The Revision and Realization of Investment Plans in the Finnish Manufacturing Industries in 1964 – 1986

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Ilmo Pyyhtiä

CONTENTS

I INTRODUCTION

I.1 Aims of the Study

The aim of this study is to examine the usefulness of survey data on manufacturing firms' investment plans in economic analysis and forecasting. Such data are valuable in studying the determination of investment and economic policy effects because data on changes in investment plans enable us to study the realization process of the plans. The plan data are also of independent value in econometric equations explaining investment, because firms have internal information on themselves which may not necessarily be included in published economic data. Such information includes factors relating to a firm's output and organization and its actual market position in its own sector. The sectoral data on manufacturing investment and investment plans used in this study cover more than two decades (Appendix 1). They have been compiled by the Bank of Finland and have never been published before.

In modelling firms' investment plans, and especially changes in plans, we follow the Modigliani tradition dating back to the 1950s. Investment plans, which are here regarded as binding decisions, are assumed to be the outcome of the same kind of optimizing behaviour as for final investments. Investment plans and final investment generally differ from each other, because there are innovations in the relevant information sets owing to the difference in time and because the realization of plans is seldom completely successful in respect of timing and volume. On the other hand, the costs of revising plans increase as the time of implementation approaches and so it pays to carry out the project even though its potential profitability has deteriorated substantially. In such cases, final investments may not be optimal with regard to the very latest information.

We develop Modigliani's (1958) investment realization function, explaining changes in investment plans with innovations in such a way that the determination of optimal investment and investment plans conforms with the neoclassical theory of investment, which was not precisely formulated until the 1960s and 1970s. In addition, we incorporate in this function the latest theoretical developments of the 1970s and 1980s, namely, the impact of uncertainty on the firm's optimal demand for capital. In modelling revisions in investment plans, use is made of rational expectations and optimal decision-making of the firm, which means efficient utilization of the latest information and optimal investment decisions with respect to the forecasts of the future and the relevant loss factors of the firm.

The emphasis in the study is on the empirical modelling of investment plans. The examination of the nature and predictive power of data on plans can be divided into the analysis of three major problems. The first is the question as to how well investment plans predict actual developments in investment. Here the difference between plans and forecasts should be emphasized. Given the available information, investment plans are conditional decisions on future investments. The firm may revise these decisions if information changes or if it encounters constraints preventing the implementation of plans. On the other hand, the investment plans for each period are the first step in an investment programme which may extend far into the future and which is optimal with respect to the capital stock at the time of the decision and forecasts of the future. Accordingly, the firm's investment plans are not intended to be forecasts of investment developments in the future. The accuracy of investment plans is examined empirically using rational expectations test methods. Although the testing of rational expectations as such is not meaningful in the case of the firm's decision data, the test methods provide a good basis for describing the data.

The second major problem is to find out on what kind of surprises changes in investment plans depend in the period leading up to the implementation of the investment. This analysis is divided into two stages: the explanation of revisions in investment plans and the explanation of the realization of plans. It can be assumed that revisions in plans only give rise to internal administrative adjustment costs, which can be assumed to be fixed, whereas final investments also face external adjustment costs and various market constraints. Hence, it can be assumed that the costs of revising investment plans increase as the time of their realization approaches because the number of various commitments related to the realization of plans grows. On the other hand, the loss arising from the fact that investment plans are not revised depends on the shocks to which the firm is subjected. We attempt to determine the information important from the point of view of the firm's optimal investment plans by applying the neoclassical theory of investment.

Thirdly, data on plans can be assumed to depict the uncertainty relating to the firm's forecasts of the future and its behaviour under uncertainty. In the neoclassical investment theory it can be shown that under very general assumptions the steady state capital stock of the firm increases with increasing uncertainty. Another result of the theory is that as uncertainty increases, the adjustment of the firm's capital stock towards the optimum decelerates. In that case, the firm endeavours to postpone its investment project and collects information so as to reduce uncertainty. Accordingly, under conditions of unusually great uncertainty, revisions in investment plans may also be greater than average. The effects of uncertainty have been analyzed in recent theoretical investment studies, and it is the aim here to test these results empirically, as the data seem to offer an opportunity for this.

I.2 Background

The first investment realization function, presented by Modigliani and Weingartner (1958), was based on ideas put forward by Hicks (1946) concerning the origin and nature of firms' plans. According to Hicks' dynamic analysis, firms must make decisions on their activities at the beginning of each period, so that the present value of profits is maximized subject to supply, demand and adjustment constraints. The best course of action selected applies to every future period over a certain interval.

The plan can be revised for the entire period covered by the plan if forecasts of economic developments prove to be incorrect (Modigliani and Cohen (1961)). However, the acquisition of information, planning and decision-making involve costs, which may force the firm to shorten the planning horizon and to choose the best possible alternative course of action for the following period only. The firm must nevertheless bear in mind the entire planning horizon, because current actions limit decisions concerning the future.

Modigliani and Cohen explain the difference between the firm's planned and realized activities merely in terms of unanticipated changes in information about the firm's operating environment. This information may concern any factor affecting the firm which is outside the control of its decision-making. Hence, plans should be interpreted as conditional statements of what the firm will do if its expectations are not revised in the future. It is not necessary to include the original information in the realization function, because it should already be included in the initial plans.

The realization function is an example of partial "choice theoretic" forecasting, which differs from the mechanical use of plans in forecasting. It is not considered possible to include plans in perfect choice-theoretic forecasting. However, frequently the problem is that an econometrician never has access to all the firm's relevant internal information. The authors call a realization function in which the original information is also an independent variable "an enforcement function". The idea here is that all available information has not been efficiently utilized in plans, so that the plans are not "rational". Modigliani and Cohen also examined the influence of uncertainty on the firm's plans for the future, as did Hicks in his dynamic analyses.

The earliest studies relating to investment plans were carried out in the United States in the 1950s using data compiled by the U.S. Department of Commerce from 1947 onwards. The studies concerning investment plan realization are summarized in Table 26 on page 181. In the realization function developed by Modigliani and Weingartner (1958), firms' investments were explained in terms of plans and unanticipated changes in sales. Eisner (1962, 1965) constructed more general realization functions in which firms' profits, unfilled orders and unrealized investment plans in the previous period were included as independent variables in addition to plans and sales. Eliasson (1967) examined the impact of imperfect financial markets on the realization of firms' investment plans using data compiled by the Statistical Centre of Sweden. Using the "Accelerator - Residual Funds" theory of Meyer and Kuhn (1957) and Meyer and Glauber (1964) as his starting point, he constructed a model of firms' financial planning, which he incorporated in Modigliani's realization function.

Under the auspices of the CIRET organization (Center for International Research on Economic Tendency Surveys), a number of studies of factors influencing the realization of investment plans has been carried out. Among the most interesting of these are the empirical studies by Aiginger (1977, 1983) explaining the realization and revision of investment plans based on Austrian data (Austrian Institute for Economic Research). The Austrian survey data are very similar to those compiled by the Bank of Finland (Pyyhtiä (1983, 1985, 1987a, b, c)). In these models, a fairly large number of variables are used as independent variables.

After Modigliani, a new study (McKelvey (1980)) was carried out on the basis of survey data on investment plans collected by the U.S. Department of Commerce; this study was mainly based on firm-specific data. The theoretical model draws on Hicks, Modigliani and Cohen. The study attempts to assess, from a number of viewpoints, the value of these data for use in mechanical forecasting and in different realization functions. The analysis of the aggregated data was supplemented by pooled data, because it was feared that important information on the realization of plans was lost in aggregation. It was, however, observed that the accuracy of plans was higher in the aggregated data than in the firm-specific data.

Various types of survey data have been widely used in testing the rational expectations hypothesis. Rational expectations are frequently classified according to their information content into weak, semi-strong and strong rationality (Fama (1976)). Weak rationality only requires efficient use of the information relating to the past values of the time series, semi-strong rationality requires efficient use of all publicly available information, while strong rationality further implies the acquisition of all relevant non-public information.

Feige and Pearce (1976) introduced a concept of economic rationality which offers a middle ground between autoregressive expectations formation and full rationality. They extend the analysis to include the acquisition costs of information and the loss function of forecast errors. The size of the information set can then be determined according to normal marginal conditions, i.e. the information set is at its optimum when the additional cost of a unit of each type of information is equal to the saving in losses resulting from the reduction in the forecast error.

Although the use of firms' planning data for testing the rationality of expectations is not sensible owing to the endogenous nature of data, these tests are, however, well-suited to examining the information content of plans. Modigliani assumed in his realization function that the information available at the time plans are made is used efficiently and that only unexpected changes in new information lead to revisions in plans. This idea is also contained in tests of rational expectations (Mishkin (1983)).

The development of investment theory opens up new avenues for the determination of realization functions for investment plans. In the 1960s, there were two main strands in the reformulation of investment theory. Jorgenson (1963, 1965, 1967) created the basis for the development of the neoclassical theory of the growth of the optimal capital stock, which was supplemented by studies of adjustment costs by Eisner and Strotz (1963), Lucas (1967) and Gould (1968). These so-called adjustment cost models provided a theoretical explanation for the slow adjustment of the capital stock in the neoclassical investment model, which had previously been based more on ad hoc hypotheses. In the neoclassical investment model, the optimal demand for capital merely depends on prices of labour and capital, when, according to Jorgenson, the price of capital includes the effect of expected developments in inflation and taxation, in addition to interest rates and prices of capital goods.

Another approach applied in the development of the theory of investment has been Tobin's q-theory. The major hypothesis of this market value theory of the firm is that investments are an increasing function of q, where q is defined as the ratio of the market value of given capital goods to the reacquisition price of capital (Tobin (1961, 1969). According to the theory, in a perfectly functioning capital market the value of a firm's shares directly reflects expectations about future profits. More recent literature (Abel (1979, 1982) and Hayashi (1982)) has, however, shown that these two theories of investment can be derived from the same points of departure, differing from each other only with respect to their emphasis. Similarity follows if the shadow price of given capital, which is the major variable in the neoclassical theory of investment, is interpreted as corresponding to the market price of capital. Thus, Tobin's q-variable can be shown to depend on the same factors as investment in neoclassical theory.

In a perfectly competitive market, the firm cannot affect the price of its sales at all. If it is assumed that the demand curve for commodities is not horizontal but downward-sloping, it can be shown that the firm's investment decisions are affected by demand (Nickell (1978)). An extreme case of this is where the firm has a perfectly monopolistic position in the market and is able to set the market price at a level which is optimal for it. Another extreme case in the goods market is that where the demand curve is vertical. In that case, the firm, for some reason, considers that the volume of its output is given in advance and that it pays to gear its investment merely to the minimization of costs (Grossman (1972)). With regard to financial markets, it is quite common to assume that some degree of rationing prevails in the market because of imperfect information (Koskela (1976)), in which case firms' liquidity positions may affect the timing of investment in some circumstances (Appelbaum and Harris (1978) and Schworm (1980)). Thus, the link between investment and the firm's profitability differs from the explanation provided by earlier profit theory. Another credit rationing case is the model of rising interest rate costs, in which the cost of external capital paid by the firm depends on its level of indebtedness (Steigum (1983), Koskenkylä (1985)).

Recently, growing attention has also been paid in investment theory to the effects of uncertainty. This is not a new issue since Hicks (1946) had already examined the role of uncertainty in connection with firm's plans, stating that, in addition to the mean values of forecasts of factors outside the company's control, it was also necessary to examine the dispersions of forecasts, the size of which indicated the importance of risk. Initially, uncertainty was only modelled within the framework of the cost function (Sandmo (1971), Lippman and McCall (1982)), but subsequently a random process describing uncertainty in relation to cash stream factors was incorporated in the neoclassical model. At first, the analyses were carried out in discrete time (Hartman (1972, 1973, 1976), Sargent (1978)), but later Ito's lemma was applied to a continuous time model (Abel (1981, 1983, 1984, 1985) and Pindyck (1982, 1986)). In these models, the objective of the firm is to maximize the expected present value of the firm, when the firm's attitude to risk is neutral. Other risk aversion behaviour is difficult to model in this framework.

The effects of uncertainty on the optimal demand for capital depend to a large extent on the type of model, but the most general result in the case of the neoclassical adjustment cost model is that uncertainty increases the optimal capital stock as compared with the model with perfect advance information. On the other hand, uncertainty retards the adjustment of the capital stock towards the optimum (Salmon (1983), Mustonen (1987)), and, under uncertainty, it may often pay to postpone investment decisions and be content with collecting information until profit expectations relating to the investment project exceed a certain boundary set in advance (McDonald and Siegel (1982), Pindyck (1986)). Although there are quite a large number of theoretical studies of the effects of uncertainty on the optimal demand for capital, experiments with empirical investment and realization functions are almost entirely lacking.

I.3 General Outlines

The aim of Chapter II is to indicate what points of departure for the present study are provided by the recent developments in the theory of investment. In the first part of this chapter, the traditional realization and revision functions for investment plans are elaborated using the hypothesis of rational expectations and the partial adjustment of capital stock as starting points (Kennan (1979)), Rotemberg (1983)). The main contribution here is to elaborate a model in which partial adjustment of announced investment plans to unexpected information is assumed. The adjustment path of the investment plans is determined by two loss functions incorporating the disequilibrium costs and transfer costs of plans (Orr (1966), Barro (1972).

Both linear and nonlinear utility functions are used as the firm's objective functions. In the nonlinear case, a solution of the closed form is obtained in which uncertainty affects the parameters of the model (Whittle (1982)). Risk-sensitive models are obtained in connection with the nonlinear utility function, so that it is not necessary to accept the standard assumption of risk neutrality associated with the original neoclassical model.

In the next stage, the neoclassical theory of investment is examined with a view to analyzing the factors affecting the firm's optimal investment plan. The framework used is a stochastic optimal control model in continous time. The objective of the competitive risk-neutral firm is to maximize the expected present value of net cash flow. Uncertainty relating to the future is illustrated by making all the price and cost variables of the model stochastic (Abel (1985)). The model is elaborated in this study by adding tax and depreciation parameters to the original framework. The model is solved and equations for gross fixed investment and the cost of capital under uncertainty about the future are calculated.

The following part of the study examines how, under uncertainty about the future, stochastic shocks influence the timing of revisions of investment plans. It is again assumed that the changing of investment plans involves costs, which are now lump sum and independent of the size of the change. The framework applied here to investment plans was first presented by McDonald and Siegel (1982).

The remaining part of the theoretical work studies the effects of imperfections in the product and credit markets on optimal investments and capital costs. The analysis is carried out at the general level within an uniform framework of continous time optimal dynamic control models (Nickell (1978), Abel (1979), Steiqum (1983), Koskenkylä (1985)). The purpose of the analysis is to map the information set relevant for the investments of the firm, applying conventional micro and macroeconomic investment theory.

In the empirical section of the study, the revision and realization of investment plans are first examined using statistical and econometric methods (Chapter III). In the statistical analysis, the nature of the data is described graphically and by calculating various indicators for revisions in plans, including root-mean-square error analysis after Theil (1961), Tichy (1976), Granger and Newbold (1977). In the econometric analysis, the accuracy of plans is examined by sectors and according to the length of the survey horizon. The accuracy of plans is described in terms of unbiasedness and the efficiency with which initial information is used. A basic requirement for the rationality of plans is that they are unbiased. A stronger requirement is their orthogonality, i.e. that publicly available initial information has been used efficiently.

It is found that investment plans are not "perfect forecasts" of the future for the two longest survey horizons. Investment plans are conditional expectations about the future and revisions of plans depend on unexpected new information. This means that investment plans cannot be used as such in forecasting. Rather, it is necessary to use realization functions. However, their utilization requires a better assessment by the forecaster of the course of development in exogenous factors than firms expected when drawing up their plans. But, because of the difference in time and resources, the forecaster may have newer and better information at his disposal than firms. The effects of unexpected new information on revisions of manufacturing firms' investment plans are tested using a large number of variables and different estimation methods (Chapter IV).

In the last chapter, Chapter V, some investment equations are estimated in the form of the Euler equation. The advantage of estimating the firm's decision rule in its unsolved form is that the dynamics is defined directly in the equation and different assumptions concerning it are not needed. This exercise has two purposes. One is to impose another test on the information content of the investment plan data. The test results of Chapter III on the rationality of investment plans are verified in the optimizing framework. The other aim is to complete the study on the use of the survey data in forecasting. The parameters of the investment equation are estimated both in the Euler equation form and in the form of solved decision rules. Overidentified and cross equation restrictions of the investment equations are tested. An interesting contribution of this work is that it enabled us to estimate the values of some structural parameters in connection with the investment equation using Finnish data.

II INVESTMENT THEORY AND INVESTMENT PLANS OF THE FIRM

II.1 Aims of the Chapter

The aim of this chapter is to lay the theoretical foundations for the empirical analysis of investment plan data appearing later. To start with, the determination of the optimal investment plans of the firm is analyzed as a function of the latest information available to the firm. In determining the optimal investment plans we apply a partial adjustment model of the capital stock, which is derived from two quadratic adjustment cost functions (Kennan (1979)). We first consider a theoretical model of investment plans in which the adjustment of plans takes place without cost and then, a new model, elaborated in this study, in which adjustment costs are associated with the revision of plans. The effects of uncertainty and risk on plans are also analyzed in this framework.

The information set relevant to the firm's expectations is difficult to define, because there is large amount of information which the firm obtains regularly. To solve this problem we limit information to that data which is directly linked to the objective function of the firm. Of course, the firm forms an opinion on the growth of its profits with the aid of a larger information set, which we cannot identify. The objective of the risk neutral firm is assumed to be the maximized expected present value of net cash flow. This is the conventional way of modelling the optimizing behaviour of the firm.

The determination of the optimal capital stock is analyzed in accordance with conventional neoclassical investment theory using a continuous time dynamic model, in which uncertainty attaches to the prices of factors of production. Uncertainty is described by an Ito-stochastic process. The effects of changing uncertainty are examined in two ways: by increasing the scale of the variance term and by changing the nature of the stochastic process. In both cases the expected value of the process stays unchanged. The model framework was first presented by Abel (1985) and it has been extended in the present study to include the effects of corporate taxation. The investment equation and Jorgensonian (1963) user cost of capital are calculated from this optimization problem. The effects of uncertainty on the timing of investment decisions are studied in a framework in which changes in investment plans are associated with costs which are independent of the realization time of the plans. With time-dependent costs the solving of the model is difficult. The model is stochastic so that there are shocks attached to the total cash stream of the firm. The model was first presented by McDonald and Siegel (1982) in connection with irreversible investment projects and it is now applied to the optimal timing of investment plans.

Demand for the output of the firm has been a statistically significant explanatory variable in investment studies on the Finnish manufacturing sector (Koskenkylä (1985)). Accordingly, a brief survey is given of the main theoretical explanations for demand in the investment equation derived from the optimizing behaviour of the firm. As is well known, demand is a decision variable in conventional neoclassical investment theory with perfect competition in the product markets. There is, however, stickiness in prices owing to information acquisition costs of the firm and adjustment costs in prices (Barro (1972)). In the short-term adjustment of investment plans, demand can be the fastest indicator of the marginal productivity of capital. The two most typical cases of product market imperfections are presented: the model with a downward-sloping demand function (Pindyck (1982)) and the constrained demand case (Grossman (1972)). An example of the macro-level investment function is the stochastic optimal growth model (Brock and Mirman (1972), Sargent (1986)).

The Finnish capital market was characterized by credit rationing during the 1960s and 1970s, the period covered by this study (Oksanen (1977)). Credit rationing was a consequence of administratively low interest rates and capital controls. The effects of credit rationing on optimal investment demand are briefly summarized using a nonlinear interest rate model in which the loan rate of the firm is related to the expected profitability of the firm to the bank. The model is elaborated from Steigum's (1983) work. For the sake of simplicity expected profitability is described in terms of the solvency of the customer. Corporate analysis by Finnish banks is highly developed so that an assumption on the differentiation of customers is justified. Loan interest rates are, however, bounded upwards at a certain default risk level so that in spite of willingness to borrow at higher interest rates no loans are granted.

II.2 Determination of Investment Plans

Let us assume that the firm's optimal investment plans are the result of the same kind of optimizing process as final investments (Hicks (1946)). Plans are, however, endogeneous to the firm and can change before realization as a function of exogeneous information. We can define investment plans as conditional expectations about future realizations.

First we analyze the theoretical situation when investment plans can be changed without cost as a function of new information. We then assume that the revisions of announced investment plans are not costless. The revision costs are an increasing function of changes in plans.

We write a conventional investment function, where adjustment of the capital stock involves lags. Initially, we assume that the loss function is quadratic because it facilitates mathematical treatment and is also intuitively relevant. The target function of the firm is assumed to be linear with a stochastic term. The assumption of the partial adjustment of the capital stock emphasizes the role of expectations formation in the determination of investments. This is in contrast to the myopic model, where adjustment to shocks is immediate and the firm does not need try to provide for different kinds of future situations in its investment policy.

The objective of the firm is to maximize the expected present value of the net cash stream

$$(1) \qquad \pi(t) = \max_{K,L} E(t) \sum_{t=0}^{\infty} R^t P^*(t),$$

where E(t) refers to the conditional expectation $E(t)(X(t)) = E[X(t) \mid \Omega(t)]$ conditional on the time-specific information set $\Omega(t)$, R is a discount factor of the form 1/(1+r), where r is the discount rate and t is time. P* is the cash stream and is of the form $P^*(t) = pQ(K(t),L(t)) - wL(t) - qI(t)$, where p is the price of production, the volume of production Q is a function of the capital stock K and the labour input L, w is the labour cost, q is the price of capital goods and I is the volume of fixed investment. Perfect foresight is assumed to prevail as regards prices as there is no time factor. If there are adjustment costs associated with the capital stock we can write the present value function in the following form (Rotemberg (1983))

$$(2) \qquad V(t) = \max_{KP,L} E(t) \sum_{t=0}^{\infty} R^t [P^*(t) - g(K(t)-K^*(t))^2 - d(K(t) - K(t-1))^2],$$

where KP is the planned capital stock defined later in equation (3). P*(t) are the profits that would accrue if there are no adjustment costs of the capital stock. The adjustment function of the capital stock is assumed to be quadratic. The first component of the loss function is a disequilibrium cost, which generates costs when the capital stock is in disequilibrium with respect to the optimal stock K*. The other component, the adjustment cost function of the capital stock, is an increasing function of fixed investments and symmetrical in the positive and negative direction. This means that a decrease in the capital stock also generates costs, implying partial irreversibility of the investments, and that the economic sales value of old capital goods decreases rapidly. In the loss function, the adjustment coefficients g and d indicate the relative significance of the two cost factors. The capital stock K(t) can be divided into two components

$$K(t) = KP(t,t-1) + v(t) \text{ with } v(t) \sim N(0,s_v^2). \tag{3}$$

In the notation KP(t,t-1) is a planned value of the capital stock K(t), when the plan is made in the period t-1. The plan differs from the realized value by the error term v(t), which is normally distributed with expected value zero and variance s_v^2.

The firm makes a sequence of plans KP(t,t-1) designed to chase a stochastic target variable K*(t). K(t) is observed and K*(t) is linearly related to an observed exogeneous variable X(t).[1]

$$K^*(t) = hX(t) + u(t) \text{ with } u(t) \sim N(0,\ s_u^2). \tag{4}$$

In the equation, h is a parameter reflecting the desired relationship between X and K and u(t) is a normally distributed disturbance term reflecting the influence of omitted variables on K*. X(t) is the relevant variable for the determination of the optimal capital stock.

We convert the maximization of the objective function into the minimization of the quadratic loss function (Kennan (1979))

$$V(t) = \min_{KP} E(t) \sum_{t=1}^{\infty} R^t[g(K(t) - K^*(t))^2 + d(K(t) - K(t-1))^2]. \tag{5}$$

The first order optimality condition for this kind of problem is

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[1] In fact this is a very simplified description. The sequence of plans is called a contingency plan (Christiano (1987)). The firm chooses contingency plans for setting KP_{t+j} and also for K_{t+j} for $j = 0, 1, 2, \ldots$ as a function of information available contemporaneously, $\Omega_{t+j} = (f_{t+j-s}, k_{t+j-s-1}, KP_{t+j-s-1};\ s = 0, 1, 2, 3, \ldots)$. In the information set f_{t+j-s} describes the fundamentals of the economy. The contingency plans are functions k and kp; $K_{t+j} = k(\Omega_{t+j})$ and $KP_{t+j} = kp(\Omega_{t+j})$. This kind of function is also called σ-field (Spanos (1986)).

(6) $$a(KP(t,t-1) - E(t)K^*(t)) + (KP(t,t-1) - K(t-1)) - RE(t)(K(t+1) - K(t)) = 0,$$

where a = g/d.

As is well known, the solution of the stochastic optimization problem (6) is a partial adjustment rule for planned capital. As certainty equivalence is assumed to be in the force, the problem reduces to the conventional perfect foresight solution, deviating from the latter only with respect to the normally distributed disturbance term v(t).

(7) $$KP(t,t-1) - K(t-1) = w(LT(t) - K(t-1)) + v(t),$$

where the term LT(t) is a long-run target for the capital stock and the weighting parameter $w = 1-\lambda$ when $\lambda < 1$ is the stable root of the difference equation (Sargent (1978b)). The solution of the characteristic equation is of the form

(8) $$\lambda_{1,2} = \frac{1 + R + a \pm\sqrt{(1+R+a)^2 - 4R}}{2},$$

where $\lambda_1 < 1 < \lambda_2$. From the equation we can see that the speed of adjustment of the capital stock after some exogeneous shock is endogeneous, depending negatively on the discount factor R and on the cost parameter a. The cost parameter measures the importance of the relative cost factors, the disequilibrium and adjustment cost of the capital stock. If, for instance, the weight of the adjustment costs d increases, the speed of adjustment of the capital stock decreases. The term LT(t) is determined as

(9) $$LT(t) = (1-\lambda R) \sum_{i=0}^{\infty} \lambda^i R^i E(t)K^*(t+i),$$

where the target capital stock K*(t+i) is optimally determined by the relevant information assuming first-period certainty equivalence.

The long-run target capital stock LT(t) is a geometrically weighted average of the present and future desired capital stocks. Equation (9) does not determine the steady state capital stock, rather the optimal adjustment path to it. Later in this chapter we examine how the steady state capital stock is determined in neoclassical investment theory and what is the exogeneous information set influencing it.

Equation (7) is the optimal adjustment rule for planned capital as a function of new information. We can write it for investment plans, because KP(t,t-1) - K(t-1) = IP(t,t-1) - δK(t-1), where δ is the depreciation coefficient and IP(t,t-1) are investment plans for period t made one period earlier. The investment plan function is now

$$(10) \qquad IP(t,t-1) = wLT(t) + (\delta - w)K(t-1) + v(t).$$

Equation (10) is the theoretical determination of investment plans. Investment plans are determined as a function of future levels of the desired capital stock. Adjustment to stochastic shocks depends on the size of the adjustment parameter w, which is connected with the changes in the final capital stock. In practice, however, there may be costs associated with the revision of announced investment plans and changes in plans do not necessarily correspond to changes in new information.

We write a loss function for the revision of announced investment plans where expectations are again conditional on new information. The dynamic function is of the form

$$(11) \qquad V(t) = \min_{KP} E(t) \sum_{t=1}^{\infty} R^t[k(KP(t,t-1) - K^*(t))^2 + l(KP(t,t-1) - KP(t,t-2))^2],$$

where KP(t,t-1) is an earlier planned capital stock, k and l are adjustment parameters and K*(t) is the desired capital stock. The first loss factor is the disequilibrium cost arising from the deviation of the planned capital stock from the desired capital stock and the second loss factor is the cost arising from the changing of announced investment plans. The idea is that large changes in investment plans become relatively more expensive than small changes, since the latter can be carried out with normal staff and working time. The revision costs of investment plans include, for instance, costs arising from the acquisition of information, planning and the cancellation of commitments.

Moreover, as a rule, the revision costs of investment plans increase as the realization time of the investment plan approaches and at the end of the planning horizon the revision costs exceed the disequilibrium costs. So it is no longer profitable to change plans as the result of some price or demand shock. Accordingly, it is also possible that final investments are not in harmony with latest information. This phenomenon is usually described in investment equations with lags. At the firm level the revision costs of investment plans can also be fixed, lump sum costs, but there are good grounds for assuming that at industry level the adjustment costs are an increasing function of plans.

The solution of the quadratic loss function is an earlier kind of partial adjustment rule with the difference that the adjustment coefficient now includes the revision costs of plans instead of the adjustment cost of the capital stock, which is assumed fixed for a certain level of announced investment plans. The partial adjustment rule is of the form

$$(12) \qquad KP(t,t-1) - KP(t,t-2) = p(LT(t) - KP(t,t-2)) + \varepsilon(t),$$

where the error term $\varepsilon(t)$ is unobservable when plans are changed. The characteristic equation is of the same form as equation (8). The planned capital stock can be rewritten as a sum of planned gross investments, depreciations and lagged capital stock

$$(13) \qquad KP(t,t-1) = IP(t,t-1) + (1-\delta)K(t-2),$$ [2]

where δ is the depreciation coefficient. Now we can write an equation for the revision of announced investment plans

$$(14) \qquad IP(t,t-1) - (1-p)IP(t,t-2) = pLT(t) - p(1-\delta)K(t-2) + \varepsilon(t),$$

where the revisions of planned gross investments at time t are a weighted sum of the desired capital stock and the lagged capital stock, with an adjustment coefficient $p = 1-\lambda$ describing how soon the desired capital stock is attained. As the revision cost of announced investment plans increases, for instance as the survey horizon shortens, this means that the coefficient l in equation (11) increases in relation to k, the reaction of investment plans to new information decreases, because p, the coefficient of LT(t), decreases, and (1-p) increases (equation (8)).

The revision of manufacturing industry investment plans as a function of exogeneous information and adjustment costs over time can be described by means of the following figure. It is assumed that the expected adjustment costs of announced investment plans increase from the year t-1 to t merely as a function of time.

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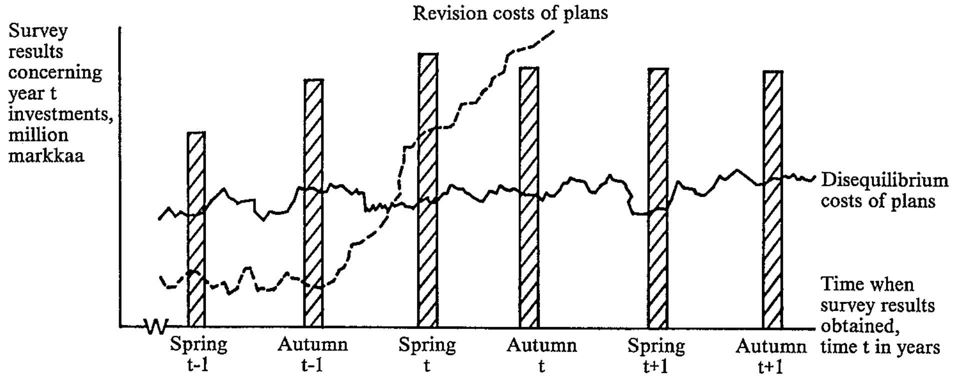
[2] In fact the equation could be written more precisely in the form $KP(t,t-s1) = IP(t,t-s1) + (1-\delta)K(t-2)$ because data on investment plans are collected semiannually (s) in the investment survey. For the sake of simplicity semiannual notations are not used.

FIGURE 1. REVISION OF INVESTMENT PLANS AS A FUNCTION OF COST FACTORS



It can be seen from the figure that the investment plans made, for instance, in the spring of the previous year for year t are changed during the planning period as more information becomes available and plans become more precise. In the beginning of the period the revision costs of plans are virtually negligible, but subsequently increase at a very rapid rate as commitments concerning investment projects increase. During the year it is planned to implement the investments, revisions of plans as a result of new information and forecasts are small because of high revision costs. Naturally, at the firm level, revision costs and disequilibrium costs are not continuous but discrete. The figure attempts to describe industry at the aggregate level.

The solution of the above stochastic "Linear Quadratic Gaussian" control problems ((5) and (11)) when there is separation of expectations formation and the optimum decision leads to the feedback policy optimization problem (Whittle (1981)).

In the following we examine how it is possible to obtain a closed loop policy which is consistent with full rationality and takes account of the agent's attitude towards risk.

The loss function is similar to the function presented above in equation (11). The value of the firm is maximized when the firm minimizes the expected quadratic costs of the disequilibrium and revision of announced investment plans. For mathematical reasons, the objective function of the firm is now assumed to be exponential (Whittle (1981))

(15)

$$V(t) = \min_{KP} E\theta\exp[0.5\theta \sum_{t=1}^{\infty} R^t(k(KP(t,t-1)-K^*(t))^2 + l(KP(t,t-1)-KP(t,t-2))^2)],$$

where θ is the Arrow-Pratt relative risk aversion measure, which can have values $\theta = 0$, $\theta > 0$ and $\theta < 0$ corresponding to risk-neutral, risk-preferring and risk-averse attitudes on the part of the optimizer (Bertsekas (1976)). The typical assumption in this kind of problem is to set the covariances of the successive (KP(t,t-1) -K*(t)) and (KP(t,t-1) - KP(t,t-2)) terms equal to zero so as to make the solution easier (Salmon (1983)). The assumption is not unreasonable because it involves two innovation terms which are jointly being updated with the same news and is in line with the martingale property of expectations.

In solving the problem, we need to take into account only the two time periods because the control problem is the same for the rest of the period according to Wold's Chain rule of forecasting (Kushner (1971)). The objective function is of the form

(16)

$$\begin{aligned} V(t) = \min_{KP} E(t)\theta \exp [&0.5\ \theta(k(KP(t,t-1) - K^*(t))^2 \\ &+ l(KP(t,t-1) - KP(t,t-2))^2 + Rk(KP(t+1,t) \\ &- K^*(t+1))^2 + Rl(KP(t+1,t) - KP(t+1,t-1))^2)]. \end{aligned}$$

It is possible to find the closed loop solutions for the expectation values because of the normality assumptions concerning the stochastic terms (page 24) and the exponential form of the objective function. By taking the expectation values, differentiating the objective function with respect to KP(t) and setting the equation equal to zero, we obtain the first degree condition for the minimum of the objective function.

$$(17) \qquad KP(t,t-1)((k/(1-g\theta s_u^2)) + 1 + (Rl/(1-Rl\theta s_v^2)))$$

$$= k/(1-k\theta s_u^2)K^*(t) + lKP(t,t-2) + (Rl/(1-Rl\theta s_v^2))KP(t+1,t),$$

where KP(t+1,t) is a conditional investment plan with respect to the information set in period t. The equation is the same as above with the difference that the uncertainty and risk terms affect the parameter values of the decision rule. If the firm is risk-neutral or the variance terms are zero, we obtain the perfect foresight Euler-equation (Salmon (1983)).

To remove the conditional expectation KP(t+1,t) from equation (17), we assume constant variance terms. The solution is based on the method of undetermined coefficients where the general form of the solution is first guessed and the total time period is solved on the basis of the law of iterated projections. The solution is (Mustonen (1987))

$$(18) \qquad KP(t,t-1) = \lambda_1 KP(t,t-2) + (1-\lambda_1)(1 - \frac{R\lambda_1}{1 - Rl\theta s_v^2})$$

$$\sum_{i=0}^{\infty} (\frac{R\lambda_1}{1 - Rl\theta s_v^2})^i E(t)K^*(t+i),$$

where λ_1 is the stable root of the characteristic equation. The equation again follows the adjustment rule with the difference that adjustment to the optimum is influenced by the attitude to risk and uncertainty about the realization of the investment plans. We can again write an equation for the investment plans taking into account that KP(t,t-1) = (1-δ)K(t-2) + IP(t,t-1). The equation is of the form

$$(19)\quad IP(t,t-1) - (1-m)IP(t,t-2) = m(1 - \frac{R\lambda_1}{1-l\theta s_v^2}) \sum_{i=0}^{\infty} (\frac{R\lambda_1}{1-Rl\theta s_v^2})^i E(t)K^*(t+i)$$

$$- m(1-\delta)K(t-2) + u(t),$$

where the weighting term m is $1-\lambda_1$.

Equation (19) is of the same form as the investment plan revision equation (14) above. But now a change in the plans is the slower the greater is the uncertainty connected with the target function of the firm (equation (4)) and the realization of the investment plans (equation (3)). This can be shown by solving the stable root of the characteristic equation λ_1 and examining the signs of the partial derivatives of λ_1 in relation to variance terms (Mustonen (1987)).

The risk parameter θ is connected multiplicatively to the variance terms. If we assume that the attitude of the firm towards risk is neutral so that θ is zero, uncertainty does not affect the behaviour of the firm at all. In this case the firm can protect itself from the losses associated with the profit stream or investment activity. If the firm is risk-averse the speed of adjustment is related positively to the absolute value of the risk parameter, which means that increasing risk-averse behaviour reduces the speed of adjustment of the capital stock to the optimal level.

The assumption of constant variances is artificial but made necessary by the solution method. There are different kinds of methods for studying how changes in the degree of uncertainty (variance) affect the speed of adjustment and the optimal level of the capital stock. As regards the Euler equation it is possible to let the variance change by forming the Taylor expansion in the vicinity of the variance term and solve the difference equation with respect to K(t). The deviation from "normal" uncertainty has a negative effect on the speed of adjustment of the capital stock, a result which is intuitively very acceptable (Mustonen (1987)). In the following section we study the effects of changes in the degree of uncertainty when uncertainty is described by a stochastic Ito-process.

II.3 Determinants of the Neoclassical Investment Function

To determine the relevant information set for the optimal investment, investment plans and capital stock of the firm, we apply investment theory concentrating mainly on neoclassical micro theory. The first model we use is the stochastic optimal control model first solved by Abel (1985). However, we modify Abel's model by taking account of the effects of corporate sector taxation in the optimization problem of the firm.

We assume convex costs of adjustment of the capital stock, with adjustment costs being a function of gross investment. The adjustment cost function is $C(I(t))$, where $I(t)$ is gross investment and adjustment costs are an increasing convex function ($C'(I(t)) > 0$, $C''(I(t)) > 0$ and $C(0) = 0$). The adjustment costs are assumed to be purely external to the firm so that adjustment does not affect the firm's productive activities (Söderström (1976)). Capital is a "quasi-fixed" factor of production in this model, which means a departure from the neoclassical principle of perfect competition in the investment goods industry.

The value of a risk-neutral firm at time t is the maximized expected present value of net cash flow from time t onwards. The value of the firm can be expressed as a time-invariant function of $w_i(t)$, $i = 0, \ldots, n_{t+1}$, and the capital stock $K(t)$, when the time index $s \geqslant t$,

$$(20) \qquad V(w_0(t), \ldots, w_{n+1}(t), K(t)) = \max_{X_1,\ldots X_n, I} E(t) \int_t^\infty e^{-r(s-t)} \Big[(1-\tau)(w_0(s)F(X_1(s), \ldots, X_n(s), K(s)) - \sum_{i=1}^{n} w_i(s)X_i(s)) - (1-D)w_{n+1}(s)C(I(s))\Big] ds.$$

The discount rate r, the tax rate τ and the present value of depreciation D are assumed constant. The production function is a neoclassical function and is parametrized to be a Cobb-Douglas function

$$(21) \qquad F(X_1, \ldots, X_n, K) = X_1^{\alpha_1} X_2^{\alpha_2}, \ldots, X_n^{\alpha_n} K^{\phi}$$

for the explicit solution of the problem. In the production function, factors of production are denoted by X_i and K, where K is the capital stock. The parameters α and ϕ indicate the relative shares of different factors of production. The price variables w_0, w_i, w_{n+1} are price indices of production and factors of production, which are assumed to be generated by a stochastic Ito process. The aim here is to make the model so general that it can also be used to describe the effects of uncertainty. In the previous section we used an ordinary normal distribution for analyzing the effects of uncertainty on the demand for capital. In the continuous time model, it is necessary to use the Ito process because it is only for this that a derivation rule has been proved (Malliaris and Brock (1982)).

The price process generated by the Ito process is

$$(22) \qquad \frac{dw_i(t)}{w_i(t)} = g_i dt + \sigma_i dW_i, \qquad i = 0, 1, \ldots, n+1$$

where g_i is the expected growth rate (drift) of the process, σ_i is the variance of prices and dW_i are Wiener processes with mean zero and unit variance. A feature of the Wiener-process is that it has no memory except for the last observation, which does not, however, determine in which direction the process moves. The process is not differentiable but it is continuous. It can have both negative and positive values. The present value of the depreciation allowance accruing to a unit of new capital is defined in the usual way (Auerbach (1983))

$$(23) \qquad D(t) = \int_0^{\infty} \tau(s) D(s-t) e^{-r(s-t)} ds.$$

If the corporate tax rate does not change, D(t) has a value $D = \tau Z$, where Z is now the present value of depreciation

$$(24) \qquad Z = \int_t^{\infty} D(v-t)e^{-r(v-t)}dv$$

and depreciation at the moment v is given by

$$(25) \qquad D(v) = \delta e^{-\delta(v-t)},$$

where δ = depreciation rate. By substituting D(v) in equation (24), we obtain the value of Z as

$$(26) \qquad Z = \frac{\delta}{r+\delta}.$$

The depreciation rate δ describes true economic depreciation, which as a rule differs from tax-deductible depreciation. Moreover, firms cannot or do not want to make the maximum amount of depreciation every year because they can also use the right to undervalue stocks for varying their taxable income. The adjustment cost function is parametrisized to have constant elasticity as follows

$$(27) \qquad C(I(t)) = I^{\beta}(t),$$

where $\beta > 1$ so that adjustment costs are a convex function of gross fixed investment I.

In addition to equation (27), another constraint is needed for the maximization of the equation, the condition for the accumulation of the capital stock

$$(28) \qquad dK(t) = (I(t) - \delta K(t))dt,$$

where δ is the above-mentioned depreciation coefficient of the capital stock. Now the strategy for the maximization of the value function follows Abel (1985). The Hamilton-Jacobi-Bellman equation is formed using Ito's Lemma for differentiating the value function of the firm.

$$(29) \qquad rV = \max_{I(t),X_1(t),\ldots,X_n(t)} \{(1-\tau)(w_0(t)F(X_1(t),\ldots,X_n(t),K(t))$$

$$- \sum_{i=1}^{n} w_i(t)X_i(t)) - (1-D)w_{n+1}(t)C(I(t)) + \sum_{i=0}^{n+1} V_i g_i w_i(t)$$

$$+ (I(t) - \delta K(t))V_K + \frac{1}{2} \sum_{i=0}^{n+1} \sum_{j=0}^{n+1} V_{ij}\rho_{ij}\sigma_i\sigma_j w_i(t)w_j(t)\},$$

where ρ_{ij} is the correlation term of the price variables.

The closed form solution to the Hamilton-Jacobi-Bellman equation is first obtained by guessing the form of the solution and then calculating the coefficients, taking into account the chosen adjustment cost function and production function.

The value function of the firm is of the following form

$$(30) \qquad V(w_0(t),\ldots,w_{n+1}(t),K(t)) = \mu_1(1-\tau)p(t)F_{K(t)}K(t)$$

$$+ \mu_2(1-D)(\beta-1)w_{n+1}(t)C(I(t)),$$

where $w_0(t)$ is the price of output $p(t)$, $F_{K(t)}$ is the partial derivative of the production function with respect to the capital stock and the coefficients μ_1, μ_2 have the following values

$$(30a) \qquad \mu_1 = \left[r + \delta + \sum_{i=0}^{n} \frac{\alpha^i}{\phi} (g_i - \frac{1}{2}\sigma_i^2) - \frac{1}{2} \sum_{i=0}^{n} \sum_{j=0}^{n} \frac{\alpha^i}{\phi}\frac{\alpha^j}{\phi} \rho_{ij}\sigma_i\sigma_j \right]^{-1}$$

and

(30b) $$\mu_2 = \left[r + \sum_{i=0}^{n+1} \frac{\beta\alpha_i}{(\beta-1)\phi} (g_i - \frac{1}{2}\sigma_i^2) - \frac{1}{2} \sum_{i=0}^{n+1} \sum_{j=0}^{n+1} \left[\frac{\beta\alpha_i}{(\beta-1)\phi}\right] \left[\frac{\beta\alpha_j}{(\beta-1)\phi}\right] \rho_{ij}\sigma_i\sigma_j \right]^{-1}$$

The terms σ_i^2 are variances of prices while the terms $\rho_{ij}\sigma_i\sigma_j$ are covariances of different factor price variables.

The investment function is derived by differentiating the Hamilton-Jacobi-Bellman equation (29) with respect to I(t) and setting the derivate equal to zero.

(31) $$I(t) = \left[\frac{(1-\tau)p(t)F_{K(t)}}{(1-D)\beta q(r+\delta+\sum_{i=0}^{n} \frac{\alpha_i}{\phi} (g_i - \frac{1}{2}\sigma_i^2) - \frac{1}{2}\sum_{i=0}^{n} \sum_{j=0}^{n} \frac{\alpha_i}{\phi} \frac{\alpha_j}{\phi} \rho_{ij}\sigma_i\sigma_j)} \right]^{\frac{1}{\beta-1}},$$

where p(t) is the price of production and $F_{K(t)}$ is the marginal productivity of the capital stock.[3] We notice from equation (31) that the optimal level of investment depends on the current and expected values of the price variables, the marginal productivity of the capital stock, tax parameters, the relative factor shares of the production technology, the convexity of the adjustment function and the variance and covariance terms of the price variables.

The investment function is a typical neoclassical equation. The rate of investment depends with an elasticity $1/(\beta-1)$ on the relationship between the marginal productivity of the capital stock $F_{K(t)}$ and the real price of new capital, which we denote by JC. This relationship

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[3]With a Cobb-Douglas production function $p(t)F_{K(t)}$ is

$$\phi\left[\prod_{j=1}^{n} \alpha_j^{\alpha_j}\right]^{1/\phi} \prod_{j=0}^{n} w_j(t)^{-\alpha_j/\phi}$$

is also called Tobin's q-variable (Abel (1979)). The Jorgensonian user cost of the capital now has the form

$$(32)\quad JC = \frac{(1 - D)\beta q(r + \delta + \sum_{i=0}^{n} \frac{\alpha_i}{\phi}(g_i - \frac{1}{2}\sigma_i^2) - \frac{1}{2}\sum_{i=0}^{n}\sum_{j=0}^{n} \frac{\alpha_i}{\phi}\frac{\alpha_j}{\phi}\rho_{ij}\sigma_i\sigma_j)}{p(t)(1 - \tau)}$$

with a Cobb-Douglas production function. The formula is the conventional Jorgensonian user cost with the difference that the degree of uncertainty influences the expected factor prices g.

According to the investment equation (31), the rate of investment is an increasing function of the marginal productivity of the capital stock and a decreasing function of the price of capital, the real user cost. The increase in adjustment costs decreases the speed of adjustment of investments to price shocks. The effect of prices of other factors of production on investment operates through the term g_i, which is the expected change in prices. For instance, an expected increase in wages or energy decreases investments. However, the magnitude of the effect depends on the substitution elasticity of the factors of production and the market power of the firm, and with certain values of the parameters α_i and ϕ the effect can also be positive. Thus, as far as the prices of factors of production are concerned, the effect depends upon whether the factors are substitutes or complements for fixed capital.

The variance and covariance terms of prices describe the effects of uncertainty in equation (31). If the combined value of the variance and covariance terms is zero, the model is a typical perfect foresight model and the earlier results are in force. If, however, the value of the uncertainty term is not equal to zero we obtain different effects on investment under different assumptions concerning the changes in the term. The degree of uncertainty is measured in two ways (Abel (1985)), by mean preserving spread (MPS) and increase in scale (IS) processes. Both processes are based on the above Ito-process with the drift term (equation (22)). The MPS increase in uncertainty is obtained by adding an uncorrelated process $\sigma_i^* dZ_i^*$ to the Ito-process

$$(33) \qquad \frac{dw_i(t)}{w_i(t)} = \pi_i dt + \sigma_i dW_i + \sigma_i^* dW_i^*.$$

The drift term stays unchanged but the variance and covariance terms of prices change. Adding this uncorrelated process to the earlier Ito process means that the value of μ_1 (30a) decreases while the optimal rate of investment increases according to equation (31). The result that an MPS increase in uncertainty increases investments is similar to earlier results by Hartman (1972) with a discrete time model and by Abel (1983) with a continuous time model in which uncertainty is associated with only one price variable.

Different results are obtained when uncertainty is measured by an increase in the scale (IS) measure. The IS uncertainty is obtained by increasing the variance term σ_i in equation (22) but leaving the distribution term dW_i unchanged. The IS increase in uncertainty increases optimal investments if the covariance of prices is positive, decreases investments if the covariance term is negative and leaves investment unchanged if the covariance of prices is zero. The result is obtained by differentiating μ_1 with respect to σ_i and holding all ρ_{ij} and σ_j, $j \neq i$ constant (Abel (1985)).

The result is very interesting and widely known in other contexts. The negative covariance of different prices reduces the effects of stochastic shocks in some price variables on the cash flow of the firm and reduces in some sense the future risk attached to a particular capital stock. On the other hand, positive covariance increases the risk and more capital is needed. The increase in optimal investment as a result of uncertainty can be attributed to the fact that since, in the case of a price or demand shock (Abel (1983)) it is impossible to acquire more capital, the firm must build up a reserve of capital beforehand. This is more optimal to the firm than to incur a loss as a result of a lack of fixed capital. This result is connected with the assumption of the neoclassical investment model according to which the capital stock is a quasi-fixed factor of production and there is instant adjustment in the labour input. With adjustment of the labour force it is possible to reduce the costs arising from excess capacity.

According to the previous model, it is not possible to analyze the effect of price uncertainty on the factor shares because they are assumed constant when the Cobb-Douglas production function is used. However, it has been shown that one of the results of increasing uncertainty is that it is optimal for the firm to increase the transformability of capital so as to meet stochastic price shocks. As a rule this also means an increase in the capital stock (Albrecht and Hart (1983)).

The optimal capital stock K* (equation (19)) depends on the same determinants as optimal investment (equation (31)). This result is obtained when we take the condition for the accumulation of the capital stock and solve the steady state capital stock. The first order difference equation for the growth of the capital stock is (equation (28))

$$(34) \qquad dK(t) = (I(t) - \delta K(t))dt$$

from which we get

$$(35) \qquad K(t) = \frac{I}{\delta} + (K_0 - \frac{I}{\delta})e^{-\delta t},$$

where $K(0) = K_0 = \frac{I}{\delta} + c$, c is an integration constant and $\lim_{t\to\infty} K(t) = \frac{I}{\delta} = K^*$, which means that in the steady state $dK(t) = 0$ and

$$(36) \qquad I = \delta K^*.$$

Investment is equal to depreciation and K* depends on the determinants of investment (equation (31)).

