figure 1. Relative share of indexed deposits calculated on the basis of existing stocks (a) and of new deposits (b).

In the following we assume that the anticipated percentual change (according to the expectations held at month t) in the cost-of-living index from month t to month t+12, $p_t^e(t,t+12)$ is a random variable the mean of which, $\bar{p}_t^e(t,t+12)$, is a function $f(x_t)$ of the relative share x_t of the amount deposited on indexed accounts out of the total amount deposited on indexed and high interest accounts. For instance, in this notation the percentual price change during the half-year period beginning after two months from now, according to the expectations held last month, would be $p_{t-1}^e(t+2,t+8)$. The exact monthly time path of the expected price development can be given as a sequence of expected monthly price changes, but as the index compensation depended only on the total change over the year following the time of depositing, a single yearly change suffices for our purposes. When it is clear from the context that expectations relate to the following year, $p_t^e(t,t+12)$ will be abbreviated as p_t^e. We further require that

$$\text{If } x(t) = 1/2 \text{ then } \bar{p}_t^e = f(x_t) = \Delta r_t \tag{1}$$

$$f'(x_t)>0 \tag{2}$$

$$f(1)>>\Delta r_t>>f(0) \tag{3}$$

where Δr_t is the difference between the rates of interest (without index compensation) on the two accounts. There was only one change of half a per cent in Δr_t during the period of investigation and we assume that depositors took its value as given.

One simple choice which leads to a function that fullfils the above desiderata is to use for the price expectations the normal distribution, i.e., $p_t^e \sim N(\bar{p}_t^e, \sigma_t)$.
This case is illustrated in Figure 2. For a discussion of the normality assumption see Carlson (1975).

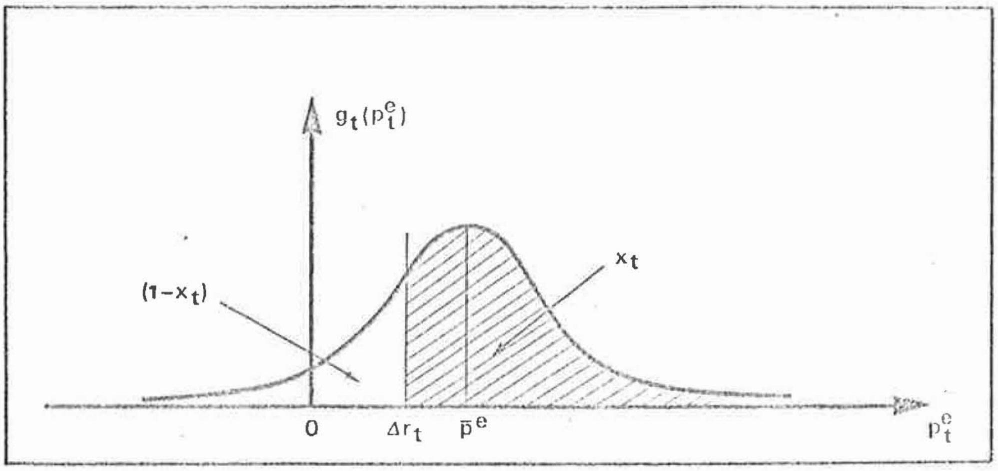

Figure 2. Density function g_t of the random variable $p_t^e(t,t+12)$

For the corresponding standardized variable we have

$$z_t = \frac{\Delta r_t - \bar{p}_t^e(t,t+12)}{\sigma_t} = \Phi^{-1}(1-x_t) = -\Phi^{-1}(x_t) \qquad (4)$$

where Φ is the distribution function of the standardized normal distribution N(0,1). Therefore, the mean expected rate of inflation satisfies

$$\bar{p}_t^e = f(x_t) = \Delta r_t + \Phi^{-1}(x_t)\sigma_t \, . \qquad (5)$$

As Δr_t is known from the terms of the different deposit forms and $\Phi^{-1}(x_t)$ from the relative shares x_t, we can use equation (5) to calculate $\bar{p}_t^e$, if we make some assumption of σ_t. We have here assumed a constant σ and derived its value by setting the variance of $\bar{p}_t^e(t,t+12)$