II.4 Stochastic Shocks and the Timing of Investment Decisions

In the following we present a formal model for the revision of investment plans as a function of new information. It is assumed that the changing of investment plans involves costs and the costs associated with a change are fixed. The expected present value of the cash stream of the firm follows a stochastic Ito-process

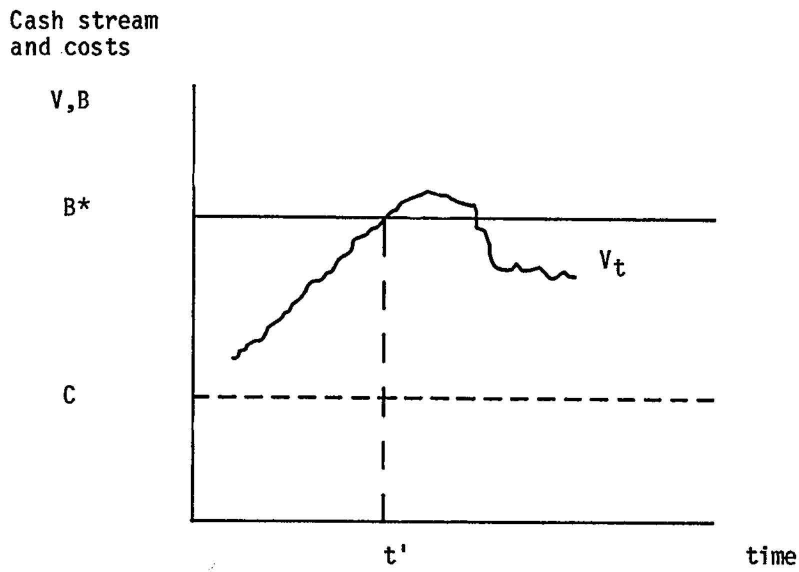
$$(37) \qquad \frac{dV(t)}{V(t)} = gdt + \sigma dW,$$

V is the expected present value of the cash stream, g is the expected growth of the cash stream, σ is the variance of the process and dW is a Wiener process. The firm knows exactly the total investment cost C but rational expectations are associated with the future cash stream. The effects of stochastic shocks in the cash stream on the investment decisions of the firm are studied using "the first passage" method of Cox and Miller (1965).

The decision to change investment plans as a function of new information is made when the value of the expected cash stream V(t) exceeds a certain level B(t). The level B(t) depends on the costs of changing announced investment plans. The boundary B(t) is found by solving the present value problem recursively from the end point of the time interval [0,T]. The optimal control rule implies that, as long as $V(t) < B(t)$, it is optimal for the firm to collect information and keep investment plans unchanged (McDonald and Siegel (1982)).

The information collection problem can be described by the following figure.

FIGURE 2. REVISION OF INVESTMENT PLANS AND CASH STREAM



In Figure 2, the cash stream V(t) reaches the boundary B*(t) at time t'. At time t' it is profitable for the firm to change its investment plans. The expected present value of the investment project for the firm at the arbitrary boundary B_0^T is

$$V(T) = E(0)\{e^{-rt'}(B(t) - C)\}, \tag{38}$$

where r is the discount rate applied and t' is the point in time referred to above. We express the probability of V(t) reaching B(t) before time t as follows (McDonald and Siegel (1982)

$$X(T)^* = \underset{B(t)}{\text{Max}} \int_0^T e^{-rt}(B(t) - C)f(\{B(s)\}_0^T, V(0), t)dt, \tag{39}$$

where f(.) is a density function. The solution of the problem is impossible because B(t) depends on time (t). By assuming that the time period analyzed is infinite (T = ∞), the boundary B(t) becomes constant and B - C is also constant (Merton (1971)). Using the Laplace transformation, the equation can be transformed into

(40) $$\max_{B}\ (B - C)E(0)(e^{-rt'}),$$

where

(40a) $$E(0)(e^{-rt'}) = \left(\frac{V(0)}{B}\right) \varepsilon,$$

where

(40b) $$\varepsilon = \frac{\frac{1}{2}\sigma^2 - g + \sqrt{(\frac{1}{2}\sigma^2 - g)^2 + 2\sigma^2 r}}{\sigma^2} > 1$$

and $g < \rho$. The optimal boundary for the revision of investment plans is

(41) $$B^* = C\left(\frac{\varepsilon}{\varepsilon-1}\right)$$

and the present value of the project is

(42) $$X^*(\infty) = \left[C\left(\frac{\varepsilon}{\varepsilon-1}\right) - C \right] \frac{V(0)}{C\left(\frac{\varepsilon}{\varepsilon-1}\right)}\ \varepsilon.$$

The revision of announced investment plans is optimal when the relationship between the lump sum adjustment costs of plans and the revision boundary of plans is in accordance with equation (41). The return on the revision of the plans must exceed the revision boundary by a certain amount. The difference depends on the relationship between the expected growth rate of the cash stream and the uncertainty (variance) associated with it. Thus an increase in the variance of the cash stream increases the revision boundary and postpones the revision. An increase in variance increases the probability of a negative return. An increase in the interest rate also increases the revision boundary and the profitability requirement of the project.

It should be noted that in the earlier analysis we stated that the revision costs of investment plans can increase as the plan horizon shortens. This analysis is difficult to incorporate in this model as there is no information on the speed of increasing revision costs.

II.5 Inclusion of Demand in the Investment Function

The acceleration theory of investment has been very popular in empirical investment studies during the last decades because of its empirical success. Accelerators have also survived in specification tests in the form of tests for Granger causality by Sims (1972) and Abel and Blanchard (1983). The acceleration theory was applied in earlier investment realization functions (Modigliani and Cohen (1961)). As was noted above, conventional neoclassical theories of investment under uncertainty do not lead to accelerator regressions.

Because demand has also proved to be a significant explanatory variable in Finnish econometric studies on manufacturing investment (Koskenkylä (1985)), the analysis below discusses how demand can be included in the investment function, which is derived by assuming optimizing behaviour on the part of agents. Three different ways of incorporating demand in the investment equation are considered. The first one is a general equilibrium model of investment under uncertainty in the form of a stochastic optimal growth model (Brock and Mirman (1972)). The other two are derived from the earlier neoclassical investment model by assuming imperfections in the product market, a downward-sloping demand curve for products or a given market demand for each firm.

II.5.1 The Accelerator Model of Investment

The accelerator model of investment can be justified on the basis of the following stochastic optimal growth model in which there is one source of random disturbance, the technology shock θ, of the form (Sargent (1986))

(43) $$a(L)\theta(t) = \varepsilon(t),$$

where

$$a(L) = 1 - a_1L - a_2L^2 - \ldots - a_rL^r,$$

when L is a lag operator.

The decision-maker maximizes the following utility function

(44) $$E\sum_{t=0}^{\infty} r^t(u_0 + u_1CO(t) - u_2CO(t)^2/2),$$

where r is a time preference factor and CO is consumption. The technology assumption of the economy is

(45) $$CO(t) + K(t+1) = fK(t) + \theta(t),$$

where f > 1. Thus, the equation for the capital stock is

(46) $$K(t+1) = fK(t) - CO(t) + \theta(t).$$

National income is defined as

(47) $$Y(t) = CO(t) + (K(t+1) - K(t)).$$

Assuming that the technology shock is a white noise process and rf = 1, the distributed lag accelerator model of investment is obtained as (Sargent (1986))

(48) $$K(t+1) - K(t) = \frac{(1-L)}{f(1 - f^{-1}L)} Y(t),$$

where net investment is a geometric distributed lag of the change in income.

The result is typical of macro-level investment equations, where the limitation of the factor markets impose a natural limit to the expansion path of capital. In micro-level sectoral investment models, a special limitation must be imposed on the investment equations so as to prevent the explosion of the model. The limitation can be in the form of the production function, increasing adjustment costs or credit rationing. This is because only the demand for investment goods is modelled while the supply of goods is assumed to be completely elastic. In macro-level growth models, market constraints are taken into account all the time.

II.5.2 Downward-Sloping Demand Curve

Monopolistic behaviour at the firm level can arise from, for instance, costs associated with acquiring information. In the short run, it may be possible for a private firm to sell its products at a price above the perfect competition price because of the incomplete information of buyers (Grossman and Stiglitz (1976)). Particularly in the home market of a small economy, it may be possible for some firms to buy out their competitors, and thereby obtain monopolistic power in their own sheltered sector. But in export markets, too, some industries may have so much market power that they can influence product prices (Sukselainen (1986)). An investment model with a decreasing demand curve assumption has been discussed by, for instance, Pindyck (1982).

Let us assume that the demand function of the firm is separable[4]

$$(49) \qquad Q^s(t) = Q^d(t) = Q^d(p(t))EX(t),$$

where demand $Q^d(t)$ in the market is equal to supply $Q^s(t)$, $EX(t)$ describes exogenous factors influencing demand and the price

[4]This means that the price elasticity of demand and marginal productivity depend only on price p and not on time at all.

elasticity of demand is

(50) $$\varepsilon(p(t)) = \frac{p(t)}{Q^d(p(t))EX(t)} \cdot \frac{\partial Q^d(p(t))}{\partial p(t)}$$

and the marginal productivity (Nickel (1978))

(51) $$M(p(t)) = p(t)(1 + \frac{1}{\varepsilon(p(t))}).$$

Let us assume that the demand function[5] can be written in the inverse form

(52) $$p(t) = p(Q(t)/EX(t)) = p(F^D),$$

where we denote the demand function by $p(F^D)$.

The Hamiltonian for a decreasing demand function of the firm can be written as

(53) $$H = e^{-rt}\{[(1-\tau)(p\cdot(Q(K(t),L(t))/EX(t))\cdot Q(K(t),L(t)) - wL(t)) - (1-D)C(I(t))] + \mu[I(t) - \delta K(t)]\}.$$

We again assume convex costs of adjustment of the capital stock, with adjustment costs as a function of gross investment C(I(t). The rationale behind the optimization is that the firm maximizes its cash flow by choosing the values of L(t), I(t) and Q(t) so that p adjusts supply to equal demand.

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[5]According to Phelps and Winter (1970) the demand function could have the following properties: finite for positive values of p, a decreasing function of p(t), decreasing marginal revenue, a convex function and demand approaches zero for large values of p(t). Mathematically, we can write $\varepsilon'(p(t)) < 0$, $0 < \varepsilon''(p(t)) < \frac{2\varepsilon'^2}{\varepsilon}$ and $\inf_p \varepsilon(p(t)) = 0$.

The capital stock is accumulated subject to the constraint

(54) $\dot{K}(t) = I(t) - \delta K(t),$

where δ is the depreciation coefficient. Assuming that the production function is concave, the following conditions are both sufficient and necessary for an optimum (Takayama (1985)):

(55) $\dot{\lambda} = (r + \delta)\lambda - (1-\tau)MR \frac{\partial Q}{\partial K(t)},$

where $\lambda = \mu \cdot e^{rt};$

(56) $\frac{\partial H}{\partial I(t)} = -(1-D)C'(I(t)) + \lambda = 0$

and

(57) $\frac{\partial H}{\partial L(t)} = -(1-\tau)(w + MR \frac{\partial Q}{\partial L(t)}) = 0.$

The term MR is the marginal revenue product of the firm and has the form

$$MR = p(F^D) + Q(t) \cdot \frac{\partial p}{\partial (F^D)} .$$

The optimal growth rate of investment depends on the relationship between the price of capital (the user cost) and the marginal productivity of the capital stock

(58) $\frac{dI}{dt} = \frac{1}{C''(I)} \{(r+\delta)(1-D)C'(I) - (1-\tau)MR \frac{\partial Q}{\partial K(t)} .$

According to the equation the form of the adjustment cost function influences the speed of adjustment of the capital stock after some price or demand shock. If the adjustment cost function is a concave rather than a convex function of gross investment, adjustment should be instantaneous ($C''(I) < 0$).

In the steady state situation, gross investment has the following function (equations (55) and (56), $\dot{\lambda} = 0$)

$$(59) \qquad I(t) = \frac{(1-\tau)MR \frac{\partial Q}{\partial K(t)}}{C'(I)(r+\delta)(1-D)}.$$

The investment function differs from the perfect competition equation (31) above in that the equation now includes a demand variable with a positive sign and there is perfect foresight concerning prices. In addition to the production technology, the marginal productivity of capital now also depends on the price elasticity of demand. The influence of demand on investment is the larger the more inelastic is the demand and vice versa.

The implicit long-run demand function for capital (K*) with a decreasing demand curve for final products is

$$(60) \qquad K^* = K^*(JC, W, Q),$$

where JC is the user cost of capital from equation (58), when $dI/dt = 0$, so that

$$(61) \qquad JC = \frac{(r+\delta)(1-D)C'(I)}{(1-\tau)MR},$$

W is the real wage rate and Q describes the effect of demand on the capital stock. The implicit demand function for capital is obtained from the marginal productivity conditions for capital and labour

$$(62a) \qquad \frac{\partial Q}{\partial K(t)} = \frac{C}{MR}$$

and

$$(62b) \qquad \frac{\partial Q}{\partial L(t)} = \frac{W}{MR}.$$

II.5.3 Constrained Demand

The third model used for incorporating demand in the investment function is the constrained demand investment model (Grossman (1972), Brechling (1975)). Markets are competitive but the firm takes the amount of demand as given beforehand. The demand curve of the firm is assumed to be vertical so that the firm believes that there is no connection between selling prices and quantity demanded.

The demand for labour is determined by the equation

(63) $$L_t^d = L(K(t), \bar{Q}),$$

where $\bar{Q}$ is demand-constrained production. The production function is of the form

(64) $$\bar{Q} = Q(K(t), L^d(t)).$$

The Hamiltonian is as follows:

(65) $$H = e^{-rt}\{[(1-\tau)(p\bar{Q} - wL^d(t)) - (1-D)C(I(t))] + \mu[(I(t) - \delta K(t)]\}.$$

Another way of writing this optimization problem would be to use a Lagrange restriction on the constrained demand (Kamien and Schwartz (1981)).

The necessary conditions for optimum, which are also sufficient if the production function is concave and the adjustment cost function convex, are

(66) $$\dot{\lambda} = (r+\delta)\lambda - (1-\tau)w\frac{Q_K}{Q_L},$$

(67) $$\frac{\partial H}{\partial I(t)} = -(1-D)C'(I(t)) + \lambda = 0$$

and

(68) $$\frac{\partial H}{\partial L(t)} = -(1-\tau)(\frac{\partial Q}{\partial L^d(t)} - w) = 0.$$

In the steady state the ratio of capital costs to labour costs is equal to the relationship between their marginal productivities

(69) $$\frac{(1-D)(r+\delta)C'(I)}{(1-\tau)w} = \frac{Q_K}{Q_L} .$$

Because the firm is demand-constrained, optimal production exceeds constrained production and the only way to increase cash flow is to minimize costs. Investment also depends on the marginal productivity of labour

(70) $$I(t) = \frac{(1-\tau)w}{C'(I)(r+\delta)(1-D)} \cdot \frac{Q_K}{Q_L} .$$

In the constrained case, only investments in projects minimizing costs are worthwhile.

The implicit long-run demand for capital is a function of relative factor prices and exogeneous demand

(71) $$K^* = K(\frac{w}{c}, \bar{Q}).$$

In the constrained case, the desired capital stock is smaller than in the unconstrained case because the marginal productivity rules cannot be satisfied.

II.6 Capital Market Imperfections and Investment Plans

II.6.1 Introduction

In the neoclassical investment theory, the capital market is assumed to be perfect. In the real world however, information is costly and there are adjustment costs involved in changing prices. Even so, the future is uncertain. These are some of the reasons put forward to explain credit rationing in the capital market.

Credit rationing theories can be divided into two groups: disequilibrium rationing and equilibrium rationing. Disequilibrium rationing is a short-term phenomenon which arises when the economy experiences an exogenous shock and there is stickiness in interest rates. Equilibrium rationing is defined as a long-term situation in the capital market and has been shown to be rational market behaviour (Stiglitz and Weiss (1981, 1983)).

The existence of short-term disequilibrium in the loan market has been attributed to the adjustment costs associated with interest rates (Barro (1976), Benassy (1975), Koskela (1976)). As the demand for loans is stochastic, it does not pay the lender to change interest rates until the returns from adjustment exceed the costs of changing rates by a certain amount. The amount depends on the relationship between the expected growth rate of the return stream and the uncertainty associated with it (the model for the timing of investment decisions on page 41 also describes this phenomenon). According to these models, interest rates are not adjusted as long as the expected returns stay inside certain "confidence" limits. The adjustment costs arise mainly from administrative information costs.

In equilibrium rationing, the backward-bending loan supply curve is explained by default risk (Hodgman (1960)). When the amount borrowed by a certain borrower reaches the critical default risk area, no increase in interest rates will compensate the lender for the risk involved. Jaffee and Modigliani (1969) consider the bank to be a price-setting monopolist which optimizes along the borrower's demand curve. Because of information acquisition costs, however, it is not profitable to discriminate between all borrowers and the average interest rate settles at a level at which some clients are subject to credit rationing. According to Koskela (1976), it is a question of risk-sharing between the lender and the borrower in a price setting situation. For "new" customers, the marginal cost of granting loans does not vary from customer to customer. The cost function is non-separable and the acquisition of information may prove uneconomic. For "old" customers the additional information investment requirements are minimal and the lender's cost function is separable. Risk-sharing is also justified in the case of uncertainty and default risk (Jaffee and Russel (1976)) and an implicit contract between the lender and the customer (Fried and Howitt (1980)).

Stiglitz and Weiss (1981, 1983) considered that interest rates per se may have adverse selection effects on customers through the probability of their repaying their loans. The expected return to the bank obviously depends on the probability of repayment, and the bank would like to minimize the default risk. The interest rate can be a screening device; those who are willing to pay high interest rates may, on average, be worse risks. On the other hand, with high interest rates, many customers may undertake more risky projects offering higher returns. The bank's total profit can decrease as a result of the increase in the interest rate.

Two main credit rationing cases have been studied using dynamic corporate sector investment models: loan quantity rationing and the non-linear interest rate case. When the firm is subject to binding credit quantity rationing, its investment is constrained by current profits. The effects of anticipated credit rationing on the firm's investment policy depend crucially on the assumption about profit distribution to shareholders. If the firm has to distribute all its profits to shareholders it can provide for anticipated rationing only by increasing its capital stock, and hence investment by a constrained firm can, for a short interval, exceed that of an unconstrained firm (Appelbaum and Harris (1978)). If the firm can retain earnings it can follow a myopic investment rule in spite of an anticipated credit constraint (Schworm (1980)). The myopic rule disappears if there are convex adjustment costs associated with the capital stock or shareholders are assumed to have a concave utility function (Koskenkylä (1985), Steigum (1983)). In any case, the most important point in credit rationing from the point of view of investments is that investment and financing decisions are linked together in the firm.

II.6.2 Investment Plans and Credit Rationing

In the Finnish capital market, quantitative credit rationing was the rule up to the early 1980s as the authorities kept interest rates so low that there was an almost permanent excess demand for credit. With deregulation of financial markets the variance of interest rates has increased and interest rates are now determined according to the type of the client. Banks try to assess more carefully the profitability of borrowers, taking into account the default risk. However, information is scarce and costly and credit rationing has not totally disappeared.

The effects of credit rationing on investment plans depend to an important extent on at what stage of the planning process the firm makes its financing arrangements. Shocks emanating from the credit market will be smaller if credit has been arranged in the early stages of the process. In that case a shock is likely to be confined mainly to the interest rate. This might be the case, for example, when conditions in the credit market are tight and there is advance selection of projects by the lender. If, however, the credit arrangements are left to the later stages of the investment planning process, there are other possibilities; a shock could affect the quantity of credit, the interest rate or the timing of the project. Another problem is that credit rationing is in fact one component of the adjustment costs of the investment plans and exerts an influence through all the variables of the realization function as we shall later see in equation (98) (Grieves (1983)).

There are many ways in which anticipated credit rationing may influence announced investment plans. It is possible that some advance selection of projects has taken place before they are reported in the investment survey. On the other hand, it is possible that firms seek to increase their credit demand because of anticipated credit rationing. Ex post there may be no sign of credit rationing in the investment survey data. Moreover, with aggregated data, it is difficult to detect signs of credit rationing, which is typically a micro-level phenomenon applying to a certain firm for a short interval.

In the following we briefly analyze the investment equation when the bank has so much information about firms that it can differentiate between them according to total profitability and default risk. The policy of the bank is to link the loan interest rate to the profitability of the firm to the bank. The profitability of the firm depends on how many of the firm's banking activities are managed by the bank. Indebtedness is a sign of default risk. High interest rates do not compensate for capital losses in default cases but it is one way to differentiate between clients. Firms which have very high default risks are subject to quantitative credit control, which means that they cannot obtain credit at any interest rate.

To simplify it is assumed that the profitability of the firm to the bank correlates positively with the solvency of the customer. We describe the solvency of the firm in terms of the debt-equity ratio and assume the following interest rate function for loan capital

$$(72) \qquad i(s) = \left| \begin{array}{l} \bar{i} + \zeta(s-\bar{s}), \text{ when } s^d > s > \bar{s}, \\ 0, \text{ when } s \geqslant s^d, \end{array} \right.$$

where i is the interest rate on bank loans, $s = B/E = B/(qK-B)$ is the debt-equity ratio of the firm, when q is the price of capital and $\zeta(\zeta'>0)$ is a parameter. The lower bound of the debt-equity ratio $\bar{s}$ is the limit of good solvency of the firm, at and below which the customer obtains credit at the lowest interest rate. The upper bound s^d is the default risk limit, at or above which the bank does not grant credit at all and the investment of the firm is limited by its current or retained earnings, if, as is likely, the firm cannot borrow from other credit institutions or abroad.

The objective function of the firm is to maximize

$$(73) \qquad \max_{I,N} \int_0^\infty e^{-rt}[(1-\tau)(pQ(K(t),L(t)) - wL(t) - i(s)B) - (1-D)C(I(t)) + N - \gamma B]dt$$

subject to the constraints

$$(74) \qquad \dot{K}(t) = I(t) - \delta K(t)$$

and

$$(75) \qquad \dot{B} = N - \gamma B,$$

where B is, as above, the debt capital of the firm, N stands for new loans and γ is the rate of repayment of the existing debt capital. In all probability the long-term discount rate r differs from the loan rate, which is affected by short-term variations in the economy and the credit-worthiness of the firm. The Hamiltonian is

$$(76) \qquad H = e^{-rt}\{[(1-\tau)(pQ(K(t),L(t)) - wL(t) - i(s)B) - (1-D) C(I(t)) + N - \gamma B] + \mu_1[I(t) - \delta K(t)] + \mu_2[N - \gamma B]\}.$$

The necessary conditions for an optimum are as follows:

$$(77) \qquad \dot{\lambda}_1 = (r + \delta)\lambda_1 - (1-\tau)p \frac{\partial Q}{\partial K(t)} - (1-\tau)qi's^2,$$

$$(78) \qquad \dot{\lambda}_2 = (r + \gamma)\lambda_2 + (1-\tau)i + \gamma,$$

$$(79) \qquad \frac{\partial H}{\partial I} = -(1-D)C'(I(t)) + \lambda_1 = 0,$$

(80) $$\frac{\partial H}{\partial N} = 1 + \lambda_2 = 0.$$

From equations (77) and (79), in the steady state the equilibrium condition for the capital stock is

(81) $$\frac{\partial Q}{\partial K(t)} = \frac{C'(I(t))(1-D)(r+\delta) - q(1-\tau)(m(s) - i(s) - si'(s))}{(1-\tau)p} = \frac{jc}{p},$$

where m(s) is the marginal cost of borrowed capital

(82) $$m(s) = \frac{\partial i(s)B}{\partial B} = i(s) + s(1+s)i'(s).$$

As above (equation (59)), the steady state investment function is of the form

(83) $$I(t) = \frac{(1-\tau)p \frac{\partial Q}{\partial K(t)}}{C'(I)(r+\delta)(1-D) - q(1-\tau)(m(s) - i(s) - si'(s))},$$

which is the investment equation in a situation where the capital market is imperfect and the lender has so much market power and information on the firm that it can differentiate credit terms - in this case the interest rate - according to the solvency (profitability) of the firm as viewed by the bank. When the loan interest rate does not depend on solvency i'(s) = 0 or the solvency of the firm is under $\bar{s}$ (equation (72)), the marginal cost of borrowed capital m(s) = i(s) and the discount rate r is equal to the loan rate and perfect competition prevails in the capital market.

The above investment model is a typical slow adjustment model (Koskenkylä (1985)). Steigum (1983) has shown that slow adjustment also follows under the assumption of linear adjustment costs of capital when the firm maximizes the shareholder's intertemporal utility and has a nonlinear interest rate function. The main difference between Steigum's model and the above model is that Steigum did not limit interest rates upwards. He did not take account of default risk or quantitative credit rationing related to it. An interesting result with his model is that the optimal plan of the firm can be approximated by a flexible accelerator model of investment and that the rate of investment is closely related to the flow of retained profits. In equation (83) credit rationing influences multiplicatively the cost of capital.

The above investment model with nonlinear interest rates and quantitative credit rationing at high interest rates is a simplified attempt to describe credit rationing in a developed capital market such as that in Finland in the 1980s. On the other hand, it provides a micro-level investment function which includes a variable for the increasing marginal cost of capital. Credit rationing in the 1960s and 1970s was different, for then interest rates were kept administratively low and excess demand for credit was chronic. At that time banks used loan terms other than interest rates to support there profitability. However, the models developed at that time used the marginal interest rate on central bank debt to explain the effects of monetary policy on investment as the cost of central bank debt was thought to influence banks' lending policy (Kukkonen (1975), Tarkka (1985), Koskenkylä (1985)).

II.7 Concluding Remarks

In the theoretical analysis of this chapter the determination of investment plans is linked to the latest investment theory of the firm. Functions for investment plans are derived under two assumptions concerning the loss functions of the firm. The first case considers a theoretical model in which plans are assumed to be changed without costs as a function of new information. This means that plans are continually updated with the latest information. The other case considers the situation where changes in plans generate costs to the firm. In that case the decision to change plans according to new information depends on the size of relative cost factors, disequilibrium costs and revision costs.

The effects of risk and uncertainty on plans are analyzed using two types of models. Attitude towards risk is described with a special parameter in the discrete time model while the error term represents the effects of uncertainty. It is observed that increasing risk-averse behaviour reduces the speed of adjustment of the capital stock to the optimal level after some exogeneous shock. The uncertainty associated with the future is described with error variances of the target function and the realization function for plans. The increase in variances decrease the speed of adjustment of the capital stock to exogeneous price shocks.

In the continuous time dynamic models it is assumed that the factor prices follow a stochastic Ito-process with a certain expected value. The results are not, however, clear-cut with respect to the increase in the variance of the Ito-process. A mean preserving spread increase in variance means that optimal investment increases, which conforms with earlier results when uncertainty was associated with only one price variable, the price of production (Hartman (1972), Abel (1983)). A new and different kind of result is obtained when the increase in uncertainty is measured by an increase in the scale of the Ito-process. The IS-increase in uncertainty increases optimal investment if the covariance of prices is positive but decreases investment if the covariance term is negative and leaves investment unchanged if the covariance of prices is zero (Abel (1985)).

According to standard neoclassical investment theory, optimal investment plans depend on the latest information on the price of capital, user cost and the price of labour. Assuming, however, that perfect competition does not prevail in the product markets, the demand curve for final products is not horizontal and demand has an independent meaning in the investment function. On the other hand, demand has a solid position in the investment functions of macro-level growth models.

The final section discusses the effects of credit market imperfections on the investment function. It is observed that credit rationing can be justified as the optimal behaviour of banks even in a situation of deregulation in the financial markets. The dynamic credit rationing theories are briefly summarized using a rationing model in which the bank can differentiate customers in terms of their expected profitability to the bank. A modified type of assumption is made concerning the loan interest rate, which depends on the solvency of the customer and stays within certain limits. The best clients obtain loans at the lowest interest rates while customers with high default risk are not granted loans at all. The total cost of capital also includes increasing borrowing costs, which are incorporated in the investment function in the case of credit rationing. Rationing can have a positive or negative influence on investment plans depending on at which stage of the planning process the firm negotiates the credit arrangements with the bank and on whether rationing is anticipated or takes the form of a surprise.

In the realization function for investment plans credit rationing may influence investment plans multiplicatively through all the variables of the function, assuming financing arrangements are part of the adjustment costs of the plans (equation 98). In addition, credit rationing affects the cost of capital to the firm multiplicatively.

III INVESTMENT PLANS AS FORECASTS

III.1 Aims of the Chapter

This chapter is concerned with the screening of the investment survey data of the Bank of Finland. We seek to answer the following questions:

a) How good are investment plans as "forecasts" of final investments, how much are investment plans revised as a function of the survey horizon and are there any observed differences between manufacturing sectors and over the time period studied?

b) Do unanticipated changes in the prices of capital goods influence the realization of investment plans?

c) How efficiently is known information used in formulating investment plans?

As noted above, investment plans are not real forecasts but endogeneous plans of the firm conditional on the latest information. The reason for testing the forecasting ability is to determine whether revisions of plans are systematic or merely stochastic. This information is very important for using survey data in forecasting.

The data are first described by means of diagrams and statistical measures, the "inequality coefficients" of Theil (1961, 1966) and Tichy (1976). The basic econometric methods applied in screening the data are the tests for unbiasedness and orthogonality used in testing rational expectations. The tests are performed using time series data according to manufacturing sector and size of firm, with the data pooled by sector. The effects of surprises on prices of investment goods are tested with the non-nested Wald-type test suggested by Mizon and Richard (1982).

The investment survey data of the Bank of Finland used in this chapter cover the period 1963 - 1984; the most recent years are missing because of publication lags for some other data at the time the main econometric analysis was carried out. It is possible to study the predictability of investment plans according to survey horizon, manufacturing sector and size of firm. A detailed description of the data is presented in Appendix 1. At its longest the survey horizon is one and half years and the survey is conducted twice a year. Companies are asked to report their investment plans in current prices.

III.2 Rationality of Plans

The point of the departure for this study is that a firm's investment plans are endogeneous decision variables which can be assumed to be conditional on information available at the time of making plans. According to Muth (1961) the rationality of expectations means that, for the same information set, expectations of firms tend to be distributed about the prediction of the theory or, more generally, the subjective probability distribution of outcomes corresponds to the "objective" probability distribution of outcomes. Objectivity means the structure of the relevant econometric model because information is scarce. Public information has no significant impact on the functioning of the economic system, because the firm can take account of it in its plans.

The rational expectations hypothesis can be written more precisely in the form $E[X(t) | \phi(t-1)] = X(t) + \varepsilon(t)$, where $E[X(t) | \phi(t-1)]$ is a conditional expectation value of future movements in variable X(t) based on the economic agent's information $\phi(t-1)$, while $\varepsilon(t)$ is the random error of expectation or prediction, whose expected value $E\varepsilon(t) = 0$. Moreover, $E[X(t) | \varepsilon(t)] = 0$; i.e. the prediction error does not correlate with any variable known at the beginning of the period because all systematic elements present in the random term $\varepsilon(t)$ are included in the information set $\phi(t-1)$ and have been used to improve the predicted value of X(t).

The numerous tests of the rational expectations hypothesis are all different versions of the test of the conditional expectation value.

Unbiasedness is the central requirement of rational expectations. Testing for unbiasedness with the aid of survey data is associated with the requirement of equality of both means and variances (Sheffrin (1983)). These test equations can also be used to correct investment plans for forecasting purposes (Aiginger (1977)). Also belonging to the same family of tests is the testing of consistency and orthogonality. Integral to these tests is the requirement that the initial information is used efficiently and that expectations are formed according to the same rule as final observations. Hence, the forecast error cannot depend on the information available at the time of making the forecast and future modifications of the forecast concerning the same period cannot be predicted on the basis of the original information.

The concept of rational expectations is important from the point of view of the realization functions of plans. If plans were fully rational given the information available at the time of planning, they could be used as such for forecasts, supplemented only by new information as it appeared. However, the data on which planning and expectations are based do not generally pass rational expectations tests. This may be due to an incomplete and asymmetrical information set resulting, inter alia, from the acquisition costs of information and the fact that the price system does not transmit correct information. The apparent irrationality of plans may also reflect a conscious view taken by the economic agent towards an asymmetric loss function.

Especially in the case of investment plans, an important reason for the deviation of the plans from rationality may be the adjustment costs associated with investments. It seems natural that the adjustment costs connected with investment plans for a certain period increase as that period approaches closer in time, i.e. when preparations related to the investment, such as financial arrangements and orders for investment goods increase. As a result, final investments need not necessarily any longer be in harmony with the most recent expectations data important from the point of view of investments.

III.3 Definitions

The full rationality of expectations requires that all relevant information has been used in an optimal way. In practice the definition of relevant information and optimality is difficult. However, in defining the information set, we can utilize the observation by Abel and Mishkin (1983) that non-optimal use of a subset of the relevant information set is a sufficient condition for rejecting the rationality of expectations. In practice, optimality is as a rule interpreted as statistical dependence, tested with the ordinary least squares method.

The method of testing for the rationality of expectations can be derived as follows (Brown - Maital (1981)). Let I(t) and IP(t,t-1) represent realized and predicted values of a given variable, where IP(t,t-1) is a prediction of I(t) in period t-1. Assume the predition is based on some subset S(t-1) of the relevant information set $\Omega(t-1)$ at time t-1 and the relation between S(t-1) and $\Omega(t-1)$ is denoted by $S(t-1) = S(\Omega(t-1))$. The dependence of IP(t,t-1) on the information used to construct it is stated as $IP(t,t-1) = f(S(t-1))$. Assume further that ER(t) is a forecast error of an agent, then by conditional expectations we can write ER(t) as

$$\begin{aligned} (84) \qquad ER(t) &= E[(I(t) - IP(t,t-1)) \mid \Omega(t-1)] \\ &= E[I(t) \mid \Omega(t-1)] - IP(t,t-1)f(S(\Omega(t-1))) \\ &= ERf(\Omega(t-1)). \end{aligned}$$

The information set S(t) used in the prediction is as a rule smaller than the relevant information set $\Omega(t)$ because of the costs of acquiring information. The prediction IP(t,t-1) is said to be fully rational and is optimal in the sense that no other unbiased predictor has smaller variance, if

$$(85) \qquad IP(t,t-1) = E[I(t) \mid \Omega(t-1)],$$

which implies that $ERf(\Omega(t)) = 0 \;\forall\; \Omega(t)$. Now we obtain an equation between the prediction error and the information set, which we write in the form of a regression equation

$$(86) \qquad I(t) - IP(t,t-1) = \alpha + \beta X(t-1) + \varepsilon(t),$$

where X(t-1) is an observation matrix, α and β are parameter vectors and the necessary condition for rationality is the joint hypothesis that $\alpha = \beta = 0$ and that the residual $\varepsilon(t)$ must be "independent" of the observations X(t-1), i.e. $E[\varepsilon(t) \mid X(t-1)] = 0 \;\forall\; \Omega(t-1)$.

According to the equation we regress prediction errors with relevant information. If the regression analysis shows statistical dependence, we reject the hypothesis of full rationality, which means that all relevant information has not been used optimally in the predictions. The forecaster usually has only a subset $S(t-1) \subset \Omega(t-1)$ of the relevant information set at his disposal. The conditional expectation value of the prediction is then

$$(87) \qquad IP(t,t-1) = E[I(t) \mid S(t-1)].$$

Independence between the information set and the prediction error is not a sufficient condition for full rationality. However, in practice the situation is often just the opposite, i.e. there is already a significant dependence between the prediction error and a small subset of the information set, which means we have a sufficient condition for rejecting full rationality. The smallest subset for testing rationality are the time series of the predictions. We can test the unbiasedness of the predictions by studying the dependence of the successive predictions. Significant dependence is a sufficient condition for rejecting the rationality of predictions. This test form is referred to as a method for testing partial rationality. If there is not significant dependence we need more data to obtain a more powerful test of rationality (Sargent (1973)). A prediction IP(t,t-1) is said to be an unbiased prediction for a realized value I(t), if

$$(88) \qquad IP(t,t-1) = E[I(t) \mid IP(t,t-1)],$$

since $IP(t,t-1) \subset S(t-1)$. Unbiasedness is a necessary condition for partial rationality. Unbiasedness can be tested with the regression equation

(89) $I(t) = \alpha + \beta IP(t,t-1) + \varepsilon(t).$

If $\alpha = 0$, $\beta = 1$ and $E[\varepsilon(t) \mid IP(t,t-1)] = 0$, the prediction IP(t,t-1) is unbiased. Rejecting the joint hypothesis means also rejecting the hypothesis of partial rationality.

III.4 Statistical Description

Various statistical indicators are used in this section to describe revisions of investment plans, including means, standard deviations, correlation coefficients and the measures of forecasting accuracy developed by Theil (1966). The indicators give an idea of the accuracy of investment plans as a function of time and the survey horizon. (A description of the Bank of Finland investment inquiry and the data is given in Appendix 1.) Investment plans are deflated in two different ways, using realized ex post prices (price expectations with perfect foresight) and ex ante ARIMA forecasts of prices, whereas ARIMA models are estimated using ex post data (Appendix 2). The realization of investment plans is examined primarily in terms of the same sample, i.e. that of the Bank of Finland investment inquiry. Some comparisons are, nevertheless, made with the figures in the official statistics.

Table 1 shows changes in manufacturing investment plans for each year from one survey horizon to another as a percentage of the total change in plans for each year. The largest changes occur in the case of the longest survey horizons, whereas the means of changes in the plans for the current year differ only marginally from zero. Another point worth noting is the fact that the investment plans for the longest survey horizons systematically underestimate actual developments, and only in exceptional cases has the direction of change been towards less investment.

TABLE 1.a. RELATIVE CHANGES IN INVESTMENT PLANS
(each change as per cent of total change in the year)
IN 1963 - 1984 DEFLATED BY PRICES OF INVESTMENT GOODS

	1963	1964	1965	1966	1967	1968	1969	1970
1 change	-	-	-	-	-	-	15.17	12.75
2 change	13.20	9.86	6.87	12.29	-1.51	9.38	22.20	21.85
3 change	0.43	-0.42	10.34	-1.39	5.90	-4.92	0.67	-5.85
4 change	3.46	1.01	3.96	5.35	3.69	8.40	2.70	-0.70
Total change	17.10	10.45	21.17	16.24	8.08	12.85	40.73	28.05

	1971	1972	1973	1974	1975	1976	1977	1978
1 change	6.11	6.79	17.61	10.67	8.21	-17.10	-12.47	-3.79
2 change	1.80	8.45	9.02	20.12	-1.33	3.46	-10.64	10.54
3 change	0.43	-1.13	5.60	0.99	0.57	4.01	-7.42	6.02
4 change	7.83	-0.45	6.75	2.50	5.03	8.58	-0.23	-11.94
Total change	14.62	20.39	34.37	33.85	15.92	-12.47	-17.32	-3.11

	1979	1980	1981	1982	1983	1984	Average value of changes	Standard deviation of changes
1 change	22.82	21.69	-0.28	5.87	5.17	20.74	7.50	11.22
2 change	5.41	10.48	2.98	-1.08	3.63	4.24	7.33	7.77
3 change	-2.95	5.63	-5.38	-8.52	3.02	-5.86	0.06	4.93
4 change	0.62	-4.28	-2.44	5.13	-6.71	-1.95	1.65	4.97
Total change	25.90	33.52	-5.12	1.41	5.12	17.18	16.56	15.05

TABLE 1.b. RELATIVE CHANGES IN INVESTMENT PLANS
(each change as per cent of total change in the year)
DEFLATED BY THE ARIMA FORECASTS OF PRICES (Appendix 2)

	1963	1964	1965	1966	1967	1968	1969	1970
1 change	-	-	-	-	-	-	13.35	11.96
2 change	24.11	18.76	14.17	23.62	8.24	12.23	31.10	27.12

	1971	1972	1973	1974	1975	1976	1977	1978
1 change	5.80	6.43	17.21	10.91	7.87	-15.88	-12.04	-3.21
2 change	6.53	12.93	10.90	18.38	2.57	10.23	-7.08	25.82

	1979	1980	1981	1982	1983	1984	Average value of changes	Standard deviation of changes
1 change	20.90	21.69	-0.25	5.43	4.38	18.88	7.09	9.02
2 change	13.57	10.48	17.14	6.78	18.97	13.50	14.55	8.60

The relative change in investment plans deflated by autoregressive price expectations between the two longest survey horizons (1st change) is on average smaller than in the case where there is no forecast error in price expectations (Table 1.b). In the case of the autoregressive deflator, the 2nd change is, however, clearly larger than in the alternative case of perfect foresight. The standard deviations of changes in plans behave in a similar fashion. On the basis of this analysis, the autoregressive model in investment prices does not seem to lead to better "accuracy" of investment plans than if realized prices are used in deflating plans.

Table 2 shows correlation coefficients between, on the one hand, investment plans and realizations and, on the other hand, the final figures of the investment survey and the Central Statistical Office of Finland. Two different deflators have again been used in investment plans. Correlations of the plans with realizations seem to increase as the survey horizon shortens. All the correlation coefficients are statistically significant. Clear differences can be observed between the various manufacturing sectors and types of goods. For the longest survey horizon the highest correlations between plans and realized investments are found in the metal and engineering industries and in investments in machinery and equipment. Differences between manufacturing sectors and types of goods diminish substantially as the survey horizon shortens. Alternative deflators of investment plans do not produce significant differences in the "accuracy" of plans. There is high correlation, more than 0.9, between the final investment data of the Bank of Finland and the Central Statistical Office of Finland, which, however, leaves room for random deviations.

In the following Tables 3.a - 3.f, the mean square error of the plans is divided as suggested by Theil into systematic and stochastic components (Appendix 3). The division is carried out in two different ways. The definition of bias is the same in both cases. By contrast, the remainder of the error is divided into two parts in two different ways according to Theil (1961). The alternative components are, on the one hand, variance and covariance compoments and, on the other hand, the regression and disturbance components. The bias and variance components (or the regression component) constitute the systematic error, the share of which in the total error should diminish as forecasting accuracy improves. The disturbance term represents the residual term of the regression between plans and realized figures. By dividing the mean square error of the plans by the variance of the final figures and taking the square root of the quotient, Tichy's V coefficient (Tichy (1976)) is obtained.

From the Tichy's V coefficients calculated for total manufacturing, it can be observed that, for the longest survey horizon (the investment plans for the following year in the spring survey), the mean square of the change in plans (logarithmic differences) exceeds the variance of investments (Tichy's coefficient more than one) and the mean of plans differs from the mean of realized investments by 7.5 units. The stochastic error accounts for almost 90 per cent of the total forecast error measured by the covariance term. Measured by the disturbance term, the stochastic error accounts for more than 50 per cent. Thus, plans tend to change substantially for the longest survey horizon with respect to final investments.

When the survey horizon shortens by six months, the value of the Tichy V coefficient falls clearly below one to 0.5. The "predictive power" is then better than a "naive" (unchanged developments) forecast. Moreover, the share of systematic error in total error falls to two per cent and the major part of the change is random. On the other hand, the share of the "regression error" still exceeds 10 per cent. The higher figure for the "regression error" is due to the correlation coefficient included therein. For the shortest survey horizons, the changes in plans are almost completely random (Chart 1).

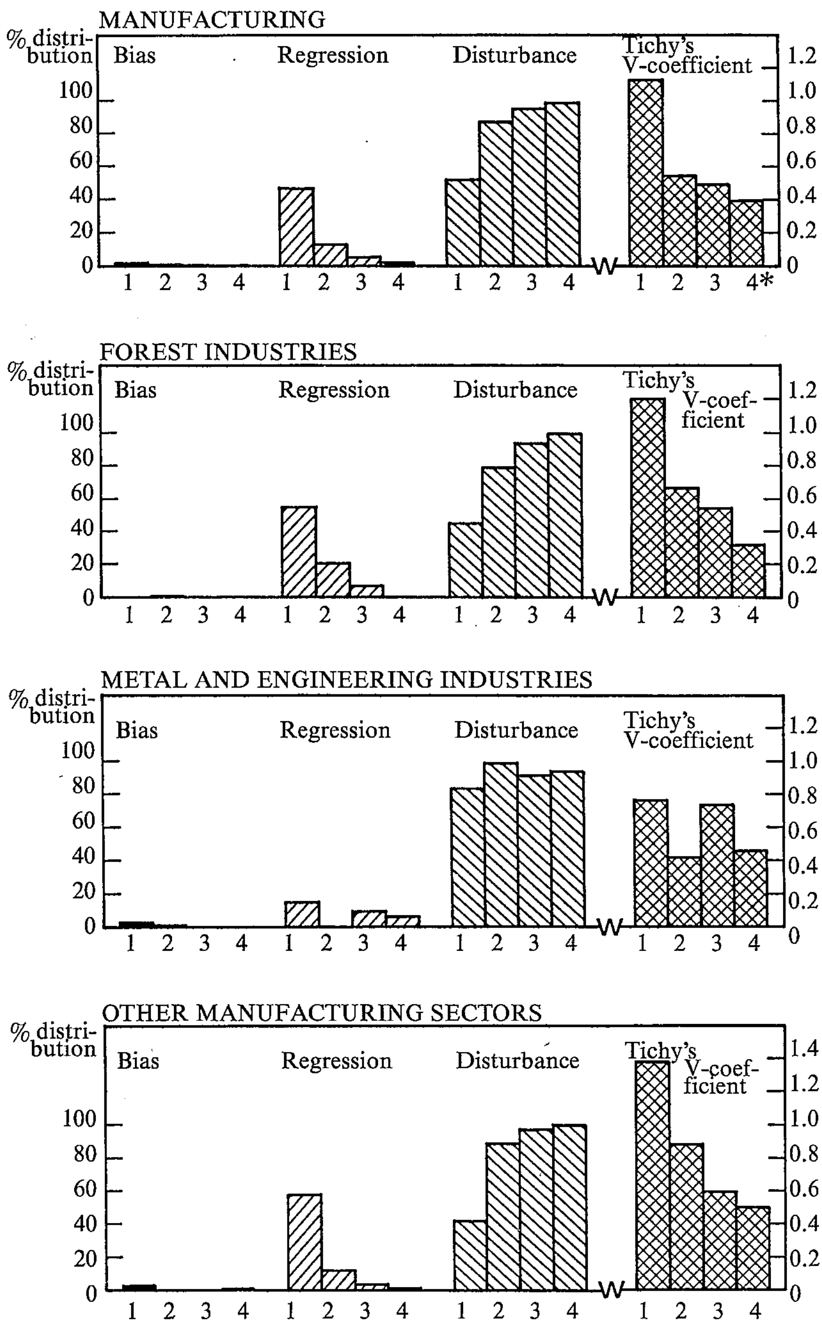
According to the calculated indicators, the "accuracy" of plans does not seem to depend significantly on alternative methods of deflating. In the case of deflating with a perfect foresight price index (realized prices), the same deflator is used for all plans concerning a particular year. Hence, the "differences in accuracy" of the series deflated in different ways are due merely to "errors" in the ARIMA forecasts of prices.

TABLE 2. CORRELATION COEFFICIENTS OF INVESTMENT PLANS WITH REALIZED INVESTMENTS FOR DIFFERENT SURVEY HORIZONS

Survey horizon		Manufacturing (1)	Forest industries (2)	Metal and engineering industries (3)	Other manufacturing industries (4)	Machinery and equipment (5)	Construction (6)
Spring of the previous year	PF*	0.614	0.459	0.804	0.629	0.742	0.544
	PA	0.673	0.501	0.820	0.672	0.763	0.643
Autumn of the previous year	PF	0.933	0.877	0.953	0.832	0.948	0.883
	PA	0.956	0.902	0.960	0.859	0.960	0.924
Spring of the realization year		0.957	0.930	0.806	0.938	0.941	0.940
Autumn of the realization year		0.980	0.963	0.965	0.951	0.969	0.976
Final data: investment survey and Central Statistical Office		0.963	0.897	0.949	0.930	0.975	0.860

* Deflator in investment plans; PF realized prices of investment goods, PA ARIMA-model forecast of prices (Appendix 2)

CHART 1. ROOT-MEAN-SQUARE PREDICTION ERRORS OF INVESTMENT PLANS (Tables 3.a - 3.d)



*Survey horizon, errors of plans in the surveys made
1 = in the spring of the previous year
2 = in the autumn of the previous year
3 = in the spring of the realization year
4 = in the autumn of the realization year

TABLE 3.a. MANUFACTURING

Root-mean-square prediction errors of investment plans according to Theil and Tichy; current value figures deflated by perfect foresight and weak rationality price expectations. Basic data in logarithmic difference form, figures in parentheses show percentage distribution of MSE.

Survey horizon		Bias	Variance	Covariance	MSE	Regression	Disturbance	Tichy's V-coef-ficient	Theil's inequality coefficient
Spring of the previous year	PF*	7.49 (1.7)	43.39 (9.7)	396.42 (88.6)	447.30 (100.0)	208.46 (46.6)	231.35 (51.7)	1.13	1.06
	PA	8.78 (2.3)	47.83 (12.9)	314.87 (84.8)	371.47 (100.0)	170.85 (46.0)	191.84 (51.7)	1.03	1.01
Autumn of the previous year	PF	1.12 (1.3)	0.87 (1.0)	86.24 (97.7)	88.23 (100.0)	10.90 (12.3)	76.21 (86.4)	0.54	0.73
	PA	1.65 (1.3)	11.43 (9.2)	110.77 (89.5)	123.85 (100.0)	36.77 (29.7)	85.43 (69.0)	0.64	0.80
Spring of the realization year		0.34 (0.5)	0.03 (0.0)	73.98 (99.5)	74.35 (100.0)	3.78 (5.1)	70.23 (94.4)	0.49	0.70
Autumn of the realization year		0.07 (0.2)	0.28 (0.6)	44.21 (99.2)	44.56 (100.0)	0.62 (1.4)	43.87 (98.4)	0.39	0.62
Final data: investment survey and Central Statistical Office		0.21 (0.3)	11.28 (17.6)	52.63 (82.1)	64.12 (100.0)	23.85 (37.2)	40.06 (62.5)	0.58	0.76

* Deflator in investment plans: PF realized prices of investment goods, PA ARIMA-model forecast of prices (Appendix 2)

TABLE 3.b. FOREST INDUSTRIES

Root-mean-square prediction errors of investment plans according to Theil and Tichy; current value figures deflated by perfect foresight and weak rationality price expectations. Basic data in logarithmic difference form, figures in parentheses show percentage distribution of MSE.