$$\begin{aligned}\mathrm{var}(\bar{p}^e_t) &= \mathrm{var}(\Delta r_t+\Phi^{-1}(x_t)\sigma) \qquad (6)\\ &= \mathrm{var}(\Delta r_t)+\mathrm{var}(\Phi^{-1}(x_t)\sigma)+\mathrm{cov}(\Delta r_t,\Phi^{-1}(x_t)\sigma)\\ &= \mathrm{var}(\Delta r_t)+\sigma^2\ \mathrm{var}\ \Phi^{-1}(x_t)+2\sigma\ \mathrm{cov}(\Delta r_t,\Phi^{-1}(x_t))\end{aligned}$$

equal to the variance of the observed inflation rate p(t-12,t) during the observation period and solving the resulting equation for σ. In our case, almost the same value of σ is obtained by setting the average of $\bar{p}^e_t$ equal to the average observed inflation rate (the resulting expectation series in Figure 3 being denoted $\bar{p}^{e'}_t$). With constant σ and Δr, $\bar{p}^e_t$ is a linear function of $\Phi^{-1}(x_t)$ and thus the choice of σ has only a limited effect on, e.g., the results obtained in explaining the formation of expectations by linear regression.

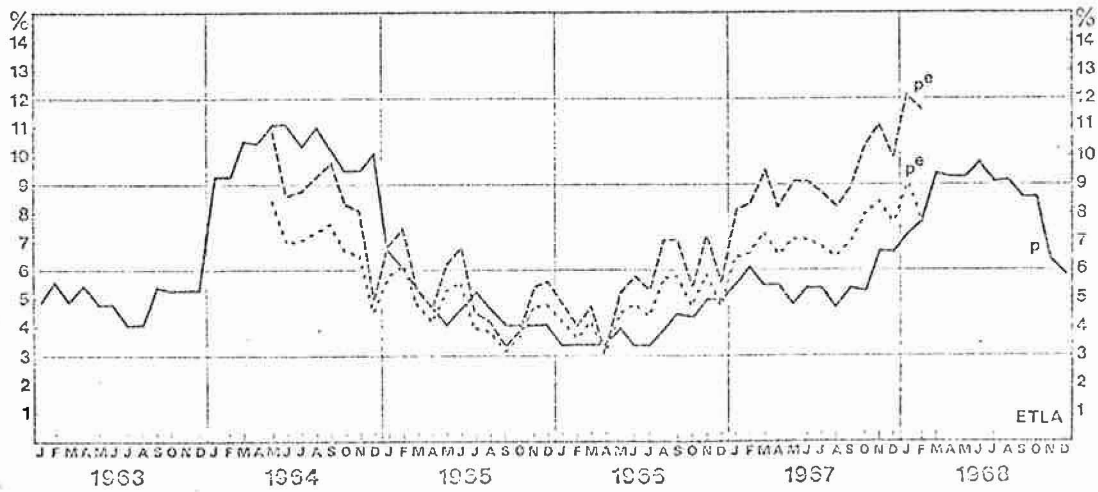

Figure 3. Actual inflation rate p(t-12,t) calculated over the last 12 months and average expected inflation rates $\bar{p}^e_t$(t,t+12) and $\bar{p}^{e'}_t$ (t,t+12) for the next 12 months

Our series for the average expected rate of inflation during the following 12 months seems to follow to some extent the observed inflation during the last 12 months, p(t-12,t), a rough measure of recent inflationary experience. Note that in order to see how expectations correspond to realization we should have to move the $\bar{p}_t^e$ series in Figure 3 forwards by 12 months, since the difference between the realized and expected inflation during the last 12 months is $\bar{p}_{t-12}^e(t-12,t)-p(t-12,t)$.