Survey horizon		Bias	Variance	Covariance	MSE	Regression	Disturbance	Tichy's V-coef-ficient	Theil's inequality coefficient
Spring of the previous year	PF*	1.04 (0.1)	185.65 (15.6)	1002.61 (84.3)	1189.31 (100.0)	653.00 (54.9)	535.27 (45.0)	1.21	1.10
	PA	1.55 (0.2)	215.24 (20.1)	851.60 (79.7)	1068.39 (100.0)	603.03 (56.4)	463.81 (43.4)	1.15	1.07
Autumn of the previous year	PF	1.90 (0.5)	10.13 (2.7)	362.90 (96.8)	374.93 (100.0)	77.58 (20.7)	295.45 (78.8)	0.67	0.82
	PA	2.04 (0.4)	43.67 (9.5)	415.29 (90.1)	460.99 (100.0)	154.46 (33.5)	304.50 (66.1)	0.74	0.86
Spring of the realization year		0.07 (0.0)	0.15 (0.1)	235.08 (99.9)	235.30 (100.0)	15.01 (6.4)	220.22 (93.6)	0.55	0.74
Autumn of the realization year		0.14 (1.1)	4.41 (5.0)	84.17 (94.9)	88.72 (100.0)	0.29 (0.3)	88.29 (99.6)	0.32	0.57
Final data: investment survey and Central Statistical Office		1.74 (1.1)	22.69 (14.6)	130.49 (84.2)	154.92 (100.0)	49.09 (31.7)	104.09 (67.2)	0.51	0.71

* Deflator in investment plans: PF realized prices of investment goods, PA ARIMA-model forecast of prices (Appendix 2)

TABLE 3.c. METAL AND ENGINEERING INDUSTRIES

Root-mean-square prediction errors of investment plans according to Theil and Tichy; current value figures deflated by perfect foresight and weak rationality price expectations. Basic data in logarithmic difference form, figures in parentheses show percentage distribution of MSE.

Survey horizon		Bias	Variance	Covariance	MSE	Regression	Disturbance	Tichy's V-coef-ficient	Theil's inequality coefficient
Spring of the previous year	PF*	12.58 (3.0)	0.10 (0.0)	407.26 (97.0)	419.94 (100.0)	59.88 (14.3)	347.48 (82.7)	0.76	0.87
	PA	14.21 (3.4)	0.04 (0.0)	397.98 (96.6)	412.23 (100.0)	55.92 (13.6)	342.10 (83.0)	1.75	1.87
Autumn of the previous year	PF	0.94 (0.9)	4.32 (3.9)	105.15 (95.2)	110.41 (100.0)	0.04 (0.0)	109.44 (99.1)	0.42	0.65
	PA	1.03 (0.8)	4.13 (3.4)	116.72 (95.8)	121.88 (100.0)	2.33 (0.2)	120.62 (99.0)	0.44	0.66
Spring of the realization year		1.10 (0.2)	3.48 (0.8)	445.08 (99.0)	449.58 (100.0)	39.85 (8.8)	408.63 (90.9)	0.73	0.85
Autumn of the realization year		0.43 (0.3)	0.05 (0.0)	134.95 (94.7)	135.43 (100.0)	8.36 (6.1)	126.64 (93.6)	0.46	0.68
Final data: investment survey and Central Statistical Office		1.29 (0.7)	7.23 (4.1)	167.78 (95.2)	176.30 (100.0)	0.40 (0.2)	174.61 (99.1)	0.48	0.69

* Deflator in investment plans: PF realized prices of investment goods, PA ARIMA-model forecast of prices (Appendix 2)

TABLE 3.d. OTHER MANUFACTURING INDUSTRIES

Root-mean-square prediction errors of investment plans according to Theil and Tichy; current value figures deflated by perfect foresight and weak rationality price expectations. Basic data in logarithmic difference form, figures in parentheses show percentage distribution of MSE.

Survey horizon		Bias	Variance	Covariance	MSE	Regression	Disturbance	Tichy's V-coefficient	Theil's inequality coefficient
Spring of the previous year	PF*	11.60 (2.2)	67.32 (13.1)	436.54 (84.7)	515.46 (100.0)	291.40 (56.6)	212.46 (41.2)	1.38	1.17
	PA	13.18 (3.4)	44.65 (11.4)	333.51 (85.2)	391.34 (100.0)	193.28 (49.4)	184.88 (47.2)	1.20	1.10
Autumn of the previous year	PF	0.01 (0.0)	4.61 (2.4)	190.61 (97.6)	195.23 (100.0)	22.89 (11.7)	172.33 (88.3)	0.88	0.94
	PA	0.00 (0.0)	0.84 (0.4)	201.99 (99.6)	202.83 (100.0)	33.91 (16.7)	168.92 (83.3)	0.90	0.95
Spring of the realization year		0.0 (0.0)	1.84 (2.2)	83.34 (97.8)	85.18 (100.0)	2.46 (2.9)	82.72 (97.1)	0.59	0.77
Autumn of the realization year		0.21 (0.3)	2.35 (3.7)	61.34 (96.0)	63.89 (100.0)	0.36 (0.6)	63.32 (99.1)	0.50	0.71
Final data: investment survey and Central Statistical Office		0.03 (0.0)	0.72 (0.7)	108.35 (99.3)	109.10 (100.0)	18.13 (16.6)	90.94 (83.4)	0.69	0.83

* Deflator in investment plans: PF realized prices of investment goods, PA ARIMA-model forecast of prices (Appendix 2)

TABLE 3.e. MACHINERY AND EQUIPMENT

Root-mean-square prediction errors of investment plans according to Theil and Tichy; current value figures deflated by perfect foresight and weak rationality price expectations. Basic data in logarithmic difference form, figures in parentheses show percentage distribution of MSE.

Survey horizon		Bias	Variance	Covariance	MSE	Regression	Disturbance	Tichy's V-coefficient	Theil's inequality coefficient
Spring of the previous year	PF*	10.54 (2.8)	59.63 (15.6)	311.25 (81.6)	381.42 (100.0)	192.34 (50.4)	178.54 (46.8)	1.11	1.05
	PA	12.01 (3.2)	83.52 (22.3)	279.57 (74.5)	375.10 (100.0)	206.40 (55.0)	156.69 (41.8)	1.10	1.05
Autumn of the previous year	PF	1.50 (1.7)	2.71 (2.9)	88.09 (95.4)	92.30 (100.0)	16.55 (17.9)	74.25 (80.4)	0.58	0.76
	PA	1.76 (1.0)	24.57 (14.2)	146.54 (84.8)	172.87 (100.0)	70.00 (40.5)	101.11 (58.5)	0.80	0.89
Spring of the realization year		0.33 (0.5)	1.38 (1.9)	72.09 (97.6)	73.80 (100.0)	9.88 (13.4)	63.59 (86.1)	0.50	0.71
Autumn of the realization year		0.10 (0.1)	1.45 (1.9)	76.0 (98.0)	77.55 (100.0)	1.62 (2.1)	75.83 (97.8)	0.53	0.73
Final data: investment survey and Central Statistical Office		0.20 (0.3)	6.50 (9.3)	63.47 (90.4)	70.17 (100.0)	19.97 (28.5)	50.00 (71.2)	0.60	0.97

* Deflator in investment plans: PF realized prices of investment goods, PA ARIMA-model forecast of prices (Appendix 2)

TABLE 3.f. CONSTRUCTION

Root-mean-square prediction errors of investment plans according to Theil and Tichy; current value figures deflated by perfect foresight and weak rationality price expectations. Basic data in logarithmic difference form, figures in parentheses show percentage distribution of MSE.

Survey horizon		Bias	Variance	Covariance	MSE	Regression	Disturbance	Tichy's V-coefficient	Theil's inequality coefficient
Spring of the previous year	PF*	1.66 (0.2)	31.85 (3.1)	997.87 (96.7)	1031.38 (100.0)	530.05 (51.4)	499.67 (48.4)	1.39	1.18
	PA	2.27 (0.3)	11.74 (1.6)	707.49 (98.1)	721.50 (100.0)	281.55 (39.0)	437.68 (50.7)	1.16	1.08
Autumn of the previous year	PF	0.18 (0.1)	0.58 (0.2)	246.02 (99.7)	246.78 (100.0)	25.40 (10.3)	221.20 (89.6)	0.71	0.84
	PA	0.16 (0.1)	0.15 (0.1)	166.46 (99.0)	166.77 (100.0)	12.03 (7.2)	154.58 (92.7)	0.59	0.77
Spring of the realization year		0.00 (0.0)	13.62 (4.4)	298.23 (95.6)	311.83 (100.0)	16.34 (5.2)	295.51 (94.8)	0.77	0.88
Autumn of the realization year		0.08 (0.0)	1.50 (1.6)	90.15 (98.4)	91.73 (100.0)	0.90 (1.0)	90.75 (99.0)	0.44	0.66
Final data: investment survey and Central Statistical Office		0.46 (0.3)	5.20 (4.0)	169.68 (96.7)	175.34 (100.0)	37.72 (21.5)	137.16 (78.2)	0.67	0.82

* Deflator in investment plans: PF realized prices of investment goods, PA ARIMA-model forecast of prices (Appendix 2)

There are distinct differences between manufacturing sectors. The plans of the metal and engineering industries are the most accurate. In the surveys of the spring and autumn preceding the realization year, the systematic error accounts for only just under five per cent of the total error, and the bias, i.e. the deviation of means, between the plans and the realized figures is only of the order of three per cent or less. The bias is also very small in the forest industries, even for the longest survey horizon, whereas the deviations of variances are very large.

Analyzed by type of capital goods, the Tichy V coefficients hardly differ at all from each other, but, for the longest survey horizons, the importance of systematic errors in the building investment of manufacturing is much less than in investment in machinery and equipment. Thus, plans concerning investment in machinery and equipment can be revised more flexibly, which of course is not surprising.

When comparing the final figures of the Central Statistical Office of Finland with those of the Bank of Finland, it can be observed that, although deviations in means are small, there is a clear difference between variances. The difference in variances seems to focus primarily on the forest industries. The share of the stochastic component is very large in other manufacturing industries.

III.5 The Unbiasedness of Plans

As was pointed out in Chapter III.3, a necessary condition for the rationality of expectations is that the mean value of the expectations of economic agents is the same as the conditional mathematical expectation (equation (87)).

The conditional expectation can be tested in different ways according to the assumption on the size of the information set. In the test of the weakest form, i.e. the test of unbiasedness, the information set comprises only the realized and planned values and thus the revisions. As noted above (page 26), the premise of the test is questionable, if changes in investment plans involve costs because in that case the economic agent does not react to all shocks and plans do not remain optimal all the time in respect to information. The test is carried out using equation (89) in regression analysis.

(89') $I(t) = a_1 + a_2 IP(t,t-1) + \varepsilon(t)$,

where a necessary condition for rationality is the joint hypothesis H_0: $a_1 = 0$ and $a_2 = 1$ and the residual $\varepsilon(t)$ is white noise. The residual also belongs to the information set but in practice the most recent forecast errors are not known and it can be assumed that a moving average process appears in the residual, the order of which depends on the length of the planning horizon. Residuals for survey horizons of less than one year can be expected to follow the MA(1) process and those for survey horizons of less than two years the MA(2) process. Because of the MA process of residuals, variance estimates with a downward bias are obtained for the parameters (Brown and Maital (1981)), as a result of which the hypothesis of rationality is rejected too easily. Estimates are thus biased for two reasons, because of the MA error and the loss function associated with changes in plans.

When testing for unbiasedness, data on realized investments obtained from the survey are explained by means of investment plans made at different times at the total manufacturing level, by manufacturing sector and type of investment good. In addition to the actual testing of the expectations hypothesis, equations can be used as a basis for comparing later realization functions (Chapter IV). The question then arises whether other economic data can be used to improve the mechanical basic equations based merely on survey data.

The "predictive power" of plans was first examined so that realized investments were explained simultaneously by all the plans concerning the same year.[1] It turned out that all the information on the realization of investment is included in the last plan and the previous plans do not receive parameter estimates differing significantly from zero.

Chart 2 summarizes the regression analysis results of the unbiasedness testing (Tables 4.a - f). The estimation method used is ordinary least squares. The columns of the chart represent the parameter estimates of the coefficient a_2 in equation (89'). It can be seen that the parameter values increase very strikingly from about 0.5 to 0.8 between the first (1) and second (2) survey concerning investments in the following year. There are clear differences between different manufacturing sectors as was observed in the earlier analysis. In the metal and engineering industries the parameter estimate of the coefficient a_2 already reaches the value one with the data of the first survey. The small revisions of the metal and engineering industries' investment plans must be connected with the stable growth of production in that sector. For that reason the innovations have been small.

As regards the deflator of investment goods, the two alternative hypotheses above are made. First, it is assumed that companies do not make mistakes in price expectations, i.e. the hypothesis of perfect foresight is used. Secondly, it is assumed that companies forecast price developments in the following year on the basis of past developments in prices of investment goods. Price expectations are described by fitting a simple ARIMA model to a quarterly series of investment goods prices in the manufacturing. The estimated model is used to forecast price developments for one year ahead (Appendix 2).

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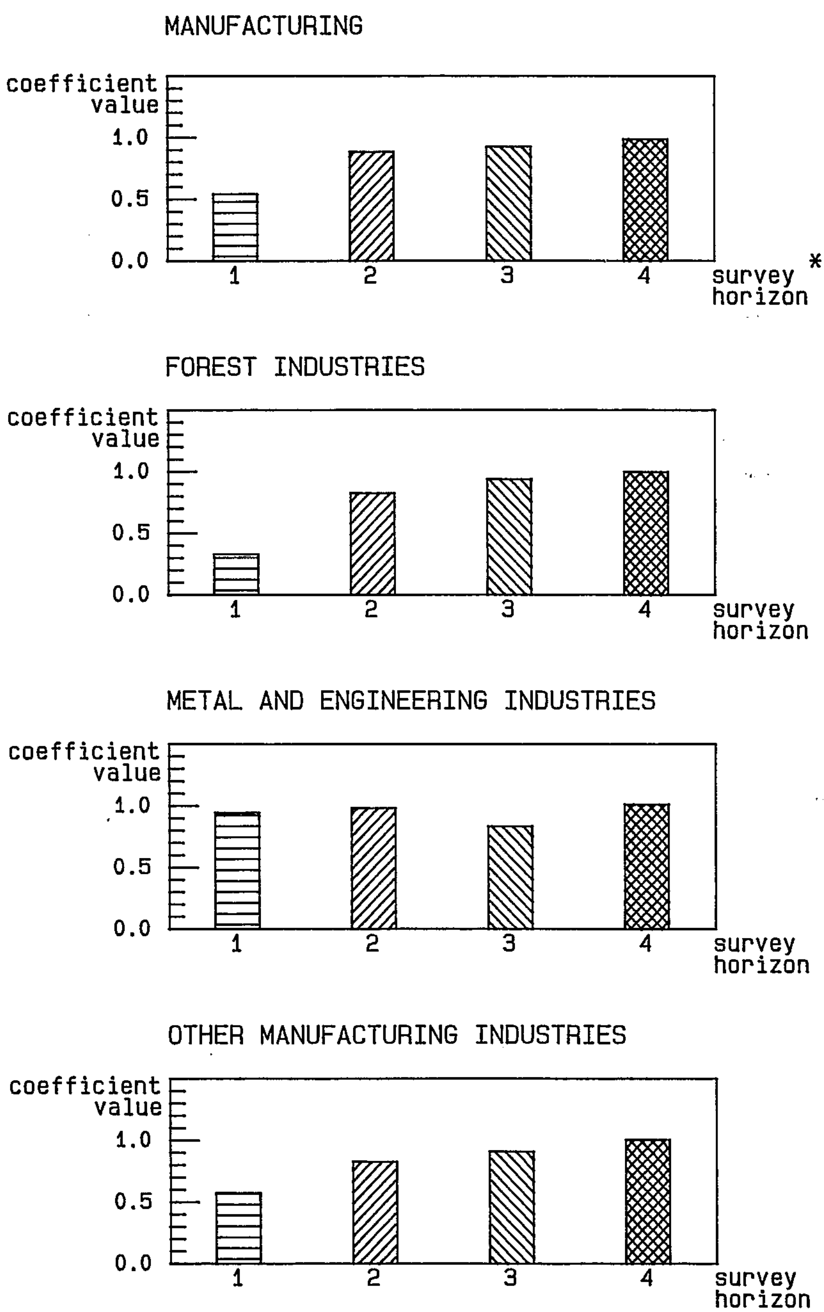
[1] The estimated equation was of the form $I_t = a_1 + a_2 \, {}_tIP_t^a + a_3 \, {}_tIP_t^s + a_4 \, {}_tIP_{t-1}^a + a_5 \, {}_tIP_{t-1}^s$. Only the parameters a_1 and a_2 differed significantly from zero. Superscript: a = autumn, s = spring; right subscript: information acquisition time; left subscript: time information concerns.

CHART 2. COEFFICIENTS OF INVESTMENT PLANS IN THE TEST FOR UNBIASEDNESS (PERFECT FORESIGHT PRICE EXPECTATIONS)



*Survey horizon; survey made
1 = in the spring of the previous year
2 = in the autumn of the previous year
3 = in the spring of the realization year
4 = in the autumn of the realization year

For the longest survey horizon, one and half years, the hypothesis of weak rationality or unbiasedness must be rejected in total manufacturing, for all major sectors and by type of investment good (Tables 4.a - f equations ${}_{t}IPF^{s}_{t-1}$ and ${}_{t}IPA^{s}_{t-1}$). The critical limits of the F-test are shown at the bottom of Table 4.a assuming that the residual is not autocorrelated and, alternatively, that the first-degree autocorrelation coefficient of the residual receives the value 0.3. In the case where there is autocorrelation, the critical limits of the F-test are based on the article by Kiviet (1980). The autoregressive process of the residual has been shown to raise the rejection limits of tests significantly.[2] For a survey horizon six months shorter, just over a year, unbiasedness is rejected in all manufacturing sectors other than the metal and engineering industries. The hypothesis of the stability of parameters remains generally valid, when Chow's stability test statistic is computed with respect to the year 1975. One problem, however, is that the power of the Chow test used remains weak in the case of such a small sample.

The autocorrelation of the residual is tested with respect to first-degree autocorrelation using the Durbin-Watson test statistic and with respect to autocorrelation of higher degree using the small sample application of the Portmanteau test, the Ljung-Box statistic (Harvey (1981)). The investment plans serving as independent variables in the regression equations have not been interpreted as lagged endogenous variables. If such an interpretation had been made, it would have been necessary to measure autocorrelation with, for example, the LM test statistic (Lagrange Multiplier Test,

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[2]Brown and Maital (1981) and Holden and Peel (1985) have used the OLS-method to estimate parameters a_1 and a_2 in situation where there is assumed to be a MA-process in the residual. The parameter estimates are consistent, but their standard deviations are inconsistent and biased. It is suggested that the GLS-method be used after OLS-estimation to obtain modified estimates of the asymptotic variance-covariance matrix. Vinod (1976) and Kiviet (1980) have shown that the AR process of the residual alters the critical limits of tests more than an error of the MA type. Rahiala (1985) has shown theoretically why autocorrelation of the residual of the model raises the critical limits of tests.

Breusch-Pagan (1980)), which, as an asymptotic test statistic, is poorly suited to such a small sample. The Ljung-Box test statistic was used to measure autocorrelation up to third degree. Higher order autocorrelation could not be tested because of the scarcity of degrees of freedom with annual data. It can also be argued that a three-years time period is adequate with a survey horizon of less than two years.

The autocorrelation coefficients AR(1), AR(2) and AR(3), employed in calculating the test are shown in Tables 4.a - f. The corresponding values of the normal distribution are shown below the autocorrelation coefficients. The Ljung-Box test statistic is distributed by χ^2, when the degrees of freedom are determined according to the degree of autocorrelation to be tested. The critical value of the χ^2 test is 7.81 (11.30) at the 5 (1) per cent significance level, so that the hypothesis that the residuals for the two longest survey horizons are uncorrelated must be rejected with respect to autocorrelation up to third degree.

The residuals are autocorrelated both in manufacturing and its main sectors. The autocorrelation of the residuals may indicate that the model lacks independent variables. The autocorrelation of the model is first corrected mechanically in order to achieve the best possible mechanical model with investment plans only. Precise identification of the residual process is impossible because of the smallness of the sample. Therefore, two alternative experimental Cochran-Orcutt estimations were carried out. Programmes correcting the first- and second-order autoregressive process of the residual were available. Under the assumption of second-order autoregression of the process, the standard errors of estimates were clearly the smallest (Tables 4.a - f).

The applicability of Cochran-Orcutt procedure is entirely conditional on the assumption of the time-series process nature of the residual. Because of the small number of observations, the time series process cannot be reliably identified, so that estimations are partly arbitrary. The autocorrelated residuals in ordinary least squares estimations imply inefficient but unbiased parameter estimates.

TABLE 4.a. MANUFACTURING

Test for the unbiasedness of investment plans (equation (89'))
Dependent variable: realized investments according to the survey
Independent variables: investment plans (IP) for different survey horizons (perfect foresight price expectations IPF, weakly rational price expectations IPA)

Variables in million markkaa at 1980 -prices

Estimation period 1963-1984 and 1969-1984 (long horizon ${}_tIPF^s_{t-1}$ and ${}_tIPA^s_{t-1}$)
Estimation method: OLS

	Spring of the previous year						Autumn of the previous year				Spring of the realization year	Autumn of the realization year
	${}_tIPF^s_{t-1}$			${}_tIPA^s_{t-1}$			${}_tIPF^a_{t-1}$		${}_tIPA^a_{t-1}$		${}_tIPF^s_t$	${}_tIPF^a_t$
Estimation method	OLS	CO-AR(1)	CO-AR(2)	OLS	CO-AR(1)	CO-AR(2)	OLS	CO-AR(1)	OLS	CO-AR(1)	OLS	OLS
Constant	5142.39	4994.7	5970.10	4632.63	4020.22	3920.79	1636.49	1967.43	1706.55	2027.40	814.87	273.76
	(3.34)	(2.54)	(3.02)	(3.16)	(2.14)	(1.98)	(2.65)	(2.13)	(3.51)	(2.96)	(1.50)	(0.72)
IP	0.542	0.556	0.427	0.653	0.721	0.728	0.883	0.843	0.946	0.903	0.924	0.984
	(2.91)	(2.53)	(1.79)	(3.40)	(3.19)	(2.82)	(11.61)	(8.19)	14.62	(10.42)	(14.78)	(22.21)
R^2C	0.332	0.279	0.144	0.414	0.395	0.348	0.864	0.768	0.910	0.843	0.912	0.959
SEE	1471.26	1355.0	1171.0	1378.69	1241.0	1036.0	796.54	685.20	648.14	628.60	649.12	437.28
DW	1.08	1.52	1.93	1.04	1.51	1.84	0.91	1.68	1.36	1.85	1.46	1.76
F	11.06	6.41	3.19	19.30	10.15	7.95	10.39	67.07	45.61	108.60	1.57	1.24
Chow (75)	1.56			1.60			8.84		6.08		0.82	1.51
Ljung-Box	7.45			7.52			6.86		2.07		3.43	1.85
AR(1)	0.438	0.448	0.708	0.441	0.443	0.649	0.521	0.543	0.300	0.340	0.230	0.106
	(1.75)	(1.86)	(2.94)	(1.76)	(1.89)	(2.76)	(2.44)	(2.88)	(1.41)	(1.61)	(1.08)	(0.50)
AR(2)	-0.208		-0.547	0.246		-0.553	0.110		0.009		0.281	0.131
	(-0.83)		(-2.27)	(-0.98)		(-2.44)	(0.52)		(0.04)		(1.32)	(0.62)
AR(3)	-0.383			-0.361			-0.002		-0.027		0.087	0.211
	(-1.53)			(-1.44)			(-0.01)		(-0.13)		(0.41)	(0.99)
ρ	0.450	0.207	0.007	0.460	0.215	0.068	0.540	0.149	0.310	0.051	0.250	0.110

Explanations: Superscript: s = spring, a = autumn; right subscript: information acquisition time; left subscript: time information concerns. Estimation methods OLS, Cochran Orcutt, residual AR(1), Cohran Orcutt, residual AR(2); t-values in parentheses below the coefficient estimates. AR(1), AR(2), AR(3) are autoregression coefficients of 1 - 3 degrees.

Critical values of the F-test (ρ = autocorrelation coefficient of residual)

F-tests, H_0: $a_1 = 0$ and $a_2 = 1$

	ρ = 0	ρ = 0.30		ρ = 0	ρ = 0.30	
$F_{0.95}(2,20)$	~ 3.49	~ 7.32	$F_{0.95}(2,14)$	~ 3.74	~ 8.1	$\chi^2_{0.95} = 7.81$
$F_{0.99}(2,20)$	~ 5.85		$F_{0.99}(2,14)$	~ 6.51		$\chi^2_{0.99} = 11.30$

TABLE 4.b. FOREST INDUSTRIES

Test for the unbiasedness of investment plans (equation (89'))
Dependent variable: realized investments according to the survey
Independent variables: investment plans (IP) for different survey horizons (perfect foresight price expectations IPF, weakly rational price expectations IPA)

Variables in million markkaa at 1980 -prices

Estimation period 1964-1984 and 1969-1984 (long horizon ${}_{t}IPF^{s}_{t-1}$ and ${}_{t}IPA^{s}_{t-1}$)
Estimation method: OLS

	Spring of the previous year						Autumn of the previous year				Spring of the realization year	Autumn of the realization year
	${}_{t}IPF^{s}_{t-1}$			${}_{t}IPA^{s}_{t-1}$			${}_{t}IPF^{a}_{t-1}$		${}_{t}IPA^{a}_{t-1}$		${}_{t}IPF^{s}_{t}$	${}_{t}IPF^{a}_{t}$
Estimation method	OLS	CO-AR(1)	CO-AR(2)	OLS	CO-AR(1)	CO-AR(2)	OLS	CO-AR(1)	OLS	CO-AR(1)	OLS	OLS
Constant	2391.63	2459.90	2328.94	2294.16	2346.07	2108.74	792.41	867.43	773.09	888.25	296.95	72.90
	(4.91)	(4.22)	(4.06)	(4.77)	(4.08)	(3.78)	(2.78)	(2.44)	(3.07)	(2.87)	(1.18)	(0.38)
IP	0.328	0.317	0.340	0.393	0.385	0.452	0.824	0.791	0.896	0.845	0.936	0.995
	(1.93)	(1.68)	(1.70)	(2.17)	(1.93)	(2.15)	(7.96)	(6.89)	(9.11)	(7.58)	(11.01)	(15.68)
R^2C	0.154	0.115	0.126	0.198	0.162	0.217	0.757	0.710	0.804	0.748	0.857	0.925
SEE	671.54	661.70	580.80	653.92	644.10	551.30	429.49	385.60	385.91	368.50	330.19	239.48
DW	1.37	1.53	1.80	1.35	1.52	1.74	1.03	1.66	1.30	1.73	1.92	1.67
F	13.79	2.83	2.88	16.88	3.72	4.60	7.82	47.51	19.84	57.53	1.55	0.61
Chow	0.13			0.15			1.12		0.99		0.07	3.13
Ljung-Box	8.59			9.20			5.41		3.17		1.23	1.41
AR(1)	0.289	0.302	0.480	0.298	0.314	0.498	0.479	0.491	0.347	0.382	0.039	0.153
	(1.16)	(1.17)	(1.91)	(1.19)	(1.21)	(2.03)	(2.20)	(2.45)	(1.59)	(1.80)	(0.18)	(0.70)
AR(2)	-0.278		-0.455	-0.303		-0.502	0.003		-0.11		0.213	-0.067
	(-1.11)		(-1.81)	(-1.21)		(-2.04)	(0.01)		(-0.50)		(0.97)	(-0.31)
AR(3)	-0.511			-0.522			-0.065		-0.06		0.064	-0.171
	(-2.04)			(-2.08)			(-0.30)		(-0.26)		(0.29)	(-0.78)
ρ	0.300	0.165	-0.007	0.310	0.171	0.007	0.480	0.161	0.350	0.124	0.040	0.150

F-tests, H_0: $a_1 = 0$ and $a_2 = 1$

	$\rho = 0$	$\rho = 0.30$		$\rho = 0$	$\rho = 0.30$	
$F_{0.95}(2,19)$	= 3.52	~ 7.42	$F_{0.95}(2,14)$	= 3.74	~ 8.1	$\chi^2_{0.95} = 7.81$
$F_{0.99}(2,19)$	= 5.93		$F_{0.99}(2,14)$	= 6.51		$\chi^2_{0.99} = 11.30$

TABLE 4.c. METAL AND ENGINEERING INDUSTRIES

Test for the unbiasedness of investment plans (equation (89'))
Dependent variable: realized investments according to the survey
Independent variables: investment plans (IP) for different survey horizons (perfect foresight price expectations IPF, weakly rational price expectations IPA)

Variables in million markkaa at 1980 -prices

Estimation period 1964-1984 and 1969-1984 (long horizon ${}_{t}IPF^{s}_{t-1}$ and ${}_{t}IPA^{s}_{t-1}$)
Estimation method: OLS

	Spring of the previous year						Autumn of the previous year				Spring of the realization year	Autumn of the realization year
	${}_{t}IPF^{s}_{t-1}$			${}_{t}IPA^{s}_{t-1}$			${}_{t}IPF^{a}_{t-1}$		${}_{t}IPA^{a}_{t-1}$		${}_{t}IPF^{s}_{t}$	${}_{t}IPF^{a}_{t}$
Estimation method	OLS	CO-AR(1)	CO-AR(2)	OLS	CO-AR(1)	CO-AR(2)	OLS	CO-AR(1)	OLS	CO-AR(1)	OLS	OLS
Constant	421.86	2.00	46.52	429.73	-47.38	62.37	119.36	87.41	202.81	182.30	395.82	-27.74
	(1.00)	(0.01)	(0.15)	(1.08)	(-0.13)	(0.20)	(0.74)	(0.41)	(1.42)	(1.04)	(1.17)	(0.19)
IP	0.945	1.089	1.095	1.013	1.196	1.160	0.981	0.988	1.017	1.024	0.834	1.012
	(5.06)	(6.38)	(8.03)	(5.36)	(7.10)	(7.70)	(13.70)	(11.33)	(14.89)	(12.70)	(5.94)	(15.96)
R^2C	0.622	0.740	0.830	0.649	0.779	0.818	0.903	0.870	0.917	0.894	0.632	0.927
SEE	442.30	341.50	216.50	426.04	317.00	234.70	208.86	199.80	193.59	195.30	434.62	181.53
DW	0.97	1.41	1.69	1.04	1.65	2.15	1.18	1.69	1.55	1.80	2.19	1.78
F	3.77	40.76	64.50	9.16	50.45	59.33	1.50	128.30	15.70	161.20	0.71	0.02
Chow	2.90			2.88			1.30		1.57		1.32	0.43
Ljung-Box	11.50			9.31			3.43		3.70		1.06	2.20
AR(1)	0.389	0.378	0.664	0.326	0.309	0.479	0.330	0.398	0.170	0.193	-0.120	0.045
	(1.56)	(2.00)	(3.80)	(1.30)	(1.72)	(2.34)	(1.51)	(1.73)	(0.78)	(0.81)	(-0.55)	(0.21)
AR(2)	-0.400		(-0.644)	-0.390		-0.524	-0.005		0.034		-0.054	-0.133
	(-1.60)		(-4.51)	(-1.56)		(-3.36)	(-0.02)		(0.16)		(-0.25)	(-0.61)
AR(3)	-0.514			-0.454			-0.191		-0.339		-0.153	0.258
	(-2.06)			(-1.82)			(-0.87)		(-1.55)		(-0.70)	(1.18)
ρ	0.390	0.288	0.123	0.330	0.166	-0.121	0.390	0.038	0.190	-0.021	-0.130	0.050

F-tests, H_0: $a_1 = 0$ and $a_2 = 1$

	$\rho = 0$	$\rho = 0.30$		$\rho = 0$	$\rho = 0.30$	
$F_{0.95}(2,19)$	$= 3.52$	~ 7.42	$F_{0.95}(2,14)$	$= 3.74$	~ 8.1	$\chi^2_{0.95} = 7.81$
$F_{0.99}(2,19)$	$= 5.93$		$F_{0.99}(2,14)$	$= 6.51$		$\chi^2_{0.99} = 11.30$

TABLE 4.d. OTHER MANUFACTURING INDUSTRIES

Test for the unbiasedness of investment plans (equation (89'))
Dependent variable: realized investments according to the survey (IRQ)
Independent variables: investment plans (IP) for different survey horizons (perfect foresight price expectations IPF, weakly rational price expectations IPA)

Variables in million markkaa at 1980 -prices

Estimation period 1964-1984 and 1969-1984 (long horizon ${}_tIPF^s_{t-1}$ and ${}_tIPA^s_{t-1}$)
Estimation method: OLS

	Spring of the previous year				Autumn of the previous year				Spring of the realization year	Autumn of the realization year
	${}_tIPF^s_{t-1}$		${}_tIPA^s_{t-1}$		${}_tIPF^a_{t-1}$		${}_tIPA^a_{t-1}$		${}_tIPF^s_t$	${}_tIPF^a_t$
Estimation method	OLS	CO-AR(1)	OLS	CO-AR(1)	OLS	CO-AR(1)	OLS	CO-AR(1)	OLS	OLS
Constant	1930.50	2545.12	1789.49	2053.15	870.20	1459.47	809.46	1354.85	364.06	70.67
	(3.18)	(3.13)	(3.06)	(2.56)	(2.09)	(2.47)	(2.13)	(2.54)	(1.34)	(0.27)
IP	0.572	0.391	0.665	0.574	0.825	0.664	0.913	0.750	0.908	1.004
	(3.03)	(1.80)	(3.40)	(2.47)	(6.54)	(3.95)	(7.33)	(4.56)	(11.77)	(13.36)
R^2C	0.353	0.138	0.413	0.266	0.677	0.435	0.725	0.511	0.873	0.899
SEE	575.02	502.20	547.73	463.30	450.01	383.50	415.07	361.30	277.49	251.86
DW	0.98	1.73	0.87	1.81	1.03	1.51	1.10	1.48	1.34	1.40
F	11.09	3.24	19.26	6.08	5.92	15.64	18.70	20.82	1.04	1.19
Chow (75)	3.28		2.51		13.30		6.46		8.74	8.47
Ljung-Box	5.56		6.68		4.80		4.22		6.51	7.13
AR(1)	0.501	0.587	0.550	0.587	0.440	0.485	0.411	0.465	0.281	0.254
	(2.00)	(2.67)	(2.20)	(2.69)	(2.02)	(2.69)	(1.88)	(2.53)	(1.29)	(1.16)
AR(2)	0.184		0.225		0.090		0.050		0.348	0.179
	(0.74)		(0.90)		(0.41)		(0.23)		(1.60)	(0.82)
AR(3)	-0.123		-0.093		-0.061		-0.098		0.162	0.432
	(-0.49)		(-0.37)		(-0.28)		(-0.45)		(0.74)	(1.98)

F-tests, H_0: $a_1 = 0$ and $a_2 = 1$

	$\rho = 0$	$\rho = 0.30$		$\rho = 0$	$\rho = 0.30$	
$F_{0.95}(2,19)$	= 3.52	~ 7.42	$F_{0.95}(2,14)$	= 3.74	~ 8.1	$\chi^2_{0.95} = 7.81$
$F_{0.99}(2,19)$	= 5.93		$F_{0.99}(2,14)$	= 6.51		$\chi^2_{0.99} = 11.30$

TABLE 4.e. MACHINERY AND EQUIPMENT

Test for the unbiasedness of investment plans (equation (89'))
Dependent variable: realized investments according to the survey (IRQ)
Independent variables: investment plans (IP) for different survey horizons (perfect foresight price expectations IPF, weakly rational price expectations IPA)

Variables in million markkaa at 1980 -prices

Estimation period 1964-1984 and 1969-1984 (long horizon ${}_{t}IPF^{s}_{t-1}$ and ${}_{t}IPA^{s}_{t-1}$)

Estimation method: OLS

	Spring of the previous year				Autumn of the previous year			Spring of the realization year		Autumn of the realization year
	${}_{t}IPF^{s}_{t-1}$		${}_{t}IPA^{s}_{t-1}$		${}_{t}IPF^{a}_{t-1}$		${}_{t}IPA^{a}_{t-1}$	${}_{t}IPF^{s}_{t}$		${}_{t}IPF^{a}_{t}$
Estimation method	OLS	CO-AR(1)	OLS	CO-AR(1)	OLS	CO-AR(1)	OLS	OLS	CO-AR(1)	OLS
Constant	3320.64	3091.87	3080.66	2729.06	1600.01	1728.22	1539.07	1246.99	1354.88	559.20
	(4.05)	(2.72)	(3.74)	(2.50)	(4.55)	(3.31)	(4.92)	(3.04)	(2.32)	(1.70)
IP	0.568	0.602	0.642	0.694	0.785	0.766	0.840	0.805	0.792	0.909
	(4.14)	(3.48)	(4.41)	(3.98)	(13.04)	(9.38)	(10.57)	(12.12)	(8.96)	(17.02)
R^2C	0.518	0.442	0.552	0.514	0.894	0.821	0.917	0.879	0.807	0.935
SEE	859.62	778.20	829.08	725.40	483.60	424.90	429.20	525.78	470.50	378.56
DW	1.02	1.35	0.95	1.28	0.98	1.74	1.83	1.05	1.94	1.85
F	12.38	12.11	17.60	15.81	13.68	88.01	31.57	4.62	80.37	1.47
Chow (75)	1.16		1.19		4.58		2.28	0.18		0.21
Ljung-Box	9.87		9.20		5.72		0.26	5.46		0.48
AR(1)	0.444	0.464	0.460	0.474	0.478	0.492	0.063	0.438	0.444	0.067
	(1.78)	(1.94)	(1.84)	(2.05)	(2.19)	(2.48)	(0.29)	(2.01)	(2.20)	(0.31)
AR(2)	-0.283		-0.294		0.135		0.053	0.202		0.101
	(-1.13)		(-1.18)		(0.62)		(0.24)	(0.93)		(0.46)
AR(3)	-0.470		0.415		-0.01		-0.055	0.020		0.068
	(-1.88)		(-1.66)		(-0.06)		(-0.250)	(0.09)		(0.31)
ρ	0.470	0.310	0.490	0.352	0.500	0.115	0.070	0.450	0.022	0.070

F-tests, H_0: $a_1 = 0$ and $a_2 = 1$

	ρ = 0	ρ = 0.30		ρ = 0	ρ = 0.30	
$F_{0.95}(2,19)$	= 3.52	~ 7.42	$F_{0.95}(2,14)$	= 3.74	~ 8.1	$\chi^2_{0.95} = 7.81$
$F_{0.99}(2,19)$	= 5.93		$F_{0.99}(2,14)$	= 6.51		$\chi^2_{0.99} = 11.30$

TABLE 4.f. CONSTRUCTION

Test for the unbiasedness of investment plans (equation (89'))
Dependent variable: realized investments according to the survey (IRQ)
Independent variables: investment plans (IP) for different survey horizont (perfect foresight price expectations IPF, weakly rational price expectations IPA)

Variables in million markkaa at 1980-prices

Estimation period 1964-1984 and 1969-1984 (long horizon ${}_tIPF^s_{t-1}$ and ${}_tIPA^s_{t-1}$)

Estimation method: OLS

	Spring of the previous year				Autumn of the previous year		Spring of the realization year		Autumn of the realization year
	${}_tIPF^s_{t-1}$		${}_tIPA^s_{t-1}$		${}_tIPF^a_{t-1}$	${}_tIPA^a_{t-1}$	${}_tIPF^s_t$		${}_tIPF^a_t$
Estimation method	OLS	CO-AR(1)	OLS	CO-AR(1)	OLS	OLS	OLS	CO-AR(1)	OLS
Constant	1421.67	1805.57	1193.24	1285.84	43.16	188.51	58.93	53.79	-125.11
	(2.26)	(2.43)	(2.12)	(1.88)	(0.13)	(0.76)	(0.26)	(0.34)	(0.84)
IP	0.654	0.475	0.870	0.806	1.114	1.218	1.008	1.012	1.087
	(2.43)	(1.59)	(3.14)	(2.49)	(8.19)	(10.57)	(11.99)	(17.29)	(19.63)
R^2C	0.246	0.099	0.371	0.271	0.767	0.847	0.877	0.940	0.951
SEE	666.94	645.00	608.94	596.90	364.96	296.10	260.22	239.50	168.36
DW	1.36	1.77	1.44	1.88	1.70	1.54	2.86	2.26	2.37
F	8.27	2.53	19.13	6.20	8.32	51.16	1.01	298.90	5.17
Chow (75)	2.45		2.37		3.30	2.27	0.18		0.92
Ljung-Box	2.50		2.01		2.95	2.73	4.97		3.83
AR(1)	0.313	0.391	0.260	0.284	0.143	0.216	-0.436	-0.438	-0.190
	(1.25)	(1.59)	(1.04)	(1.13)	(0.65)	(0.99)	(-2.00)	(-2.13)	(-0.87)
AR(2)	-0.087		-0.130		-0.234	-0.18	-0.132		-0.13
	(-0.35)		(-0.52)		(-1.07)	(-0.84)	(-0.60)		(0.58)
AR(3)	-0.162		-0.146		-0.209	-0.18	0.068		0.318
	(-0.65)		(-0.58)		(-0.96)	(-0.83)	(0.31)		(1.46)
ρ	0.310	0.056	0.260	-0.011	0.140	0.220	-0.440	-0.153	-0.190

F-tests, H_0: $a_1 = 0$ and $a_2 = 1$

$\rho = 0$: $F_{0.95}(2,19) = 3.52$, $F_{0.99}(2,19) = 5.93$; $\rho = 0.30$: ~ 7.42

$\rho = 0$: $F_{0.95}(2,14) = 3.74$, $F_{0.99}(2,14) = 6.51$; $\rho = 0.30$: ~ 8.1

$\chi^2_{0.95} = 7.81$

$\chi^2_{0.99} = 11.30$

It is not possible to distinguish between the price expectations hypotheses in favour of one or the other. Plans deflated by autoregressive price expectations explain realized investments slightly better than plans deflated by realized prices. The choice of deflator was tested using the F-test suggested by Mizon and Richard (1982), which is a Wald-type test of non-nested hypotheses. The test equation is then a regression equation as shown in Tables 4.a - 4.f, which incorporates an alternative additional independent variable to be tested, in this case plans deflated by ARIMA expectations of prices. Hypothesis H_0 is that the coefficient of the additional independent variable is zero. The estimation results are shown in Table 5. The null hypothesis cannot be rejected for any sectors with respect to the long survey horizon but must be rejected with respect to the survey horizon which is six months shorter. However, the time series are so highly correlated that the original parameter values change decisively compared with the results in Table 4. This may be due to the fact that the variation of plans in current prices in relation to price variations is much greater. Hence, the use of alternative deflators does not bring about sufficiently differing variation in the time series, and the question of deflators is left open.

For the shortest survey horizons, i.e. less than one year (equations ${}_tIPF_t^s$ and ${}_tIPF_t^a$), the hypothesis of weak rationality cannot be rejected at the 5 per cent level of significance, when the autocorrelation of residuals is taken into account in the critical limits of the F-test. Therefore the coefficient estimates of investment plans do not deviate significantly from one and the constant from zero. Thus, the investment plans of the spring and the autumn for the current year are unbiased forecasts of the same year's investment.

To improve the efficiency of estimation, the testing of unbiasedness was also carried out using combined time series and cross-section data. For this purpose, the data of the investment survey were classified into eight sectors corresponding to the 2-digit classification of the Industrial Classification. Time series in current prices were obtained for the period 1977 - 1984, giving a total of 64 observations. The data were transformed into logarithmic differences in order to make the data stationary, to avoid the problem of heteroscedascity and to test parameter restrictions.

TABLE 5. TEST FOR THE SELECTION OF THE PRICE EXPECTATIONS HYPOTHESIS OF THE DEFLATOR FOR INVESTMENT PLANS

H_0 hypothesis in F-test: coefficient a_3 of the variable IPA in the underlying equations is zero

Sectors: Manufacturing (1), Forest industries (2), Metal and engineering industries (3), Other manufacturing industries (4)

Dependent variable: realized investments according to the survey (IRQ)
Independent variables: perfect foresight price expectations (IPF), weakly rational price expectations in deflator (IPA)

Variables in million markkaa at 1980 -prices
Estimation period: 1964 - 1984
Estimation method: OLS

	Spring of the previous year				Autumn of the previous year			
	Estimated equation $IRQ_t = a_1 + a_2\ {}_tIPF^s_{t-1} + a_3\ {}_tIPA^s_{t-1}$				Estimated equation $IRQ_t = a_1 + a_2\ {}_tIPF^a_{t-1} + a_3\ {}_tIPA^a_{t-1}$			
	${}_tIPF^s_{t-1}$				${}_tIPF^a_{t-1}$			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
IPF	-0.829	-1.352	-0.061	-0.405	-0.219	-0.655	0.255	-0.119
	(1.02)	(1.17)	(0.06)	(0.51)	(0.61)	(1.04)	(0.64)	(0.22)
IPA	1.542	1.859	1.075	1.093	1.164	1.582	0.758	1.037
	(1.73)	(1.47)	(1.01)	(1.27)	(3.09)	(2.37)	(1.85)	(1.79)
Constant	4662.0	2273.0	435.0	1812.0	1847.0	823.5	169.8	822.3
	(3.18)	(4.78)	(1.03)	(3.01)	(3.23)	(3.22)	(1.10)	(2.08)
R^2c	0.416	0.218	0.622	0.380	0.892	0.805	0.914	0.710
SEE	1377.0	645.6	442.1	562.8	675.0	385.1	196.7	425.9
F	2.99	2.16	1.02	1.61	9.55	5.62	3.42	3.20
DW	1.07	1.40	1.04	0.79	1.56	1.63	1.42	1.12

t-test values in parentheses
Critical values of the F-test (ρ = autocorrelation coefficient of residual)

	$\rho = 0$	$\rho = 0.30$		$\rho = 0$	$\rho = 0.30$
$F_{0.95}(1,13)$	= 4.67	~ 7.71	$F_{0.95}(1,18)$	= 4.41	~ 7.22
$F_{0.99}(1,13)$	= 9.07		$F_{0.99}(1,18)$	= 8.29	

A condition for using combined cross-section and time series data is that the slopes of the equations for each sector do not differ from each other in a statistically significant fashion (Maddala (1977)). To find out whether or not this was the case, restricted and unrestricted models were estimated by sectors and the F-test statistics for different survey horizons were calculated using residual sums of squares. Restriction means that the sectoral parameter estimates of investment plans are restricted to be equal by means of dummy techniques. The hypothesis H_0 could not be rejected for all survey horizons, because the F-values are below the critical limit $F_{0.95}(7.47) \sim 2.22$ (Table 6, F_1-values). Consequently, the combined cross-section and time series data are used in testing for unbiasedness.

Unbiasedness was tested using the combined time series and cross-section data in the same way as for the time series data above. In the present case, the data are in current prices, but the results are comparable with the previous models of perfect foresight price expectations, because the deflator was unchanged with respect to the plans concerning a certain year. The results differ from the previous ones in that the hypothesis H_0 is now rejected in respect of plans in the spring survey of the current year at the 5 per cent level of significance, even though it cannot be rejected at the 1 per cent level of significance (F2)(Table 6). This provides a slightly different picture of the accuracy of plans according to the length of the survey horizon from that obtained using only time series data, where the hypothesis of unbiasedness could not be rejected even at the 5 per cent level.

Table 6 also shows the parameter estimates of investment plans estimated from annual cross-section data. In order to study the stability of the model, the equality of annual parameter values was tested using the F-test. For the longest survey horizon, the hypothesis of the stability of parameters must be rejected as measured by the F-test (F3) at the 1 per cent level of significance. For the shorter survey horizons, the hypothesis of stability cannot be rejected.

TABLE 6. COMBINED TIME SERIES AND CROSS-SECTION ESTIMATION (POOLED DATA) (equation (89'))

Test for the unbiasedness of investment plans

Dependent variable: realized investments according to the survey
Independent variable: investment plans for different survey horizons

Variables: logarithmic differences at current prices
Estimation period 1978 - 1984
Estimation method: OLS
t-values in parentheses

	Survey horizon			
	Spring of the previous year	Autumn of the previous year	Spring of the realization year	Autumn of the realization year
IP	0.432	0.489	0.685	0.895
	(4.29)	(3.74)	(4.80)	(9.39)
Constant	0.081	0.069	0.031	0.016
	(2.08)	(1.64)	(0.75)	(0.53)
R^2C	0.241	0.191	0.286	0.613
SEE	0.278	0.288	0.270	0.199
F_2	16.00	7.67	2.50	0.61
DW	2.61	2.79	2.90	2.94
Chow	0.27	7.67	3.41	0.11
F_1	0.88	0.83	0.51	0.24
IP78	0.529	0.485	0.503	0.882
IP73	0.746	0.554	0.663	1.000
IP80	0.768	0.733	0.781	0.920
IP81	0.264	0.392	0.478	0.962
IP82	0.658	0.658	0.622	0.976
IP83	0.539	0.456	0.542	0.783
IP84	0.569	0.429	0.591	0.908
F_3	3.80	1.27	1.03	1.08

Critical values of the F-tests

$F^1_{0.95}(7,47) = 2.22$

$F^1_{0.99}(7,47) = 3.06$

H_0: Parameter estimates of IP are equal across different manufacturing sectors

$F^2_{0.95}(2,54) = 2.30$

$F^2_{0.99}(2,54) = 5.04$

H_0: $a_1 = 0$ and $a_2 = 1$

$F^3_{0.95}(6,48) = 2.30$

$F^3_{0.99}(6,48) = 3.22$

H_0: Parameter estimates of IP are equal across different years

Attempts were also made to examine the realization of investment plans according to company size (Table 7). Data cover only the period 1979 - 1984, so that the observations are few in number thus making the statistical testing very unreliable. The test for unbiasedness was carried out separately for large, medium-sized and small companies. The results (Table 7) show a clear increase in correlation between plans and the realized figures as the survey horizon shortens in the case of the data on large and small companies but not in the case of medium-sized companies.

A general feature of the above regressions is that the coefficient of investment plans for survey horizons longer than one year is significantly below one and the constant differs from zero in a positive direction. In other words, the variation of investment plans exceeds the variation of final investment but, on the other hand, the plans are characterized by underestimation of final investments. These systematic deviations do not appear in the plans for the current year. Sectoral differences in the accuracy of plans are rather large. Investment plans in the metal and engineering industries have a high degree of permanency for even the longest survey horizon. As for the other sectors, the plans of the spring of the realization year pass the test for unbiasedness. Plans concerning industry's investment in machinery and equipment have been adjusted for a shorter horizon than those concerning construction.