From the beginning of 1967 the expected rate of inflation seems to rise clearly above the observed rate p(t-12,t). This may, of course, be due to a more complicated lag structure between realized and expected price changes, not revealed by the series in Figure 3, but it may also be due to the effects of some intervening variables. Besides the change in the tax treatment of indexed deposits at the beginning of our estimation period, there were also other factors (e.g., a tax reform in the housing market, quite heavy personal taxation and an unfavourable business climate preceding the 1967 devaluation) contributing to the growth of indexed and high interest deposits (see Puumanen, 1973, p. 113). Their relative shares (at a given inflation rate) may also have been affected by these factors i.e., our separability assumption may have been invalid. Speculation preceding the 1967 devaluation is another explanation which could be given to the raised expectations.

II Formation of expectations

After deriving the expected inflation rate for the next 12 months of those making deposits on the index accounts or on the high interest accounts, we may investigate how these expectations are formed. Naturally, great care must be used in generalizing the results obtained here to other groups and to different time horizons.

There are several variables which might directly affect the inflationary expectations. If expectations were formed on the basis of economic theory, we would arrive at equations similar to those used to explain and predict price changes in econometric models including e.g., wage, tax and import price changes and excess demand as explanatory variables. Furthermore, several factors related to, say, political developments, incomes policy agreements and "the general business climate" may directly affect people's ideas of future inflation. Here we only shortly explore how current and past inflation as measured by the cost of living index (which also was the basis for the index linkage) affected the expectations. Our data suggests that the devaluation in October 1967 had a noticeable effect on expectations, and therefore we have included a dummy for this month. It is clear, however, that a simple dummy is not sufficient to explain the effect of devaluation on expectations, which were probably raised permanently over several months, and possibly due to the speculation concerning a possible devaluation even in the months preceeding the actual devalutaion. The effects of a single dummy depend also on the specification of the rest of the model. Thus e.g. in the models where the Koyck-transformation is used the October 1967 devaluation will be represented by a geometrically declining distribution.

Our simple one-equation models are estimated by the ordinary least squares method, a more complete model for the inflationary process being left un specified. Some shortcomings connected with this approach are given in G. Fisher (1975).

The cost-of-living-index for any given month is published in Finland in the middle of the next month, and there is some uncertainty as to whether we may use the price development (as measured by the index) of the current month to explain the current expectations. If we believe that it is the published index figures which mainly affect expectations we should have a minimum lag of one month in this series. On the other hand, if we suppose that various pieces of price information received from other sources during the current month affect the expectations, we can also use the non-lagged price changes. According to our experiments the latter specification is better.

Some previous studies explaining the formation of inflationary expectations have used a specification where monthly observations for the expected price change during, say, the next n months $\bar{p}^e_t(t,t+n)$ have been explained by actual inflation rates $p(t-12,t)$ calculated from the corresponding month of the previous year. The lenght of the difference used with explanatory variables in relation to the lenght of successive observation periods in an important factor affecting the dynamic properties of the model. Thus e.g. the distributed lag model

$$\bar{p}^e_t(t,t+12)=a+\sum_{i=0}^{11}b_i p(t-\tau-i,\ t-i)+cD\ , \qquad (7)$$

where we have denoted the October 1967 dummy by D, gives very different results depending on the lenght of the period(=τ) over which the observed price changes are calculated. A comparison between results obtained from this model with monthly and yearly differences without constraints on the parameters b_i is presented in Table 1. It seems to suggest that monthly rather than yearly differences should be used and that, in our case, the last few months' price changes had the most noticeable effect on expectations, after which the lag parameters decline rather sharply. In interpreting the results it is important to remember that we have not transformed the observed price changes to an annual level. Both these models imply that expectations would not be fully adjusted to the observed inflation rate.