TABLE 7. MANUFACTURING

Test for the unbiasedness of investment plans according to the size of firm (equation (89'))

Dependent variable: realized investments according to the survey
Independent variables: investment plans for different survey horizons (perfect foresight price expectations)
Variables in million markkaa at 1980 -prices
Estimation period: 1979 - 1984
Estimaton method: OLS
t-values in parentheses below the coefficient estimates

	Large firms (500 employees and over)				Medium-sized firms (100 - 499 employees)				Small firms (20 - 99 employees)			
	survey horizon				survey horizon				survey horizon			
	${}_{t}IPF^{s}_{t-1}$	${}_{t}IPF^{a}_{t-1}$	${}_{t}IPF^{s}_{t}$	${}_{t}IPF^{a}_{t}$	${}_{t}IPF^{s}_{t-1}$	${}_{t}IPF^{a}_{t-1}$	${}_{t}IPF^{s}_{t}$	${}_{t}IPF^{a}_{t}$	${}_{t}IPF^{s}_{t-1}$	${}_{t}IPF^{a}_{t-1}$	${}_{t}IPF^{s}_{t}$	${}_{t}IPF^{a}_{t}$
Constant	3643.20	543.95	-58.84	-810.98	2110.88	1373.22	1011.98	705.27	796.89	277.76	27.26	-197.57
	(2.91)	(0.67)	(0,13)	(0.87)	(5.17)	(2.63)	(2.52)	(1.43)	(2.45)	(2.58)	(0.09)	(0.70)
IP	0.493	0.880	0.663	0.749	-0.159	0.273	0.080	0.121	0.468	0.871	0.111	0.135
	(2.52)	(7.31)	(13.81)	(7.72)	(0.63)	(0.95)	(1.90)	(2.37)	(1.23)	(7.80)	(3.55)	(4.61)
R^2C	0.517	0.897	0.964	0.907	-0.136	-0.017	0.272	0.435	0.095	0.909	0.624	0.771
SEE	717.27	445.65	265.54	423.54	207.36	299.33	233.49	233.16	194.05	80.63	173.43	127.76
DW	1.52	1.95	1.65	2.88	2.60	1.20	2.70	1.29	1.94	1.98	2.04	1.31
F	4.76	1.57	605.23	202.55	15.60	3.47	4433.89	4265.06	10.95	14.22	9473.00	15661.72
ρ	-0.47	-0.10	-0.08	-0.50	-0.57	0.21	-0.44	0.22	0.02	-0.44	-0.04	0.33

Critical values of the F-test, H_0: $a_1 = 0$ and $a_2 = 1$

$F_{0.95}(2,4) = 6.94$
$F_{0.99}(2,4) = 18.00$

III.6 The Information Content of Plans

The biasedness of plans for survey horizons exceeding one year raises various questions. Has all the relevant public information been utilized efficiently in the preparation of plans? Do plans covering a survey horizon exceeding one year have time to react to unexpected information? To answer these questions the information content of plans is first examined with respect to the initial information. The following section examines the response of plans to unexpected changes in information.

The efficiency of the utilization of information is tested using equation (86)

(86') $$I(t) - IP(t,t-1) = a_1 + a_2X(t-1) + \varepsilon(t),$$

where X(t-1) is an observation matrix, a_1 and a_2 are parameter vectors.

The testable hypothesis is $H_0 = a_1 = a_2 = 0$ and $\varepsilon(t)$ are serially uncorrelated. Efficiency refers to the minimization of prediction errors using the ordinary least squares method. There are, however, problems with multiperiod plans, because the most recent deviations from plans are not known when making new plans. Hence, the residuals $\varepsilon(t)$ may follow at least a MA process. For that reason the test is first carried out by examining the correlation of changes in plans concerning the same period as suggested by Berger and Krane (1984).

The use of revisions concerning the same period removes the problem of the biased test statistic related to predictions for several periods with respect to the MA error of the residual. Changes in plans concerning a certain period are denoted by ER(t+1,t)

(90) $$ER(t+1,t) = IP(t+1,t) - IP(t+1,t-1).$$

Changes can be written as conditional expectations, i.e.

(91) $$ER(t+1,t) = E[IP(t+1,t)| \Omega(t)] - E[IP(t+1,t-1)| \Omega(t-1)],$$

which are uncorrelated with all previous changes in plans for that period. This condition derives from the property of rational expectations (the martingale concept) that future changes in predictions concerning the same period cannot be predicted on the basis of the original information. However, the absence of correlation between changes in plans is a sufficient but not a necessary condition for rational expectations. It is a sufficient condition for rejecting rationality.

The hypothesis H_0 can be written in the form:

(92) $$H_0: E[ER(t+1,t) \mid ER(t+1,t-1)] = 0,$$

where ER(t+1,t) is a change in plan and correlation can be tested by the regression equation

(93) $$ER(t+1,t) = a_1 + a_2 ER(t+1,t-1) + \varepsilon(t),$$

where the absence of correlation requires the joint hypothesis $a_1 = a_2 = 0$ and that $\varepsilon(t)$ is serially uncorrelated.

The results of the regression analysis show that changes in investment plans are not, as a rule, correlated with previous changes when the dependent variables are the investment plans for the current year obtained in the autumn less the plans obtained in the spring. In this test, investment plans have been converted into fixed prices using actual price developments (the left-hand columns in Table 8). The parameters are stable, with the exception of other manufacturing industries, where the assumption of the stability of parameters must be rejected.

A similar test was also carried out in which the plan horizon of each variable in the regression was lengthened by six months. In that case, changes in the plans concerning the same period generally correlated with each other in the different manufacturing sectors (the right-hand columns in Table 8). According to the F-test, the null hypothesis must be rejected at the 5 per cent level of significance with the exception of the metal and engineering industries. The assumption of the stability of parameters cannot be rejected.

The results of the test can be interpreted as meaning that correlation between changes in plans is an indication that some information used previously in investment plans has no longer been used systematically in subsequent plans. The utilization of information has not been efficient, investment plans do not include all initial information and the hypothesis of semi-strong rationality of plans is rejected. The result according to which the hypothesis was rejected was obtained for all the longest survey horizons. The previous reservations about the endogenous nature of data and about loss functions must be borne in the mind.

The orthogonality test of Brown and Maital (1981) is applied as an alternative test of the efficient utilization of initial information. In this test, changes in plans are regressed on the economic information assumed to be available to the firm at the time the plans were first made (equation (86')). Each time series is regressed separately with changes in plans. This procedure solves the multicorrelation problem and ensures the highest possible number of degrees of freedom. The information set is restricted in accordance with investment theory to apply to time series on demand and various price and cost factors. The set of variables is deliberately extensive, because it is not easy to determine beforehand which time series will best describe the relevant information set. The parameter restrictions are tested using a normal F-test.[3] The autocorrelation of the residual is taken into account in the critical limits of the F-test.

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[3]Brown and Maital (1981) state that, in the case of a forecast covering several periods ahead, not all forecast errors are known at the time of forecasting, so that the possibility that residual errors are correlated with each other cannot be ruled out. In this case, the Wald test statistic would be asymptotically better. However, in the present study, asymptotic properties are of no significance because of the small number of observations. On the other hand, the autoregressive process of the residual has been shown to have more serious consequences from the point of view of the critical limits of the test than a residual process of the moving average type. Ahtola (1986) has stated that, when using stochastic difference models and the ordinary least squares method for testing rational expectations, the null hypothesis is easily accepted on too weak grounds, unless sufficient attention is paid to the residual process.

TABLE 8. TEST FOR THE WEAK RATIONALITY OF INVESTMENT PLANS (equation (93))

Dependent variable: changes in investment plans

Independent variables: previous changes in investment plans for the same period (perfect foresight price expectations)

Variables in million markkaa at 1980 prices
Estimation method: OLS
Estimation period 1964-1984 and 1969-1984
t-values in parentheses

	Dependent variable ${}_tIPF^a_t - {}_tIPF^s_t$; Independent variable ${}_tIPF^s_t - IPF^a_{t-1}$				Dependent variable ${}_tIPF^s_t - {}_tIPF^a_{t-1}$; Independent variable ${}_tIPF^a_{t-1} - {}_tIPF^s_{t-1}$			
	Manufacturing	Forest industries	Metal and engineering industries	Other manufacturing industries	Manufacturing	Forest industries	Metal and engineering industries	Other manufacturing industries
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Regr. coeff.	-0.057	-0.038	-0.762	0.193	0.324	0.355	0.264	0.047
	(0.40)	(0.25)	(7.44)	(1.25)	(1.72)	(2.06)	(0.76)	(0.28)
Constant	13.68	42.74	45.32	-33.28	400.46	163.78	112.64	222.63
	(0.10)	(0.63)	(1.22)	(0.66)	(1.69)	(1.55)	(0.97)	(2.46)
R^2c	-0.044	-0.049	0.731	0.028	0.116	0.178	-0.029	-0.066
F	0.10	0.21	29.31	0.81	7.16	5.22	1.58	6.04
Chow (75)	0.71	1.71	0.69	10.76	5.17	3.19	1.15	3.23
DW	2.44	2.59	2.24	1.92	2.27	1.09	2.51	2.19
SEE	464.76	258.71	156.66	175.47	763.46	393.61	397.24	275.64

Critical limits of the F-test, H_0: $a_1 = a_2 = 0$ (ρ = autocorrelation coefficient of residual)

	$\rho = 0$	$\rho = 0.30$		$\rho = 0$	$\rho = 0.30$
$F_{0.95}(2,19)$	= 3.52	~ 7.22	$F_{0.95}(2,14)$	= 3.74	~ 8.1
$F_{0.99}(1,19)$	= 5.93		$F_{0.99}(2,14)$	= 6.51	

Tables 9.a and 9.b show the results of the orthogonality tests. In Table 9.a various indicators of domestic and international demand are used as exogeneous variables. The demand indicators obtained from the Economic Barometer of the Confederation of Finnish Industries differ from other demand variables in that they also include companies' internal information. The response distributions have been quantified on the assumption of a normal distribution (Carlson and Parkin (1975), Appendix 4).

According to the results, the hypothesis H_0 (a_1 = 0 and a_2 = 0) must be rejected in several cases. This does not necessarily mean that companies have not utilized all the relevant information available. It is also possible that the real information lags are longer than those used here (one quarter in the case of quarterly data and, at the most, slightly more than six months in the case of annual data). On the other hand, companies have only had provisional data at their disposal, whereas final, and possibly subsequently revised, data have been used in the test. Moreover, in interpreting the very latest observations difficulties frequently arise as to whether they indicate permanent or temporary changes.

Rejection of the H_0 hypothesis is evident primarily in the case of the two longest survey horizons, where the rejections of the hypothesis of the unbiasedness of plans also occurred. The information set in Table 9.b comprises variables indicating various domestic and international price and cost factors. As regards these, the method of calculating the real user cost of capital is dealt with in Appendix 5. In terms of this information set, the null hypothesis must also be rejected in many cases, which again applies mainly to the two longest survey horizons.

The results of the test are similar to the previous test of the efficient utilization of information (Berger and Krane). The results support the previous view that particularly the investment plans for the two longest survey horizons must be revised for forecasting purposes, using both new and, in certain cases, also initial information. In the case of initial information, it may merely be a question of the definition of the lags of new information.

TABLE 9.a. TEST FOR THE ORTHOGONALITY OF INVESTMENT PLANS (equation (86')) Information set contains different demand variables

F-test statistics in the table, DW-values of residuals in parentheses H_0: $a_1 = 0$ and $a_2 = 0$

Dependent variable: A) investments less plans made in the spring of the previous year
B) investments less plans made in the autumn of the previous year
C) investments less plans made in the spring of the current year

Independent variables: variables indicating domestic and foreign demand (X_{t-i}, i=1,2)

Variables at constant prices

Estimation period: 1970—1984

Estimation method: OLS

	Estimated equations											
	A) $_tIRQ_{t+1} - _tIPF^s_{t-1} = a_1 + a_2X_{t-2}$ manufacturing sectors[b)]				B) $_tIRQ_{t+1} - _tIPF^a_{t-1} = a_1 + a_2X_{t-2}$ manufacturing sectors				C) $_tIRQ_{t+1} - _tIPF^s_t = a_1 + a_2X_{t-1}$ manufacturing sectors			
	1	2	3	4	1	2	3	4	1	2	3	4
Manufacturing[c)] output (Q)	5.84*	2.19	3.59*a	7.09**a	8.71**	2.35	0.67	7.91**a	2.01	1.55	0.20	3.98*a
	(1.36)	(1.28)	(1.29)	(1.50)	(1.34)	(0.83)	(1.34)	(1.40)	(1.76)	(2.29)	(2.09)	(2.18)
Manufacturing output	6.51*	2.36	3.87*	7.69**a	10.77**a	2.33	0.97	10.78**	1.68	1.39	0.19	4.32*a
	(1.38)	(1.30)	(1.30)	(1.53)	(1.47)	(0.83)	(1.36)	(1.53)	(1.74)	(2.20)	(2.09)	(2.36)
Manufacturing[d)] output, CFI survey	12.17**a	2.33	8.98**a	13.89**a	16.77**a	3.58	1.03	11.54**a	2.77	4.53**a	0.27	7.34**a
	(1.42)	(1.20)	(1.18)	(1.71)	(1.53)	(0.95)	(1.30)	(1.51)	(1.72)	(1.50)	(2.34)	(2.40)
Gross (sales) value of manufacturing output	4.29*	1.79	2.55	3.71	7.52**a	2.86	1.22	3.46	3.11	2.06	0.47	2.44
	(1.26)	(1.15)	(1.19)	(1.53)	(1.55)	(0.91)	(1.46)	(1.53)	(2.17)	(1.46)	(2.38)	(1.77)
GDP	6.78**a	3.16	3.59	7.89**a	12.83**a	4.56*	0.71	11.87**a	1.86	0.91	0.19	5.57*
	(1.42)	(1.40)	(1.29)	(1.57)	(1.52)	(1.01)	(1.31)	(1.52)	(1.69)	(2.06)	(2.09)	(2.47)
Total domestic demand	8.73**a	3.80	4.49*	9.98**a	15.34**a	4.65*	0.65	16.84**a	0.89	0.57	0.15	6.18*
	(1.46)	(1.37)	(1.28)	(1.72)	(1.39)	(0.92)	(1.24)	(1.75)	(1.50)	(1.98)	(2.07)	(2.58)
Exports	5.43*	2.21	3.50	5.87*	8.82**a	2.33	1.07	6.49*	3.21	2.89	0.26	4.86*a
	(1.34)	(1.29)	(1.31)	(1.44)	(1.49)	(0.84)	(1.42)	(1.31)	(2.09)	(2.56)	(2.12)	(2.25)
Imports of FEC countries[e)]	4.61*	3.09	2.27	4.05*a	10.13**a	9.17**a	0.84	3.59	3.53	4.38*a	0.49	2.68
	(1.31)	(1.32)	(1.20)	(1.47)	(1.70)	(1.30)	(1.33)	(1.47)	(2.44)	(1.91)	(2.42)	(1.98)
Finnish export markets[f)]	4.79*	3.33	2.37	3.95*a	11.51**a	10.48**a	0.93	3.73	3.56	4.36*a	0.40	3.51
	(1.34)	(1.33)	(1.21)	(1.51)	(1.79)	(1.39)	(1.35)	(1.46)	(2.33)	(1.83)	(2.38)	(2.04)
Total domestic demand[g)] in OECD countries	3.70	2.45	2.14	3.39	7.14**a	6.98**	0.70	2.76	5.66*	6.12*	0.92	2.45
	(1.32)	(1.30)	(1.18)	(1.53)	(1.59)	(1.29)	(1.35)	(1.41)	(2.54)	(1.95)	(2.45)	(1.91)
Stockbuilding in OECD[h)] countries, contribution to GDP	3.87	2.89	4.25*a	3.09	3.28	4.91*	1.17	0.95	1.30	1.08	0.45	3.11
	(1.47)	(1.29)	(1.48)	(1.38)	(1.38)	(1.05)	(1.49)	(1.24)	(1.25)	(1.05)	(2.17)	(1.82)
GDP weighted by OECD countries	3.78	2.55	2.15	3.37	7.61**a	7.44**	0.81	2.77	5.73*	6.04*a	0.86	2.82
	(1.33)	(1.30)	(1.19)	(1.54)	(1.64)	(1.32)	(1.37)	(1.42)	(2.53)	(1.90)	(2.45)	(1.94)
World trade	4.51*	3.18	2.35	3.65	10.62**a	10.01**a	1.04	3.33	4.09*a	4.72*a	0.47	3.78
	(1.34)	(1.32)	(1.21)	(1.53)	(1.80)	(1.39)	(1.39)	(1.46)	(2.38)	(1.81)	(2.39)	(2.04)

a) F-values: * significant at 5 per cent level,.** significant at 1 per cent level, when the effect of the autocorrelation of the residual on the critical limit of the F-test has not been taken into account. Figures marked with a are significant at 5 per cent level, when the effect of autocorrelation has been taken into account.

b) Manufacturing sectors: 1 = manufacturing, 2 = forest industries, 3 = metal and engineering industries, 4 = other manufacturing industries.

c) In the Q series, information is given with an accuracy of quarters; in other series, annual data is used.

d) CFI's survey for one year ahead.

e) The five countries most important for Finnish exports.

f) The countries and market areas most important for Finnish exports, all export markets.

g) FEC countries weighted together by output shares.

h) Takes into account the effect of stockbuilding on GDP.

Critical values of the F-test

	$\rho=0$	$\rho=0.30$
$F_{0.95}(2,13)$	= 3.81	~7.81
$F_{0.99}(2,13)$	= 6.70	

TABLE 9.b. TEST FOR THE ORTHOGONALITY OF INVESTMENT PLANS (equation (86')) Information set contains different price and cost variables

F-test statistics in the table, DW-values of residuals in parentheses H_0: $a_1 = 0$ and $a_2=0$

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
C) final investments less plans made in the spring of the current year
Independent variables: price and cost factors (X_{t-i}, i=1,2)
Variables in real terms
Estimation period: 1970—1984
Estimation methods: OLS

	Estimated equations											
	A) ${}_tIRQ^s_{t+1}-{}_tIPF^s_{t-1}$ $=a_1+a_2X_{t-2}$ manufacturing sectors				B) ${}_tIRQ^a_{t+1}-{}_tIPF^a_{t-1}$ $=a_1+a_2X_{t-2}$ manufacturing sectors				C) ${}_tIRQ^s_{t+1}-{}_tIPF^s_{t}$ $=a_1+a_2X_{t-1}$ manufacturing sectors			
	1	2	3	4	1	2	3	4	1	2	3	4
Price of capital[b] (lending rate)	7.39**	3.74	4.90	9.08**a	7.84**a	6.48*	1.61	5.23*	1.53	1.80	0.81	0.53
	(1.21)	(1.30)	(0.97)	(1.52)	(0.91)	(1.06)	(1.16)	(1.16)	(1.43)	(2.12)	(2.32)	(1.27)
Price of capital[b] (rate of interest in balance sheet statistics)	8.21**a	3.52	5.59*	11.54**a	8.13**	6.03*	1.52	5:98*	1.66	2.41	0.92	0.50
	(1.20)	(1.27)	(1.01)	(1.60)	(0.88)	(1.04)	(1.18)	(1.14)	(0.25)	(2.17)	(2.35)	(1.26)
Wages[c]	5.32*	2.30	3.19	6.53*a	9.69**a	2.75	1.02	8.42**a	2.77	0.49	0.37	6.56*
	(1.41)	(1.19)	(1.31)	(1.55)	(1.54)	(0.94)	(1.41)	(1.42)	(1.69)	(1.93)	(2.11)	(2.58)
Net cash flow	4.69*	2.19	3.56	6.56*a	4.34*	3.54	0.16	2.98	0.02	0.91	0.34	0.00
	(1.36)	(1.27)	(1.13)	(1.68)	(1.04)	(0.99)	(1.28)	(0.91)	(1.31)	(1.98)	(2.05)	(1.24)
Gross cash flow	5.53*	2.26	6.87**	5.39*	3.04	3.12	0.28	2.80	0.03	1.12	0.77	0.12
	(1.05)	(1.22)	(1.26)	(1.22)	(0.82)	(0.94)	(1.17)	(0.82)	(1.36)	(1.99)	(1.92)	(1.38)
Marginal rate of interest	5.62*	2.85	3.86*	6.24*	8.22**	6.39*	2.44	4.50*	3.75	1.35	1.55	2.74
	(1.09)	(1.27)	(0.96)	(1.21)	(1.07)	(1.23)	(1.56)	(1.06)	(1.88)	(2.06)	(2.53)	(1.42)
Eurodollar rate	6.71**	2.92	5.44*	7.93**a	7.29**	5.05*	1.23	4.33*	0.48	0.63	0.05	4.11*a
	(1.34)	(1.34)	(1.23)	(1.50)	(1.39)	(1.35)	(1.30)	(1.34)	(1.54)	(1.97)	(2.31)	(2.35)
Price of energy[d]	11.33**a	6.00*	6.28*	9.62**a	31.57**a	14.38**a	4.90*	11.87**a	4.38*	2.11	0.20	9.81**a
	(1.29)	(1.42)	(1.02)	(1.40)	(2.03)	(1.60)	(1.60)	(1.56)	(2.07)	(2.10)	(2.38)	(2.35)
Price of investments	6.24*a	3.24	3.55	6.31*a	14.89**a	6.93**	1.44	7.28**	3.11	1.13	0.28	8.44**a
	(1.43)	(1.44)	(1.31)	(1.48)	(1.75)	(1.19)	(1.43)	(1.31)	(1.86)	(2.13)	(2.12)	(2.63)

a) Significant at 5 per cent level, when the effect of autocorrelation is taken into account.
b) The price of capital is calculated according to Jorgenson's user cost method. The interest rates used are the banks' average lending rate and the rate of interest on total liabilities calculated from industry's balance sheet statistics.
c) Total compensation per hour.
d) The average price of oil in OPEC's long-term agreements

III.7 Concluding Remarks

The accuracy of investment plans increases substantially as the length of the survey horizon shortens. Changes in investment plans are notable between the three longest survey horizons but are minor for shorter horizon. This finding accords with the analysis of Chapter II on the adjustment costs of investment plans, which apparently increase as the realization time of investment plans approaches. Clear differences in the accuracy of investment plans can be observed between different manufacturing sectors and by type of investment. The investment plans of the metal and engineering industries change the least while plans concerning construction change less than plans concerning investments in machinery and equipment.

The second main finding was that it is not possible to differentiate the nature of the price expectations of firms. Two hypotheses were studied and tested, rational expectations in the form of perfect foresight and weak rationality. A major problem here is that up till now firms have been requested to report their plans in current prices; there have not been any questions on price expectations. Consequently, the tests of price expectations are always joint tests associated with the quantitative investment plans and loss functions of the firm.

The third main finding was that the hypothesis of rational expectations must be rejected in the case of investment plans for the two longest survey horizons. Taking this as a point of departure, it is then natural to test the nature of firms' expectation formation on the basis of the investment plan data. This is done in the following chapter by testing what kind of innovations influence investment plans and to what information set firms react.

IV REVISION OF INVESTMENT PLANS

IV.1 Aims of the Chapter

The conclusion of the preceding chapter was that the hypothesis of rational expectations must be rejected in the case of plans for the two longest survey horizons. The hypothesis which follows naturally from this is to test the dependence of investment plans on new information. The alternative expectations hypotheses used are either static or rational. The testing is reduced to the following three problems:

a) What is the information set on which the revision of manufacturing investment plans depends?

b) How do announced investment plans respond to new information?

c) What is the significance of future uncertainty as regards investment plans?

In Chapter II the information set was limited to comprise the explanatory variables of the modified neoclassical investment theory, that is, factor prices, demand and credit rationing variables. There nevertheless remains the empirical problem as to what is the best way to measure each theoretical variable. We try to examine this problem by means of econometric testing, first using a very large amount of information on each variable then, having found the best candidates in each group, using these in multiple regression analysis. In a similar fashion, we study the best use of the information set when all demand variables are condensed to one variable by means of principal component analysis and use this new variable in the regression analysis. Finally, we use the total data set - price and demand variables - in principal component analysis; this is not, however, analytically satisfactory as is discussed below.

Next, we use the selected information set to explain revisions of announced investment plans. The reason for explaining changes in plans is that we want to avoid multicorrelation problems in the estimations because it can be assumed that there is significant correlation between investment plans and other explanatory variables. The functions we estimate in this chapter are called revision functions and realization functions by Modigliani and Cohen (1961) and McKelvey (1980).

The basic assumption in the estimations is that investment plans are revised only as the result of unanticipated changes in the new information set because all anticipated changes are already taken account in announced plans. In the first and most parsimonious model we regress changes in investment plans on changes in the explanatory variables. This means that all movements in the data are viewed as surprising and the expectations hypothesis is static. The aim here is to carry out the most general test of the correlation between changes in information. Furthermore the time interval of the innovation is made as long as possible so as to reveal persistent movements in the information set.

In the more restricted models the expectations formation process is assumed to be rational. In this case expectations are described, on the one hand, with ARIMA-models and, on the other hand, with data on expectations obtained from business climate surveys. Unfortunately, only demand data could be used in these experiments. In forming indicators of expectation formation we utilized long quartely time series and survey data on the production expectations of manufacturing firms. The estimation methods used are OLS and SURE estimation.

IV.2 Revision and Realization Functions of Investment Plans

In Chapter II two different investment plan functions were derived which differed from each other in terms of the assumption on the adjustment costs of announced plans. The first equation (10) was a typical investment function with slow adjustment of the capital stock and forward-looking expectations. The second equation (14 and 19) was a new investment plan function with slow adjustment of announced plans to the exogeneous shocks.

It is possible to examine the revision function of investment plans using the following simple cost function, where the firm again has two types of costs, disequilibrium costs and the revision costs of announced plans. The cost function has a quadratic form

$$(94) \qquad V(t) = a(KP(t,t-1) - K(t)^*)^2 + d(KP(t,t-1) - KP(t,t-2))^2,$$

where KP(t,t-1) and KP(t,t-2) are plans concerning capital stock made at times (t-1) and (t-2) concerning time (t), and K(t)* is the desired capital stock with the same period t-1 information as the plan KP(t,t-1). a and d are weights of the cost factors. Minimizing the function with respect to KP, we obtain a function for the planned capital stock

$$(95) \qquad KP(t,t-1) = \frac{1}{a+d}(aK(t)^* + dKP(t,t-2)),$$

where plans are a function of the desired capital stock and previous plans. Manipulating the equation and taking into account the definition of gross investment (equation (13)), yields an equation for the revision of investment plans

$$(96) \qquad IP(t,t-1) - \frac{d}{a+d} IP(t,t-2) = (1 - \frac{d}{a+d})(K^*(t) - (1-\delta)K(t-2)),$$

which is of similar form as the earlier more general equation (19).

In fact the revisions of the investment plans are made semiannually IP(t, t-s1) and IP(t,t-s2) and K(t-2) denote annual data (see footnote 2 on page 28). The realization function of investment plans is, in principle, of the same form, but on the left-hand side of the equation we have realized investments instead of investment plans IP(t,t-1). Moreover, in the case of the realization function, more cost factors are included in the adjustment cost parameter of the plans d.

According to the equation the revision of investment plans depends on the difference between the desired capital stock and existing capital stock at any moment. Announced investment plans change if the desired capital stock changes. The desired capital stock K*(t) is assumed to depend linearly on the observation matrix (equations (97) and (4)). The observation matrix constitutes the factors determining the optimal investment and capital stock of the firm (Chapter II). The information lag is assumed to be the normal official statistics publication lag. Rather than constrain expectations formation beforehand, we estimate the parameters freely from the data. In the following chapter we discuss and test the parametrization in connection with Euler equation estimations.

The information set the firm uses may be partly unknown to the econometrican. The observation matrix that we test contains the following time series (Chapter II)

$$(97) \qquad X(t) = \{Q(t), JC(t), W(t), P(t), EP(t), CF(t), MIR(t)\},$$

where Q(t) is demand, JC(t) is the price of capital, W(t) is total labour cost, P(t) is the price of final products, EP(t) is the price of energy, CF(t) is the cash flow and MIR(t) is the marginal cost of capital.

The basic function we use in testing the problems a-c noted above takes the form

$$(98) \qquad IP(t,t-1) - \frac{d}{a+d} IP(t,t-2) = a_1 + \left(1- \frac{d}{a+d}\right) \sum_{i=2}^{n} h_i X^s_{t,i} + \varepsilon(t),$$

where $X^s_{t,i}$ is a surprise connected with the variable $X_{t,i}$ of the observation matrix X(t) and describes the change in the difference of the desired capital stock K*(t) and the existing capital stock K(t-2) on the right-hand side of equation (96). The expectation formation behind the surprise can be static or rational. The error term ($\varepsilon(t)$ has a different meaning in the case of the revision function and in the case of the realization function. In the realization function the error term also includes the effects of failure in the realization of the investment plans as well as the missing explanatory variables of the revision function.

The reaction of the plans to the shock $X^s_{t,i}$ depends on the relative size of the adjustment parameters a and d (equation (98)) and the parameter vector h (see also equation (4)). In the case where a = 0, there is no reaction to the shock, because there are no costs associated with the disequilibrium of the planned capital stock. We noticed earlier (equation (19) in Chapter II) that the attitude of the firm towards risk can also affect the parameter values as well as changes in the degree of uncertainty. It was pointed out that the increasing risk-averse behaviour of the firm reduces the speed of adjustment of the capital stock to the optimal level, which means smaller reactions to shocks.

There are some problems associated with the expected signs of the parameters. The negative sign of user cost (JC) is quite clear, but the sign of wages W is not self-evident (Koskenkylä (1985)). Depending on the parameters of the production function and the price elasticity of demand, it can vary from positive to negative. The energy price variable (EP) is based on a production function in which energy is one factor of production. The sign of the demand variable (Q) is positive but the sign of the credit market tightness indicator (MIR) can vary as discussed earlier. The energy price variable can also have a positive or negative sign depending on whether energy is a complementary or substitute factor for capital in manufacturing.

New information is measured in a number of different ways, because there is no general rule for distinguishing between expected and unexpected events or between temporary and permanent shocks. The most general hypothesis, a static one, to be tested is that all changes in the information set are shocks, but in such a way that the change is measured by one-year periods. Shocks of a permanent nature can be assumed to occur in a period of such length (Buck, Gahlen, Gerhaussen (1987)). An alternative expectations hypothesis tested is rational expectations, as was noted above.

IV.3 Information Set

The small size of the sample and the large number of potential independent variables set limits to the econometric testing of the revision function. Correlation of the exogeneous variables is first studied. Variables correlating strongly with each other are then compressed using principal component analysis into one new weighted independent variable. Following the example of previous investment studies, changes in investment plans are explained by demand, the cost of capital, the price of labour and the price of energy (Koskenkylä (1985) and Virén (1986)).

The profusion of independent variables applies particularly to the various variables describing demand. The indicators used for domestic demand are industrial output, the output estimate of the Economic Barometer published by the Confederation of Finnish Industries, the gross value of output, GDP and aggregate domestic demand. The information set of companies is, of course, wider and more detailed, and it also includes internal information; however, these aggregated variables are considered to give an overall picture of trends in demand. The data of the Economic Barometer are particularly valuable, as they do not entail the usual problem of changes in preliminary data.

In addition, the Barometer is published at frequent intervals so that the lags involved are short and companies are very well informed about these data. The data are published in the form of qualitative balance figures as the difference between companies' "increase" and "decrease" answers weighted by their turnovers. As mentioned above, the data have been quantified in connection with the present study (Appendix 4).

The indicators used for foreign demand are exports, changes in export markets, macroeconomic variables describing aggregate demand of the OECD countries and world trade. Changes in export markets are approximated by two import concepts weighted by the export share of the countries important for Finnish exports. In the first one, the imports of the five most important countries for Finnish exports (FEC) are weighted together, and in the other, all the countries and country groupings important for Finnish exports are weighted together. Three different variables are used as indicators of economic developments in the OECD countries: weighted aggregate domestic demand, GDP and inventory demand for the six countries most important for Finnish exports.

The demand variables show a high level of correlation with each other (Table 10.a). This is due to the cyclical sensitivity of the variables and the strong correlation of economic developments in Finland with foreign imports.

The indicators for companies' price, cost and financial factors are divided into variables describing the prices of capital, labour and oil, and cash flow. The price of capital is described using Jorgenson's user cost of capital concept. Two different variables have been calculated for the real cost of capital, which differ from each other with respect to the interest rate concept used. The average bank lending rate and the interest cost of manufacturing companies' total external capital calculated from the Balance Sheet Statistics are used as indicators of companies' interest expenses. The correlation between these variables is very high (Table 10.b). The user cost can be calculated using very many different tax assumptions, but in this study only conventional corporate tax has been taken into account.[1] The user cost of capital employed is real in the sense that it takes into account the expected growth rate of the price of capital and is divided by the price of output.

[1]Koskenkylä (1985) considers different ways of calculating the cost of capital under various assumptions about capital taxation.

TABLE 10.a. CORRELATION COEFFICIENTS OF DEMAND VARIABLES
Variables in real terms and in logarithmic difference form

	Value added of manufacturing industries	Gross (sales) value of manufacturing output	Manufacturing output (CFI survey)	GDP	Total domestic demand	Exports	Imports of FEC countries (Table 9.a)	Finnish export markets	World trade
Value added of manufacturing industries	1.00								
Gross (sales) value of manufacturing output	0.88	1.00							
Manufacturing output (CFI survey)	0.69	0.76	1.00						
GDP	0.86	0.74	0.77	1.00					
Total domestic demand	0.48	0.46	0.74	0.80	1.00				
Exports	0.67	0.53	0.22	0.31	-0.21	1.00			
Imports of FEC countries (Table 9.a)	0.65	0.41	0.48	0.47	0.26	0.68	1.00		
Finnish export markets	0.27	-0.07	-0.09	-0.06	-0.12	0.34	0.49	1.00	
World trade	0.35	0.11	0.01	0.01	-0.24	0.55	0.50	0.86	1.00

TABLE 10.b. CORRELATION COEFFICIENTS OF PRICE AND COST VARIABLES
(Variables in real terms and in logarithmic difference form)

	User cost (interest rate used: average bank lending rate)	User cost (interest rate from balance sheet statistics)	Wages (total compensation per hour)	Price of energy	Price of investment goods
User cost (interest rate used: average bank lending rate)	1.00				
User cost (interest rate from balance sheet statistics)	0.88	1.00			
Wages (total compensation per hour)	-0.40	-0.52	1.00		
Price of energy	-0.46	-0.47	0.62	1.00	
Price of investment goods	-0.21	-0.31	0.01	0.00	1.00

Expectations concerning the prices of capital goods have been approximated in three alternative ways. In the first alternative, the actual rate for each year has been used, which conforms with rational expectations. However, in the case of the user cost of capital, it is hard to believe that long-term price expectations are altered fully in line with changes in the rate of inflation. Thus, as alternative methods of describing price expectations, use was made of 5-year moving averages set in the last year and a one-year ARIMA model forecast (Appendix 2). The method of moving averages is the simplest way of describing the long-term inflation expectations about which no empirical expectations data are available. Analytically, the best way to calculate inflation expectations would be to use an ARIMA forecast but it is difficult to describe variation with a longer wavelength using ARIMA models, particularly when the time series covers only the period 1960 - 1984. Moreover, the measurement problems attached to the interest rate concept, the price index of investments and the corporate tax rate are passed over in this context (Ylä-Liedenpohja (1987)).

Other indicators of the cost of capital include the marginal rate on central bank debt, the Eurodollar rate and the price index of investment goods. The marginal rate on central bank debt is an indicator of the stringency of conditions in the financial markets. Account has been taken in this variable of refunds of interest payments to banks in certain years.

Table 10.c shows the coefficients of correlation between cash flow, the marginal rate on central bank debt and the Eurodollar rate. As expected, the correlation between the gross and the net cash flow is high, 0.86, but the correlation between the marginal rate of interest and foreign rate is negative and non-significant.

As regards the rational expectations shock and uncertainty variables, the ARIMA model is estimated for quarterly data on manufacturing production with a stepwise regression using actual historical data, and the standard deviations for the model's one period forecasts are calculated (Rosen, Rosen and Holz-Eakin (1984)). The AR(1) model was shown to meet the statistical criteria with the exception of two estimation periods (Appendix 8). It has been argued that the AR(1) model is appropriate for situations involving cost minimization by economic agents (Klein (1978)).

TABLE 10.c. CORRELATION COEFFICIENTS OF LIQUIDITY AND MONEY MARKET VARIABLES
(Variables in real terms and in logarithmic difference form)

	Net cash flow	Gross cash flow	Marginal rate on central bank debt	Eurodollar rate
Net cash flow	1.00			
Gross cash flow	0.86	1.00		
Marginal rate on central bank debt	-0.18	-0.07	1.00	
Eurodollar rate	0.48	0.56	-0.12	1.00

Survey data on companies' output expectations were obtained from the data in the Economic Barometer of the Confederation of Finnish Industries. Here use has been made of one-quarter expectations which have been quantified in the same way as realizations (Appendix 4). The output shock used is actual output less expected output.

The above-mentioned shock variables have also been used to describe uncertainty about the future (Kawasaki, Gahlen and Buck (1983)). In addition, uncertainty about the future has been measured by means of moving and cross-section variances. Variables derived from surveys have been regarded as the most genuine indicators of uncertainty (Aiginger (1985), Batchelor (1985) and Batchelor and Jonung (1987)). Accordingly, the variance of the response sign distribution is calculated for the output expectations series of the Confederation of Finnish Industries on the assumption that the responses are normally distributed (Jalas (1981)). An increase in variance over time implies an increase in uncertainty. However, it could also be interpreted as measuring only sectoral differences in growth or signifying that, for one reason or another, economic agents have different information sets (Cukierman and Wachtel (1979)).

Instead of the constant-parameter AR process, a conditional stochastic ARCH process could be used in which the conditional variance of an ordinary linear model changes autoregressively. This model is based on the idea that the AR process is conditional on the heteroscedastic nature of disturbances (Engle (1982) and (1983)). So it should be possible empirically to describe the changing nature of uncertainty with ARCH-models. However, they entail the problem that the learning process takes place with a one period lag, even if advance information is available on the "shock". Owing to the small size of the sample, the endogenization of the stochastic process is not, however, possible in this study.

Finally, we calculate the 12-month moving variance of industrial output on the basis of the Official Statistics; it has also been used as an indicator of uncertainty (Klein (1975)). The greatest problem with this variable is its ex post nature. Changes in variance can only be observed with a substantial lag. The use of moving variances is based on the assumption that the stochastic structure of a time series comprises constant drift and a variance term.

Of the above-mentioned indicators of the "uncertainty" of demand, the prediction errors describe mainly shocks and the variance variables uncertainty. For this reason, and also because of different samples, correlation between the indicators is low, even negative (Table 10.d). However, there is statistically significant correlation between the shock variable, deviation of output expectations, derived from the data of the Economic Barometer of the Confederation of Finnish Industries, and the "uncertainty variable", variance of output expectations, calculated from the same data. The other uncertainty variable, the moving variance of industrial output, also correlates with this shock variable. By contrast, the standard deviation of the ARIMA forecast does not seem to correlate with the variables calculated from the data of the Confederation of Finnish Industries.

The time series nature of the indicators measuring the uncertainty of demand is also expressed by an autocorrelation and partial autocorrelation functions, and the stochasticity of the series is tested using the Box-Pierce test statistic (Appendix 9). If the time series is not white noise, the ARIMA (p,q) model is fitted to the data. From the appendix it can be seen that the hypothesis of white noise in the time series holds true in only two cases. The time series are for the most part different processes. The variance of output expectations seems to be mainly a MA process, whereas other non-stochastic time series are mainly of AR type. On this basis alone, it can be stated that the measurement of uncertainty entails considerable problems, the examination of which it is not worth undertaking in a cost-benefit sense in the present study.

TABLE 10.d. CORRELATION COEFFICIENTS OF VARIABLES DESCRIBING DEMAND SHOCKS AND UNCERTAINTY

	Deviation of output expectations of the CFI	Standard deviation of the ARIMA forecast	Variance of output expectations of the CFI	Moving variance of manufacturing output
Deviation of output expectations of the CFI	1.00			
Standard deviation of the ARIMA forecast	0.15	1.00		
Variance of output expectations of the CFI	0.50	-0.08	1.00	
Moving variance of manufacturing output	0.55	0.31	0.07	1.00

IV.4 Condensing the Information Set

IV.4.1 Demand Shocks and Revisions of Plans

We start the examination of the data by testing correlation between changes in investment plans and demand shocks, which we call the revision function of investment plans. Attention is paid only to the investment plan data for the two longest survey horizons, because they did not pass the previous rationality tests. Correlation is tested separately for each independent variable using linear regression analysis and the F-test, when the null hypothesis is that the constant and the regression coefficient receive the value zero. The critical limits of the F-tests are corrected if the residuals are significantly autocorrelated.

Changes in investment plans between the spring and the autumn of the previous year and between the autumn of the previous year and the spring of the current year serve as dependent variables. The demand variables are quarterly and annual sectoral data on industrial output, the quantified sectoral output series of the Confederation of Finnish Industries and GDP as a general exogenous economic indicator. The quarterly demand data (Q-variables) are timed according to the surveys, so that they should have been available at the time of the survey was carried out.

In manufacturing, the null hypothesis is rejected in the case of all demand variables with respect to the change in plans for the two longest survey horizons (Table 11). The fit is not so evident at the sectoral level, with particularly the metal and engineering industries differing from other sectors. The null hypothesis cannot be rejected in this sector with respect to virtually all independent variables. As stated above, this can be explained by the fact that the plans of the metal and engineering industries seem much more permanent than those of the other sectors.

TABLE 11. REVISION FUNCTIONS OF INVESTMENT PLANS

F-test statistics in the table (DW-values of residuals in parentheses)
H_0: $a_1 = 0$ and $a_2 = 0$

Dependent variable: A) autumn plans less spring plans concerning investments in following years
B) spring plans concerning investments in current year less autumn plans concerning investments in the following year
Independent variables: demand indicators (surprise $X_t - X_{t-1}$)
Estimation period: A) 1969 - 1984
B) 1964 - 1984
Variables in real terms
Estimation method: OLS

Surprise variable	Estimated equations A) ${}_tIPF^a_{t-1} - {}_tIPF^s_{t-1} = a_1+a_2(X_t-X_{t-1})$				B) ${}_tIPF^s_t - {}_tIPF^a_{t-1} = a_1+a_2(X_t-X_{t-1})$			
X_t-X_{t-1}	manufacturing sectors				manufacturing sectors			
	1	2	3	4	1	2	3	4
Manufacturing output (Q)	8.86**a	1.31	5.30*	6.82**a	9.37**a	4.27*	1.75	8.29**a
	(1.45)	(1.51)	(1.16)	(2.15)	(1.60)	(1.27)	(2.46)	(2.27)
Manufacturing output	12.34**a	6.73**a	3.46	7.19**a	15.03**a	4.05*	2.15	12.85**a
	(1.48)	(1.57)	(1.12)	(1.95)	(1.56)	(1.27)	(2.46)	(2.30)
Manufacturing output (CFI survey)	4.79*	2.39	3.19	5.05*a	18.51**a	1.38	1.89	12.54**a
	(1.25)	(1.26)	(1.02)	(1.81)	(2.49)	(1.30)	(2.57)	(2.60)
GDP	8.44**a	4.87*a	10.89**a	5.14*a	12.81**a	7.03**	2.58	11.86**a
	(1.76)	(1.54)	(1.57)	(1.89)	(2.21)	(1.20)	(2.61)	(2.63)

a = significant at 5 per cent level, when the effect of residual autocorrelation has been taken into account.
** = significant at 1 per cent level, when $\rho = 0$, and * = significant at 5 per cent level, when $\rho = 0$
Critical values of the F-test (ρ = autocorrelation coefficient of residual)

$\rho = 0$
$F_{0.95}(2,19) = 3.47$ $F_{0.99}(2,19) = 5.78$
$F_{0.95}(2,14) = 3.63$ $F_{0.99}(2,14) = 6.23$

$\rho = 0.30$
$F_{0.95}(2,19) \sim 7.22$
$F_{0.95}(2,14) \sim 7.71$

1 = manufacturing
2 = forest industries
3 = metal and engineering industries
4 = other manufacturing industries

No marked difference can be observed between the quarterly and annual information, although in certain cases annual information produced even higher F-values than the quarterly figures. This is evidently due to lags in the availability and treatment of information, because in the case of quarterly figures the information lag was assumed to be no more than one quarter. When using annual data, the lags between investment plans and information are on average six months long.

IV.4.2 The Implementation of Plans and Shocks

As has been discussed above, the selection of the information set is a problem with respect to the demand indicators, in particular. For this reason, the choice of independent variables is first made applying linear regression analysis with one independent variable and testing for parameter restrictions by means of the F-test. The dependent variable is now realized investments less investment plans according to the survey. The null hypothesis to be tested is the same as above, i.e. that the constant of the regression equation and the coefficient for the independent variable both receive the value zero and residuals are serially uncorrelated.

In Tables 12.a and 12.b, the results of the F-tests are presented with regard to demand, price, cost and financial variables. The tests have been carried out according to the length of the survey horizon and the manufacturing sector. All regressions are carried out for the same period, 1970 - 1984. In the case of the quarterly series for manufacturing output the information lag used is shorter than with annual data, being less than three months. In the case of annual data, the shock variables for the two longest survey periods have been calculated using the difference X(t) - X(t-2) and the shock variable for the shorter survey horizon X(t) - X(t-1). The critical limits of the F-tests have again been corrected if the residuals are significantly autocorrelated (Kiviet (1980)). The F-test values rejecting the null hypothesis after the autocorrelation correction have then been denoted by the letter a.

TABLE 12.a. CORRELATION OF REVISIONS OF INVESTMENT PLANS (REALIZATION LESS PLANS) WITH CHANGES IN DEMAND FACTORS

F-test statistics in the table, DW-values of residuals in parentheses H_0: $a_1 = 0$ and $a_2=0$

Estimation period: 1970–1984
Dependent variables: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
C) final investments less plans made in the spring of the current year
Independent variables: variables indicating domestic and foreign demand (surprise X_t-X_{t-i}, i=1,2)
Variables at constant prices
Estimation method: OLS

	Estimated equations											
Surprise variable	A) ${}_tIRQ^s_{t+1}-{}_tIPF^s_{t-1}$ $=a_1+a_2(X_t-X_{t-2})$ manufacturing sectors[b)]				B) ${}_tIRQ^a_{t+1}-{}_tIPF^a_{t-1}$ $=a_1+a_2(X_t-X_{t-2})$ manufacturing sectors				C) ${}_tIRQ^s_{t+1}-{}_tIPF^s_t$ $=a_1+a_2(X_t-X_{t-1})$ manufacturing sectors			
X_t-X_{t-2}	1	2	3	4	1	2	3	4	1	2	3	4
Manufacturing[c)] output (Q)	8.65**a (1.24)	2.34 (1.25)	8.37**a (1.57)	12.18**a (2.06)	3.51 (0.67)	2.92 (0.99)	0.13 (1.22)	5.08*a (1.40)	4.00*a (1.52)	0.88 (2.15)	0.29 (2.23)	0.00 (1.27)
Manufacturing output	10.45**a (1.23)	2.53 (1.24)	12.88**a (1.31)	16.52**a (2.24)	4.04* (0.73)	2.75 (0.88)	0.40 (1.20)	11.06**a (1.48)	2.00 (1.35)	0.63 (2.07)	0.33 (2.09)	0.01 (1.30)
Manufacturing[d)] output, CFI survey	27.45**a (1.63)	2.00 (1.07)	13.53**a (1.16)	16.26**a (1.96)	18.94**a (1.47)	2.11 (0.68)	1.64 (1.31)	15.54**a (1.71)	0.23 (1.40)	1.00 (1.14)	0.20 (2.20)	6.07*a (2.22)
Gross (sales) value of manufacturing output	4.96* (1.14)	2.16 (1.07)	5.97* (1.22)	5.54*a (1.74)	2.10 (0.80)	2.17 (0.64)	0.19 (1.17)	2.98 (1.27)	0.61 (1.19)	1.35 (1.23)	0.16 (2.25)	0.57 (1.31)
GDP	16.98**a (1.31)	5.24* (1.15)	8.93**a (1.19)	19.79**a (2.27)	5.74* (0.70)	2.66 (0.72)	0.14 (1.24)	9.53**a (1.14)	0.36 (1.48)	0.60 (2.19)	0.95 (2.32)	0.17 (1.38)
Total domestic demand	29.26**a (1.80)	9.92**a (1.38)	30.26**a (1.51)	11.81**a (0.79)	10.45** (0.83)	5.66* (0.65)	1.10 (1.02)	5.76* (1.22)	0.07 (1.24)	0.55 (2.05)	0.15 (2.09)	1.20 (1.55)
Exports	4.53* (1.23)	2.18 (1.28)	3.07 (1.26)	5.08* (1.34)	3.00 (0.87)	3.52 (0.96)	0.22 (1.18)	2.62 (0.83)	1.90 (1.16)	0.46 (1.96)	1.07 (1.77)	0.03 (1.25)
Imports of FEC countries[e)]	5.37* (1.32)	3.11 (1.30)	2.21 (1.17)	6.35*a (1.60)	2.68 (0.83)	2.15 (0.69)	0.09 (1.18)	3.22 (1.26)	0.71 (0.96)	0.91 (1.05)	1.71 (2.00)	0.31 (1.23)
Finnish export markets[f)]	6.59*a (1.50)	4.40*a (1.56)	2.57 (1.23)	5.58*a (1.50)	6.14*a (1.31)	3.33 (1.03)	0.51 (1.18)	6.13*a (1.39)	0.28 (0.93)	0.90 (1.10)	1.72 (1.73)	0.75 (1.38)
Total domestic demand[g)] in OECD countries	3.13 (1.18)	1.79 (1.09)	4.80* (1.23)	3.60 (1.59)	1.68 (0.85)	2.31 (0.55)	1.75 (1.34)	1.89 (1.17)	0.41 (1.14)	0.92 (1.15)	0.59 (2.27)	0.79 (1.27)
Stockbuilding in OECD[h)] countries, contribution to GDP	3.15 (1.20)	1.82 (1.10)	3.66 (1.28)	3.35 (1.47)	1.70 (0.89)	2.62 (0.61)	0.74 (1.42)	1.63 (0.97)	1.89 (0.71)	0.95 (1.01)	4.32 (1.89)	0.42 (1.27)
GDP weighted by OECD countries	3.16 (1.17)	1.80 (1.09)	4.79* (1.21)	3.42 (1.58)	1.67 (0.85)	2.34 (0.52)	1.40 (1.23)	2.09 (1.17)	0.34 (1.12)	0.95 (1.19)	0.68 (2.22)	0.60 (1.25)
World trade	5.00*a (1.41)	3.57 (1.41)	2.40 (1.23)	4.01*a (1.54)	4.82*a (1.36)	2.69 (0.98)	0.49 (1.30)	5.28*a (1.33)	0.37 (0.81)	0.90 (1.07)	2.03 (1.60)	0.70 (1.42)

a) F-values: * significant at 5 per cent level, ** significant at 1 per cent level, when the effect of the autocorrelation of the residual on the critical limit of the F-test has not been taken into account. Figures marked with a are significant at 5 per cent level, when the effect of autocorrelation has been taken into account.
b) Manufacturing sectors: 1 = manufacturing, 2 = forest industries, 3 = metal and engineering industries, 4 = other manufacturing industries.
c) In the Q series, information is given with an accuracy of quarters precision; in other series, annual data is used.
d) CFI's survey for one quarter ahead
e) The five countries most important for Finnish exports
f) The countries and market areas most important for Finnish exports, all export markets
g) FEC countries weighted together by output shares
h) Takes into account the effect of stockbuilding on GDP

Critical values of the F-test

	$\rho=0$	$\rho=0.30$
$F_{0.95}(2,13)$	3.68	~7.81
$F_{0.99}(2,13)$	6.36	

According to Table 12.a, the null hypothesis must be rejected in total manufacturing for the longest survey horizon (the spring of the previous year; columns 1 - 4 on the left-hand side of the table) with respect to all the indicators for domestic demand other than the gross value of manufacturing output. Rejection of the null hypothesis is also generally the rule when analyzed by industrial sector. Rejection of the null hypothesis implies that investment plans react to unanticipated changes in information, which in this preliminary analysis are interpreted as all changes taking place in the chosen information set during a one or two-year period. The output values of the Confederation of Finnish Industries, GDP and aggregate domestic demand appear as the major independent variables for changes in investment plans.

In the case of the variables measuring foreign demand, correlation does not seem to be so apparent as in the case of domestic demand. Of the foreign demand variables, the expansion of export markets is the most obvious independent variable for changes in investment plans.

For a survey horizon six months shorter, the null hypothesis cannot be rejected for two-thirds of the equations. As regards the indicators of foreign and domestic demand, the null hypothesis must be rejected in the case of the output data of the Confederation of Finnish Industries and in the case of the indicator describing developments in Finnish export markets in total manufacturing and the sectors other than the metal and engineering industries and the forest industries. In the metal and engineering industries and the forest industries, the null hypothesis cannot be rejected in the case of all demand variables when the first-degree autocorrelation of residuals is taken into account in critical limits. The plans of the metal and engineering industries displayed permanence in the previous tests of rationality. The investments of the forest industries differ from those of other sectors owing to their large unit size, as a result of which the real lags of the dependent variables may differ considerably from those used here. In the plans concerning the current year obtained in the spring, the null hypothesis cannot be rejected in the case of all demand shock which could be expected on the basis of the tests for unbiasedness.

Table 12.b shows the corresponding results of the F-tests for price and cost variables. In the case of total manufacturing, the null hypothesis is rejected with respect to virtually all independent variables. By contrast, in the major manufacturing sectors, only the shocks concerning the cost of capital and the marginal rate of interest explain the changes in investment plans to a significant degree, when the effects of the autocorrelation of residuals on the critical values of the F-tests have been taken into account. When the survey horizon shortens by six months, the null hypothesis is rejected only in the case of the cost of capital variables for total manufacturing, the forest industries and other manufacturing industries. The deviation of the plans in the survey of the spring of the realization year from final investments cannot be explained by any price or cost shock appearing in the table.

According to the test results it is quite clear that investment plans react to the innovations in the new information concerning the two longest survey horizons. There are clear differences between the various manufacturing sectors; the investment plans of the metal and engineering industries are very stable compared to the other sectors. The most effective shock variables are different indicators of demand, the user cost of capital and wages.

TABLE 12.b. CORRELATION OF REVISIONS OF INVESTMENT PLANS (REALIZATION LESS PLANS) WITH CHANGES IN PRICE AND COST FACTORS

F-test statistics in the table, DW values of residuals in parentheses H_0: $a_1 = 0$ and $a_2 = 0$

Dependent variables: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
C) final investments less plans made in the spring of the current year

Independent variables: price and cost factors (surprise $X_t - X_{t-i}$, i=1,2)

Estimation period: 1970–1984

Variables in real terms

Estimation method: OLS

	Estimated equations											
	A) ${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + a_2(X_t - X_{t-2})$ manufacturing sectors				B) ${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + a_2(X_t - X_{t-2})$ manufacturing sectors				C) ${}_tIRQ^s_{t+1} - {}_tIPF^s_{t} = a_1 + a_2(X_t - X_{t-1})$ manufacturing sectors			
Surprise variable $X_t - X_{t-2}$	1	2	3	4	1	2	3	4	1	2	3	4
User cost[b] (lending rate)	7.86**a	8.32**a	4.84*	6.59**	16.21**a	24.09**a	3.19	5.33*	2.32	3.80	0.06	1.93
	(1.24)	(1.55)	(1.06)	(1.23)	(1.40)	(1.69)	(1.39)	(1.19)	(1.76)	(1.79)	(2.32)	(1.79)
User cost[b] (rate of interest in balance sheet statistics)	11.79**a	9.05**a	7.00*	8.79**a	26.16**a	24.02**a	4.60*	7.88**a	2.47	2.13	0.02	5.69*a
	(1.34)	(1.60)	(1.13)	(1.26)	(1.41)	(1.64)	(1.33)	(1.28)	(1.62)	(1.89)	(2.28)	(1.97)
Wages	9.26**a	6.73**	4.87*	5.05*	3.92*	2.44	0.89	2.38	0.50	0.58	0.44	0.01
	(0.94)	(1.03)	(1.24)	(1.35)	(0.64)	(0.76)	(1.06)	(1.00)	(1.06)	(1.92)	(1.90)	(1.26)
Net cash flow	5.55*	3.70	3.99*	5.17*	3.09	2.45	0.19	2.40	2.10	0.46	0.18	2.11
	(1.03)	(1.07)	(1.22)	(1.30)	(0.96)	(0.88)	(1.14)	(0.91)	(1.63)	(1.96)	(2.05)	(1.28)
Gross cash flow	8.60**a	4.14*	7.59**	7.13**	3.00	2.39	0.34	2.37	2.61	0.46	1.01	1.14
	(0.88)	(1.05)	(1.20)	(1.20)	(0.73)	(0.86)	(1.07)	(0.80)	(1.37)	(1.94)	(1.95)	(1.23)
Marginal rate of interest	7.53**a	4.29*a	6.36*a	6.47*	7.93**	5.72*	1.52	5.10*	0.85	1.56	0.52	0.51*
	(1.33)	(1.45)	(1.36)	(1.26)	(0.86)	(1.06)	(1.17)	(1.04)	(1.32)	(1.92)	(2.23)	(1.18)
Eurodollar rate	7.09**	3.49	4.19*	7.94**a	4.97*	3.69*	0.45	4.28*	0.16	0.66	0.14	0.05
	(1.06)	(1.21)	(0.95)	(1.24)	(0.70)	(0.93)	(1.24)	(0.84)	(1.32)	(1.92)	(2.23)	(1.22)
Price of energy[c]	6.86**	3.81*	5.58*	6.34*	13.27**	7.19**	3.82*	7.77**	0.72	1.23	0.15	1.18
	(1.00)	(1.19)	(0.86)	(1.18)	(0.61)	(1.08)	(0.98)	(0.84)	(1.39)	(1.94)	(2.14)	(1.30)
Price of investments	4.61*	2.20	3.11	5.90*a	2.91	2.52	1.63	2.90	0.70	0.84	0.29	0.32
	(1.29)	(1.29)	(1.25)	(1.66)	(0.81)	(0.79)	(1.51)	(1.12)	(1.31)	(1.93)	(2.20)	(1.07)

a) Significant at 5 per cent level, when the effect of autocorrelation is taken into account.
b) The price of capital is calculated according to Jorgenson's user cost method. The interest rates used are the banks' average lending rate and the rate of interest on total liabilities calculated from industry's balance sheet statistics.
c) Total compensation per hour.
d) The average price of oil in OPEC's long-term agreements.

IV.4.3 Principal Component Analysis and the Information Set

Principal component analysis is used to construct a time series describing the covariation of foreign and domestic demand, which is used in the estimations as a variable indicating demand. In the other application of principal component analysis, principal components are calculated for the total set of variables. The last-mentioned principal component has no certain interpretation; rather, it describes the covariation of data.

The demand variables employed in principal component analysis are chosen according to how well they correlate with the dependent variable. This can be seen from the F-tests in Table 12.a. The demand variables which best explain the changes in investment plans (realizations less plans) are manufacturing output (MQ), the output indicator of the Economic Barometer of the Confederation of Finnish Industries (CFIQ), gross domestic product (GDP), exports (XQ) and the indicator for Finnish export markets (XM). The significance of the principal components is tested by means of the Burt-Banks test statistic (Koutsoyiannis (1973)). This test statistic takes into account the number of observations and the order of components. The critical limit of the first principal component at the 1 per cent level of significance is 0.56, which the characteristic root of the first component clearly exceeds (Table 13.a). The characteristic root of the second component, 0.11, is far below the critical limit of 0.40. The strong complete concentration of the characteristic root in the first component is a result of strong correlation between the demand variables.

In the following, experiments are made with calculating the principal components for demand, price and cost variables. The set of variables used consists of manufacturing output (MQ), the demand indicator of the Confederation of Finnish Industries (CFIQ), gross domestic product (GDP), exports (XQ), export markets (XM), user cost of capital (JC), wages (W), the price of energy (EP), gross cash flow (CF), all in real terms. Here two of the characteristic roots exceed the critical value at the 1 per cent significance level as measured by the Burt-Banks test (Table 13.b).

TABLE 13.a. PRINCIPAL COMPONENT ANALYSIS

The characteristic roots of demand variables

	Characteristic root	Percentage share of the sum of the characteristic roots
1	4.83	97.7
2	0.11	1.6
3	0.04	0.5
4	0.02	0.2
5	0.00	0.0

Critical limits of the Burt-Banks test statistics at the 1 per cent level of significance

Component	
1	0.56
2	0.63

The loadings for principal components

	1	2	3	4	5
MQ	0.45	0.15	0.56	0.02	-0.68
CFIQ	0.44	-0.68	-0.10	0.56	0.08
GDP	0.45	-0.03	0.45	-0.40	0.66
XQ	0.44	0.70	-0.32	0.42	0.19
XM	0.45	-0.14	-0.61	0.59	-0.25

TABLE 13.b. PRINCIPAL COMPONENT ANALYSIS

The characteristic roots of demand and price variables

	Characteristic root	Percentage share of the sum of the characteristic roots
1	7.66	85.1
2	0.80	8.9
3	0.33	3.7
4	0.15	1.6
5	0.03	0.3
6	0.03	0.3
7	0.01	0.1
8	0.00	0.0
9	0.00	0.0

Critical limits of the Burt-Banks test statistics at the 1 per cent level of significance

Component	
1	0.56
2	0.60
3	0.64
4	0.69

The loadings for principal components

	1	2	3	4	5	6	7	8	9
MQ	0.36	-0.04	-0.14	0.09	0.22	0.44	0.36	0.33	0.60
CFIQ	0.34	-0.27	-0.36	-0.02	0.21	0.15	-0.36	-0.69	0.10
GDP	0.36	-0.10	-0.12	0.16	0.37	0.11	0.31	0.14	-0.75
XQ	0.36	0.03	0.01	0.13	-0.81	0.14	0.34	-0.25	-0.09
XM	0.35	-0.14	-0.26	0.27	-0.25	-0.23	-0.57	0.53	-0.01
JC	0.31	0.36	0.69	0.12	0.10	0.34	-0.38	-0.05	-0.06
W	0.35	-0.04	0.31	0.23	0.20	-0.74	0.25	-0.17	0.24
EP	0.32	-0.32	0.22	-0.84	-0.06	-0.07	-0.01	0.16	-0.03
CF	0.23	0.81	-0.39	-0.31	0.06	-0.18	0.00	-0.02	-0.01

The principal components are used in two different ways in the analysis of investment plans. In the following, the principal components calculated for the total information set are used as the only shock variable of the regression analysis (Table 14). Later, the principal component comprising only the demand variables is included in the regression analysis of several variables (Tables 15.a - 15.d).

Table 14 shows the results of the regression analysis when the two significant principal components calculated for the total information set are used as the shock variables. The method helps to avoid the multicorrelation problem, although the economic interpretation of the principal components remains unclear. It describes the joint variation of both demand and price and cost variables. The results are not very good in terms of either the standard error of estimate or the F-test. The second principal component does not attain any significant t-value in regressions.

The robustness of the results are examined using the logarithmic difference transformation of the data in the principal component analysis. The logarithmic difference transformation is carried out in order to remove the trend component from the data. As a result of differencing, one more significant principal component is attained (Appendix 6). However, in so doing, it is possible that stochastic fluctuations of the series are also included in the principal components. Before estimation the three significant principal components are transformed back to the level series by selecting an arbitrary starting point (here 1.0) for the series. The estimations are made in the same way as in Table 14. Measured in terms of F-test statistics the estimation results do not differ very much from the preceding estimations. However the residual autocorrelations are in most cases smaller and the corrected R^2-coefficients in most cases higher than before.

TABLE 14. CHANGES OF INVESTMENT PLANS AND PRINCIPAL COMPONENT ANALYSIS (Total information set condensed with principal component analysis)

Dependent variable:
A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year

Independent variable: statistically significant principal components of the total information set Table 13.b and Appendix 16 (surprise $X_t - X_{t-2}$).

Estimation period: 1969 - 1984
Estimation method: OLS
t-values in parentheses

Surprise variables $\Delta = PC_t - PC_{t-2}$	A) ${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + a_2\,\Delta PC_2 + a_3\,\Delta PC_3$				B) ${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + a_2\,\Delta PC_2 + a_3\,\Delta PC_3$			
$X_t - X_{t-2}$	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
PC_2	0.206	0.062	0.035	0.109	0.090	0.003	-0.007	0.094
	(2.09)	(1.01)	(1.22)	(3.25)	(1.38)	(0.09)	(0.47)	(3.55)
PC_3	0.080	0.091	0.014	-0.026	-0.067	0.005	-0.007	-0.065
	(0.43)	(0.79)	(0.27)	(0.42)	(0.55)	(0.07)	(0.23)	(1.32)
R^2C	0.280	0.095	0.045	0.426	-0.002	-0.151	-0.106	0.426
SEE	1442.0	898.9	418.9	492.0	945.8	546.3	225.2	384.8
F	8.18	3.40	3.67	12.14	3.37	1.93	0.36	7.76
DW	0.10	1.03	0.94	1.98	0.75	0.81	1.32	1.11

Critical values of the F-test, H_0: $a_1 = a_2 = a_3 = 0$

	$\rho = 0$	$\rho = 0.30$
$F_{0.95}(2,14)$	= 3.74	~ 7.71
$F_{0.99}(2,14)$	= 6.51	

1 = manufacturing
2 = forest industries
3 = metal and engineering industries
4 = other manufacturing sectors

IV.5 Estimation Results of the Realization Function

After the selection of variables, we now turn to estimate basic models for realization of investment plans. Equation (98) is chosen as the point of departure. The expectation hypotheses used are static and rational ones. In the static case all changes in information are first interpreted as shocks when the change is measured by two-year periods. The total change in investment plans (realization less plans) for the two longest survey horizons serves as the dependent variable. The exogeneous variables selected as a result of the earlier analysis are, in the case of demand, manufacturing output from the data of the CFI survey, the principal component of demand variables, and, in the case of costs and prices, user costs calculated with average lending rate and with interest rate from balance sheet statistics, total compensation per hour, price of energy, gross cash flow and marginal interest rate of central bank debt (Tables 15.a - 15.d). Ordinary Least Squares and SURE methods are used in the estimations.

The estimations are based on equation (98) assuming first that the value of the coefficient of lagged investment plans ($\frac{d}{a+d}$) on the left-hand side has a value one. This means that the information shocks have no effect on the investment plans. If the values of the parameter estimates of the exogeneous shock variables differ significantly from zero the unity assumption must be rejected. The estimation strategy has been selected to mitigate the multicorrelation problem arising from the possible high correlation between investment plans and shocks. The estimation results without unity restriction are presented in Appendix 11 and are discussed later in Section IV.6.

According to the estimation results it is clear that the unity restriction is not valid. The results also confirm the previous view that adjustment to unanticipated shocks slows when the survey horizon shortens (Tables 12.a and 12.b). The result is in line with the assumption that the adjustment costs increase in relation to the disequilibrium costs (equation (98); d increases in relation to a, see also IV.6, Table 20 and Appendices 7 and 11). For example, the values of the parameter estimates of static demand shocks fall by almost a half when the survey horizon shortens by six months. Moreover, when the survey horizon shortens by a further six months, these shocks no longer have any significant impact on investment plans. The signs of the parameter estimates are as anticipated (those of demand factors positive and those of cost factors negative). In the case of wages, a fall in the parameter estimates of at least the same magnitude as that of the coefficient of the demand shock can be observed. By contrast, the parameter estimates of capital costs hardly change at all when the survey horizon shortens by six months. Estimates of the surprise parameters h_i are presented in Table 20 on page 156.

The results obtained are interesting. The average lag between changes in wages and demand and investments is longer than the lag following changes in capital costs. This would suggest that monetary policy affects investments over a fairly short time-span - about a year. However, it is difficult to draw conclusions because, in addition to the rate of interest, companies' capital costs are affected by fiscal policy measures and anticipated changes in the rate of inflation (Koskenkylä (1985)).

IV.5.1 The Basic Model

In general, there is no autocorrelation of the first order in the residuals of the basic models, when autocorrelation is measured by means of the DW-test (Tables 15.a - d). In exceptional cases, the DW-values fall into an undetermined region. Autocorrelated residuals could indicate that the specification of the model is deficient. The small sample size prevents careful analysis of the time series nature of the residual process.

The alternative demand variables consisted of the output series of the Confederation of Finnish industries (CFIQ), gross domestic product (GDP) and the principal component of the five demand variables best correlating with the change in investments (PC_1). According to the t-test, in the basic model for total manufacturing all these variables received coefficients deviating from zero at the five per cent level of significance for the two longest survey horizons (Table 15.a). The first expectation hypothesis used here is a static one and the innovation variable X(t) - X(t-2) is formed in the same way as in the earlier correlation tests (Tables 12.a - 12.b). Because the data are annual, it could not be specified separately for each survey horizon.

The estimation results with the principal component of demand variables do not differ significantly from the equations in which only one demand variable is used, because the correlation between the demand variables is very high (Table 10.a). The same principal component describing demand has been applied to all manufacturing sectors, and so it functions as a general economic indicator. Sectoral deviations from the overall course of development may give rise to differences in explanatory power.

In addition to demand, prices of factors of production exert a clearly significant impact on investment plans. The negative sign of total hourly wage costs (W) indicates that in this context the cost effect of wages are a more important factor than the substitution effect.

The coefficient estimate of the user cost of capital receives a negative sign in all the experiments carried out with the aggregated manufacturing data. Table 15.a shows the estimation results for user cost with two alternative interest rate concepts, the average bank lending rate (JC_1) and the rate of interest on external capital (JC_2) calculated on the basis of the cost of external capital in the Balance Sheet Statistics. The results are fairly similar and it is difficult to draw any distinction between interest rates on the basis of these estimations. Using alternative price expectations hypotheses to specify the real rate of interest has a marked impact on the results. When only observations for the year t or forecasts made with the ARIMA model for one year ahead are used as a proxy for the expected price of capital, the cost of capital receives significant coefficients in only a few estimations. The estimation results improve significantly when inflation expectations are formed with the moving average process (Tables 15.a - 15.d). The method applied is, of course, an arbitrary way of describing long-term inflation expectations associated with the real rate of interest. It is not in the spirit of rational expectations owing to its retrospective nature.

TABLE 15.a. MANUFACTURING

REALIZATION FUNCTIONS OF INVESTMENT PLANS, regression coefficients, t-values in parentheses (equation (98))

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: demand, factor prices and liquidity (surprise X_t-X_{t-2})
Variables in real terms
Estimation period: 1968 (1969)-1984
Estimation method: OLS

surprise variable	A) $_tIRQ^s_{t+1} - _tIPF^s_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$							B) $_tIRQ^a_{t+1} - _tIPF^a_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$						
X_t-X_{t-2}	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
CFIQ	274.7			234.7	324.6	250.7	288.5	143.2			106.4	149.5	148.0	148.3
	(5.82)			(4.50)	(5.62)	(6.08)	(5.49)	(4.72)			(3.09)	(3.90)	(4.82)	(4.75)
GDP		0.179							0.059					
		(7.62)							(2.76)					
PC_1			0.222							0.098				
			(5.22)							(3.08)				
JC_1	-96.47	-209.6	-268.7		-84.11	-164.7	-103.5	-114.8	-160.0	-196.4		-113.2	-101.5	-116.5
	(1.89)	(5.16)	(4.69)		(1.69)	(3.18)	(1.94)	(3.54)	(3.96)	(4.57)		(3.42)	(2.64)	(3.59)
JC_2				-118.9							-122.9			
				(2.19)							(3.46)			
W	-149.8	-148.4	-133.1	-157.4	-144.8	-38.47	-151.7	-45.29	-51.84	-41.53	-52.64	-44.67	-66.64	-44.08
	(4.18)	(5.13)	(3.36)	(4.55)	(4.18)	(0.69)	(4.13)	(1.97)	(1.83)	(1.40)	(2.35)	(1.97)	(1.65)	(1.97)
EP					-42.55							-5.421		
					(1.40)							(0.27)		
CF						22.24							-4.315	
						(2.39)							(0.63)	
MIR							-0.136-D6							-0.396-D7
							(0.67)							(0.56)
Constant	1323.0	336.6	450.9	1539.7	1168	493.2	1257	385.9	419.6	117.6	583.1	366.4	543.0	338.7
	(3.39)	(0.83)	(0.81)	(3.85)	(2.98)	(1.03)	(3.05)	(1.54)	(1.18)	(0.28)	(2.31)	(1.44)	(1.59)	(1.33)
R^2C	0.835	0.892	0.807	0.847	0.848	0.882	0.827	0.780	0.583	0.649	0.772	0.767	0.773	0.772
SEE	690.1	558.3	742.2	664.5	664.0	584.8	706.4	442.8	562.1	559.6	437.3	441.5	436.7	437.2
F	38.03	59.69	32.10	41.26	33.26	43.52	29.13	23.34	14.26	13.49	24.57	19.43	20.01	19.86
DW	1.89	2.49	2.17	2.17	2.18	2.60	1.75	2.60	1.38	1.98	2.16	2.60	2.68	2.74

Critical values of the F-test, H_0: a_i=0, when i=1, ..., n
$F_{0.95}(4,15) = 3.06$ $F_{0.95}(4,14) = 3.11$ $F_{0.95}(5,14) = 2.96$ $F_{0.95}(5,13) = 3.03$
$F_{0.99}(4,15) = 4.39$ $F_{0.99}(4,14) = 5.04$ $F_{0.99}(5,14) = 4.70$ $F_{0.99}(5,13) = 4.86$

Variable list

CFIQ = manufacturing output (CFI survey)
GDP = gross domestic product
PC_1 = principal component of demand variables
JC_1 = user cost (calculated with average lending rate)
JC_2 = user cost (interest rate calculated from balance sheet statistics)
W = total compensation per hour
EP = price of energy
CF = gross cash flow
MIR = marginal interest rate on central bank debt

The information set is now extended to include the price of energy (EP), cash flow (CF) and the marginal rate on central bank debt (MIR) and the quantified output series of the Confederation of Finnish Industries. In total manufacturing (Table 15.a) new information on the price of energy (EP) receives a negative but non-significant coefficient for the two long survey horizons. A negative sign can be expected if energy and capital are complements; on the other hand energy can also be interpreted as a factor of production in the production function.

Finnish financial markets were subject to credit rationing during the period covered by the study. In conditions of permanent rationing, investments are continually subject to liquidity constraints or the company's interest expenses rise in line with the level of indebtedness. However, the modelling of credit rationing is problematic in the case of aggregated data, because individual companies are in different positions in the credit market with respect to both time and type of company. The present study follows the Finnish tradition, whereby either a cash flow variable describing the liquidity constraint (Koskenkylä (1985)) or a financial stringency indicator depicting the regulation of bank lending (Tarkka (1985)) are included in the investment equation. So as to eliminate inflation bias, both variables are deflated by the price index of manufacturing output. The functional form used is additive, because the multiplicative form would require an extra parametrization of the adjustment costs. However, as is discussed earlier in Chapter II.6.2, if credit rationing is included in the adjustment cost of the investment plans, credit rationing effects the investment plans multiplicatively through all the variables of equation (98). In order to reduce the number of combinations of estimation results, only the results concerning the gross cash flow variable are reported, as it displayed higher correlation with the dependent variable than net cash flow.

Measured in terms of t-values, gross cash flow (CF) receives a statistically significant parameter estimate in total manufacturing for the longest survey horizon (Table 15.a). The standard error of estimate also decreases as a result of adding the variable to the equation. Nevertheless, the equation does not necessarily indicate the effects of credit rationing, since the cash flow variable can also be interpreted as an indicator of profitability and hence the expected profitability of the new capital. After the cash flow variable was added to the model, the coefficient estimate of wages no longer received significant t-values. The marginal rate on central bank debt (MIR) did not receive significant coefficients, although the coefficients were negative, as could be expected. Hence, there was little support for the credit rationing hypothesis using the additive function form and the results are similar to the estimations by Koskenkylä (1985).

The basic model and the more restricted models have also been estimated with data on the main manufacturing sectors, the forest industries, the metal and engineering industries and other manufacturing industries. The output series of the Confederation of Finnish Industries have been quantified by manufacturing sector. Similarly, the variables for the price of capital, wage costs and cash flow have been calculated from sectoral data. Gross domestic product, the principal component of demand, the price of energy and the marginal rate of interest are common to all manufacturing sectors. On the whole, the results show that, irrespective of the industrial sector, demand receives significant positive coefficients for the long survey horizon (Tables 15.b - d). As the survey horizon shortens, the explanatory power weakens, because the "permanence" of plans increases and the adjustment to shocks decelerates. The cost of the capital variable and unit wages receive the same negative sign as in total manufacturing, but the coefficients are not necessarily always significant. The importance of demand as an independent variable is clearly greater than that of relative prices, when all manufacturing sectors are taken into account. There are intersectoral differences in so far as the cost of capital receives significant coefficients in all the models of the forest industries, whereas in the metal and engineering industries, wages are a more important independent variable than capital costs. The result may be due to differences in the capital and labour-intensity of the respective sectors.

TABLE 15.b. FOREST INDUSTRIES

REALIZATION FUNCTIONS OF INVESTMENT PLANS,
regression coefficients, t-values in parentheses (equation (98))

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: demand, factor prices and liquidity (surprise $X_t - X_{t-2}$)
Variables in real terms
Estimation period: 1968 (1969) - 1984
Estimation method: OLS

Estimated equations

surprise variable $X_t - X_{t-2}$	A) ${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$							B) ${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
CFIQ	78.62			25.21	50.49	67.05	68.50	22.80			-4.753	13.82	39.73	17.63
	(2.52)			(0.80)	(1.12)	(0.94)	(1.35)	(1.24)			(0.25)	(0.62)	(1.13)	(0.65)
GDP		0.054							0.009					
		(2.13)							(0.69)					
PC_1			0.046							0.006				
			(1.20)							(0.29)				
JC_1	-84.55	-111.7	-119.7		-161.6	-164.4	-162.7	-87.61	-85.70	-96.19		-105.6	-103.9	-109.5
	(2.30)	(2.99)	(2.83)		(2.82)	(2.73)	(2.85)	(4.05)	(4.19)	(4.28)		(3.69)	(3.50)	(3.58)
JC_2				-168.9							-99.87			
				(4.71)							(4.68)			
W	-22.28	-18.22	-18.18	-27.91	-18.40	-28.06	-18.94	-1.168	0.413	-1.005	-4.283	2.176	-11.22	1.064
	(2.79)	(2.05)	(1.70)	(3.16)	(1.48)	(1.01)	(1.54)	(0.25)	(0.08)	(0.18)	(0.82)	(0.35)	(0.82)	(0.16)
EP					20.77							14.89		
					(0.80)							(1.14)		
CF						-7.627							-11.89	
						(0.31)							(0.98)	
MIR							0.019-D5							0.004-D5
														(0.31)
Constant	286.5	-25.18	218.6	734.5	550.5	627.6	644.0	204.7	225.9	255.6	388.7	265.6	323.0	323.0
	(1.39)	(0.07)	(0.54)	(4.17)	(2.17)	(2.57)	(2.71)	(1.69)	(1.26)	(1.19)	(3.71)	(2.10)	(2.69)	(2.54)
R^2C	0.656	0.619	0.531	0.727	0.514	0.482	0.513	0.592	0.490	0.542	0.634	0.542	0.523	0.473
SEE	553.7	583.0	647.0	512.1	682.8	705.2	683.5	325.4	336.3	344.4	304.7	341.1	347.8	365.8
F	12.29	10.79	8.20	12.19	4.90	4.49	4.88	10.23	9.47	8.81	8.77	5.44	5.17	4.52
DW	1.67	1.52	1.61	2.39	2.04	1.86	2.09	1.82	1.50	1.76	1.63	2.30	2.09	1.93

Critical values of the F-test, H_0: $a_i = 0$, when $i = 1, \ldots, n$

$F_{0.95}(4,15) = 3.06$ $F_{0.95}(4,14) = 3.11$ $F_{0.95}(5,14) = 2.96$ $F_{0.95}(5,13) = 3.03$
$F_{0.99}(4,15) = 4.39$ $F_{0.99}(4,14) = 5.04$ $F_{0.99}(5,14) = 4.70$ $F_{0.99}(5,13) = 4.86$

TABLE 15.c. METAL AND ENGINEERING INDUSTRIES

REALIZATION FUNCTIONS OF INVESTMENT PLANS,
regression coefficients, t-values in parentheses (equation (98))

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: demand, factor prices and liquidity (surprise $X_t - X_{t-2}$)
Variables in real terms
Estimation period: 1968 (1969) - 1984
Estimation method: OLS

surprise variable $X_t - X_{t-2}$	Estimated equations A) $_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$							B) $_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
CFIQ	91.16			107.3	71.36	92.51	95.54	21.40			14.33	-10.68	26.72	20.36
	(7.42)			(6.80)	(4.78)	(6.65)	(5.97)	(1.46)			(0.78)	(0.78)	(1.82)	(1.34)
GDP		0.036							-0.002					
		(2.91)							(0.32)					
PC_1			0.042							-0.005				
			(2.31)							(0.42)				
JC_1	29.62	-31.36	-41.45		21.31	30.94	29.90	-65.15	-16.02	-14.04		-19.81	-1.251	-6.685
	(2.15)	(1.36)	(1.55)		(1.63)	(2.02)	(2.09)	(0.40)	(1.07)	(0.80)		(1.63)	(0.08)	(0.41)
JC_2				39.83							-13.58			
				(2.39)							(0.70)			
W	-46.90	-37.49	-39.48	-43.84	-55.57	-51.11	-46.63	-12.52	-14.07	-13.96	-12.55	-27.25	-30.70	-12.400
	(4.95)	(2.14)	(2.08)	(4.95)	(5.80)	(2.60)	(4.75)	(1.11)	(1.28)	(1.12)	(1.24)	(3.06)	(1.58)	(1.10)
EP					15.00							24.59		
					(1.97)							(3.50)		
CF						-3.198							-14.93	
						(0.25)							(1.14)	
MIR							0.272-D7							0.560-D8
							(0.45)							(0.15)
Constant	320.0	142.0	229.6	241.2	419.6	353.2	300.1	61.80	188.4	193.0	86.37	230.1	203.1	64.18
	(3.52)	(0.62)	(0.95)	(2.53)	(4.37)	(2.15)	(2.89)	(0.57)	(1.51)	(1.22)	(0.78)	(2.57)	(1.25)	(0.56)
R^2C	0.855	0.523	0.438	0.864	0.883	0.842	0.844	0.171	0.075	0.038	0.202	0.562	0.202	0.117
SEE	163.5	296.0	321.4	158.3	146.9	170.3	169.2	195.0	193.4	210.0	185.5	137.4	185.5	195.1
F	36.43	9.04	7.20	39.06	36.87	26.88	27.25	1.70	1.56	1.05	2.00	5.26	1.80	1.40
DW	2.08	1.26	1.25	2.08	2.45	2.13	2.01	1.12	1.25	1.26	1.08	2.09	1.24	1.13

Critical values of the F-test, H_0: $a_i = 0$, when $i = 1, \ldots, n$

$F_{0.95}(4,15) = 3.06$ $F_{0.95}(4,14) = 3.11$ $F_{0.95}(5,14) = 2.96$ $F_{0.95}(5,13) = 3.03$
$F_{0.99}(4,15) = 4.39$ $F_{0.99}(4,14) = 5.04$ $F_{0.99}(5,14) = 4.70$ $F_{0.99}(5,13) = 4.86$

TABLE 15.d. OTHER MANUFACTURING INDUSTRIES

REALIZATION FUNCTIONS OF INVESTMENT PLANS,
regression coefficients, t-values in parentheses (equation (98))

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: demand, factor prices and liquidity (surprise $X_t - X_{t-2}$)
Variables in real terms
Estimation period: 1968 (1969) - 1984
Estimation method: OLS

Estimated equations

surprise variable $X_t - X_{t-2}$	A) $_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$							B) $_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
CFIQ	86.31			97.09	148.3	86.17	103.2	67.55			77.43	107.6	72.56	78.20
	(2.21)			(2.87)	(4.78)	(3.76)	(3.19)	(2.43)			(3.24)	(4.55)	(3.68)	(3.53)
GDP		0.085							0.052					
		(4.66)							(3.60)					
PC			0.118							0.090				
			(5.56)							(5.63)				
JC_1	-68.73	-38.72	-86.57		11.90	-56.91	-2.208	-61.20	-45.06	-79.54		-5.723	-39.34	-10.53
	(1.26)	(1.22)	(2.96)		(0.37)	(1.68)	(0.06)	(1.58)	(1.74)	(3.61)		(0.24)	(1.36)	(0.38)
JC_2				-8.269							-10.18			
				(0.19)							(0.33)			
W	-35.19	-67.27	-40.83	-68.77	-107.3	0.590	-69.81	-11.87	-13.37	4.958	-22.63	-40.91	11.16	-24.91
	(0.51)	(1.44)	(1.06)	(1.25)	(2.25)	(0.01)	(1.22)	(0.24)	(0.37)	(0.17)	(0.60)	(1.17)	(0.28)	(0.63)
EP					-48.85							-28.74		
					(2.53)							(1.97)		
CF						48.30							23.37	
						(3.14)							(1.77)	
MIR							0.390-7D							0.176-7D
							(0.29)							(0.27)
Constant	545.7	-11.34	-136.9	649.9	802.8	17.51	623.2	145.4	-162.8	-517.4	116.5	170.3	-188.1	138.9
	(1.05)	(0.03)	(0.42)	(1.62)	(2.37)	(0.05)	(1.46)	(0.39)	(0.60)	(2.09)	(0.44)	(0.70)	(0.63)	(0.47)
R^2C	0.156	0.618	0.659	0.379	0.571	0.642	0.326	0.206	0.406	0.684	0.459	0.561	0.539	0.422
SEE	594.1	399.4	379.1	511.6	425.3	388.5	533.1	423.2	359.1	285.5	361.8	326.0	334.1	374.0
F	3.26	9.94	17.81	8.43	11.03	13.66	6.22	2.15	7.28	13.47	7.17	7.87	7.38	5.40
DW	1.56	2.26	2.70	1.68	2.40	2.75	1.68	1.63	1.31	2.17	1.74	2.09	2.25	1.70

Critical values of the F-test, H_0: $a_i = 0$, when $i = 1, \ldots, n$

$F_{0.95}(4,15) = 3.06$ $F_{0.95}(4,14) = 3.11$ $F_{0.95}(5,14) = 2.96$ $F_{0.95}(5,13) = 3.03$
$F_{0.99}(4,15) = 4.39$ $F_{0.99}(4,14) = 5.04$ $F_{0.99}(5,14) = 4.70$ $F_{0.99}(5,13) = 4.86$

The additional independent variables incorporated in the basic model receive significant coefficients in only a few cases. In the forest industries, the price of energy receives a negative but not significant coefficient for the long survey horizon, whereas the sign changes as the survey horizon shortens. In the metal and engineering industries, the sign for the price of energy is positive and significant at the 95 per cent level according to the t-test for the two longest survey horizons. As a result of the inclusion of the price of energy in the basic model, the total explanatory power of the basic model improves decisively and the positive autocorrelation of the residual disappears, but the coefficient for the cost of capital becomes positive. This result could indicate that in the metal and engineering industries energy is a substitute for capital rather than a complement. However, it is more likely that it indicates the impact of bilateral exports on the investment plans of the metal and engineering industries. Under the trading arrangements with the Soviet Union, when the price of oil has risen, the prospects for bilateral exports have improved and investment plans have been adjusted upwards.

Estimated by manufacturing sector, cash flow receives negative and non-significant coefficients almost without exception, so that the hypothesis of permanent credit rationing is not supported. In other manufacturing industries, the inclusion of cash flow in the basic model results in the sign of the coefficient for wages becoming positive, which is due to the high correlation between these variables. The inclusion of cash flow does not reduce the standard error of estimate of the basic model in any manufacturing sector. Contrary to expectations, the marginal rate of interest receives positive non-significant coefficients in the sectoral estimations, whereas in the models of total manufacturing the coefficients were negative as expected. Thus, the effects of monetary policy are reflected solely through the cost of capital variables, while additional rationing variables do not seem to exert any influence.

Moreover, as was noted earlier, the effects of credit rationing could be exerted multiplicatively and not additively as assumed in the equations. Credit rationing could be one factor in the adjustment costs of the plans and exerts an influence through all the parameters of the model (equation (98)). Hence we cannot isolate the influence of credit rationing to one marginal cost of capital parameter.

The sectoral estimations carried out to test the hypothesis of rising interest expenses using the method of instrumental variables did not produce any result, since the model did not converge with the available data. The level of indebtedness was used in the test as the instrument for companies' capital costs.

IV.5.2 Sectoral Analysis

Next, the systems method of estimation devised by Zellner (1962), SURE (Seemingly unrelated regression equations), was performed on the sectoral realization functions. By applying this method, it is possible to enhance the efficiency of estimation in two different cases: when the residuals of equations correlate with each other or when parameter constraints can be set between equations (Harvey (1982)). Tables 16.a and 16.b show the correlation coefficients for the residuals of the basic models estimated for the main sectors of manufacturing. Statistically significant correlation appears between the residuals of the equations in the metal and engineering industries and the forest industries (Table 16.b). The correlation between residuals may indicate that some factor outside the set of independent variables jointly affects the dependent variables. Such an external factor is well-justified in a world of rational expectations. The firm's management has instant access to information on international financial markets, exchange rates and share prices, and this may affect future expectations more rapidly than it affects the relative prices.

TABLE 16.a. RESIDUAL CORRELATIONS

Correlations between the residuals of the sectoral basic models (equations (15.b.1), (15.c.1) and (15.d.1))

Dependent variable: final investments less plans made in the spring of the previous year

Manufacturing sector	Metal and engineering industries	Forest industries	Other manufacturing industries
Metal and engineering industries	1.00		
Forest industries	-0.04	1.00	
Other manufacturing industries	-0.22	-0.39	1.00

TABLE 16.b. RESIDUAL CORRELATIONS

Correlations between the residuals of the sectoral basic models (equations 15.b.8, 15.c.8 and 15.d.8)

Dependent variable: final investments less plans made in the autumn of the previous year

Manufacturing sector	Metal and engineering industries	Forest industries	Other manufacturing industries
Metal and engineering industries	1.00		
Forest industries	0.52	1.00	
Other manufacturing industries	-0.25	-0.22	1.00

To enable a comparison to be made, Table 17.a shows the separately estimated equations for manufacturing sectors for two different survey horizons and Table 17.b the systems estimations made for the same survey horizons. Here the model consists of the realization functions for investment plans in the three major manufacturing sectors, the forest industries, the metal and engineering industries and other manufacturing industries. Estimation was carried out using the Mindis program included in the RAL program package, which is also suitable for non-linear systems estimation.

TABLE 17.a. REALIZATION FUNCTIONS OF INVESTMENT PLANS BY MANUFACTURING SECTOR (equation (98))

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year

Independent variables: demand, user cost and wages (surprise $X_t - X_{t-2}$)

Estimation period: 1972 - 1984

Variables in real terms

Estimation method: ML

Estimated equations

Surprise variable $X_t - X_{t-2}$	A) ${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{4} a_i(X_{t,i} - X_{t-2,i})$			B) ${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{4} a_i(X_{t,i} - X_{t-2,i})$		
	(1)	(2)	(3)	(1)	(2)	(3)
CFIQ	50.46	90.33	91.40	13.88	27.98	70.45
	(1.14)	(6.69)	(2.87)	(0.60)	(1.59)	(3.13)
	(1.51)	(11.63)	(3.32)	(0.96)	(2.51	(5.52)
JC_1	-168.8	24.69	11.93	-110.7	-6.513	1.749
	(3.04)	(1.74)	(0.29)	(3.85)	(0.35)	(0.06)
	(5.06)	(1.74)	(0.36)	(6.02)	(0.55)	(0.04)
W	-20.36	-38.77	-77.90	0.7694	-17.16	-44.81
	(1.71)	(3.35)	(1.22)	(0.12)	(1.13)	(1.00)
	(2.22)	(7.48)	(0.97)	(0.01)	(2.76)	(1.23)
Constant	625.1	272.9	649.1	319.1	98.20	227.2
	(2.70)	(2.65)	(1.41)	(2.66)	(0.73)	(0.70)
	(3.97)	(5.24)	(1.51)	(4.30)	(1.77)	(0.74)
R^2	0.650	0.856	0.490	0.645	0.368	0.528
SEE	668.9	164.1	533.4	346.9	214.5	376.8
LF	-100.6	-82.36	-97.69	-92.09	-85.85	-93.17

1 = forest industries
2 = metal and engineering industries
3 = other manufacturing industries

t-ratios are in parentheses immediately below the coefficient estimates; below them are White's t-ratios adjusted for heteroscedasticity

TABLE 17.b. SYSTEM ESTIMATION OF THE REALIZATION FUNCTION (equation (98))

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: demand, user cost and wages (surprise $X_t - X_{t-2}$)
Estimation period: 1972 - 1984
Variables in real terms
Estimation method: SURE

Estimated equations

Surprise variable $X_t - X_{t-2}$	A) ${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{4} a_i (X_{t,i} - X_{t-2,i})$			B) ${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{4} a_i (X_{t,i} - X_{t-2,i})$		
	(1)	(2)	(3)	(1)	(2)	(3)
CFIO	72.60	67.48	116.2	30.23	-6.580	76.99
	(2.43)	(6.86)	(4.63)	(2.88)	(0.62)	(4.23)
JC_1	-164.1	10.92	23.81	-114.2	-26.67	4.249
	(3.54)	(0.81)	(0.66)	(5.21)	(1.40)	(0.17)
W	-5.694	-22.43	-128.5	64.45	17.67	-54.48
	(0.67)	(2.75)	(2.71)	(2.01)	(1.87)	(1.51)
Constant	489.4	216.0	903.9	250.9	-69.06	268.7
	(2.54)	(2.74)	(2.56)	(2.76)	(0.70)	(1.02)
R^2	0.596	0.841	0.482	0.605	0.001	0.5271
LF	-101.7	-84.86	-98.38	-92.79	-89.97	-93.25

Total model

	A)	B)
R^2	0.577	0.524
SEE	543.9	348.5
LF	-293.8	-276.5

The efficiency of estimation can be further enhanced by restricting the number of parameters to be estimated. For this reason, the equality of parameters is tested by means of the Mindis program. First, the parameters of the demand variables (CFIQ) are restricted to be equal in individual sectors, and the likelihood ratio test is used to test the difference between the unrestricted and restricted models. The likelihood ratio-test statistic is obtained by calculating the differences between the log likelihood functions of the restricted and unrestricted models and multiplying the differences by two. The LR-test statistic thus obtained follows the χ^2 -distribution asymptotically, the degrees of freedom being determined according to the constraints (Harvey 1982). The asymptotic nature of the test lessens the reliability of the results presented.

The value of the LR-test statistic is 3.2 (logarithmic transformation 4.9), when $\chi^2_{0.95}$ with two degrees of freedom is 5.99. Thus, the hypothesis of the equality of demand parameters cannot be rejected with the LR-test for the long survey horizon.[2] The difference between the likelihood functions calculated from the autumn survey multiplied by two is 11.2 (logarithmic transformation 2.5), which clearly exceeds the critical limit. Thus, the hypothesis that demand has an equal effect in all manufacturing sectors is rejected with respect to the autumn survey. This is fairly obvious a priori, because in Zellner estimation the coefficient estimate of demand is negative in the forest industries, unlike the other manufacturing sectors, and in the metal and engineering industries this variable does not have a significant parameter estimate at all.

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[2]The sectoral models were also estimated in logarithmic form in order to examine the sensitiveness of the results to the functional form and to mitigate the heteroscedasticity problem (Appendices 7.a - d). Heteroscedasticity is, however, a minor problem, as can be seen from the t-values corrected for heteroscedasticity in Table 17.a (White's t-test statistics), because the independent variables are in the form of volume indices or the real price of capital and the dependent variables,volume of investment plans, are almost as large by manufacturing sectors. The change in the logarithmic form estimation results as compared with the level form estimations was minor. The test results of the parameter restrictions changed so that the equality hypothesis of the demand parameter estimates could not be rejected even for the shorter planning period, the autumn of the previous year. The calculated test statistics obtained with the logarithmic transformation are shown in parentheses in the text.

The coefficients of the cost of capital for individual manufacturing sectors are of quite a different order of magnitude: the coefficients for the metal and engineering industries and other manufacturing industries are not significant at all, and in certain cases, even positive, so that there is no reason for testing equality. It was stated above that the cost of capital affects changes in investment plans primarily in the forest industries. The estimation results differ partly from the previous ones because of the shorter observation period (the demand variable for the forest industries is available only since 1970) and the estimation method (ML), which is not particularly suitable for small samples.

As regards wage costs, testing for the equality of sectoral parameters is appropriate only for the long survey horizon, because even the signs differ from each other over the shorter survey horizon. The calculated value of the likelihood ratio test is 2.8 (logarithmic transformation 9.2), so that the hypothesis of the equality of coefficients cannot be rejected with respect to wage costs for the long survey horizon. However, the separability of the test is rather weak, since there are great differences between the coefficients of wages. This is due to the wideness of the confidence intervals caused by the small sample size and the asymptotic nature of the likelihood ratio test. In logarithmic form the parameter equality restriction must be rejected at the 5 per cent level of significance, but cannot be rejected at the 1 per cent level ($\chi^2_{0.99}(2) = 9.21$).

As for the SURE estimation results, it can be stated that the values of the adjustment coefficients clearly rise compared with the models estimated with OLS, a result which is in accordance with the estimation method and models of rational expectations. In fact, the usual result has been that the hypothesis of rational expectations generally produces a quicker adjustment to shocks than, for example, adaptive expectations. In this context, "rationality" refers to the enlargement of the information set by the inclusion of error variance in the model. With regard to the signs and the significance of the parameter estimates, the estimation results remain broadly unchanged.

TABLE 17.c. CONSTRAINED SYSTEM ESTIMATION OF THE REALIZATION FUNCTION (demand parameters constrained equal by sectors) (equation (98))

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: demand, user cost and wages (surprise $X_t - X_{t-2}$)
Estimation period: 1972 - 1984
Variables in real terms
Estimation method: constrained SURE

Estimated equations

Surprise variable $X_t - X_{t-2}$	A) ${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{4} a_i(X_{t,i} - X_{t-2,i})$			B) ${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{4} a_i(X_{t,i} - X_{t-2,i})$		
	(1)	(2)	(3)	(1)	(2)	(3)
CFIQ	84.09 (10.66)	R	R	18.54	R	R
JC_1	-179.9 (4.11)	20.56 (1.80)	16.89 (0.49)	-112.7 (5.14)	-16.15 (1.01)	-1.903 (0.06)
W	-10.94 (1.25)	-32.34 (3.82)	-111.2 (2.32)	4.109 (1.16)	6.069 (0.63)	-53.01 (1.19)
Constant	499.7 (2.93)	242.0 (3.12)	910.7 (2.56)	291.1 (3.41)	-52.56 (0.56)	-190.9 (1.49)
R^2	0.617	0.854	0.647	0.633	0.197	0.260
LF	-101.2	-82.68	-97.97	-92.31	-87.41	-96.41

Total model

	A)	B)
R^2	0.611	0.453
SEE	503.0	359.6
LF	-292.2	-279.1

TABLE 17.d. CONSTRAINED SYSTEM ESTIMATION OF THE REALIZATION FUNCTION
(wage parameters constrained equal by sectors)
(equation (98))

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: demand, user cost and wages (surprise $X_t - X_{t-2}$)
Estimation period: 1972 - 1984
Variables in real terms
Estimation method: constrained SURE

	Estimated equations					
	A)			B)		
Surprise variable $X_t - X_{t-2}$	${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{4} a_i(X_{t,i} - X_{t-2,i})$			${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{4} a_i(X_{t,i} - X_{t-2,i})$		
	(1)	(2)	(3)	(1)	(2)	(3)
CFIQ	36.80 (1.03)	85.96 (7.60)	97.74 (3.76)	30.05 (2.44)	1.967 (0.18)	70.33 (3.68)
JC_2	-158.2 (3.35)	20.49 (1.73)	4.710 (0.14)	-115.0 (5.19)	-19.56 (1.19)	-6.536 (0.26)
W	-31.45 (4.73)	R	R	4.988 (1.40)	R	R
Constant	710.6 (3.78)	230.1 (3.27)	299.0 (1.74)	259.7 (2.82)	2.616 (0.04)	-120.7 (0.97)
R^2	0.630	0.852	0.455	0.617	0.102	0.464
LF	-101.2	-82.68	-98.15	-92.58	-88.13	-94.04

Total model

	A)	B)
R^2	0.613	0.531
SEE	506.1	333.1
LF	-292.4	-276.1

IV.5.3 Uncertainty

The theoretical results on the effects of uncertainty on investment demand were not clear-cut as was discussed in Chapter 2. The increase in uncertainty delays adjustment to the shocks but increases or decreases the optimal capital stock depending on the stochastic process used in the model. So the affects of uncertainty could be different in the short and long run. This study, however, concerns the short-term adjustment of investment demand and a priori the sign of the increase in uncertainty concerning demand could, on theoretical grounds, be negative.

Correlation between changes in investment plans and alternative rational expectations shock and uncertainty variables is first examined using OLS-estimation and F-statistics. The analysis is carried out sectorally for each variable according to the length of the survey horizon. The results are shown in Table 18.

Attempts are made to increase the efficiency of estimation by applying sectoral parameter restrictions. On the basis of the results of the previous chapter, demand and wage costs are restricted to be equal in each manufacturing sector.

According to the estimation results, the H_0 hypothesis must be rejected in manufacturing over the long horizon with respect to all the independent variables. By contrast, the signs vary from positive to negative. Moreover, when the rise in the critical limit of the F-test caused by the autocorrelation of the residual term is taken into account, there remains only one case where the zero restriction must be rejected. This result is obtained in the model where uncertainty is described by the variance of output expectations calculated from the data of the Confederation of Finnish Industries. The sign of this variable is negative. Analyzed by manufacturing sector, there are three significant test statistics for the long survey horizon, of which two are negative. Negative correlation seems to be the result of this test whenever significant correlation appears. When the survey horizon is shortened by six months, significant correlation no longer appears.