In order to constrain the form of the lag distribution we estimated models with the most recent observed price change, and lagged expectations as explanatory variables, which (if we forget specification of the error process) can be interpreted to correspond to the geometrical lag distribution. To further illustrate the importance of the choice of the period over which observed price changes are calculated, we have presented in Table 2 the results obtained with various lenghts of differences. This specification has sometimes also been derived from the assumption of (first order) adaptive expectations, i.e.,

$$\bar{p}_t^e(t,t+n)-\bar{p}_{t-1}^e(t-1,t-1+n)=\lambda(p(t-\tau,t)-\bar{p}_{t-1}^e(t-1,t-1+n)). \quad (8)$$

However, if the difference on the right hand side is to represent a comparison between forecast and outcome for any given period, it is necessary for the lenght of the horizon for which the expectations are formed (=n) and the lenght of the period over which the observed inflation rate is calculated (=τ) to equal the lenght of the successive observation periods (which is here taken as 1). This is not the case if expectations are formed, say, for the next 6 months, the observation period is one month and the relative differences in the observed inflation rate are calculated over 12 months. In our case $\tau = 1,...,12$ but in all the models n=12, and we cannot give our models the interpretation of adaptive expectations, at least not in the ordinary sense.

Table 1. Parameter estimates, coefficent of determination (corrected for the degrees of freedom) and Durbin-Watson statistic D-W for the model $\bar{p}_t^e(t,t+12)= a+\sum_{i=0}^{11} b_i p\ (t-i-\tau,t-i)+cD$ when τ is given the values 1 and 12. t-values in parentheses.

	$\tau=1$		$\tau=12$	
a	2.608		5.534	
b_0	2.140	(3.354)	0.924	(2.131)
b_1	1.848	(2.821)	-0.333	(-0.590)
b_2	2.120	(3.229)	0.467	(0.840)
b_3	0.226	(0.345)	-0.334	(-0.607)
b_4	0.278	(0.577)	-0.496	(-0.976)
b_5	0.874	(1.843)	0.131	(0.289)
b_6	1.021	(2.240)	0.337	(0.753)
b_7	0.831	(1.788)	-0.074	(-0.167)
b_8	0.603	(1.388)	0.224	(0.508)
b_9	-0.250	(-0.594)	-0.426	(-0.963)
b_{10}	0.461	(1.103)	0.007	(0.016)
b_{11}	-0.312	(-0.769)	-0.134	(-0.405)
c	4.103	(2.363)	3.496	(1.813)
R^2	0.677		0.576	
$\bar{R}^2$	0.536		0.390	
D-W	2.608		0.790	
$\sum_{i=o}^{11} b_i$	9.84		.293	

According to the results set out in Table 2, recent inflationary experience is clearly reflected in the expectations concerning price changes during the next 12 months. In all cases the approximate long-run response of expectations to a permanent 1 % change (at annual level) in the observed inflation rate ($\approx \frac{b}{i-c}\frac{\tau}{12}$) is seen to be smaller than the a priori value of 1 %. For different values of τ the form of the response is, of course, somewhat different. With $\tau=1$ we have the geometrical lag distribution and with $\tau>1$ combinations of geometrical distributions. Instead of employing percentage changes, models of this kind should be specified in logarithmic changes, which are a better indicator for relative changes, and which due to their methodologically more appealing properties - e.g., symmetricity and additivity - would allow for an easier investigation of the properties of the models, However, as the drawbacks of using percentages in the case of small changes are not serious, we have followed the traditional specification (for a comparision of different indicators of relative change, see Y. Vartia, 1976).

With our partial and very crude models, it is difficult to draw any firm conclusions about the formation of inflationary expectations. Of course, we have also to remember the weaknesses of the method with which the expectation series was obtained. Although a part of the variation in the mean expected inflation rate of the depositors can clearly be

Table 2. Parameter estimates, coefficent of determination (corrected for the degrees of freedom) and Durbin-Watson statistic D-W for the model $\bar{p}_t^e(t,t+12)=a+bp(t-\tau,t)+c\bar{p}_{t-1}^e(t-13,t-1)+dD$ when τ is given the values $\tau=1,\ldots,12$. t-values under the corresponding parameter in parentheses.