TABLE 18. REVISIONS OF INVESTMENT PLANS AND UNCERTAINTY ABOUT DEMAND

F-test statistics in the table (DW values of the residuals and the signs of the parameter a_2 in parantheses) (equation (89'))
H_0: $a_1 = 0$ and $a_2 = 0$

Dependent variables: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: "indicators of uncertainty" (change $UC_t - UC_{t-2}$)
Estimation period: 1969 - 1984
Variables in real terms
Estimation method: OLS

Surprise and "uncertainty" variables change $UC_t - UC_{t-2}$	A) ${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + a_2(UC_t - UC_{t-2})$				B) ${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + a_2(UC_t - UC_{t-2})$			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Variance of output expectations	10.01**a (1.04) (-)	2.11 (1.10) (+)	17.13**a (1.15) (+)	3.65 (1.62) (-)	4.59* (0.77) (-)	2.06 (0.66) (-)	0.92 (1.02) (+)	2.73 (1.63) (-)
Deviation of output expectations	5.92* (1.01) (-)	1.90 (1.15) (+)	10.00**a (1.04) (-)	7.28**a (1.38) (-)	5.51* (1.10) (+)	2.61 (0.83) (+)	0.45 (1.23) (+)	3.57 (1.00) (-)
Moving variance of output	6.08* (1.21) (+)	2.99 (1.23) (-)	5.07 (0.78) (+)	6.24 (1.22) (+)	5.24* (1.02) (+)	4.36 (1.09) (+)	6.54 (1.40) (-)	3.92 (0.95) (+)
Standard deviation of ARIMA forecast	5.62* (1.08) (+)	3.06 (1.17) (+)	3.80* (0.90) (+)	7.25**a (1.49) (-)	4.91* (0.91) (-)	3.75* (0.94) (+)	0.75 (1.24) (+)	4.99* (1.25) (-)

Critical values of the F-test

	$\rho = 0$	$\rho = 0.30$		$\rho = 0$	$\rho = 0.30$
$F_{0.95}(2,16)$	= 3.36	~ 7.71	$F_{0.95}(2,17)$	= 3.59	~ 7.52
$F_{0.99}(2.16)$	= 6.23		$F_{0.99}(2,17)$	= 6.11	

1 = manufacturing
2 = forest industries
3 = metal and engineering industries
4 = other manufacturing industries

The direction of the effect of uncertainty on changes in investment plans remains partly open on the basis of the above tests. The problem of drawing conclusions largely centres on theory and the measurement of changes in uncertainty. As stated above, the variance and deviation of expectations variables based on the survey of the Confederation of Finnish Industries seem, to a very large extent, to have a different time series nature from that in the corresponding series constructed from the manufacturing output series. Moreover, variables derived from surveys have been regarded as the most genuine indicators of uncertainty (Batchelor 1985). If any conclusions can be drawn about the direction of the effect of uncertainty, it is perhaps worth noting that, of the five significant F-values obtained, the coefficient estimate of uncertainty was negative in as many as four cases.

In the next stage, estimations are carried out by incorporating uncertainty indicators in the previous basic model of the realization of investment plans (Tables 17.a - 17.d), in which the exogenous independent variables consisted of the quantified sectoral output series of the Confederation of Finnish Industries, sectoral user cost calculated using the average lending rate and sectoral wage costs; all time series are in fixed prices. When the estimation results (Tables 19.a - 19.d) are compared with the previous results (Tables 17.a - 17.d), it can be observed that the incorporation of uncertainty additively in the realization function hardly increases the explanatory power at all. According to the t-values the parameter estimate of the uncertainty variable differs statistically significantly from zero with respect to certain indicators in total manufacturing (19.a.A.2) and the metal and engineering industries (19.c.A.3, 19.c.B.2 and 19.c.B.3). In these cases, the impact of uncertainty is negative with respect to investments in total manufacturing and in two cases out of three in the metal and engineering industries. The variables receiving significant coefficient estimates are the variances of companies' output expectations and the moving variance of industrial output. These tests also provide support for the view that uncertainty has a negative effect on investment plans in the case of the sample used.

To examine this question more closely, restricted systems estimation is carried out using the SURE method. Attempts are made to improve estimation by taking into account the correlation between residuals and, at the same time, restricting the number of parameters to be estimated. Estimation is carried out by the main manufacturing sectors so that in the models estimated for each survey horizon both the demand parameters and wage costs parameters are restricted beforehand to be equal in each sector. As a result of increasing the efficiency of estimation, coefficient estimates of uncertainty variables significantly deviating from zero are received for all sectors (Appendix 10). However, it is now difficult to determine the dominant sign, and, when examined sectorally, it can only be observed that all the signs are positive in the forest industries. A significant coefficient estimate for the uncertainty variables is obtained in this test in almost half of the possible cases. This test casts doubt on the previous conclusion that uncertainty tends to reduce investment plans; however, there are considerable reservations about the test as regards the justification of the parameter restrictions and the asymptotic t-test.

Although the results concerning the effects of alternative shock and uncertainty variables on changes in investment plans are not very convincing, they do not refute the view that these variables affect investment plans. In previous regression analysis (Table 18) parameter estimates deviating significantly from zero were observed between investment plans and the indicators employed. The estimation results obtained with the uncertainty variable incorporated additively in the basic model are not very convincing. So it is possible that uncertainty is connected multiplicatively to the innovation variables of the basic model as was pointed out in the theoretical part (Chapter II). Hence, the basic model with innovation terms probably already explains a very large part of the potential effects of uncertainty.

TABLE 19.a. REALIZATION FUNCTIONS UNDER UNCERTAINTY ABOUT DEMAND (equation (98))

Manufacturing

Dependent variables:	A) final investments less plans made in the spring of the previous year B) final investments less plans made in the autumn of the previous year
Independent variables:	demand, prices of factors of production and "uncertainty" about demand (change $UC_t - UC_{t-2}$)
Variables in real terms	
Estimation period:	1969 - 1984
Estimation method:	OLS
t-values in parentheses	

Estimated equations

Surprise and "uncertainty" variables	A) $_tIRQ^s_{t+1} - {_tIPF^s_{t-1}} = a_1 + \sum_{i=2}^{5} a_i(X_{t,i} - X_{t-2,i})$				B) $_tIRQ^a_{t+1} - {_tIPF^a_{t-1}} = a_1 + \sum_{i=2}^{5} a_i(X_{t,i} - X_{t-2,i})$			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Demand (CFIQ)	253.0	256.3	239.1	271.7	160.4	150.6	128.6	147.0
	(5.00)	(6.39)	(4.84)	(5.27)	(5.32)	(5.24)	(4.02)	(4.69)
User cost	-121.1	-159.0	-91.15	-92.57	-95.39	-91.12	-112.4	-120.0
	(2.20)	(3.22)	(1.90)	(1.63)	(2.91)	(2.58)	(3.59)	(3.46)
Wages	-125.2	-145.3	-181.8	-155.0	-64.09	-46.14	-58.19	-38.69
	(3.00)	(4.85)	(4.67)	(3.38)	(2.63)	(2.19)	(2.35)	(1.41)
Uncertainty	-0.136+D5	-214.9	0.680+D5	-7.000	0.107+D5	80.80	-0.286+D5	9.308
	(1.12)	(2.5)	(1.62)	(0.19)	(1.48)	(1.33)	(1.06)	(0.43)
Constant	1215.	1839	1689	1352	462.9	178.4	531.0	351.2
	(3.05)	(4.77)	(3.93)	(3.11)	(2.03)	(0.65)	(1.61)	(1.38)
R^2C	0.839	0.885	0.855	0.821	0.802	0.796	0.786	0.769
SEE	682.0	575.8	647.4	719.6	407.4	413.4	423.5	439.5
F	31.32	44.95	35.10	27.99	23.24	22.50	21.33	19.62
DW	2.23	2.63	1.67	1.96	2.93	2.92	2.61	2.69

Critical values of the F-test, H_0: $a_i = 0$, when $i = 1, \ldots, 5$

$F_{0.95}(5,11) = 3.20$

$F_{0.99}(5,11) = 5.32$

"Uncertainty" variables (UC)

(1) Variance of output expectations
(2) Deviation of output expectations
(3) Moving variance of output
(4) Standard deviation of ARIMA forecast

TABLE 19.b. REALIZATION FUNCTIONS UNDER UNCERTAINTY ABOUT DEMAND (equation (98))

Forest industries

Dependent variables: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year

Independent variables: demand, prices of factors of production and "uncertainty" about demand (change $UC_t - UC_{t-2}$)

Variables in real terms

Estimation period: 1972 - 1984

Estimation method: OLS

Estimated equations

Surprise and "uncertainty" variables	A) $_tIRQ^s_{t+1} - {_tIPF^s_{t-1}} = a_1 + \sum_{i=2}^{5} a_i(X_{t,i} - X_{t-2,i})$				B) $_tIRQ^a_{t+1} - {_tIPF^a_{t-1}} = a_1 + \sum_{i=2}^{5} a_i(X_{t,i} - X_{t-2,i})$			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Demand (CFIQ)	103.0	48.80	68.65	42.98	55.42	16.82	18.24	19.39
	(1.44)	(1.04)	(1.23)	(0.85)	(1.61)	(0.73)	(0.62)	(0.75)
User cost	-183.1	-177.4	-147.0	-160.9	-122.0	-95.50	-105.5	-116.6
	(3.16)	(2.70)	(2.14)	(2.60)	(4.40)	(2.96)	(2.91)	(3.67)
Wages	-22.82	-20.31	-25.74	-25.98	-1.172	0.679	-0.522	4.916
	(1.86)	(1.62)	(1.66)	(1.35)	(0.20)	(0.11)	(0.06)	(0.50)
Uncertainty	-3396	-17.63	0.506+6D	-34.60	-2683	31.28	0.121+6D	25.51
	(0.94)	(0.29)	(0.58)	(0.38)	(1.54)	(1.03)	(0.26)	(0.55)
Constant	489.1	662.8	586.3	654.3	211.6	252.0	309.8	297.5
	(1.78)	(2.39)	(2.35)	(2.57)	(1.61)	(1.86)	(2.36)	(2.27)
R^2C	0.527	0.481	0.496	0.485	0.58	0.530	0.471	0.486
SEE	673.4	705.8	695.0	703.0	323.0	345.6	366.4	361.2
F	5.08	4.48	4.67	4.53	6.25	5.25	4.50	4.67
DW	1.73	1.97	1.83	1.97	1.99	2.07	1.91	2.025

Critical values of the F-test, H_0: $a_i = 0$, when i = 1, ..., 5

$F_{0.95}(5,8) = 3.69$

$F_{0.99}(5,8) = 6.63$

"Uncertainty" variables (UC)

(1) Variance of output expectations
(2) Deviation of output expectations
(3) Moving variance of output
(4) Standard deviation of ARIMA forecast

TABLE 19.c. REALIZATION FUNCTIONS UNDER UNCERTAINTY ABOUT DEMAND (equation (98))

Metal and engineering industries

Dependent variables: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year

Independent variables: demand, prices of factors of production and "uncertainty" about demand (change $UC_t - UC_{t-2}$)

Variables in real terms

Estimation period: 1972 - 1984

Estimation method: OLS

Estimated equations

Surprise and "uncertainty" variables	A) ${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{5} a_i(X_{t,i} - X_{t-2,i})$				B) ${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{5} a_i(X_{t,i} - X_{t-2,i})$			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Demand (CFIQ)	81.44	96.23	90.38	93.31	28.88	51.56	20.11	22.88
	(4.28)	(6.15)	(8.64)	(8.24)	(1.37)	(5.03)	(1.85)	(1.66)
User cost	20.25	32.47	31.00	21.47	0.735	10.74	-4.814	-13.69
	(1.03)	(2.15)	(2.63)	(1.60)	(0.03)	(1.08)	(0.39)	(0.83)
Wages	-39.81	-50.30	-43.86	-42.65	-17.58	-33.45	-8.038	-8.461
	(2.79)	(4.36)	(5.37)	(4.75)	(1.14)	(4.41)	(0.96)	(0.78)
Uncertainty	635.1	16.51	-0.104+6D	11.50	-525.6	95.01	-0.142+6D	9.714
	(0.68)	(0.55)	(2.36)	(1.81)	(0.51)	(5.03)	(3.08)	(1.25)
Constant	303.7	335.1	300.8	314.1	67.43	161.9	32.52	52.35
	(3.16)	(3.43)	(3.86)	(3.77)	(0.63)	(2.54)	(0.41)	(0.52)
R^2C	0.848	0.846	0.895	0.878	0.134	0.716	0.507	0.217
SEE	167.3	168.4	139.2	149.8	193.3	110.7	145.9	83.7
F	27.93	27.52	41.32	35.36	1.47	9.40	4.39	1.88
DW	2.04	2.28	2.69	2.15	1.20	1.28	1.91	1.63

Critical values of the F-test, H_0: $a_i = 0$, when i = 1, ..., 5

$F_{0.95}(5,8) = 3.69$

$F_{0.99}(5,8) = 6.63$

"Uncertainty" variables (UC)

(1) Variance of output expectations
(2) Deviation of output expectations
(3) Moving variance of output
(4) Standard deviation of ARIMA forecast

TABLE 19.d. REALIZATION FUNCTIONS UNDER UNCERTAINTY ABOUT DEMAND (equation (98))

Other manufacturing

Dependent variables:	A) final investments less plans made in the spring of the previous year B) final investments less plans made in the autumn of the previous year
Independent variables:	demand, prices of factors of production and "uncertainty" about demand (change $UC_t - UC_{t-2}$)
Variables in real terms	
Estimation period:	1969 - 1984
Estimation method:	OLS

Estimated equations

Surprise and "uncertainty" variables	A) ${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{5} a_i(X_{t,i} - X_{t-2,i})$				B) ${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{5} a_i(X_{t,i} - X_{t-2,i})$			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Demand (CFIQ)	108.8	102.7	100.9	96.87	83.83	73.78	80.72	77.27
	(3.38)	(2.97)	(3.24)	(3.30)	(3.67)	(3.27)	(3.75)	(3.69)
User cost	-1.917	-10.64	2.175	24.00	-13.09	13.94	-5.920	2.213
	(0.05)	(0.13)	(0.05)	(0.50)	(0.48)	(0.32)	(0.20)	(0.17)
Wages	-77.64	-65.29	-73.07	-116.2	25.80	-31.14	-28.27	-48. 8
	(1.37)	(0.96)	(1.22)	(1.74)	(0.67)	(0.79)	(0.71)	(1.08)
Uncertainty	4582	64.34	-0.502+6D	-31.22	2404	-163.6	-0.148	-19.18
	(0.75)	(1.15)	(0.13)	(1.17)	(0.56)	(0.74)	(0.57)	(1.03)
Constant	627.5	6317	646.1	919.4	94.97	1009	92.68	254.1
	(1.53)	(1.45)	(1.54)	(2.00)	(0.35)	(0.37)	(0.34)	(0.84)
R^2C	0.354	0.322	0.322	0.395	0.433	0.444	0.434	0.465
SEE	521.9	534.6	534.7	504.9	370.4	366.8	370.1	359.6
F	6.58	6.17	6.17	7.19	5.55	5.71	5.56	6.04
DW	1.916	1.72	1.72	2.06	1.828	1.809	1.82	2.02

Critical values of the F-test, H_0: $a_i = 0$, when i = 1, ..., 5

$F_{0.95}$ (5,8) = 3.69

$F_{0.99}$ (5,8) = 6.63

"Uncertainty" variables (UC)

(1) Variance of output expectations
(2) Deviation of output expectations
(3) Moving variance of output
(4) Standard deviation of ARIMA forecast

IV.6 Estimates of the Adjustment and Innovation Parameters

To complete the examination of the realization function we present some estimates of the adjustment parameters and short- and long-term coefficients (Table 20). These estimations are used to examine the relative size of the weighting parameters in the loss function and the dependence of the parameters on the survey horizon. We also noticed that there is not any good justification for restricting the parameter of lagged investment plans to one in the earlier estimations (equation (98)).

The unity assumption of the investment plan parameter is abandoned and the parameter is estimated freely. The estimation results are shown in Appendix 11. The estimations are conditional on the static expectations in the innovation variables. In addition to investment plans, demand and prices of capital and labour are used as explanatory variables. It can be noticed from the estimation results that the parameter estimate of the investment plans deviates from one in total manufacturing and in all the main sectors except the metal and engineering industries, where investment plans have been observed to be very stable. In fact the parameter estimates of the innovation term in the metal and engineering industries receives a value zero because the term (1-d/(a+d) has a value zero. To mitigate the multicorrelation problem the original estimations were performed by shifting the investment plan variable to the left-hand side of the equation.

The heteroscedasticity tests used were White's test and the Lagrange Multiplier test. Heteroscedasticity is not a significant problem in the estimated models. The t-values corrected for heteroscedasticity do not change significantly as a rule. As regards the Lagrange multiplier test, the hypothesis on the homoscedasticity of the residuals could not be rejected in any case (Appendix 11). The heteroscedasticity test is, however, conditional on the right specification of the model. Moreover, estimation was carried out with the data transformed into logarithmic form, which is one way of reducing the heteroscedasticity problem.

TABLE 20. PARAMETER ESTIMATES OF THE REALIZATION FUNCTION* (equation (98))

A) Investment plans made in the spring of the previous year

B) Investment plans made in the autumn of the previous year

	A)				B)			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Adjustment cost parameters								
$\frac{d}{a+d}$	0.793	0.543	1.030	0.652	0.826	0.816	0.950	0.822
Effects of innovations on short-term investment plans								
CFIQ	2.889	0.893	4.726	2.326	1.454	0.742	1.246	1.784
JC_1	-0.042	-0.290	0.122	-0.005	-0.060	-0.239	-0.007	0.006
W	-0.661	-0.178	-1.830	-1.405	-0.062	0.219	-0.733	-0.864
Effects of innovations on long-term "target" capital stock (parameter h_i)								
CFIQ	13.96	1.950	-157.5	6.684	8.356	4.033	24.92	10.02
JC_1	-0.203	-0.633	-4.067	-0.014	-0.345	-1.299	-0.140	0.034
W	-3.193	-0.389	61.00	-4.037	-0.356	1.190	-14.66	-4.854

1 = manufacturing
2 = forest industries
3 = metal and engineering industries
4 = other manufacturing industries

* Estimation results are presented in Appendix 11

The parameter values of the disequilibrium costs (a) and the revision costs (d) are not identifiable from equation (98) without extra restrictions but we can draw conclusions from the estimation results about their relative change by survey horizon.

The calculated adjustment cost parameters indicate the increase in revision costs in relation to disequilibrium costs resulting from the shortening of the survey horizon in all cases except the metal and engineering industries. In this sector the hypothesis on rational expectations could not be rejected for the second longest survey horizon either. The result of rising revision costs and falling disequilibrium costs with decreasing length of the survey horizon is in line with the falling parameter estimates of innovations. Apart from the metal and engineering industries, intersectoral differences are not very clear cut.

We present short- and long-term effects of static demand and price innovations on investment plans and "target" capital stock. The results are comparable to those in previous investment studies (Koskenkylä (1985)) according to which the long-term effects of innovations are clearly larger than the short-term effects. This is due to the short-term adjustment costs of investment plans.

The estimation results confirm the above result that the adjustment to shocks slows when the survey horizon shortens (Table 20). Demand innovations have a very clear-cut influence on investment plans as is discussed in Chapter IV.5. As can be seen from Table 20, a 1 per cent increase in demand increases investment plans concerning the following year by 2.9 per cent and the long-term "target" capital stock by 14 per cent in total manufacturing. The response of investment plans to a 1 per cent increase in wages is -0.7 per cent and to a 1 per cent increase in user cost -0.04 per cent.

There are large differences across manufacturing sectors. For instance the effect of increase in user cost is largest in the forest industries, -0.3 per cent, and the long-term effect is -0.6 per cent, and this effect stays as large when the survey horizon shortens by six months. The effects of demand and wages are larger and user costs smaller than in earlier investment function studies (Koskenkylä (1985)). However, the estimation results with real user cost in the forest industries are of the same magnitude as in earlier studies.

IV.7 Concluding Remarks

Testing the response of investment plans to innovations in information clearly shows that investment plans change as the picture of demand, relative prices of factors of production and liquidity change. According to the parameter estimates, reactions to shocks decrease when the survey horizon shortens. This supports the hypothesis on the increasing revision costs of investment plans as the realization time approaches. The effects of demand and wages are larger and real user costs smaller than in earlier investment studies.

The exact nature of expectations formation of firms remains open, but some evidence of rationality can be found. Assuming that adjustment costs are associated with investment plans, the joint test procedure cannot be avoided, as was noted above. The first expectations hypothesis tested, static expectations, was in a very general form in which all changes in information were thought to be innovations. Only permanent innovations were taken into account by using the long time span for the change in information, i.e. two years. Basic estimations were carried out using OLS. When sectoral SURE - estimation was used, it was found that the information set of the firm was larger than that used originally. This was thought to be an indication of the partial rationality of investment plans as the adjustment lag to innovations also proved to be shorter than in the previous OLS - estimations.

The estimation results with "rational" expectations innovations also supported the partial rationality of investment plans, although the results were not particularly consistent, partly because of empirical measurement reasons. The results concerning the effects of uncertainty also deviated clearly from each other, not least because of measurement problems. However, the results gave some support to the theoretical outcome, i.e. that an increase in uncertainty about the future leads to a postponement of investments. The test results raise the question as to whether uncertainty is connected multiplicatively with the innovation variables of the model. The same kind of question was raised concerning the functional form in respect of credit rationing. Both these questions are issues for further research.

V APPLICATION OF THE EULER RULE TO INVESTMENT EQUATIONS

V.1 Aims of the Chapter

In the final part of the study we estimate some investment equations in the form of the Euler equation. The aim in this chapter is to impose another test on the information content of the investment plan data. In the preceding chapters it was observed that the rationality of investment plans could not be rejected for the two shortest survey distances, the plans reported in the spring and autumn of the investment year. However, for the two longest survey horizons, survey distances of over a year, the rationality hypothesis had to be rejected. The aim of the chapter is to test the earlier results in an optimizing framework.

Another aim is to complement the study on the use of survey data in forecasting. For this purpose, investment equations are estimated in the Euler equation form, a new framework in empirical studies on investment in Finland (compare Koskenkylä (1985)). The Euler equation gives the dynamics of the demand for capital without any more or less "ad hoc" restrictive assumptions (Shapiro (1986)). The structural so-called "deep parameters" can be estimated from the equation and the Lucas critique can be avoided by stating explicitly the assumptions on rational expectations.

The chapter is organized as follows. A very simplified capital demand equation is derived drawing upon the research carried out by Abel (1982) and Sargent (1978a and b). The equation is, however, basically the same as the continuous time neoclassical framework in Chapter II (equation (20)) except that the adjustment costs of the capital stock are now assumed quadratic in contrast to the earlier more general functional form. The overidentifying restrictions set by the Euler equation are tested using both ex post realized observations on the capital stock from the official statistics and expectational data from the investment survey.

In the second stage, the Euler equation is solved and assumptions are made on the expectations formation of the firm concerning the exogeneous variables of the model, which are prices of capital and output or, depending on the product market assumption, demand shocks. The cross equation restrictions are tested by estimating constrained and unconstrained models (Sargent (1978)).

V.2 The Euler Equation

Recently, a very common way to estimate rational expectations equations has been to use Euler equations instead of closed-form decision rules. The Euler equation is based on two properties of dynamic choice under rational expectations. First, efficient decisions under uncertainty require that infinitesimal marginal changes in current actions yield no expected gains or losses. Second, rational expectations imply that realized gains or losses differ from expected levels by a random variable that has zero mean and is uncorrelated with any information available at the decision date (Garber and King (1983)).

The Euler equation and closed-form decision rules involve the same parameters. More information (cross equation restrictions and transversality conditions) is used to estimate the decision rules. The gain in efficiency is a high price to pay for restricting the rate of return to be constant and for having to make strict assumptions about the technology. In spite of this there is as a rule a gap between theory and empirical work in the standard models of investment. Estimating Euler equations offers plausible estimates of investment dynamics that are consistent with a structural model (Shapiro (1986)). This kind of estimation is also very suitable in the context of survey data, because the nature of expectations can be tested very effectively.

The model is neoclassical by nature. The firm maximizes the present discounted value of expected profits subject to a technology with adjustment costs. The adjustment costs are external to the firm as was assumed in Chapter II. The firm is competitive in the output and factor markets. The production function of the firm is $Q(t) = fK(t)$, where K(t) is the capital stock of the firm at time t and the coefficient of average productivity f > 1. The labour input is assumed to be a fully elastic factor of production, the amount used always being at the level where the marginal productivity of labour equals its marginal cost. The exact form of the production function is left unspecified so as to retain a certain degree of generality in the model.

The firm is a price-taker with respect to the price of the capital (q(t)) and also with respect to the output market equilibrium prices (p(t)). The prices and tax parameters are exogeneous stochastic processes for the firm, about which it has rational expectations. At time t the firm has an information set $\Omega(t)$ consisting of at least $\{p(t), p(t-1), \ldots, q(t), q(t-1), \ldots, \tau(t), \tau(t-1), \ldots, D(t), D(t-1), \ldots, K(t-1), K(t-2), \ldots\}$, where τ is the marginal tax rate of the firm and D is the marginal tax depreciation rate applied to investments. The adjustment function of the capital stock are assumed to be quadratic.

The firm chooses a stochastic process for the capital stock K(t+j), $j = 0, 1, 2, \ldots, \infty$ subject to a given K(t-1) so as to maximize the discounted present value V(t)

$$V(t) = E(t) \sum_{i=0}^{\infty} R^{i} \{(1-\tau(t+j))p(t+j)fK(t+j) - (1-D(t+j))(q(t+j)(K(t+j) - K(t+j-1)) - (1-D(t+j)) \frac{d}{2} (K(t+j) - K(t+j-1))^{2}\}, \tag{99}$$

where R is the discount factor of the firm, obeying $R = \frac{1}{(1+r)}$, $r > 0$ and $i, j = 0, 1, 2, \ldots, \infty$ are time indices and $d > 0$ is the adjustment cost parameter.

The first-order necessary condition, the Euler equation, for this kind of problem is (Sargent (1978b))

$$(100)\quad (1-\tau(t+j))fp(t+j) - (1-D(t+j))q(t+j)$$
$$- (1-D(t+j))d(1+R)K(t+j) + (1-D(t+j))dK(t+j-1)$$
$$+ RE(t+j)(1-D(t+j+1))q(t+j+1)$$
$$+ RdE(t+j)(1-D(t+j+1))K(t+j+1) = 0.$$

We need only to look at the first two periods of the total time interval, because the control rule is the same for the rest of the period (Kushner (1971)). The equation states that the net change in expected discounted costs from hiring one more unit of capital at t is zero. We can use this quality for testing the overidentifying restrictions imposed by the rational expectations assumption.

The equation to be estimated is of the following form, when the expected capital stock variable is first shifted to the left-hand side of the equation

$$(101)\quad E(t+j)(1-D(t+j+1))K(t+j+1)$$
$$= (\frac{1}{R} + 1)(1-D(t+j))K(t+j) - \frac{1}{R}(1-D(t+j))K(t+j-1)$$
$$+ \frac{1}{Rd}(1-D(t+j))q(t+j) - \frac{1}{d}E(t+j)(1-D(t+j+1))q(t+j+1)$$
$$- \frac{f}{Rd}(1-\tau(t+j))p(t+j).$$

For the estimation we still have to replace conditional expectations with actual values. In this form it is possible to obtain estimates for all the parameters. It can be observed from the equation that an increase in the adjustment cost parameter d delays the adjustment of the capital stock to the exogeneous price shock. The expected increase in the price of capital q has a negative effect on the expected capital stock and the lagged price of capital a positive effect. The effect of the lagged price of production p on the expected capital stock is negative.

V.3 Data and Estimation of the Euler Equation

The data are the same used in the empirical work above but they have now been converted to a quarterly basis, using reference series when quarterly data are not available. Though the quarterly fluctuation of the data is in some cases approximative, the reference series are taken from the official statistics. In the estimation of the Euler equation and the decision rules we have more parameters to estimate than in the preceding tests in Chapters III and IV. The data on the total manufacturing industry is probably more reliable than the data on the main sectors of manufacturing because in some cases the reference data are available only for total manufacturing and the variation of this data has then been used in constructing the sectoral data. The method of calculation employed ensures that the annual changes correspond to the original statistics. The exact formulation of the quarterly data is described in Appendix 12. The data are made stationary before estimation by taking natural logarithms so as to isolate indeterministic components from deterministic ones. Experiments were also carried out with the residuals of a trend equation. However, it was noticed that there was a change in trend, and fitting a simple log-linear trend to the data is a highly questionable task.

The estimation method applied - nonlinear two-stage least-squares estimation - can be used to estimate equations of a model which are nonlinear both in variables and parameters (Mindis program package, Amemiya (1974)). The procedure used here does not require an explicit representation of the economic environment or strong a priori assumptions about the nature of the forcing variables. Estimation and inference can be conducted when only a subset of the economic environment is specified a priori (Hansen and Singleton (1982)). We have specified the objective functions of the agents but in the first stage we do not specify the decision rules or the expectations formation process of the agents. The Euler equation implies a set of orthogonality conditions that depend in a nonlinear way on observed variables and on unknown parameters characterizing preferences, profit functions, etc. To test the rational expectations restrictions we use a set of variables which are predetermined as instruments as of time period t. The predetermined instruments need not be econometrically exogeneous (Shapiro (1986)). Basically, the Euler equation method requires that the instrumental variables are independent of the objective function shocks and, as a rule, it is very difficult to find such instruments.

The equation to be estimated is the same as (101) except that the zero value error term is replaced by a vector of error terms which comes from the rational expectations restriction when conditional expectations are replaced with actual values. The rational expectations restriction is of the form

$$X(t+1) = X(t) + u(t+1), \tag{102}$$

where $E(u(t+1) \mid \Omega(t)) = 0$. This orthogonality condition enables the use of the instrumental variables method in testing the overidentified restrictions of the Euler equation. The error term u(t+1) equals a forecast error only if the model is specified correctly. Taking into account the quality of the quarterly data, u(t+1) may include a measurement error, and in addition perhaps also a specification error because of the simplifications of the model.

The estimation method is equivalent to the generalized instrumental variables procedure of Hansen (1982) and Hansen & Singleton (1982), if the error term is conditionally homoscedastic. The procedure minimizes the correlation between instruments known at t and the residuals of the estimating equation. Hansen's GMM estimator is consistent even when the disturbances are serially correlated. In this method, a weighting matrix is searched for which minimizes the correlation between the residuals and the instruments used. To reduce the exogeneity problem associated with the Euler equation only lagged instruments are used in this study.

V.4 Estimation Results and Testing of the Overidentifying Restrictions

Estimations of the first order condition are made in the form of equation (101), where the variables of the equation are multiplied by tax parameters so that they are in the "after tax form". In the first experiment the capital stock data are taken from the official statistics. The instruments used are prices of new capital goods, total labour costs of industry and value added in manufacturing in volume terms. All instruments are lagged from two to five quarters. More instruments and lags were not used owing to the lack of degrees of freedom. All calculated parameters in Table 21 and in Appendix 13 are in the form of elasticities as the estimations were carried out using logarithmic difference transformation. So as not to lose information or induce unnecessary distortions, the data have been used in seasonally unadjusted form.

The estimation results are plausible and the R^2-values corrected for degrees of freedom are very high. The coefficient estimates have correct signs in all cases except one. The estimates of the structural parameters are sensible. However, the parameter estimates of the exogeneous variables are not as a rule very accurate. The problem may originate from the artificially constructed quarterly data and cannot be solved in connection with this study. The Euler equation properties mentioned in the beginning of the chapter imply substantial restrictions on data that can be used to estimate parameters and test hypotheses (Garber and King (1983)).

TABLE 21. ESTIMATES OF THE STRUCTURAL PARAMETERS OF THE EULER EQUATION (101) AND THE TEST FOR OVERIDENTIFYING RESTRICTIONS*

	Manufacturing	Forest industries	Metal and engineering industries	Other manufacturing industries
Real discount rate r	-0.85	-0.84	-0.66	-0.37
Adjustment cost d	0.64	3.43	0.86	2.74
Productivity of the capital stock f	0.07	0.05	0.02	0.11
Standard error of estimate	0.01	0.004	0.06	0.01
Correlation coefficient squared	0.98	0.99	0.96	0.98
Box-Pierce statistics of the residual	19.98	14.32	22.65	23.30
$\chi^2_{0.95}(12)$	21.03	21.03	21.03	21.03
Log likelihood function	244.0	258.7	224.0	237.8
$\chi^2_{0.95}(9)$	16.92	16.92	16.92	16.92

* The coefficient estimates are presented in Appendix 13.

The estimates of the discount rate r are plausible and the respective coefficient estimates differ very significantly from zero. At an annual level, the real discount rate varies around minus two to three per cent, which is quite possible during the estimation period. The highest estimated values are in the forest industries. The estimates of the external adjustment costs of the capital stock differ quite clearly from industry to industry. It is difficult to assess the plausibility of these parameters both because there are no previous estimates of these parameters in Finland and because the estimates are very inaccurate. The coefficient estimates are not significantly different from zero in all cases although the signs are correct. In any case, the highest values are found in the forest industries, which can be attributed to the high capital intensity of that sector. This result may also be connected with the earlier observation that the adjustment of the investment plans of the forest industries to exogeneous shocks is exceptionally low, which emphasizes the significance of adjustment costs in the loss function. The sectoral variation of the productivity parameter estimates is also quite large, but this, too, can be attributed to the data and inaccurate estimates.

For the orthogonality conditions of the Euler equation, the value of the log likelihood function can be used for testing the overidentifying restrictions when the model is estimated using the instrumental variable method (Sargent (1978a)). Because of the problem of heteroscedasticity we have used only lagged instruments. According to the test results the overidentifying restrictions must be rejected in all manufacturing sectors. The values of the log likelihood functions exceed the critical $\chi^2_{0.95}(9) = 16.92$ values very clearly in each case (Table 21). The degrees of freedom (9) are obtained by subtracting the number of free parameters from the number of instruments. Failure of the overidentifying restrictions is inconsistent with the hypothesis that firms are optimizing with rational expectations. This does not, however, mean that the expectations formation of firms is not rational because tests of this kind are usually joint tests, which are conditional on the model used. Another point is that there are adjustment costs associated with changes in the capital stock, which makes the testing of expectations formation difficult.

In the second stage, we use the test procedure which the over-identifying restrictions offer to complement the analysis of investment plans. This is carried out by constructing planned capital stock data using investment plans from different survey horizons. Four estimates of planned capital stocks are obtained in this way. The data are constructed using the definition of gross investment and the historical share of depreciation in the capital stock. The constructed capital stock data is used as a proxy for the capital stock in period (t+1) in the Euler equation estimations.

The planned capital stock data are in annual form because of the annual investment plan data. Annual data imply a lack of degrees of freedom. To increase the efficiency of estimations the data have been pooled by main manufacturing sector. The equality of the corresponding parameters is first tested using the likelihood ratio test. The model is estimated with and without parameter restrictions and the likelihood ratio-test statistics are obtained by calculating the differences between the log-likelihood functions of the restricted and unrestricted equations and multiplying the difference by two (Appendix 14). The test statistics are distributed according to the χ^2-distribution and the degrees of freedom are the number of restrictions. The values of the test statistics are presented in Table 22.

TABLE 22. LIKELIHOOD RATIO TEST FOR PARAMETER EQUALITY RESTRICTIONS

	Values of the log likelihood function		Likelihood ratio
	Restricted	Unrestricted	
Forest industries	31.15	32.69	3.08
Metal and engineering industries	34.41	35.43	2.04
Other manufacturing industries	38.11	40.81	5.40

$\chi^2_{0.95}(10) = 18.31$

The value of the χ^2-distribution with 10 degrees of freedom at the 5 per cent significance level is 18.31, which means that the null hypothesis cannot be rejected in any manufacturing sector.

Heteroscedasticity of the residuals is a problem which is frequently experienced with the pooling regression. In the present case, however, there are not very large differences in the level of the capital stock between the main manufacturing sectors. In spite of this, a logarithmic transformation was used to diminish the heteroscedasticity problem and to make the data stationary.

TABLE 23. INVESTMENT PLANS AND OVERIDENTIFYING RESTRICTIONS

Manufacturing sector	Values of the log likelihood function				
	Official	Investment plans made in the autumn of year t	spring of year t	autumn of year t-1	spring of year t-1
Forest industries	31.15	29.59	29.98	29.45	27.42
Metal and engineering industries	34.41	30.80	29.81	30.99	30.93
Other manufacturing industries	38.11	36.87	35.83	36.51	36.90

$\chi^2_{0.95}(3) = 7.81$

The test results of the overidentifying restrictions are presented in Table 23 (the estimation results are shown in Appendix 14). The lack of degrees of freedom limited the number of instruments used. The instruments were the volume of production and the price index of new capital goods by manufacturing sectors. All instruments are lagged by 2 years to minimize the problem of heteroscedasticity. According to the test results the hypothesis of overidentifying restrictions must be rejected in all manufacturing sectors both for the data of the official statistics and the data of the investment survey. The results are subject to all the qualifications presented in connection with the quarterly data. One new feature compared to the earlier estimations is that the exogeneous variable, the price of new capital goods, does not receive the correct sign, which diminishes the plausibility of the estimates.

V.5 Decision Rules

The standard way to estimate an investment equation is to use the solved form of the target function. By solving equation (100) forward we get that the optimal decision rule of the firm is to set the rate of investment as a function of the expected future values of the price of capital and the price of output as follows

$$(103)\qquad K(t+j+1) = \lambda_1 K(t+j) - \frac{\lambda_1}{d} \sum_{i=0}^{\infty} \left(\frac{1}{\lambda_2} \right)^i$$

$$E(t+j+1)\ \{q(t+j+i+1) - Rq(t+j+i+2) - \frac{(1-\tau)}{(1-D)}\, fp(t+j+i+1)\},$$

where the roots of the difference equation are $\lambda_1 < 1 < \lambda_2$. The solution satisfies the transversality condition that the limit value of the first derivative of the value function at time t + T is equal to zero as $T \to \infty$. To make the calculations easier, the tax parameters are taken as given to the firm; there is perfect foresight in this respect.

The equation is a typical partial adjustment equation for investments according to which a rise in the adjustment costs of the capital stock (d) delays adaptation to exogeneous price and policy shocks. The partial adjustment rule emphasizes the role of expectations in the capital demand formation.

The estimation of the above decision rule of the firm is not, however, possible without assumptions on the expectations formation processes, which are as a rule ad hoc in spite of a forward-looking solution and rational expectations. The gap between theoretical decision rules and empirical estimation becomes uncomfortably large.

Rational expectations theory traditionally assumes that the information set of the firm includes at least the history of the time series the expectations concerned. Thus, the practical assumption is made that prices of capital and production follow a first-order autoregressive process

(104) $X(t+j) = a^j X(t) + \varepsilon(t+j) + a\varepsilon(t+j-1) + \ldots a^{j-1}\varepsilon(t+1),$

which has the expected value

(105) $EX(t+j) = a^j X(t),$

since $E(t)\varepsilon(t+k) = 0$ according to the expectations formation hypothesis. The coefficient a has a value $|a| < \frac{1}{R}$.

Substituting the expected values of q and p in equation (103) we obtain the formulation

(106) $$K(t+j+1) = \lambda_1 K(t+j) - \frac{1}{d} \sum_{i=0}^{\infty} R^i$$

$$\{\alpha^i q(t+j+1)(1-R\alpha) - \beta^i \frac{(1-\tau)}{(1-D)} fp(t+j+1)\},$$

where α^i and β^i are parameters of the expected value in the first order Markov processes

(107a) $Eq(t+i) = \alpha^i q(t)$

and

(107b) $Ep(t+i) = \beta^i p(t).$

Taking the cumulative sum from equation (106), we obtain an observable capital demand equation

(108) $$K(t+j+1) = \lambda_1 K(t+j) - \frac{1}{d} q(t+j+1) + \frac{(1-\tau)}{(1-D)} \frac{f}{d(1-R\beta)} p(t+j+1),$$

where the demand for capital is a function of the lagged capital stock, the prices of capital and production known at the time of observation. The assumption on the expectations formation, the first order Markov process, imposes the testable cross equation restrictions on the decision rule.

To make another more empirical version of the model we drop the preceding perfect competition assumption in the product markets. The private firm takes the market price as given but the actions of all the firms affect the price of production and final demand is a surprise to the firm. The market clearing demand equation for final products is of the form

$$(109) \qquad \bar{p}(t+j) = A_0 - A_1 f_0 \bar{K}(t+j) + u(t+j),$$

where the stochastic process for output prices $\bar{p}(t+j)$ clears the market. The firm takes the price as given and chooses a stochastic process for the capital stock $\bar{K}(t+j)$. The equilibrium in the market is called the rational expectations equilibrium, because firms have rational expectations concerning the stochastic processes of prices (Sargent (1979)).

The preceding first order optimum condition of the firm (101) now has the form

$$(110) \qquad E(t+j)K(t+j+1) = \left(\frac{1}{R} + 1 + \frac{(1-\tau)A_1 n f_0^2}{(1-D)Rd} \right) K(t+j) - \frac{1}{R} K(t+j-1)$$
$$+ \frac{1}{Rd} q(t+j) - \frac{1}{d} E(t+j)q(t+j+1)$$
$$- \frac{(1-\tau)A_0 f_0}{(1-D)Rd} - \frac{(1-\tau)}{(1-D)Rd} f_0 u(t+j)$$

according to which realized demand shocks, rather than the price of output, affect the capital stock in the following period.

The decision rule of the firm (103) is now

(111) $$K(t+j+1) = \lambda_1 K(t+j) - \frac{\lambda_1}{d} \sum_{i=0}^{\infty} \left(\frac{1}{\lambda_2} \right)^i$$

$$E(t+j+1)\{q(t+j+i+1) - Rq(t+j+i+2)$$

$$- \frac{(1-\tau)}{(1-D)} f_0 u(t+j+i+1) - \frac{(1-\tau)}{(1-D)} A_0 f_0\}.$$

Assuming that the stochastic process of u(t+j+i+1) is a first-order Markov process, the expected value is

(112) $$Eu(t+i) = \gamma^i u(t),$$

when the expected value of the error term is zero.

In that case, with a stochastic shock in market demand, the optimal "rational expectations decision rule" for the capital stock is of the form

(113) $$K(t+j+1) = \lambda_1 K(t+j) - \frac{1}{d} q(t+j+1) + \frac{(1-\tau)}{(1-D)} \frac{f_0}{d(1-R\gamma)} u(t+j+1)$$

$$+ \frac{(1-\tau)}{d(1-D)} A_0 f_0,$$

where the capital price shock (q) has a negative effect on the desired capital stock and the demand shock (u) a positive effect, and the magnitude of the effects is dampened by adjustment costs (d). The assumption on the form of the expectations formation process again imposes the testable cross equation restrictions on the equation. Equation (113) is a competing presentation of the rational expectations decision rule of the firm in equation (108).

V.6 Estimation Results of the Decision Rule

The estimation strategy applied for the decision rule is to test the cross equation restrictions set by the assumption on the expectations hypothesis. The model is estimated in restricted form and in free form. The variables of the decision rule differ from the variables of the Euler equation in the sense that tax parameters are now, for purely mathematical reasons, constants over the estimation period. Data from the official statistics are used as a capital stock variable.

Estimations are again made with pooled data. The test for parameter restrictions is presented in Table 24. According to the likelihood ratio test the H_0-hypothesis cannot be rejected in the forest industries and the metal and engineering industries, but it is rejected in other manufacturing industries. So, pooling the data by sectors is somewhat questionable and more careful attention needs to be paid to which parameters can be restricted to be equal and which cannot. However, to survey the data, some preliminary estimations were made with pooled data.

TABLE 24. LIKELIHOOD RATIO TEST FOR PARAMETER EQUALITY RESTRICTIONS

	Values of the log likelihood function		Likelihood ratio
	Restricted	Unrestricted	
Forest industries	37.03	41.39	8.72
Metal and engineering industries	26.38	33.67	14.58
Other manufacturing industries	38.16	46.26	16.20

$\chi^2_{0.95}(10) = 15.51$

It was noted above in connection with the Euler equation that the estimation results are not very robust and are very sensitive to transformations of the data. There can be at least two reasons for this. The statistics on the prices of investment goods are not very reliable. This is a well-known problem. Another problem is related to the formulation of the theoretical model when constant factor productivity is assumed. To solve the estimation problem, experiments were made with the model assuming imperfect product markets. In the estimations the constant productivity term in equation (113) was replaced with the value-added variable by manufacturing sector (Shapiro 1986). The variance of production expectations taken from the survey of the Confederation of Finnish Industries is used as a market surprise variable.

Using the volume of value added as a proxy for productivity, plausible estimates for prices of capital goods could be obtained (Table 25). All parameter estimates have correct signs, but the residual is not white noise at the 5 per cent level of significance. At the 1 per cent significance level the white noise hypothesis cannot be rejected, however. The speed of adjustment coefficient has a value of 0.076, which implies about 13 years adjustment time for the capital stock to some exogenous shock. The result is very plausible, if we compare it with previous Finnish studies (Koskenkylä 1985). The constant speed of adjustment rate is very close to the depreciation coefficients calculated from Finnish data, and is also a well-known result in neoclassical investment theory (Gould (1968)).

Finally, the expectations hypothesis on the first order Markov process is tested against an unconstrained version of an autoregressive process. A nested test situation is arranged. The free model is estimated so that there is an n^{th}-order autoregressive process for prices of investment goods. For the annual data, n was, however, limited to two periods for reasons of degrees of freedom and it is assumed that period t prices are not known. The coefficients are of the same form as in equation (113) apart from the higher order autoregressive coefficients in the parameter values (Sargent 1978). The estimation results are presented in Table 25. The hypothesis on cross equation restrictions is tested using the likelihood ratio test. The LR-test statistics are shown at the bottom of Table 25. According to the test, the null hypothesis cannot be rejected and we are not able to distinguish between the expectations hypotheses. The result may be due to the data problems mentioned above and to very inaccurate parameter estimates of investment goods prices.

TABLE 25. ESTIMATION RESULTS OF THE DECISION RULE-EQUATION, (equation (113)) POOLED DATA

Manufacturing industry
Dependent variable: capital stock at 1985 prices
Independent variables: lagged capital stock, price index of capital goods, value added at fixed prices and variance of production expectations
Estimation period: 1971 - 84
Variables in logarithmic form
t-values in parentheses under the coefficient estimates
Estimation method: ML

	Restricted	Unrestricted
Capital stock (t-1)	0.924 (41.5)	0.928 (45.3)
Prices of capital goods (t)	-0.17 (1.82)	
(t-1)		-0.168 (2.61)
(t-2)		0.146 (2.45)
Value added	0.33 (4.23)	0.029 (3.99)
Variance of production expectations	-0.029 (2.26)	-0.032 (2.64)
Constant	0.524 (2.62)	0.554 (2.80)
Standard error of estimate	0.027	0.029
R^2	0.988	0.986
Box-Pierce stat. of residual	16.64	16.15
$\chi^2_{0.95}(10)$ =	20.09	20.09
Log-likelihood function	95.09	91.75
LR test statistics	6.68	
$\chi^2_{0.95}(10)$ =	18.31	

V.7 Concluding Remarks

The test results are rather clear. It appears that firms do not use all relevant information in making their investment decisions. The result is the same for the official statistics and the investment survey data. However, we are concerned here with a joint test, in which test results are conditional on the assumptions of the model. In particular, the assumption on adjustment costs makes it difficult to test the nature of the expectations hypothesis. Moreover, the quality of the data and lack of degrees of freedom are serious problems in the Euler equation estimations.

The second conclusion is that we cannot distinguish between the expectations hypotheses. The test is, however, very weak and it is again a question of a joint hypothesis. An interesting result of these exercises is that we can estimate values of some structural parameters and most of the results are plausible. We also managed to obtain an estimate for the capital adjustment costs external to the firm.

All in all, the research method is promising but there is much room for further research particularly in the estimation of the structural parameters, which requires more work with the basic data.

VI SUMMARY OF THE STUDY

VI.1 Summary of Empirical Results and Comparison with Earlier Studies

The "predictive power" of investment plans in manufacturing improves markedly as the survey horizon shortens. The spring and autumn plans concerning the current year are unbiassed estimates for the current year and the latest relevant information has been used efficiently in forming plans. So the investment plans of the two shortest survey horizons fulfil the criteria of rational expectations. However, the predictive power of the data differs by sector and type of capital goods. Investment plans in the metal and engineering industries undergo fewer changes than those in other manufacturing sectors. Plans concerning manufacturing investment in machinery and equipment may still be changed after the spring of the current year in accordance with changes in economic conditions whereas plans concerning building investments are less likely to be changed.

With regard to the two longest survey horizons - the investment plans in the spring and autumn preceding the realization year - the predictive power of investment plans is poor. Plans are changed as new information on economic conditions becomes available. Thus the plans can be considered conditional forecasts of future developments in investments. The plans also systematically underestimate actual investment. The deviations of the plans from realized investment cannot be shown to be attributable to price surprises of investment goods. The whole analysis of the accuracy of plans is, however, restricted by the lack of observations due to annual data.

In connection with the Euler equation estimation, all the test results with the overidentifying restrictions were in contradiction with the rational expectations hypothesis. It seems that the result contradicts the testing of unbiasedness concerning the two shortest investment survey horizons. The test situations, however, differ from each other. The testing of the overidentifying restrictions entailed a joint test conditional on the assumptions of the model while the test of unbiasedness was unconditional.

The information set on which changes in investment plans can be shown to be dependent comprises variables describing demand and the relative prices of factors of production. Demand surprises account for half of the changes in the investment plans of the manufacturing industry, wages for one-third and the price of capital for the rest. Of the demand indicators, the most significant coefficient estimates were obtained for the demand indicator of the Confederation of Finnish Industries, industrial output, gross domestic product, foreign demand and the main component describing demand.

With respect to the longest survey horizon, deviations are strongly negatively dependent on new information on prices of factors of production in the total manufacturing industry and also in its main sectors. The coefficient estimate of wages received a negative sign in all sectors, indicating short-term cost effects.

The main finding is that the adjustment of investment plans to surprises becomes slower as the horizon of investment plans shortens by six months, i.e. from the spring preceding the realization year to the autumn of that year. The reason for this is that the revision costs of the investment plans increase in relation to disequilibrium costs of the capital stock. There are, however, considerable differences between the surprise variables. The average lag of the impact of the liquidity shock arising from changes in wages and demand is longer than the lag of the impact caused by changes in capital costs. This suggests that monetary policy measures might influence investment even in the relatively short term, i.e. in less than twelve months, though it is difficult to draw any clear-cut conclusions because companies' capital costs are also affected by fiscal policy measures and anticipated changes in inflation.

Sectoral differences can also be observed when the survey horizon shortens. By then the commitment to investment plans is so firm that only really significant innovative factors lead to a change in plans. Thus wage costs receive a significant coefficient only in the metal and engineering industries, as, too, does the price of energy, which, with its positive sign, accounts for the impact of the energy crises and bilateral exports on investments. By contrast, changes in the investment plans of the forest industries can be explained solely by surprises in the price of capital.

The impact of uncertainty has been a central issue in recent investment theory. However, both problems relating to changes in uncertainty and to modelling are encountered in empirical analysis. The theory does not even offer a clear hypothesis on the direction of the impact of uncertainty; on the other hand, it is difficult to distinguish between the surprise connected with new information as such and uncertainty. Uncertainty and surprises are described sectorally by four indicators calculated from ex post and ex ante demand data. Demand was selected because of its great significance for investment plans and because the most comprehensive survey data and quarterly statistics are available on it.

There is significant correlation between changes in investment plans and changes in the degree of uncertainty for the two longest survey horizons. The signs of the statistically significant coefficients are mainly negative except for the system estimation, where the results are divided equally into negative and positive signs. There are, however, some reservations concerning the parameter restrictions and test statistics of the system estimation. Thus, a negative a priori effect can be retained as the main result of the estimations. This can be interpreted to mean that, under exceptionally great uncertainty, only obligatory decisions are taken and decision-making is postponed for as long as possible so that additional information can be acquired.

Finally, we compare the results of this study with earlier studies, which were outlined in the introduction. The main theoretical bases, results and the data sources for realization models are shown in Table 26. As can be seen the models are based on very different theories ranging from the early Hicksian theory of the firm to the accelerator and residual funds theory, which is a typical credit reationing theory of investment. The explanatory variables used also differ from one study to another. Similarly, the expectations formation hypothesis differs reflecting the decade in which the study is made. The hypotheses used are static, adaptive and rational expectations. Common to all the studies is that the demand variable in one form or another has been a significant explanatory variable in almost all the studies. Prices of factors of production are used in the later studies.

TABLE 26. MAIN STUDIES ON REALIZATION OF INVESTMENT PLANS

STUDY MADE BY	Theoretical basis	MAIN EXPLANATORY VARIABLES (unexpected change)	EXPECTATION HYPOTHESIS USED	SURVEY	SURVEY HORIZON AND DATA
Modigliani and Weingartner (1985)	Accelerator theory	Sales	Empirical data on expectations	U.S. Department of Commerce	Current and following year, annual data 47-55
Eisner (1962, 1965)	Accelerator theory	Sales, unfilled orders, unrealized investment plans	Adaptive	McGraw-Hill, U.S. Department of Commerce	McGraw-Hill; current and following year, annual data 55-62. U.S. Department of Commerce; one quarter anticipations 48Q1-62Q4
Eliasson (1967)	Accelerator — Residual Funds Theory, Mayer and Kuhn (1957), Mayer and Glauber (1964)	Output and credit availability	Adaptive	Statistical Centre of Sweden	Current and following year, annual data 50-63
Aiginger (1977, 1981)	Different theories (Accelerator and Neoclassical theories)	Output, employment, rate of capacity utilization, price of capital goods	Static, Regressive, Adaptive, Rational	Austrian Institute for Economic Research	Current and following year, annual data 65-78. Survey made twice a year
McKelvey (1980)	Theory based on writings of Hicks (1946), Modigliani and Cohen (1961)	Sales, output, activities of other firms, price of capital goods, investment tax credit	Static, Rational	U.S. Department of Commerce	Three quarters, quarterly data 67Q1-77Q1. Survey made quarterly
Pyyhtiä (1989)	Neoclassical theory	Output, foreign demand, user cost of capital, wages, price of energy, cash flow, demand uncertainty	Static, Rational, Empirical data on expectations	Bank of Finland	Current and following year, annual data 63-86. Survey made twice a year

VI.2 Conclusions

As far as the use of investment plans for forecasting purposes is concerned, it can be concluded that the plans of the spring and autumn for the current year can be used as such for forecasting. They do not contain any systematic forecast error which can be explained by economic factors. Of course, not even these plans are implemented as such because implementation is affected by unpredictable random factors. On the other hand, the realized investment figures of the investment survey and those of the official statistics deviate in a way which cannot be forecast. Investment plans provide valuable information for forecasting because they contain internal information on companies which is not publicly available.

Investment plans for the following year can be revised for forecasting purposes by either using a model which is calculated from historical data and mechanically corrects investment plans or, if the forecaster assumes that he has better information on future economic developments than companies, by using an actual explanatory model for changes in investment plans, i.e. the realization function. Changes in investment plans can be shown to be dependent to a certain extent on developments in demand and the prices of factors of production. This can be considered to indicate that companies' investment plans are rational decision-making data from the point of view of economic information, similar in nature to final investments. Thus the original hypothesis of this study on the nature of the data is accepted with the minor reservation that the first plans (those with the two longest survey horizons reported in the spring and autumn of the previous year) are only provisional and do not contain all public economic information.

The study showed that companies' investment plans are fairly sensitive to changes in the economic environment, including those in economic policy, even in the short term. However, only some suggestions were obtained concerning the effects of economic policy, because the prices of factors of production, particularly the variable used for indicating the price of capital, are also affected by factors other than monetary and fiscal policy, e.g. expected changes in inflation. Nevertheless, companies' investment can be affected in the fairly short term through the prices of factors of production, whereas previous investment studies have emphasized long lags in effects. Various surprise factors have had an impact on companies' investment plans; these include fluctuations in the price of energy, the effects of which have been reflected in the investment of the metal and engineering industries via bilateral trade.

The theoretical framework used in the study, i.e. the realization function and the neo-classical investment theory applied in connection with it, proved useful in investigating the problem. However, the small size of the sample did not permit the testing of the exact form of the model, and therefore the study had to be restricted to testing the accuracy of investment plans and their information content. The estimation of the Euler equation shed new light on this, though the results for investment plans are still contradictory. However, the results obtained using the Euler equation in the estimation of investment function are promising and point the way to further research.

SYMBOLS USED IN THE TEXT

The symbols are also explained when they are first used in the text. Because of the need for a large number of symbols, the same symbol has different meanings in different chapters. Conventional mathematical signs are not shown.

Greek symbols

α, β, γ, ζ, ϕ	parameters
γ	rate of repayment of debt capital
δ	depreciation coefficient
ε	root of difference equation, change in plans, disturbance term
$\varepsilon(p(t))$	price elasticity of demand
θ	Arrow-Pratt relative risk aversion measure, technology shock
π	expected present value of the net cash stream
ρ	correlation coefficient
$\rho_{ij}\ \sigma_i\ \sigma_j$	covariance term
λ_1, λ_2	roots of the difference equation, λ_1 = stable root
λ	shadow price of capital
μ, μ_1, μ_2	adjoint parameters
σ	variance, σ-field
τ	firm's tax rate
Ω	observed exogeneous information set of the firm

Other symbols

B	boundary of present value; firm's debt capital
c	integration constant
C	adjustment cost function
CF	cash flow
CFIQ	demand according to the survey of the Confederation of Finnish Industries
d	time derivative; derivative; adjustment cost parameter
D	present value of depreciation allowance

EX	exogeneous factors influencing demand
e	Neper's number
E	conditional expectation operator
EP	price of energy
ER	prediction error
f	density function
fK, f_0	production function
F_K	partial derivative of production function with capital stock
g	drift term
GDP	gross domestic product
H	Hamilton's function
i	interest rate on bank loans; time
i(s)	marginal cost of borrowed capital
I	volume of gross fixed investment
IP	investment plans
j	time
jc	Jorgensonian user cost
JC_1	Jorgensonian real user cost calculated with banks' average lending rate
JC_2	Jorgensonian real user cost, interest rate calculated from balance sheet statistics
k	function
kp	function
K	volume of capital stock
$\bar{K}$	market clearing capital stock
K*	target capital stock
KP	planned capital stock
L	labour input; lag operator
L_d	demand for labour
LT	long-run target for the capital stock
M(p(t))	marginal productivity
MIR	marginal rate on central bank debt
MQ	manufacturing output
MR	marginal revenue product
N	new borrowing by the firm
p	price of production
$p(F^d)$	demand function

P*	cash stream
PC_1, PC_2, PC_3	principal components
q	price of new capital goods
Q	volume of production; production function, demand
Q^d	demand function
Q^s	supply function
r	discount rate
R	discount factor
$s = \frac{B}{E}$	debt-equity ratio
$\bar{s}$	lower bound of debt equity ratio
s^d	upper bound of debt equity ratio (default risk bound)
s^2	variance
t	time
T	time
u	utility function
UC	uncertainty variable
v	time
V	present value of the firm
W	stochastic Wiener-process
w	labour cost; price of factor of production
X	factor of production, observation matrix
XM	imports
XQ	exports
Y	national income
Z	present value of depreciation allowances with unchanged corporate tax rate

h; a, b, A_0, A_1	parameters
v, u	disturbance terms
d, g, d, a, w, k, l, p	weighting parameters

Investment plans and realized investments

${}_{t}IPF^{s}_{t-1}$	investment plans asked in the spring of the previous year, deflated by realized prices of investment goods
${}_{t}IPF^{a}_{t-1}$	investment plans asked in the autumn of the previous year, deflated by realized prices of investment goods
${}_{t}IPF^{s}_{t}$	investment plans asked in the spring of the current year, deflated by realized prices of investment goods
${}_{t}IPF^{a}_{t}$	investment plans asked in the autumn of the current year, deflated by realized prices of investment goods
${}_{t}IRQ^{s}_{t+1}$	realized investments reported in the survey in the spring of the following year
${}_{t}IRQ^{a}_{t+1}$	realized investments reported in the survey in the autumn of the following year
IPA	investment plans deflated by ARIMA-model forecast prices
IRQ	realized investments according to the survey deflated by prices of investment goods
IP(t,t-1)	investment plans for period t made in period t-1
KP(t,t-1)	planned value of the capital stock K(t), when the plan is made in period t-1

REFERENCES

ABEL, A.B. (1979) Investment and the Value of Capital. Ph.D. Thesis (Garland, New York).

ABEL, A.B. (1981) Optimal Investment under Uncertainty: Towards a Stochastic q Theory. Discussion Paper No. 873, Harvard Institute of Economic Research.

ABEL, A.B. (1982) Dynamic Effects of Permanent and Temporary Tax Policies in a q Model of Investment. Journal of Monetary Economics, 9, 353 - 373.

ABEL, A.B. (1983) Optimal Investment under Uncertainty. American Economic Review 73, 228 - 233.

ABEL, A.B. (1984) The Effects of Uncertainty on Investment and the Expected Long-Run Capital Stock. Journal of Economic Dynamics and Control 7, 39 - 53.

ABEL, A.B. (1985) A Stochastic Model of Investment, Marginal q and the Market Value of the Firm. International Economic Review 26, 305 - 322.

ABEL, A.B. and BLANCHARD, O. (1983) The Present Value of Profits and Cyclical Movements in Investment. NBER, Working Paper 1122.

ABEL, A.B. and MISHKIN, F.S. (1983) An Integrated View of Tests of Rationality, Market Efficiency and the Short-Run Neutrality of Monetary Policy. Journal of Monetary Economics 11, 3 - 24.

AHTOLA, J. (1986) Consequences from Improper Use of Ordinary Least Squares Estimation with Time Series Data. The Research Institute of the Finnish Economy No. 209.

AIGINGER, K.A. (1977) The Use of Survey Data for the Analysis of Business Cycles. CIRET (Center for International Research on Economic Tendency Surveys) Studien 24.

AIGINGER, K. (1983) Economic Rational Expectations and their Influence on Production and Inventory Decisions, in K.H. Oppenländer and G. Poser, eds., Leading Indicators and Business Cycle Surveys (Papers presented at the 16th CIRET Conference Proceedings, Washington D.C. 1983, England, Gower Publishing Company Limited).

AIGINGER, K. (1985) Alternative Empirical Measures for the Degree of Uncertainty, in K.H. Oppenländer and G. Poser, eds., Business Cycle Surveys in the Assessment of Economic Activity (Papers Presented at the 17th CIRET Conference Proceedings, Vienna 1985, England, Gower Publishing Company Limited).

ALBRECHT, J.W. and HART, A.G. (1983) A Putty-Clay Model of Demand Uncertainty and Investment. Scandinavian Journal of Economics 85, 393 - 402.

AMEMIYA, T. (1974) The Non-Linear Two-Stage Least-Squares Estimator. Journal of Econometrics 2, 105 - 110.

APPELBAUM, E. and HARRIS, R.G. (1978) Optimal Capital Policy with Bounded Investment Plans. International Economic Review 19, 103 - 114.

AUERBACH, A.J. (1983) The Taxation of Capital Income (Harvard Economic Studies 153, Cambridge).

BALTENSBERGER, E. and DEVINNEY, T.M. (1983) Credit Rationing Theory: A Survey and Synthesis.

BARRO, J.R. (1972) A Theory of Monopolistic Price Adjustment. Review of Economic Studies.

BARRO, J.R. (1976) Integral Constraints and Aggregation in an Inventory Model of Money Demand. Journal of Finance 31, 77 - 87.

BATCHELOR, R.A. (1985) Inflation Uncertainty: Theory and Measurement for the European Economy, in K.H. Oppenländer and G. Poser, eds., Business Cycle Surveys in the Assessment of Economic Activity, Papers Presented at the 17th CIRET Conference Proceedings, Vienna, England, Gover Publishing Company Limited).

BATCHELOR, R.A. and DUA, P. (1987) The Accuracy and Rationality of UK Inflation Expectations: Some Quantitative Evidence. Applied Economics 19, 819 - 828.

BATCHELOR, R.A. and JONUNG, L. (1987) Confidence about Inflation Forecasts: Evidence from Surveys of Swedish Consumers. Paper presented to the 18th CIRET Conference, Zürich.

BENASSY, J.P. (1975) Neo-Keynesian Disequilibrium Theory in a Monetary Economy. Review of Economic Studies 42, 503 - 523.

BERGER, A.N. and KRANE, S.D. (1984) The Informational Efficiency of Econometric Forecasts. Review of Economics and Statistics 51, 128 - 134.

BERTSEKAS, D.P. (1976) Dynamic Programming and Stochastic Control (Academic Press, New York).

BRECHLING, F. (1975) Investment and Employment Decisions (Manchester University Press).

BREUSCH, T.S. (1978) Testing for Autocorrelation in Dynamic Linear Models. Australian Economic Papers 17, 334 - 355.

BREUSCH, T.S. and PAGAN, A.R. (1980) The Lagrange Multiplier Test and its Applications to Model Specification in Econometrics. Review of Economic Studies 47, 239 - 253.

BROCK, W.A. and MIRMAN, L. (1972) Optimal Economic Growth and Uncertainty: the Discounted Case. Journal of Economic Theory 4:3, 479 - 513.

BROWN, B.W. and MAITAL, S. (1981) What do Economists Know? An Empirical Study of Experts' Expectations. Econometrica 49, 491 - 504.

BUCK, J., GAHLEN, B. and GERHÄUSSER, K. (1987) Do Firms Smooth Prices of Production? Paper presented to the 18th CIRET Conference, Zürich.

CARLSON, J.A. and PARKIN, M. (1975) Inflation Expectations. Economica 42, 123 - 138.

CHRISTIANO, L.J. (1987) Why is Consumption Less Volatile than Income? Federal Reserve Bank of Minneapolis, Quarterly Review II, 1-20.

COX, D.R. and MILLER, H.D. (1965) The Theory of Stochastic Processes (Great Britain, Spottiswoode, Ballantyne & Co. Ltd).

CUKIERMAN, A. and WACHTEL, P. (1982) Relative Price Variability and Nonuniform Expectations. Journal of Political Economy 90, 147 - 157.

EISNER, R. (1962) Investment Plans and Realizations. American Economic Review 52, 190 - 203.

EISNER, R. (1965) Realization and Investment Anticipations, in J.S. Duesenberry, E. Kuh, G. Fromm and L.R. Klein, eds., The Brookings Quarterly Econometric Model of the United States (Chicago 1965).

EISNER, R. and STROTZ, R.H. (1963) Determinants of Business Investment. Research Study Two in Impacts of Monetary Policy for Commission on Money and Credit (Englewood Cliffs, New York, Part II, section 3).

ELIASSON, G. (1967) Credit Markets and Industrial Investments - An Economic Study of the Short-Term Investment Behaviour of the Firm (IUI, Uppsala). (In Swedish)

ENGLE, R.F. (1982) Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of U.K. Inflation. Econometrica.

ENGLE, R.F. (1983) Estimates of the Variance of U.S. Inflation Based upon the ARCH Model. Journal of Money, Credit, and Banking 15, 286 - 301.

FAMA, E.F. (1976) Foundations of Finance (Basic Books, Inc., Publishers).

FEIGE, E.L. and PEARCE, D.K. (1976) Economically Rational Expectations: Are Innovations in the Rate of Inflation Independent of Innovations in Measures of Monetary and Fiscal Policy? Journal of Political Economy 84, 499 - 522.

FRIED, J. and HOWITT, P. (1980) Credit Rationing and Implicit Contract Theory. Journal of Money, Credit, and Banking 12, 471 - 487.

GARBER, P.M. and KING, R.G. (1983) Deep Structural Excavation? A Critique of Euler Equation Methods. NBER Technical Paper Series 31.

GOULD, J.P. (1968) Adjustment Costs in the Theory of Investment of the Firm. Review of Economic Studies 35, 47 - 55.

GOULD, J.P. (1969) The Use of Endogeneous Variables in Dynamic Models of Investment. Quarterly Journal of Economics 83, 580 - 599.

GRANGER, C.W.J. and NEWBOLD, P. (1977) Forecasting Economic Time Series (Academic Press, New York).

GRIEVES, R. (1983) The Demand for Consumer Durables. Journal of Money, Credit, and Banking 15, 316 - 326.

GROSSMAN, H.I. (1972) A Choice-Theoretic Model of an Income-Investment Accelerator. American Economic Review 62, 630 - 641.

GROSSMAN, S.J. and STIGLITZ, J.E. (1976) Information and Competitive Price Systems. American Economic Review 66, 246 - 253.

HANSEN, L.P. (1982) Large Sample Properties of Generalized Method of Moments Estimators. Econometrica, 50, 1029 - 1054.

HANSEN, L.P. and SINGLETON, K.J. (1982) Generalized Intrumental Variables Estimation of Nonlinear Rational Expectations Models. Econometrica 50, 1629 - 1286.

HARTMAN, R. (1972) The Effects of Price and Cost Uncertainty on Investment. Journal of Economic Theory 5, 258 - 266.

HARTMAN, R. (1973) Adjustment Costs, Price and Wage Uncertainty, and Investment. Review of Economic Studies 40, 259 - 267.

HARTMAN, R. (1976) Factor Demand with Output Price Uncertainty. American Economic Review 66, 675 - 681.

HARVEY, A.C. (1981) Time Series Models (Phillip Allan, Oxford).

HARVEY, A.C. (1982) The Econometric Analysis of Time Series (Phillip Allan, Oxford).

HAYASHI, F. (1982) Tobin's Marginal q and Average q: A Neoclassical Interpretation. Econometrica 50, 213 - 224.

HICKS, J.R. (1946) Value and Capital (Clarendon Press, Oxford).

HOLDEN, K. and PEEL, D.A. (1985) An Evaluation of Quarterly National Institute Forecasts. Journal of Forecasting 4, 227 - 234.

HODGMAN, D.R. (1960) Credit Risk and Credit Rationing. Quarterly Journal of Economics 74, 258 - 278.

JAFFEE, D.M. and MODIGLIANI, F. (1969) A Theory and Test of Credit Rationing. American Economic Review 59, 850 - 872.

JAFFEE, D.M. and RUSSELL, T. (1976) Imperfect Information, Uncertainty and Credit Rationing. Quarterly Journal of Economics 90, 651 - 666.

JALAS, K. (1981) Business Expectations of Finnish Industrial Firms in 1966 - 1979 according to the Business Survey of the Confederation of Finnish Industries. ETLA A 6. (In Finnish, summary in English)

JORGENSON, D.W. (1963) Capital Theory and Investment Behaviour. American Economic Review 53, 247 - 259.

JORGENSON, D.W. (1965) Anticipations and Investment Behaviour, in J. Duesenberry, G. Fromm, L. Klein and E. Kuh, eds., The Brookings Quarterly Econometric Model of the United States (Rand McNally, Chicago).

JORGENSON, D.W. (1967) The Theory of Investment Behaviour, in R. Ferber, ed., Determinants of Investment Behaviour (Universities-National Bureau Conference, Series, No. 18, New York, Columbia University Press for NBER).

KAMIEN, M.I. and SCHWARTZ, N.L. (1981) Dynamic Optimization: The Calculus of Variations and Optimal Control in Economics and Management (North Holland, New York).

KAWASAKI, S., GAHLEN, B. and BUCK, A.J. (1983) The Variability of Relative Price Expectations, the Rate of Inflation and the Phillips Curve, in K.H. Oppenländer and G. Poser, eds., Leading Indicators and Business Cycle Surveys, Papers presented at the 16th CIRET Conference Proceedings, Washington, D.C. (England, Gover Publishing Company Ltd).

KENNAN, J. (1979) The Estimation of Partial Adjustment Models with Rational Expectations. Econometrica 47, 1441 - 1455.

KIVIET, J.F. (1980) Effects of ARMA Errors on Tests for Regression Coefficients: Comments on Vinod's Article; Improved and Additional Results. Journal of the American Statistical Association 75, 353 - 358.

KLEIN, B. (1975) Our New Monetary Standard: The Measurement and Effects of Price Uncertainty, 1880 - 1973. Economic Inquiry 13, 461 - 483.

KLEIN, B. (1978) The Measurement of Long-Term Price Uncertainty: A Moving Regression Time Series Analysis. Economic Inquiry 16, 438 - 452.

KNIGHT, F.H. (1933) Risk, Uncertainty and Profit (Houghton Mifflin, Boston)

KOSKELA, E. (1976) A Study of Bank Behavior and Credit Rationing (Helsinki, Scientiarum Fennica).

KOSKENKYLÄ, H. (1985) Investment Behaviour and Market Imperfections with an Application to the Finnish Corporate Sector. Bank of Finland, B:38.

KOUTSOYIANNIS, A. (1973) Theory of Econometrics (The Macmillan Press Ltd, Hong Kong).

KUKKONEN, P. (1975) The Transmission of Monetary Policy through Credit Rationing, the Case of Finland. Conference on Monetary Policy in Open Economies, Haikko.

KUSHNER, H.J. (1971) Introduction to Stochastic Control (New York).

LUCAS, R.E. (1967) Optimal Investment Policy and the Flexible Accelerator. International Economic Review 8, 78 - 85. Lucas, R.E. (1967b) Adjustment Costs and the Theory of Supply. Journal of Political Economy 75, 321 - 334.

MADDALA, G.S. (1977) Econometrics (McGraw-Hill Kogakusha,Tokyo).

MALLIARIS, A.G. and BROCK, W.A. (1982) Stochastic Methods in Economics and Finance (North-Holland, Netherlands).

McDONALD, R.L. and SIEGEL, D.R. (1982) The Value of Waiting to Invest. NBER Working Paper No. 1019.

McKELVEY, M.J. (1980) The Realization of Investment Plans: A Microeconometric Analysis. PH.D. Thesis, University of Pennsylvania.

MEYER, J.R. and GLAUBER, R.R. (1964) Investment Decisions, Economic Forecasting and Public Policy (Boston, Harvard University Press).

MEYER, J.R. and KUH, E. (1957) The Investment Decision (Cambridge, Harvard University Press).

MERTON, R.C. (1971) Optimal Consumption and Portfolio Rules in a Continuous-Time Model. Journal of Economic Theory 3, 373 - 413.

MILLER, M. and ORR, D. (1966) A Model of the Demand for Money by Firms. The Quarterly Journal of Economics 3, 413 - 435.

MISHKIN, F.S. (1983) A Rational Expectations Approach to Macroeconometrics. NBER Monograph (The University of Chicago Press).

MIZON, G.E. and RICHARD, J-F. (1982) The Encompassing Principle and Its Application to Testing Non-Nested Hypotheses, Core Discussion Paper No. 8330.

MODIGLIANI, F. and COHEN, K.J. (1961) The Role of Anticipations and Plans in Economic Behavior and Their Use in Economic Analysis and Forecasting (University of Illinois, Urbana, USA).

MODIGLIANI, F. and WEINGARTNER, H.M. (1958) Forecasting Uses of Anticipatory Data on Investment and Sales. Quarterly Journal of Economics 72, 23 - 54.

MUSTONEN, J. (1987) Oligopolistic Bank Competition and Credit Supply under Rational Expectations and Uncertainty. University of Helsinki, licentiate thesis. (In Finnish)

MUTH, J.F. (1961) Rational Expectations and the Theory of Price Movements. Econometrica 29, 315 - 335.

MÄKELÄINEN, T. (1970) Exterma for Characteristic Roots of Product Matrices. A Specification Analysis of the General Linear Model. Commentationes Physico - Mathematicae 4.

NICKELL, S.J. (1978) The Investment Decisions of Firms (Cambridge University Press).

OKSANEN, H. (1977) Bank Liquidity and Lending in Finland 1950 - 1973, Commentationes Scientiarum Socialum (Helsinki).

PHELPS, E.S. and WINTER, S.G. (1970) Microeconomic Foundations of Employment and Inflation Theory (W.W. Norton, New York).

PINDYCK, R.S. (1982) Adjustment Costs, Uncertainty, and the Behavior of the Firm. American Economic Review 72, 415 - 427.

PINDYCK, R.S. (1986) Irreversible Investment, Capacity Choice, and the Value of the Firm. NBER Working Paper No. 1980.

PYYHTIÄ, I.J. (1981) Using the Bank of Finland's Investment Inquiry in the Prediction of Industrial Investments. Bank of Finland, D:50. (In Finnish)

PYYHTIÄ, I.J. (1983) The Realization of Investment Plans of Finnish Manufacturing Firms, in K.H. Oppenländer and G. Poser, eds., Leading Indicators and Business Cycle Surveys, Papers presented at the 16th CIRET Conference Proceedings, Washington, D.C. (Gower, England).

PYYHTIÄ, I.J. (1985) The Revision of Investment Plans in the Finnish Manufacturing Industry. Papers presented at the 17th CIRET Conference, Wien.

PYYHTIÄ, I.J. (1987a) Neoclassical Investment Theory, Uncertainty and Revisions of Investment Plans. Paper presented to the 18th CIRET Conference, Zürich.

PYYHTIÄ, I.J. (1987b) Industrial Investment Plans as Forecasts. Bank of Finland, Research Papers, TU 17/87. (In Finnish)

PYYHTIÄ, I.J. (1987c) Revisions of Industrial Investment Plans. Bank of Finland, Research Papers, TU 18/87. (In Finnish)

RAHIALA, M. (1985) On the Identification and Estimation of Multiple Input Transfer Function Models with Autocorrelated Errors. ETLA A:8.

ROOSA, R. (1951) Interest Rates and the Central Bank, in Money, Trade, and Economic Growth: Essays in Honor of John H. Williams 270 - 295 (McMillan, New York).

ROSEN, H.S., ROSEN, K.T. and HOLTZ-EAKIN, D. (1984) Housing Tenure, Uncertainty, and Taxation. Review of Economics and Statistics 66, 405 - 416.

ROTEMBERG, J.J. (1983) Monetary Policy and Costs of Price Adjustment. Journal of Economic Dynamics and Control 5, 267 - 288.

SALMON, M. (1983) Rational Consumption Behaviour. University of Warwick, Coventry.

SANDMO, A. (1971) On the Theory of the Competitive Firm under Price Uncertainty. American Economic Review 61, 65 - 73.

SARGENT, T.J. (1973) Rational Expectations, the Real Rate of Interest, and the Natural Rate of Unemployment. Brookings Papers on Economic Activity 2.

SARGENT, T.J. (1978a) Estimation of Dynamic Labor Demand Schedules under Rational Expectations. Journal of Political Economy 86, 1009 - 1044.

SARGENT, T.J. (1978b) Macroeconomic Theory (Academic Press).

SARGENT, T.J. (1986) Equilibrium Investment Under Uncertainty, Measurement Errors, and Investment Accelerator. Working Paper Series. Hoover Institution. E-86-53.

SCHWORM, W.E. (1980) Financial Constraints and Capital Accumulation. International Economic Review 21, 643 - 660.

SHAPIRO, M.D. (1986) The Dynamic Demand for Capital and Labour. The Quarterly Journal of Economics, 513 - 542.

SHEFFRIN, S.M. (1983) Rational Expectations (Cambridge University Press).

SIMS, C.A. (1972) Money, Income and Causality. The American Economic Review 4, 540 - 552.

SPANOS, A. (1986) Statistical Foundations of Econometric Modelling. (Cambridge University Press.)

STEIGUM, E. (1983) A Financial Theory of Investment Behavior. Econometrica 51, 637 - 645.

STIGLITZ, J.E. and WEISS, A. (1981) Credit Rationing in Markets with Imperfect Information. American Economic Review 71, 393 - 410.

STIGLITZ, J.E. and WEISS, A. (1983) Incentive Effects of Terminations: Applications to the Credit and Labor Markets. The American Economic Review 5, 912 - 927.

SUKSELAINEN, T. (1986) Price Formation in the Finnish Manufacturing Industry in 1969 - 1981. PH.D.Thesis, Bank of Finland B:42. (In Finnish, summary in English)

SÖDERSTRÖM, H.T. (1976) Production and Investment under Costs of Adjustment, A Survey. Zeitschrift für Nationalökonomie 36, 369 - 388.

TAKAYAMA, A. (1974) Mathematical Economics (Dryden Press, Illinois).

TARKKA, J. (1985) Consumption and Investments, in J. Tarkka and A. Willman, eds., Quarterly Model of The Bank of Finland 3, Series D:59.

THEIL, H. (1961) Economic Forecasts and Policy (North-Holland, Amsterdam).

THEIL, H. (1966) Applied Economic Forecasting (Rand McNally).

TICHY, G.J. (1976) Konjunkturschwankungen (Springer-Verlag, Berlin).

TOBIN, J. (1961) Money, Capital and Other Stores of Value. American Economic Review Papers and Proceedings 51, 26 - 37.

TOBIN, J. (1969) A General Equilibrium Approach to Monetary Theory. Journal of Money, Credit and Banking 1, 15 - 29.

VINOD, H.D. (1976) Effects of ARMA Errors on the Significance Tests for Regression Coefficients. Journal of the American Statistical Association 71, 929 - 933.

VIRÉN, M. (1986) Estimating the Output Effects of Energy Price and Real Interest Rate Shocks: A Cross-Country Study. Bank of Finland, Research Papers 14/86.

WHITTLE, P. (1982) Optimization over Time (John Wiley & Sons).

YLÄ-LIEDENPOHJA, J. (1987) Effective Marginal Tax Rates on Investment in Finland. Helsinki School of Economics and Business Administration. D-102.

ZELLNER, A. (1962) An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias. Journal of the American Statistical Association 57, 348 - 368.

APPENDIX 1

THE BANK OF FINLAND'S INVESTMENT INQUIRY

The content of the inquiry

Since 1963, the Bank of Finland has conducted a survey of investment intentions among industrial companies. The surveys are carried out twice a year, in spring and autumn, and they concern the companies' plans for the acquisition of fixed capital[1] during the current and following year and actual investments in the previous year. Companies are requested to report their investment outlays in current prices and according to the accruals convention, i.e. only actual or planned investment outlays relating to each year. Investment plans are reported only to the extent to which a binding decision has been taken on them (the investment inquiry form is shown on pages 200 - 201).

In order to maintain the comparability of the concept of investment with that in the System of National Accounts (SNA), the survey is restricted to outlays on new investment goods and buildings. Companies are requested to provide a breakdown of their investment outlays by capital goods into construction, investments in machinery and equipment and other construction (land and waterway construction). Recent additions to the survey include a provincial breakdown and questions on R&D expenditure and the financing of investments. In addition, companies are asked about their capacity utilization rate in the current and following year. The volume of output for which the industrial plant has been designed is regarded as the maximum capacity utilization rate.

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[1]Corresponding investment surveys are carried out by the following institutions: US Department of Commerce, Bureau of Economic Analysis (BEA), Confederation of British Industry (CBI), Statistiska Centralbyrån, Sweden and Österreichisches Institut für Wirtschaftsforschung, whose survey most closely resembles the Bank of Finland's investment inquiry.

The survey currently covers some 800 industrial companies; up to 1975, the sample comprised some 600 companies. The number of companies which can be included in the sample is limited by the timetable set for carrying out the survey and cost factors. The response rate has been high. It has been almost 90 per cent on the basis of the number of the companies which have responded and 95 per cent when weighted by the number of employees; thus the response of large companies has been higher than that of small ones.

The population of the sample comprises all industrial companies with over 20 employees. The sampling method applied is stratified random sampling, the sub-populations being mining and quarrying, the wood and wood products industry, the paper industry, the food beverages and tobacco industries, the textile, clothing, footwear and leather industries, the chemical industry, the clay, glass and stone industries, the printing and publishing industry, the metal and engineering industries, and electricity, gas and water.[2]

As a rule, companies are classified according to their main industrial sector; the largest conglomerates are also requested to provide information on their investments in accordance with the sectoral breakdown used in the survey. In addition, the sub-populations are divided into strata according to the size of the industrial company. Manufacturing companies are classified into three strata: small companies (20 - 49 employees), medium-sized companies (50 - 499 employees) and large companies. In electricity, gas and water, plants are divided into two strata, under 50 employees and 50 or more employees. The survey covers all large companies and all companies in the mining and quarrying industry. The sampling ratio of medium-sized companies is 50 per cent and that of small companies 20 per cent. Actual sampling is carried out among small and medium-sized companies.

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[2]Prior to 1975, the main sectors of manufacturing industry - the forest industries, the metal and engineering industries and other manufacturing were not divided into subsectors.

To take account of mergers and bankruptcies, the sample is revised every 2 or 3 years. The sample is continually updated by including in it any new large companies established during the sampling period. Total investment is estimated on the basis of the responses using an ordinary ratio estimation method. The auxiliary variable used in the ratio estimator is the number of employees in each company. The estimate of investment by each stratum is defined as

$$\hat{Y}_i = \frac{Y_i}{x_i} X_i ,$$

where

Y_i companies' investment plans in stratum h,

x_i number of employees in stratum h companies,

X_i number of employees of the companies in the population of stratum h.

The estimate of investment by the total population is then as follows:

$$\hat{Y} = \sum_{1}^{h} \frac{Y_i}{x_i} X ,$$

where X is the number of employees in the total population. An attempt has been made to select a variable with the highest possible correlation with y_i for the auxiliary variable x_i. Exact estimates also require that the regression line between y_i and x_i roughly passes through origin, i.e. it is of the form $y_i = ax_i$, and that the variance of y_i increases in relation to x_i around the regression line (Cochran (1963)).

Inquiry form

BANK OF FINLAND	INVESTMENT ENQUIRY	Confidential
Economics Department	April 1985	Instructions overleaf

Company

PLEASE RETURN THE FORM
BY 28 APRIL 1985
Person in charge of inquiry
....

INDUSTRIAL INVESTMENT

		Value, FIM 1000 1984	1985	1986
A. Investments by type of investment	Buildings Machinery and equipment Land and water construction Total			
B. Investments by province	Uusimaa 1 Turku & Pori 2 Åland 3 Häme 4 Kymi 5 Mikkeli 6 North Karelia 7 Kuopio 8 Central Finland 9 Vaasa 10 Oulu 11 Lapland 12 Total			
C. Expenditure on research and development				

	1985 I II	1986 I II
D. Capacity utilization rate Capacity utilization rate, semiannually, %		
E. Loans not yet negotiated, % of investment in 1986		

Contact person in the company Tel.

REPORTING INSTRUCTIONS

This inquiry concerns only industrial investments. If, in addition to industrial activity, the industrial plant carries on other lines of business, they are to be omitted. However, even if the company's or plant's main line of business is not industrial activity, the questionnaire should be completed in respect of all industrial units.

All questions (except question C) refer to new buildings, land and waterway construction and the acquisition of machinery and equipment, excluding the purchase of used capital goods and costs of recurrent repairs (e.g. annual maintenance). Investments should include all costs of capital goods which have been or will be purchased during the calendar year, including building, installation and manufacturing work performed by the company itself and alteration and renovation work increasing the value of assets.

Investments should be reported on an accruals basis for each calendar year.

A. Definitions of buildings, machinery and equipment and land and waterway construction are the same as those used in the general questionnaire for the official industrial statistics, except that here cars and other transport equipment should be included under machinery and equipment. The acquisition of land falls outside the scope of this inquiry, and hence e.g. purchase costs of building sites should not be included in the costs of new buildings. Investments in networks by the energy sector are to be entered under land and waterway construction.

C. By research and development is meant systematic activity designed to increase knowledge and the use of knowledge to devise new applications.

The criterion is that the activity should aim at discovering something essentially new.

D. By capacity utilization rate is meant output as a percentage of the total capacity of the plant. Total capacity denotes the total volume of production which the plant is basically designed for. Full capacity utilization is to be entered as 100.

E. By loans not yet negotiated are meant loans which it is planned to use for financing investments during the year in question, but which have not yet, even provisionally, been agreed on with the lender.

The questionnaire may be returned post-free in the enclosed envelope.

Special factors which have affected or will affect investments:
....
....
....
....

The data on investment plans

The data in Charts A.1.a - A.1.g below are based on the results of the Bank of Finland investment inquiry adjusted to the 1980 price level under two different price assumptions. The first alternative assumes perfect foresight concerning future price developments at the investment planning stage; the other extreme hypothesis assumes that the price forecast is based solely on the past values of prices, and it can be justified by the fact that it minimizes the cost of acquiring information. A simple AR(1) model was obtained as a model suited to the data (for more detailed information on the construction of the quarterly price index and the application of the model, see Appendix 2). These arbitrary choices were necessary because there is no information available on expectations.

Investment plans are compared with the final data obtained from the inquiry and with the official investment figures compiled by the Central Statistical Office.[3] As regards the realization of investments, survey data on realized investments are always compared with the data on plans obtained in the corresponding survey, because the information content of the figures are thus believed to correspond better with each other. The data in the charts suggests that different methods of deflating do not result in much difference in investment plans. The main price surprises coincide with the 1974 and 1980 oil crises and the turnover tax concessions for industry in 1983. The figures clearly indicate that investment plans become more accurate as the survey horizon shortens. Increased accuracy over time is also discernible in the plans. This may be connected with the more accurate sampling introduced in 1975, when the earlier one-stage sampling based on company size was replaced by a two-stage method including a sectoral breakdown.

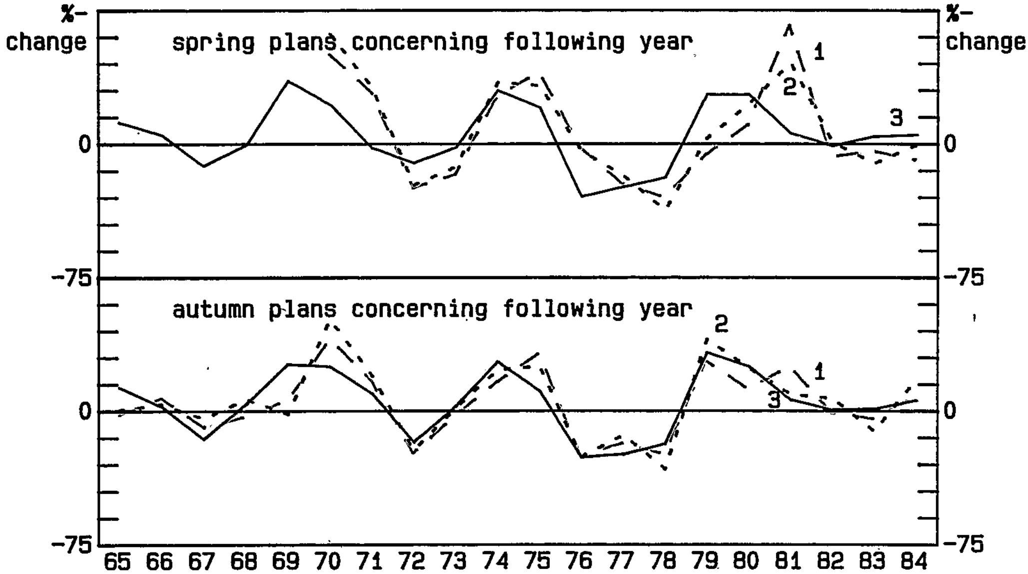
[3]As far as the manufacturing industry is concerned, the final figures of the Central Statistical Office are based on a survey covering the entire sector. Preliminary figures based on the sample are published since the final statistics can only be published after fairly long lag.

Sectoral analysis of the "predictive power" of investment plans reveals that the investment plans of the metal and engineering industries undergo the smallest changes among the main manufacturing sectors. It is difficult to find any ad hoc explanation for this other than that there have been fewer surprises in the operating environment of the metal and engineering industries than in that of the other sectors.

CHART A.1.a. MANUFACTURING

Percentage Volume Changes in Investment Plans over Different Survey Horizons and Realized Investments

1 Investment Plans (Deflated by actual prices)
2 Investment Plans (Autoregressive forecast in prices)
3 Realized Investments according to the Survey



1 Investment Plans (Deflated by actual prices)
2 Realized Investments according to the Official Statistics
3 Realized Investments according to the Survey

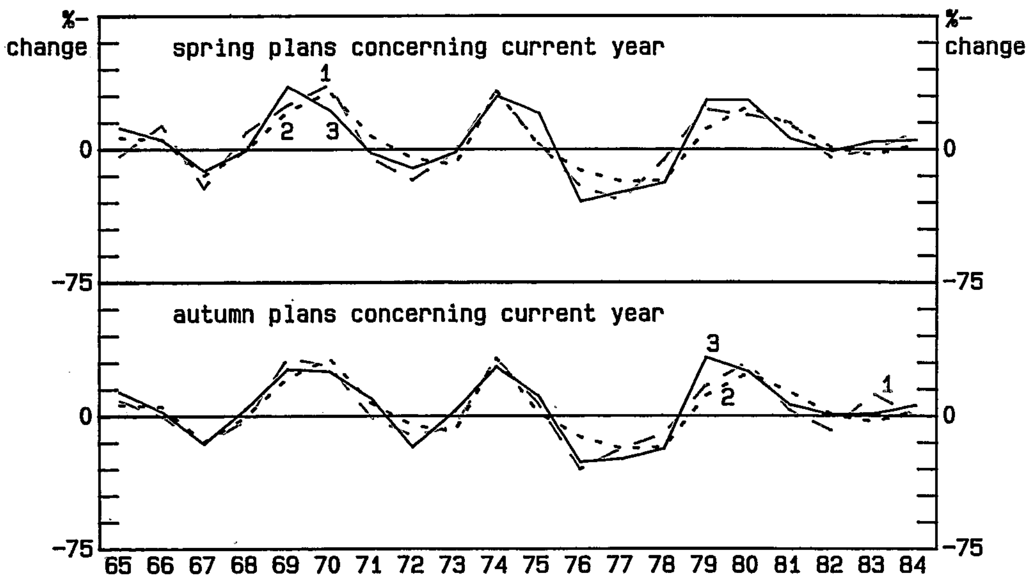
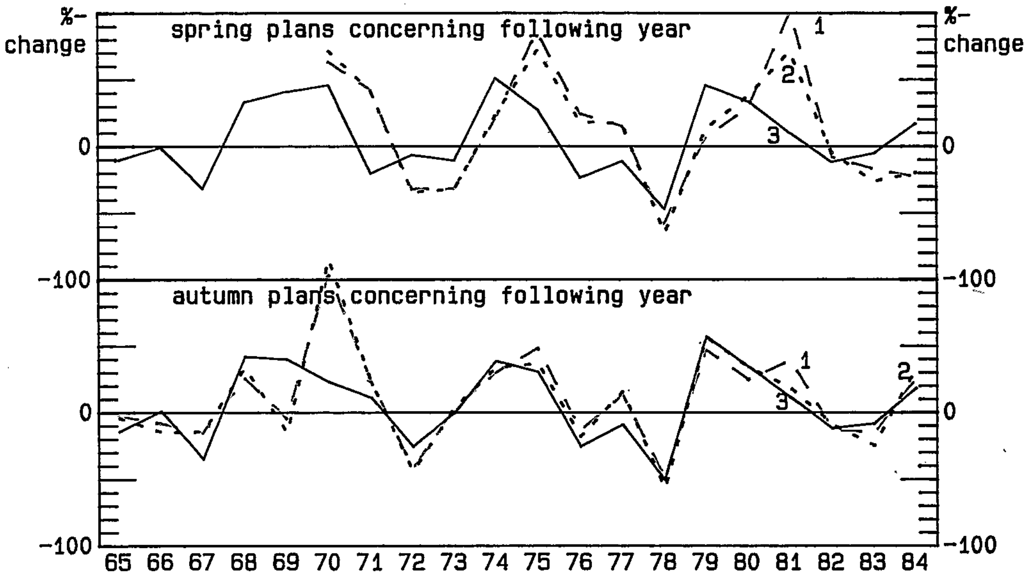


CHART A.1.b. FOREST INDUSTRIES

Percentage Volume Changes in Investment Plans over Different Survey Horizons and Realized Investments

1 Investment Plans (Deflated by actual prices)
2 Investment Plans (Autoregressive forecast in prices)
3 Realized Investments according to the Survey



1 Investment Plans (Deflated by actual prices)
2 Realized Investments according to the Official Statistics
3 Realized Investments according to the Survey

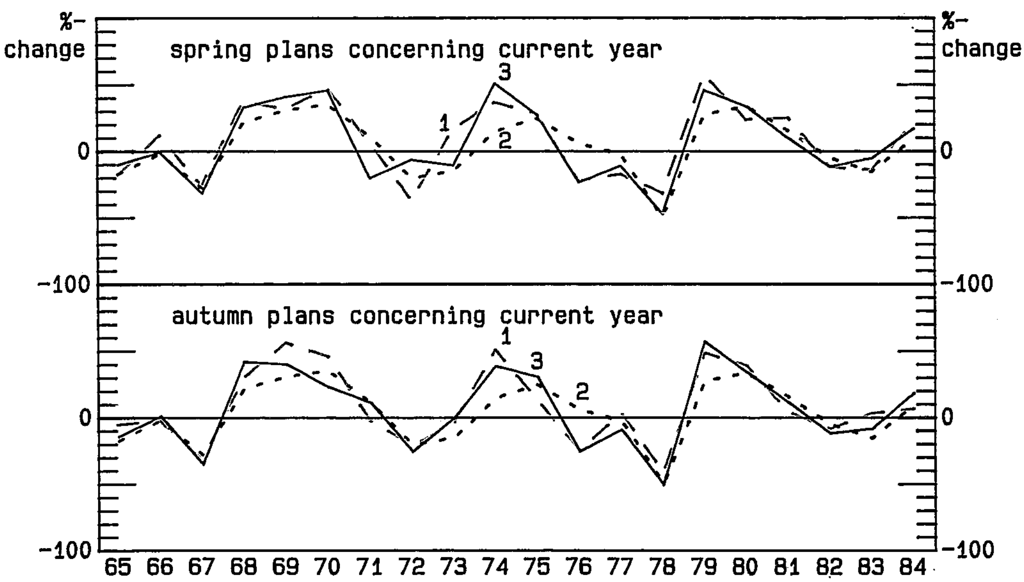
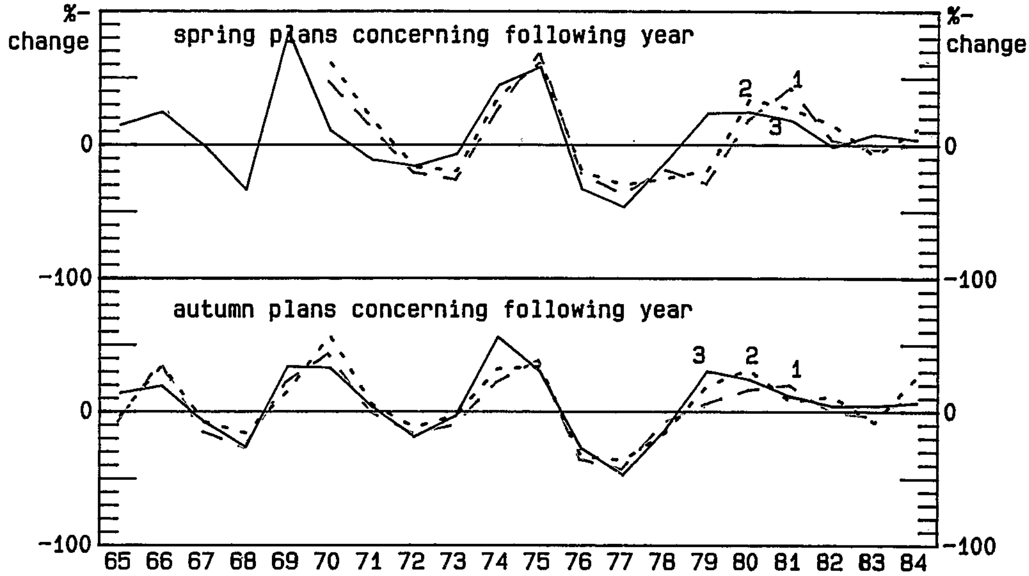


CHART A.1.c. METAL AND ENGINEERING INDUSTRIES

Percentage Volume Changes in Investment Plans over Different Survey Horizons and Realized Investments

1 Investment Plans (Deflated by actual prices)
2 Investment Plans (Autoregressive forecast in prices)
3 Realized Investments according to the Survey



1 Investment Plans (Deflated by actual prices)
2 Realized Investments according to the Official Statistics
3 Realized Investments according to the Survey