τ	a	b	c	d	$\bar{R}^2$	D-W	$\frac{b}{1-c}\ \frac{\tau}{12}$
1	1.109	0.794	0.792	1.783	0.701	2.409	.318
		(1.617)	(9.124)	(1.404)			
2	1.097	0.618	0.768	1.461	0.700	2.438	.443
		(1.605)	(8.325)	(1.137)			
3	1.093	0.709	0.713	1.820	0.717	2.225	.618
		(2.284)	(7.408)	(1.474)			
4	1.170	0.340	0.748	1.818	0.692	2.370	.450
		(1.208)	(6.844)	(1.411)			
5	0,998	0.579	0.678	1.815	0.720	2.263	.749
		(2.366)	(6.549)	(1.477)			
6	1.163	0.340	0.704	2.040	0.702	2.253	.574
		(1.677)	(6.232)	(1.596)			
7	1.148	0.281	0.710	2.008	0.698	2.236	.565
		(1.493)	(6.058)	(1.561)			
8	1.116	0.288	0.691	2.185	0.701	2.216	.621
		(1.641)	(5.775)	(1.688)			
9	1.108	0.244	0.698	2.140	0.698	2.154	.606
		(1.513)	(5.717)	(1.648)			
10	1.146	0.084	0.780	1.855	0.684	2.308	.318
		(0.581)	(6.330)	(1.412)			
11	1.093	0.121	0.754	1.968	0.688	2.189	.451
		(0.954)	(6.376)	(1.499)			
12	1.174	0.000	0.832	1.765	0.682	2.382	.000
		(0.002)	(7.136)	(1.332)			

explained by recent inflationary experience, a considerable part of the total variance is in our exercise left unexplained. This suggests that a lot of further research both analytical and empirical, is required regarding the nature of expectations, the way they are formed and on regarding how they eventually could be affected by policy measures, e.g., as a part of counter - inflationary programs.

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REFERENCES

BANK OF FINLAND (1964), Institute for Economic Research. The index clause system in the Finnish money and capital markets, D 2, Helsinki.

CARLSON, J.A. (1975). Are price expectations normally distributed? Journal of American Statistical Association, 70, 749-754.

CARLSON, J.A. and PARKIN, M. (1975). Inflation expectations, Economica 42, 123-135.

FISHER, G. (1975). Discussion of Parkins paper "The causes of inflation: Recent Contributions and Current Controversies" in Current Economic problems, (M. Parkin and A.R. Nobay, eds.) 274-291. Cambridge University Press.

KNÖBL, A. (1974). Price expectations and actual price behaviour in Germany. IMF Staff Papers. Vol. XXI, No. 1, 83-100.

MUKHERJEE, S. and ORLANS, Cl. (1974). Indexation in an inflationary economy, a case study of Finland, Political and Economic Planning, Vol. XL Broadsheet No. 551.

PARKIN, M. (1975). The causes of inflation: recent contributions and current controversies, in Current economic problems, (M. Parkin and A.R. Nobay, eds.). Cambridge University Press. 243-274.

SUVANTO, A. and PAUNIO, J. (1975). Changes in price expectations: some tests using data on indexed and non-indexed bonds, Department of Economics, University of Helsinki, Discussion Papers No. 24.

PUUMANEN, K. (1967). Indeksivaateet valintakohteina. Bank of Finland Institute for Economic Research, D 19, Helsinki.

PUUMANEN, K. (1973). The index clause in financial markets: the Finnish system in retrospect. Kansallis-Osake-Pankki, Economic Review 1973:3, 109-116.

SUVIRANTA, BR. (1960). A unique experiment in escalated wages. Banca Nazionale del Lavoro, Quarterly Review, No. 54, Vol. XIII, 265-281.

TUOMELA, R. (1973). Theoretical Concepts. Library of Exact Philosophy, Vol. 10, Springer Verlag, Wien.

TURNOVSKY, S.J. (1970). Empirical evidence on the formation of price expectations. Journal of American Statistical Association, Vol. 65, No. 322, 1441-1454.

TURNOVSKY, S.J. and WACHTER, M.L. (1972). A test of the expectations hypothesis using directly observed wage and price expectations. The Review of Economics and Statistics, 47-54.

VARTIA, Y. (1976). Relative changes and index numbers. Research Institute of the Finnish Economy, A 4, Helsinki.