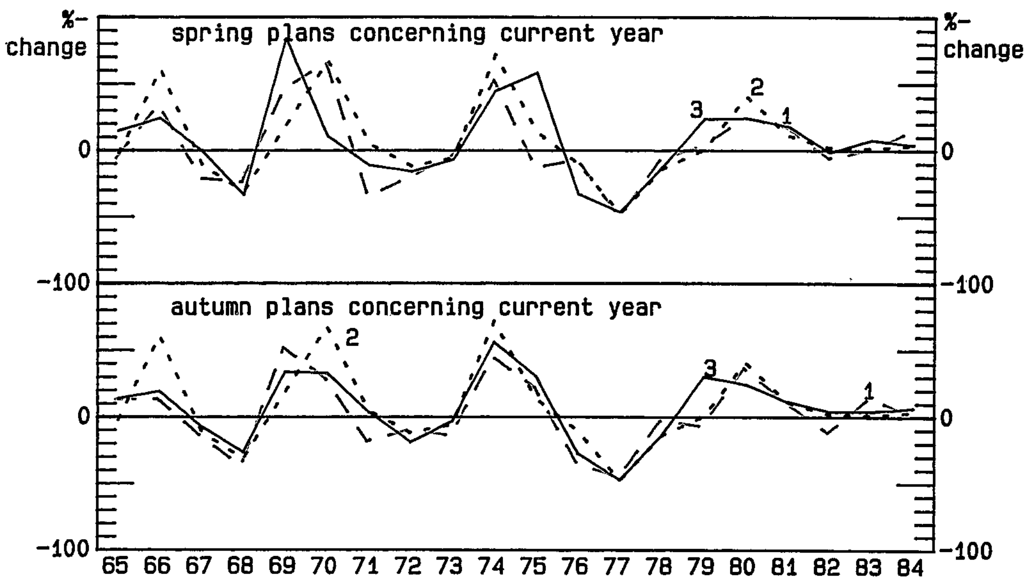
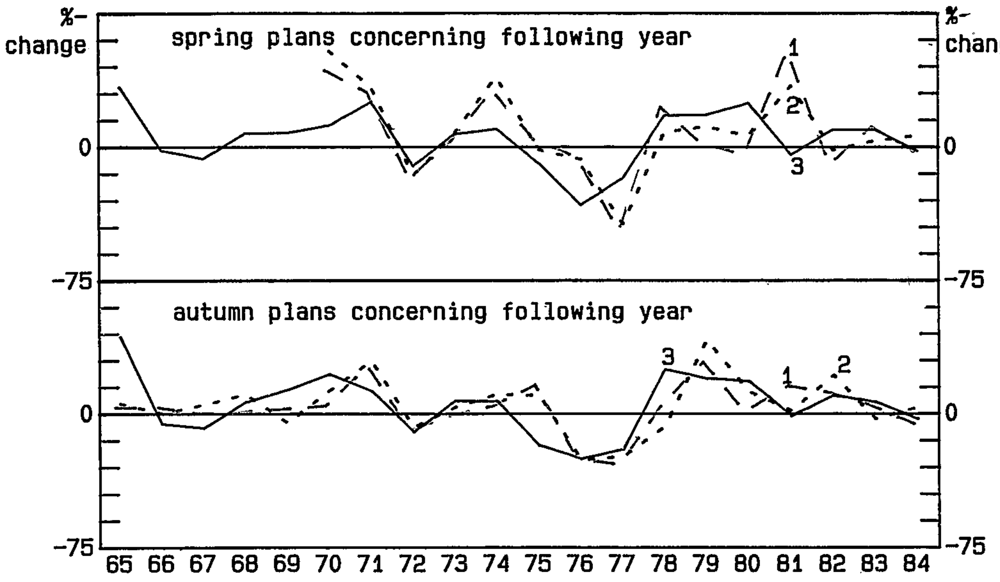


CHART A.1.d. OTHER MANUFACTURING INDUSTRIES

Percentage Volume Changes in Investment Plans over Different Survey Horizons and Realized Investments

1 Investment Plans (Deflated by actual prices)
2 Investment Plans (Autoregressive forecast in prices)
3 Realized Investments according to the Survey



1 Investment Plans (Deflated by actual prices)
2 Realized Investments according to the Official Statistics
3 Realized Investments according to the Survey

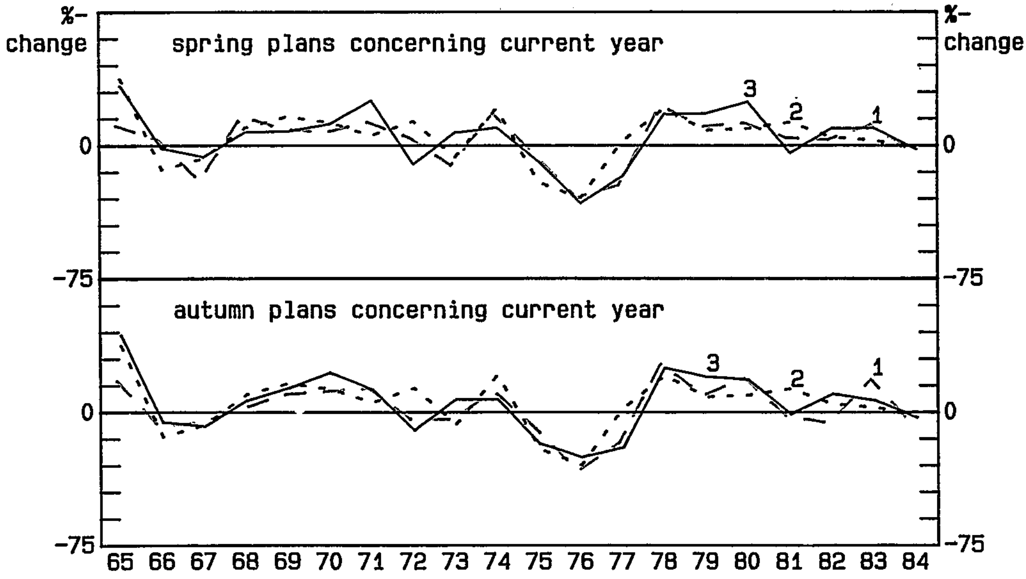
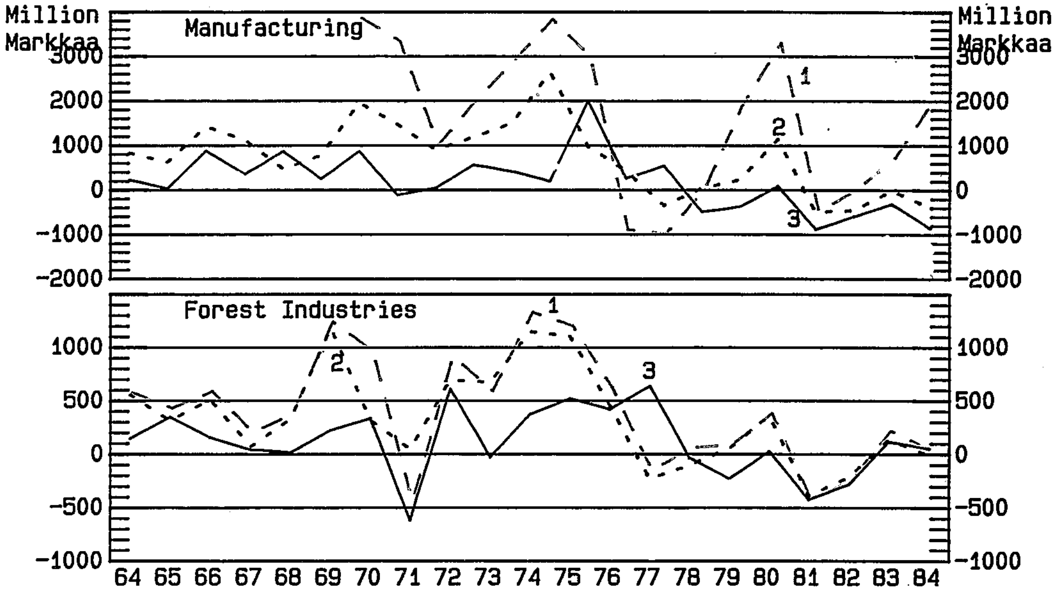


CHART A.1.e. DEVIATION OF INVESTMENT PLANS FROM REALIZED INVESTMENT OVER DIFFERENT SURVEY HORIZONS

Million Markkaa, at 1980 Prices

1 spring t-1
2 autumn t-1
3 spring t



1 spring t-1
2 autumn t-1
3 spring t

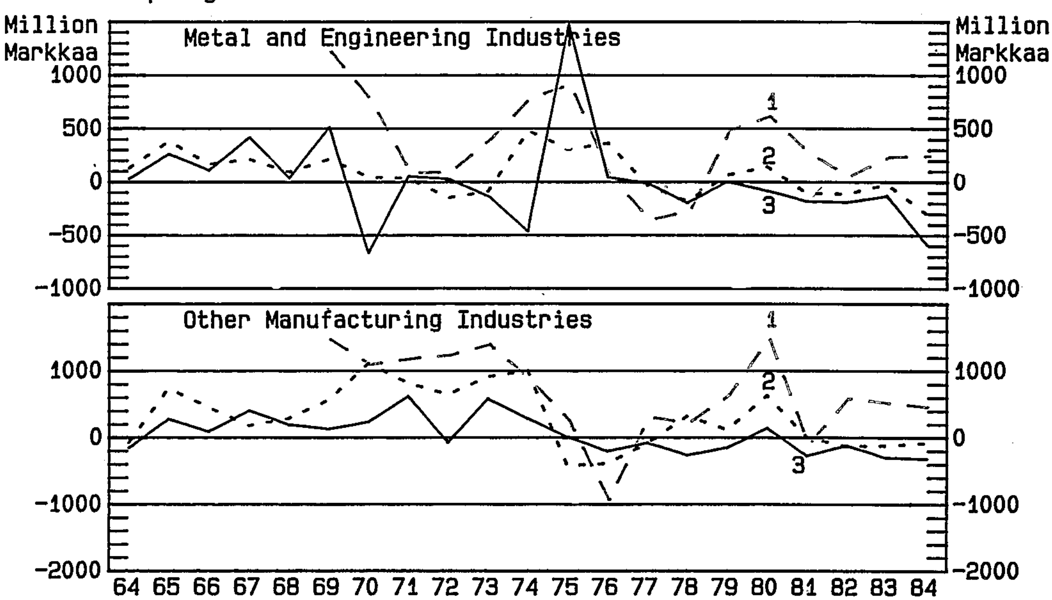
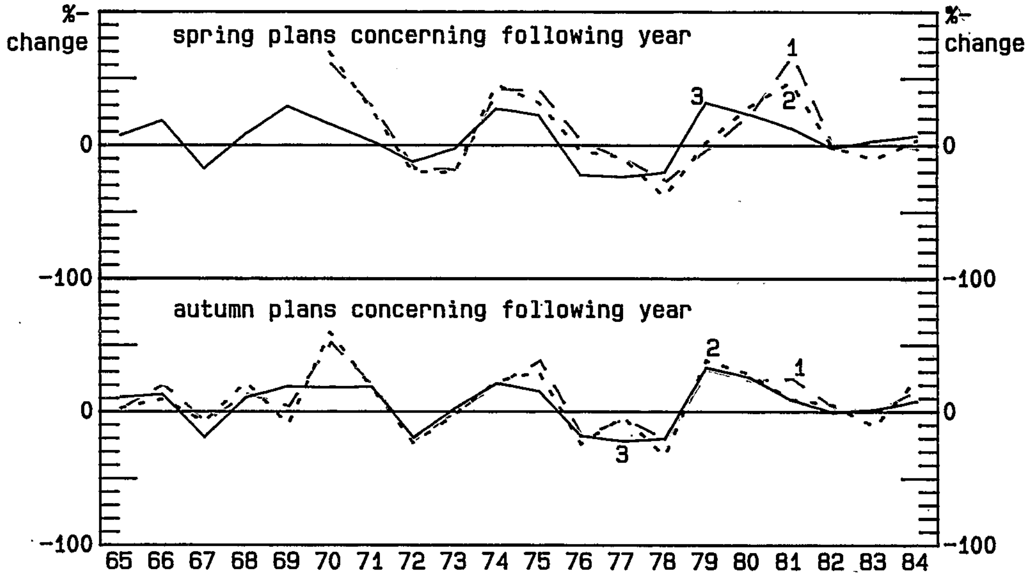


CHART A.1.f. MANUFACTURING INVESTMENTS: MACHINERY AND EQUIPMENT

Percentage Volume Changes in Investment Plans over Different Survey Horizons and Realized Investments

1 Investment Plans (Deflated by actual prices)
2 Investment Plans (Autoregressive forecast in prices)
3 Realized Investments according to the Survey



1 Investment Plans (Deflated by actual prices)
2 Realized Investments according to the Official Statistics
3 Realized Investments according to the Survey

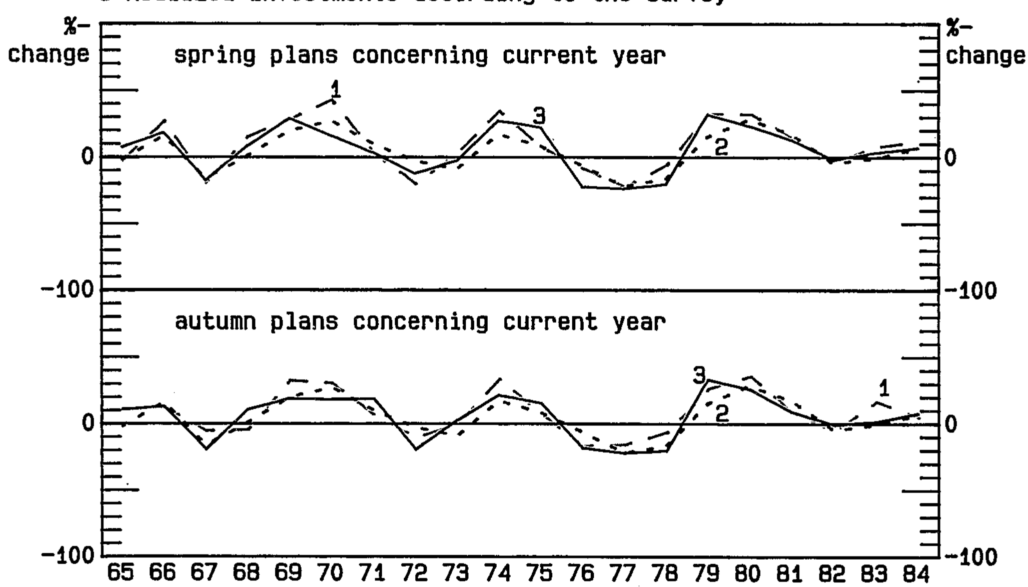
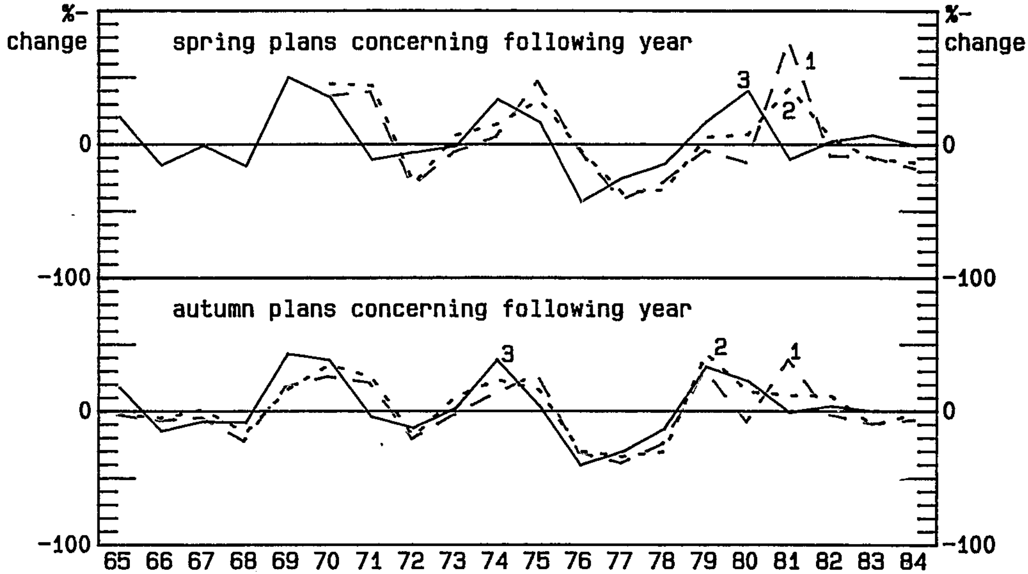


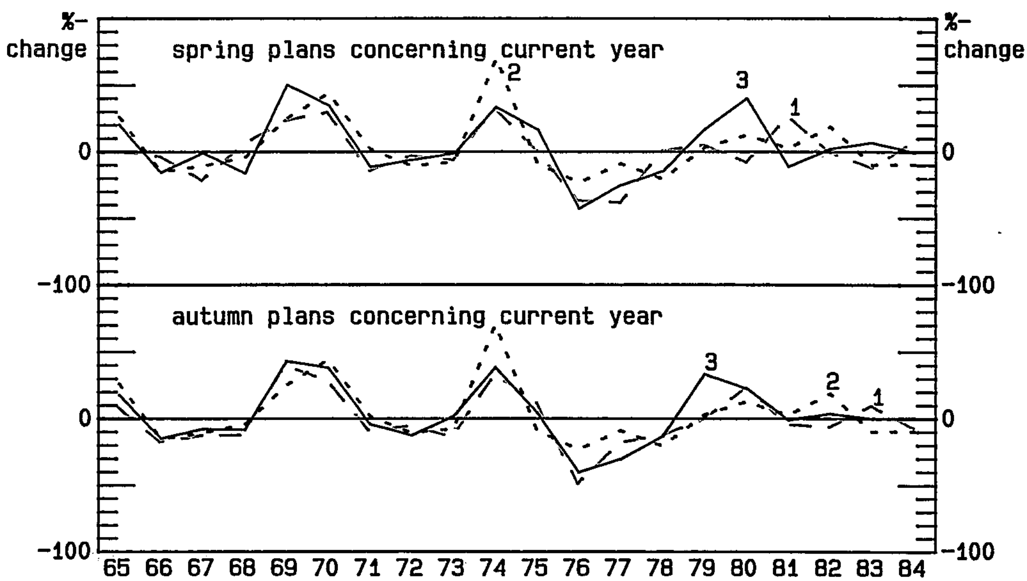
CHART A.1.g. MANUFACTURING INVESTMENTS: BUILDINGS

Percentage Volume Changes in Investment Plans over Different Survey Horizons and Realized Investments

1 Investment Plans (Deflated by actual prices)
2 Investment Plans (Autoregressive forecast in prices)
3 Realized Investments according to the Survey



1 Investment Plans (Deflated by actual prices)
2 Realized Investments according to the Official Statistics
3 Realized Investments according to the Survey



APPENDIX 2

CONSTRUCTION OF QUARTERLY INDICATORS FOR PRICES OF INVESTMENT GOODS IN MANUFACTURING, MACHINERY AND EQUIPMENT AND BUILDINGS AND THE ARIMA MODELS APPLIED TO THESE SERIES

Quarterly indicators for investment prices were constructed for machinery and equipment and buildings by applying the quarterly variation of the wholesale price index and the building cost index to their annual deflators. The price index for the total manufacturing industry was obtained by weighting the above-mentioned indices together with annual weights according to the breakdown of investment by capital goods. Sectoral price developments are assumed to follow those in manufacturing on average. ARIMA models were applied to the series thus obtained.

Before applying the ARIMA models, the series were made stationary by taking their logarithms and first differences. The hypothesis of white noise must be rejected for all three series. On the basis of the series' autocorrelation and partial autocorrelation functions it was decided to experiment with the simple first-order autoregressive process for all the series, i.e. the models are of the form ARIMA (1,1,0). No seasonal variation seems to be present in the series.

The maximum-likelihood estimation results of the ARIMA(1,1,0) model for the quarterly price indices of investment in the period 1960.I to 1984.IV were as follows:

Manufacturing

$$\underset{(4.25)}{(1 - 0.396\ L)}\ (1-L)\log PI = \underset{(4.44)}{0.012} + \varepsilon_t$$

$$Q(17) = 15.71 \qquad \chi^2_{0.95} = 27.59$$

Industrial machinery and equipment

$$\underset{(3.35)}{(1 - 0.322\ L)}\ (1-L)\log PI = \underset{(4.58)}{0.013} + \varepsilon_t$$

$$Q(17) = 10.64 \qquad \chi^2_{0.95} = 27.59$$

Industrial buildings

$$(1 - \underset{(3.45)}{0.330}\, L)\,(1-L)\log PI = \underset{(4.32)}{0.014} + \varepsilon_t$$

$Q(17) = 27.15 \qquad \chi^2_{0.95} = 27.59$

According to the Box-Pierce test statistics (Q), the hypothesis that the residuals of the ARIMA models are white noise cannot be rejected at the 5 per cent significance level. Significant coefficients are obtained for all parameter estimates (t-values are in parentheses). The stability assumption for the models is necessary when ex ante expectations are described. Below are shown the forecasts for one year ahead calculated using the models and converted to annual figures. The year 1980 has been assigned the value 100.

AR(1) forecasts for prices of investment goods

Time	Manufacturing	Machinery and equipment	Buildings
1961	19.96	19.74	20.91
1962	20.49	20.21	21.54
1963	21.91	21.73	22.43
1964	22.15	21.85	23.58
1965	23.54	22.89	25.56
1966	25.16	24.73	26.77
1967	25.33	24.72	27.59
1968	26.95	26.10	29.34
1969	30.74	30.28	32.21
1970	31.89	31.33	33.86
1971	35.49	35.01	37.17
1972	39.99	39.57	41.36
1973	44.95	45.03	44.92
1974	52.82	51.95	54.83
1975	64.88	62.68	70.30
1976	73.88	72.19	79.00
1977	81.28	79.64	86.40
1978	93.12	92.42	96.20
1979	91.78	91.97	93.86
1980	100.00	100.00	100.00
1981	119.46	115.78	129.48
1982	120.60	118.47	128.62
1983	132.01	127.99	144.18
1984	130.15	123.50	153.49

APPENDIX 3

MEASURING THE ACCURACY OF FORECASTS BY MEANS OF THE MEAN SQUARE ERROR AND THE INEQUALITY COEFFICIENT

Theil (1961, 1966) defines two decompositions of the mean square error of forecasts.

$$MSE = \frac{1}{n} \sum_{t=1}^{n} (p_t - a_t)^2$$

First decomposition

$$\text{Bias } U^M = \frac{(\bar{p} - \bar{a})^2}{MSE}$$

$$\text{Variance } U^S = \frac{(Sp - Sa)^2}{MSE}$$

$$\text{Covariance } U^C = \frac{2(1 - \rho)\ Sp\ Sa}{MSE}$$

Second decomposition

$$\text{Bias } U^M = \frac{(\bar{p} - \bar{a})^2}{MSE}$$

$$\text{Regression } U^R = \frac{(Sp - \rho Sa)^2}{MSE}$$

$$\text{Disturbance } U^D = \frac{(1 - \rho)^2\ Sa^2}{MSE}$$

These decompositions add up to one, i.e.

$$U^M + U^S + U^C = U^M + U^R + U^D = 1$$

In the equations, a depicts realized changes in the time series to be estimated and p forecast changes in the same time series, while $\bar{a}$ and $\bar{p}$ are the means of the series. Changes are shown as logarithmic differences, so that they are symmetric upwards and downwards. Logarithmic differences were chosen because of the great variation in sectoral investment. In addition, ρ describes the correlation coefficients between the respective time series and Sp and Sa the variances of the same time series. Of the components, U^M and U^S and U^M and U^R represent the systematic part of the error, the share of which should diminish as the forecast becomes more accurate. The last component U^C or U^D describes the stochastic error.

Tichy's V coefficient corresponds to Theil's inequality or U coefficient, with the difference that in Tichy's V coefficient the mean square error is divided by the variance of the time series, whereas in Theil's coefficient the square sum of the series serves as the divisor. Because of the great variation of the time series, Tichy's V coefficient is probably better suited to the standardization of changes in sectoral investment plans than the U coefficient. Thus, Tichy's coefficient is of the form

$$V = \frac{\sqrt{\sum_{t=1}^{n} (p - a)^2 / n}}{\sqrt{\sum_{t=1}^{n} (a - \bar{a})^2 / n}},$$

where n represents the number of observations.

APPENDIX 4

QUANTIFICATION OF THE QUALITATIVE ECONOMIC DATA COMPILED BY THE CONFEDERATION OF FINNISH INDUSTRIES

Since 1966, the Confederation of Finnish Industries has carried out quarterly business cycle surveys - the Economic Barometer - covering various demand factors, the use of factors of production and stocks. Over that period, the sample has grown from one hundred to more than four hundred companies. The sectoral coverage of the sample has been improved substantially since 1970, when forest industry companies were added to the survey (for details of the sample, see Jalas (1981)). In the Economic Barometer, companies are asked to describe their assessment of changes in the business outlook in terms of three alternatives: higher, the same, lower, where the same is defined as being between -2 per cent and +2 per cent. The questionnaires are sent to the companies' senior management. Companies' replies are weighted by turnover to obtain sectoral figures. In the present study, use has been made of the sectorally weighted sign distributions of the Confederation of Finnish Industries.

In order to quantify the qualitative survey data it is assumed that companies' replies indicating a certain relative change are distributed normally with the parameters $\mu = 0$ and $\delta^2 = 1$. The following expression for the expected value of the sign distributions (Carlson and Parkin (1975) and Jalas (1981)) is then obtained

$$\mu = \frac{l_1 k^+ - l_2 k^-}{k^+ - k^-},$$

where l factors describe the indifference interval, which in the survey by the Confederation of Finnish Industries is defined so that $l_1 = -0.02$ and $l_2 = 0.02$, and the k variables correspond to the values of the cumulative distribution function of the shares of normally distributed + and -replies.

Below are shown the sectoral output series calculated as described above and corresponding to the question in the Economic Barometer "Is the volume of your company's output during the current quarter higher, the same or lower than in the preceding quarter?".

TABLE A.4.a. MANUFACTURING OUTPUT BY SECTORS, VOLUME INDICES 1980 = 100 (Quantified figures of CFI survey)

Manufacturing

Time	Q1	Q2	Q3	Q4
66	61.51	62.27	62.88	64.14
67	63.79	64.39	64.46	64.89
68	64.88	66.18	66.61	67.78
69	68.96	69.96	71.22	72.42
70	73.82	75.16	75.92	76.95
71	75.69	77.20	77.54	78.20
72	79.77	80.11	80.63	82.25
73	83.28	84.22	85.46	87.17
74	88.69	89.43	89.70	90.95
75	91.37	90.94	90.03	90.22
76	89.93	91.09	91.43	91.92
77	91.10	90.74	89.80	89.09
78	88.63	89.50	90.15	91.40
79	92.65	94.51	96.40	98.32
80	98.80	99.99	100.62	100.59
81	99.97	99.75	100.26	100.05
82	98.80	98.27	97.79	97.93
83	97.56	98.42	98.46	99.32
84	99.69	101.00	101.72	102.53

TABLE A.4.b.

Forest industries, volume indices 1980 = 100

Time	Q1	Q2	Q3	Q4
66	58.96	59.76	60.96	62.18
67	61.56	62.15	61.92	62.04
68	61.78	62.75	63.35	64.29
69	65.57	66.57	67.90	69.26
70	70.64	72.06	73.50	74.37
71	75.05	76.44	77.41	77.98
72	79.54	80.56	82.18	83.82
73	85.46	84.59	86.29	87.58
74	89.33	89.94	90.41	92.22
75	92.36	90.51	90.38	89.99
76	89.19	90.58	90.92	91.00
77	89.39	88.17	88.38	87.43
78	87.06	87.75	89.50	90.14
79	91.94	93.78	95.66	97.57
80	97.89	99.84	101.29	100.98
81	100.69	100.64	101.09	100.09
82	98.33	98.36	98.10	99.38
83	98.62	99.30	98.89	99.09
84	99.35	101.22	101.69	102.53

TABLE A.4.c

Metal and engineering industries, volume indices 1980 = 100

Time	Q1	Q2	Q3	Q4
66	69.70	70.56	70.63	71.96
67	71.99	72.83	73.23	74.12
68	74.29	75.78	76.11	77.61
69	78.82	80.01	80.84	82.05
70	82.86	84.15	84.30	85.58
71	83.87	85.55	85.33	86.21
72	87.61	87.43	87.13	88.87
73	89.68	91.47	91.95	93.78
74	94.70	95.95	96.30	97.90
75	98.86	99.19	97.48	98.59
76	97.55	97.94	97.19	97.81
77	97.62	97.19	95.25	94.92
78	93.33	93.81	93.38	93.80
79	93.67	95.21	96.37	98.30
80	99.19	100.09	99.94	100.78
81	100.07	100.85	100.76	101.87
82	101.69	101.27	100.60	100.90
83	100.21	100.82	100.80	101.66
84	101.66	102.08	102.52	103.67

TABLE A.4.d

Other manufacturing industries, volume indices 1980 = 100

Aika	Q1	Q2	Q3	Q4
70	81.39	81.39	82.35	83.95
71	83.90	83.81	84.01	85.52
72	86.86	87.67	87.67	89.43
73	90.17	88.99	88.57	89.81
74	90.32	89.00	87.22	85.47
75	83.76	84.14	84.10	82.41
76	84.06	85.74	87.46	88.56
77	87.61	88.31	87.61	86.46
78	87.97	89.73	90.90	92.72
79	94.58	96.28	98.20	99.58
80	99.70	99.86	100.69	99.75
81	98.64	97.00	98.83	97.89
82	95.94	94.50	93.93	92.29
83	94.06	95.95	96.81	98.75
84	99.90	101.72	103.36	103.58

APPENDIX 5

CALCULATION OF THE REAL USER COST OF CAPITAL

The user cost of capital devised by Jorgenson (1963) has been calculated for the main manufacturing sectors using two different concepts of interest rate, the average bank lending rate (JC_1) and the rate of interest on the total external capital of manufacturing companies calculated from the Balance Sheet Statistics (JC_2).

When the user cost of capital is examined in connection with the determination of investment, it always applies to the expected real cost. Because of unsolved problems relating to expectations formation, experiments were carried out under three different assumptions on inflation expectations. The five-year moving average (Series C_1^1 and C_2^1), the change in the prices of investment goods for the current year (Series C_1^t and C_2^t) and the ARIMA expectation (C_1^a) have been used as proxies for inflation expectations. A more detailed discussion of the calculation of companies' capital costs can be found in Koskenkylä (1985). The user cost of capital has been calculated using the following formula:

$$JC_i = \frac{jc_i}{p} = \frac{q_t(r+\delta-g)(1-\tau Z)}{p(1-\tau)}, \quad i = 1,2,$$

where
- p = price of output
- q = price of investment
- r = average bank lending rate C_1 or the rate of interest in the Balance Sheet Statistics C_2 (in the tables)
- δ = economic rate of depreciation of the capital stock
- g = expected change in the prices of capital goods (three alternatives mentioned above)
- τ = corporate tax rate
- Z = present value of tax depreciations, which is derived from the formula

$$Z = \frac{\alpha}{r+\alpha},$$

where α = the maximum rate of depreciation in taxation on the total undepreciated capital stock (calculated separately for machinery and equipment and buildings, and taking into account the effect of the extra depreciation rights for 1976 - 1984) and r is the rate of interest used for calculation. In the sectoral calculations for the wearing out of the capital stock, use has been made of the Balance Sheet Statistics on industrial manufacturing companies and the data on the capital stock of the Central Statistical Office of Finland. The same price index of manufacturing investments has been used for all manufacturing sectors, because no sectoral data have been published. Tables A.4.a - A.4.c show that the cost of capital is negative in some years, owing to the unusually rapid rates of inflation following the oil crises. If, however, long-term inflation expectations were lower in these years, these theoretically impossible negative "user cost" values did not appear in reality.

TABLE A.5.a. REAL USER COST BY MANUFACTURING SECTOR, CALCULATED ACCORDING TO THE AVERAGE BANK LENDING RATE C_1, AND TOTAL INTEREST COST C_2; IN BOTH THE INFLATION EXPECTATIONS RELATING TO INVESTMENT GOODS IS THE FIVE YEAR MOVING AVERAGE

C_1^1

Time	Manufacturing	Forest industries	Metal and engineering industries	Other manufacturing industries
61	10.96	12.61	11.09	10.29
62	11.63	14.49	11.93	10.50
63	11.95	15.11	11.34	10.96
64	11.74	14.64	11.11	10.97
65	11.72	15.22	11.21	10.57
66	12.53	17.88	11.10	11.16
67	13.37	17.79	11.56	11.53
68	12.50	15.74	11.10	12.28
69	10.65	12.25	9.35	10.66
70	10.05	11.29	8.90	10.08
71	8.99	11.81	7.56	8.46
72	6.44	9.02	5.57	5.72
73	8.20	10.19	7.18	7.75
74	2.47	3.54	2.07	1.96
75	2.05	3.52	1.45	1.58
76	3.44	6.19	2.53	2.84
77	2.46	4.25	2.11	1.71
78	5.83	7.78	5.29	5.10
79	10.07	11.31	9.66	9.59
80	10.65	11.12	10.84	10.17
81	13.72	15.04	14.33	12.63
82	12.56	14.99	12.41	11.64
83	13.87	15.93	13.93	12.89
84	15.11	15.82	15.36	14.55

C_2^1

Time	Manufacturing	Forest industries	Metal and engineering industries	Other manufacturing industries
61	7.73	9.81	6.80	7.16
62	8.01	10.90	7.31	7.07
63	8.55	11.88	7.31	7.61
64	8.12	11.37	6.83	7.33
65	7.65	11.46	6.72	6.46
66	8.44	14.52	6.15	7.11
67	9.52	16.25	7.35	7.87
68	7.96	12.16	6.38	7.35
69	6.95	9.52	5.44	6.58
70	5.81	7.77	4.35	5.66
71	3.67	6.41	2.25	3.20
72	2.13	4.58	1.64	1.13
73	1.37	3.27	0.73	0.65
74	-3.16	-1.28	-3.85	-3.80
75	-3.73	-2.12	-4.55	-4.07
76	-1.86	-0.17	-2.61	-2.20
77	-1.40	0.42	-2.31	-1.84
78	3.50	5.88	2.79	2.59
79	5.92	8.07	5.40	4.88
80	5.22	6.98	4.74	4.34
81	8.70	10.87	8.23	7.79
82	8.68	11.89	7.75	7.77
83	9.03	12.00	9.02	7.60
84	9.99	11.37	10.33	8.95

TABLE A.5.b. REAL USER COST BY MANUFACURING SECTOR; ALL VARIABLES FROM THE CURRENT YEAR

c_1^t Time	Manufac-turing	Forest industries	Metal and engineering industries	Other manufacturing industries
61	10.14	11.62	10.33	9.51
62	8.46	10.39	9.00	7.59
63	12.01	15.19	11.40	11.02
64	10.42	12.93	9.93	9.74
65	9.02	11.64	8.81	8.09
66	15.66	22.33	13.78	14.03
67	13.30	19.68	11.50	11.47
68	0.22	-0.93	0.57	0.77
69	13.70	15.71	11.93	13.79
70	5.89	6.78	5.26	5.74
71	4.83	6.69	4.09	4.26
72	4.10	6.04	3.58	3.41
73	2.18	3.28	1.97	1.60
74	-7.18	-6.51	-6.84	-8.08
75	3.58	5.27	2.84	3.15
76	9.26	14.04	7.49	8.64
77	3.55	5.61	3.13	2.75
78	19.12	23.16	17.47	18.24
79	12.54	13.93	12.00	12.07
80	-1.16	-0.69	-0.97	-1.65
81	21.02	22.76	21.83	19.63
82	11.91	14.22	11.77	11.02
83	21.92	25.12	21.86	20.50
84	16.00	16.75	16.26	15.41

C_2^t

Time	Manufac-turing	Forest industries	Metal and engineering industries	Other manufacturing industries
61	6.96	8.86	6.12	6.43
62	5.08	7.03	4.71	4.40
63	8.61	11.96	7.36	7.66
64	6.90	9.75	5.78	6.20
65	5.19	8.08	4.59	4.23
66	11.31	18.77	8.48	9.70
67	9.45	16.15	7.29	7.81
68	-3.05	-3.56	-2.79	-2.76
69	9.74	12.80	7.74	9.42
70	2.03	3.55	1.14	1.73
71	-0.09	1.67	-0.79	-0.58
72	-0.02	1.78	-0.16	-0.96
73	-3.94	-2.96	-3.78	-4.74
74	-11.72	-10.48	-11.51	-12.69
75	-2.37	-0.52	-3.35	-2.67
76	3.42	7.07	1.80	3.09
77	-0.38	1.72	-1.37	-0.87
78	16.22	20.80	14.34	15.11
79	8.22	10.57	7.57	7.17
80	-5.68	-4.16	-6.03	-6.47
81	15.48	18.18	15.07	14.27
82	8.06	11.14	7.16	7.18
83	16.52	20.76	16.39	14.59
84	10.81	12.25	11.16	9.73

TABLE A.5.c. REAL USER COST BY MANUFACTURING SECTOR; INFLATION EXPECTATIONS RELATING TO INVESTMENT GOODS CALCULATED ACCORDING TO THE ARIMA MODEL

C_1^a

Time	Manufac-turing	Forest industries	Metal and engineering industries	Other manufacturing industries
62	12.22	15.25	12.48	11.04
63	7.45	9.32	7.33	6.79
64	14.50	18.21	13.56	13.54
65	9.99	12.93	9.67	8.98
66	9.57	13.68	8.57	8.45
67	17.46	25.68	15.03	15.21
68	13.00	16.43	11.54	12.76
69	1.46	1.79	1.54	1.21
70	14.32	15.94	12.64	14.54
71	6.47	8.70	5.46	5.92
72	4.07	6.01	3.56	3.39
73	7.03	8.85	6.17	6.56
74	-0.02	0.95	-0.22	-0.63
75	-7.04	-6.90	-6.81	-7.71
76	4.99	8.27	3.85	4.38
77	9.28	12.76	8.48	8.21
78	1.94	3.28	1.73	1.24
79	22.07	24.06	21.03	21.64
80	12.28	12.75	12.47	11.80
81	-1.91	-1.50	-1.71	-2.34
82	20.78	24.66	20.37	19.44
83	10.80	12.42	10.90	9.98
84	25.38	26.64	25.73	24.44

APPENDIX 6

PRINCIPAL COMPONENT ANALYSIS, DATA IN LOGARITHMIC FORM
(Revised estimations of Table 14)

TABLE A.6.a. PRINCIPAL COMPONENT ANALYSIS
(logarithmic difference transformation of the original data)

The characteristic roots of demand and price variables

	Characteristic root	Percentage share of the sum of the characteristic roots
1	4.10	45.5
2	2.35	26.1
3	0.87	9.6
4	0.66	7.3
5	0.55	6.1
6	0.27	3.0
7	0.11	1.2
8	0.06	0.7
9	0.03	0.3

Critical limits of the Burt-Banks test statistics at the 1 per cent level of significance

Component
1 0.56
2 0.60
3 0.64
4 0.69

The loadings for principal components

	1	2	3	4	5	6	7	8	9
MQ	0.48	-0.08	0.11	-0.13	0.07	-0.24	-0.08	-0.17	0.80
CFIQ	0.36	-0.39	0.29	-0.04	0.05	0.09	0.46	0.64	-0.09
GDP	0.40	-0.17	0.37	-0.42	-0.02	-0.08	-0.39	-0.30	-0.50
XQ	0.38	0.17	-0.26	0.48	-0.12	-0.62	-0.16	0.21	-0.25
XM	0.41	0.02	0.08	0.54	-0.26	0.53	0.17	-0.40	-0.04
C	0.07	0.47	0.36	0.21	0.77	0.07	-0.01	0.03	-0.05
W	-0.21	-0.51	0.18	0.42	0.11	0.13	-0.63	0.19	0.13
EP	0.01	-0.55	-0.38	0.09	0.51	-0.17	0.29	-0.40	-0.14
CF	0.35	0.09	-0.62	-0.23	0.21	0.46	-0.31	0.27	-0.01

TABLE A.6.b. REALIZATION FUNCTION AND PRINCIPAL COMPONENT ANALYSIS (Total information set condensed by principal component analysis)

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: principal components of the total information set (surprise $X_t - X_{t-2}$)
Estimation period: 1969 - 1984
Estimation method: OLS

Surprise variables $X_t - X_{t-2}$	Estimated equations A) $_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + a_2\Delta P_1 + a_3\Delta P_2 + a_4\Delta P_3$ (1)	(2)	(3)	(4)	B) $_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + a_2\Delta P_1 + a_3\Delta P_2 + a_4\Delta P_3$ (1)	(2)	(3)	(4)
P_1	5.684	1.611	0.291	3.785	2.318	-0.136	-0.497	2.953
	(3.03)	(1.19)	(0.43)	(3.79)	(1.65)	(0.19)	(1.03)	(3.28)
P_2	-19.18	-4.941	-1.417	-12.84	-16.36	-4.766	-0.200	-11.40
	(2.54)	(0.91)	(0.52)	(3.20)	(2.89)	(1.64)	(0.10)	(3.14)
P_3	-7.443	-8.875	-3.341	4.790	0.556	-2.841	-1.480	4.884
	(1.29)	(2.13)	(1.61)	(1.56)	(0.13)	(1.28)	(1.00)	(1.76)
Constant	2.417	3.044	2.018	-2.652	-1.238	1.749	0.894	-3.883
	(0.51)	(0.89)	(1.18)	(1.05)	(0.35)	(0.96)	(0.74)	(1.71)
R^2C	0.765	0.642	0.408	0.552	0.567	0.573	0.105	0.457
SEE	7.984	5.771	2.876	4.249	5.993	3.077	2.048	3.839
F	22.44	10.30	5.87	11.13	8.95	8.33	1.24	5.82
DW	2.52	2.34	1.72	2.60	2.22	2.08	2.05	1.77

Critical values of the F-test, H_0: a_1, a_2, a_3, a_4 = 0

	$\rho = 0$	$\rho = .30$
$F_{0.95}(2,14)$	= 3.74	~ 7.71
$F_{0.99}(2,14)$	= 6.51	

1 = manufacturing
2 = forest industries
3 = metal and engineering industr
4 = other manufacturing sectors

APPENDIX 7

REALIZATION FUNCTIONS OF INVESTMENT PLANS BY MANUFACTURING SECTORS, DATA IN LOGARITHMIC FORM
(Revised estimations of Tables 17.a - 17.d)

TABLE A.7.a. REALIZATION FUNCTION OF INVESTMENT PLANS OF MANUFACTURING SECTORS

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: demand, user cost and wages (surprise $X_t - X_{t-2}$)
Estimation period: 1972 - 1984
Variables in real terms and logarithmic form
Estimation method: constrained SURE

Surprise variable $X_t - X_{t-2}$	Estimated equations A) $_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i}-X_{t-2,i})$			B) $_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i}-X_{t-2,i})$		
	(1)	(2)	(3)	(1)	(2)	(3)
CFIQ	2.645	4.639	2.615	1.190	1.185	1.767
	(1.81)	(9.80)	(3.00)	(1.53)	(1.67)	(3.17)
JC_1	-0.401	0.112	0.036	-0.260	0.003	0.018
	(2.87)	(4.56)	(0.62)	(3.49)	(0.07)	(0.47)
W	-0.527	-1.818	-1.574	0.218	-0.674	-0.849
	(1.29)	(5.52)	(1.06)	(1.01)	(1.37)	(0.90)
Constant	0.204	0.123	0.144	0.063	0.033	0.040
	(2.45)	(3.39)	(1.18)	(1.42)	(0.61)	(0.50)
R^2	0.650	0.929	0.501	0.579	0.387	0.530
SEE	0.227	0.054	0.159	0.121	0.080	0.102
LF	3.22	21.99	7.86	11.43	16.74	13.64

1 = forest industries
2 = metal and engineering industries
3 = other manufacturing industries

TABLE A.7.b. SYSTEM ESTIMATION OF THE REALIZATION FUNCTION

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: demand, user cost and wages (surprise $X_t - X_{t-2}$)
Estimation period: 1972 - 1984
Variables in real terms and logarithmic form
Estimation method: contrained SURE

Surprise variable $X_t - X_{t-2}$	Estimated equations A) $_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$ (1)	(2)	(3)	B) $_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$ (1)	(2)	(3)
CFIQ	0.308	4.602	3.076	1.492	0.293	1.649
	(2.63)	(11.73)	(4.32)	(3.20)	(0.59)	(3.59)
JC_1	-0.427	0.111	0.045	-0.271	-0.016	-0.015
	(3.69)	(5.43)	(0.92)	(4.83)	(0.49)	(0.47)
W	-0.400	-1.845	-1.420	0.325	0.142	-1.329
	(1.20)	(6.84)	(1.17)	(2.35)	(0.42)	(1.78)
Constant	0.185	0.127	0.110	0.048	-0.018	0.085
	(2.69)	(4.23)	(1.10)	(1.44)	(0.45)	(1.35)
Total model				Total model		
R^2 0.676				R^2 0.521		
SEE 0.165				SEE 0.108		
LF 22.16				LF 38.51		

1 = forest industries
2 = metal and engineering industries
3 = other manufacturing industries

TABLE A.7.c. CONSTRAINED SYSTEM ESTIMATION OF THE REALIZATION FUNCTION (Demand parameters constrained to be equal by sectors)

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: demand, user cost and wages (surprise $X_t - X_{t-2}$)
Estimation period: 1972 - 1984
Variables in real terms and logarithmic form
Estimation method: constrained SURE

Estimated equations

Surprise variable $X_t - X_{t-2}$	A) ${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$			B) ${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$		
	(1)	(2)	(3)	(1)	(2)	(3)
CFIQ	3.878	R	R	0.970	R	R
	(13.18)			(3.79)		
JC_1	-0.463	0.090	0.059	-0.244	0.005	0.004
	(4.43)	(4.28)	(1.13)	(4.50)	(0.19)	(0.11)
W	-0.163	1.601	-2.089	0.227	0.021	-1.551
	(0.55)	(5.70)	(1.79)	(1.86)	(0.06)	(2.03)
Constant	0.149	0.125	0.128	0.067	-0.028	0.134
	(2.51)	(3.98)	(1.26)	(2.26)	(0.73)	(2.03)
Total model				Total model		
R^2	0.639			R^2	0.492	
SEE	0.169			SEE	0.108	
LF	19.70			LF	37.27	

1 = forest industries
2 = metal and engineering industries
3 = other manufacturing industries

TABLE A.7.d. CONSTRAINED SYSTEM ESTIMATION OF THE REALIZATION FUNCTION (Wage parameters constrained to be equal by sectors)

Dependent variable: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: demand, user cost and wages (surprise $X_t - X_{t-2}$)
Estimation period: 1972 - 1984
Variables in real terms and logarithmic form
Estimation method: constrained SURE

Estimated equations

Surprise variable $X_t - X_{t-2}$	A) $_tIRQ^s_{t+1} - {_tIPF^s_{t-1}} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i}-X_{t-2,i})$			B) $_tIRQ^a_{t+1} - {_tIPF^a_{t-1}} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i}-X_{t-2,i})$		
	(1)	(2)	(3)	(1)	(2)	(3)
CFIQ	1.230	4.437	2.721	1.572	0.202	1.489
	(0.93)	(10.18)	(4.00)	(3.29)	(0.38)	(3.20)
JC_1	-0.297	0.106	0.037	-0.272	-0.020	0.008
	(2.24)	(4.65)	(0.78)	(4.84)	(0.57)	(0.26)
W	-1.336	R	R	0.319	R	R
	(5.64)			(2.29)		
Constant	0.292	0.083	0.120	0.047	-0.033	-0.044
	(3.90)	(2.87)	(2.33)	(1.38)	(1.05)	(1.25)
Total model				Total model		
R^2	0.612			R^2 0.489		
SEE	0.179			SEE 0.108		
LF	17.57			LF 37.24		

1 = forest industries
2 = metal and engineering industries
3 = other manufacturing industries

APPENDIX 8

ALTERNATIVE WAYS OF MEASURING UNCERTAINTY ABOUT DEMAND

Variables based on ex post data

In the literature, a frequently used method for measuring uncertainty is to calculate the forecast error of an ARIMA model. The size of the forecast error then indicates the uncertainty about the future (or, more precisely the difficulty of forecasting the future). The underlying idea is that the economic agent knows the model and only stochastic deviations from the model's forecast path are considered real surprises. Assuming cost minimization, the model is usually assumed to be of the AR(1) type. This is also the case here. In order to obtain forecasts calculated on the basis of historical data known to the economic agent at the time of decision-making, the model must be estimated by recursive regression analysis or by stepwise regression. Here we use the latter technique solely for practical reasons. It can be also argued that agents do not use earlier data in their "model" because it no longer belongs to the sphere of their experience. The model is estimated for the period 1950Q1 - 1983Q4 so that one observation is omitted from the beginning and one observation is added to the end starting with the period 1950Q1 - 1963Q4. A forecast for one year ahead is made with each model application and the standard deviation of the forecast is calculated.

The model is applied to one of the demand indicators, industrial output, on which quarterly data are available from the 1950s onwards. The time series on total manufacturing output is used to describe demand in all industries because it can be considered to be exogeneous from the point of view of an individual company.

For the application of the ARIMA model, the time series are first made stationary by taking its logarithm and four-quarter difference. The differencing was not sufficient to eliminate seasonality and so it was complemented by the inclusion of a moving average seasonal term. On the basis of an examination of autocorrelation and partial autocorrelation functions, the AR(1) model seems to be suited to the data.

TABLE A.8.a. PARAMETER ESTIMATES OF STEPWISE ESTIMATED AR(1) MODEL FOR VOLUME OF INDUSTRIAL PRODUCTION.
First estimation period 1950Q1 - 1963Q4

Latest point in time in estimation	Q1	Q2	Q3	Q4
63				0.99
64	0.99	0.98	0.98	0.98
65	0.98	0.99	0.99	0.99
66	1.00	0.99	0.99	0.98
67	1.00	0.98	0.98	0.99
68	0.98	0.98	0.97	0.98
69	0.97	0.98	0.98	0.97
70	0.88	0.88	0.88	1.00
71	0.99	0.88	0.88	0.88
72	0.88	0.97	0.97	0.97
73	0.97	0.98	0.96	0.98
74	0.99	0.98	0.88	0.88
75	0.88	0.83	0.83	0.83
76	0.88	0.88	0.90	0.88
77	0.90	0.90	0.90	0.90
78	0.95	0.96	0.95	0.95
79	0.96	0.96	0.95	0.96
80	0.96	0.95	0.83	0.88
81	0.83	0.88	0.88	0.83
82	0.83	0.88	0.99	0.79
83	0.92	0.90	0.79	0.78
84	0.78	0.78	0.78	

TABLE A.8.b. BOX-PIERCE STATISTICS FOR RESIDUAL OF STEPWISE ESTIMATED AR(1) MODEL.
First estimation period 1950Q1 - 1963Q4.

Latest point in time in estimation	Q_1	Q_2	Q_3	Q_4
63				9.84
64	14.44	15.35	14.95	14.24
65	16.01	16.92	16.43	16.02
66	17.98	18.35	19.67	19.26
67	19.10	18.01	19.00	17.31
68	17.37	18.20	16.80	16.81
69	9.87	9.58	12.38	11.93
70	7.47	8.24	9.70	7.14
71	3.20	8.98	6.87	5.77
72	6.51	8.92	7.05	7.78
73	9.89	16.39	16.40	17.52
74	15.57	14.05	13.78	14.34
75	11.76	12.62	12.69	12.51
76	13.37	13.46	13.24	13.00
77	12.72	12.87	12.90	13.56
78	12.35	12.55	12.52	12.77
79	12.74	13.20	12.17	12.50
80	12.86	12.39	13.95	14.88
81	11.58	13.14	13.74	12.67
82	12.31	15.41	11.90	6.64
83	14.12	16.01	12.13	13.42
84	11.77	10.80	11.52	

TABLE A.8.c. STANDARD ERRORS OF ONE YEAR AR(1) FORECAST FOR INDUSTRIAL PRODUCTION.
Stepwise estimation beginning from period 1950Q1 - 1963Q4

Latest point in time in estimation	Q1	Q2	Q3	Q4
64				0.140
65	0.131	0.128	0.129	0.129
66	0.128	0.128	0.126	0.124
67	0.122	0.122	0.122	0.121
68	0.124	0.121	0.121	0.122
69	0.120	0.121	0.119	0.120
70	0.109	0.089	0.089	0.079
71	0.065	0.067	0.067	0.060
72	0.068	0.068	0.066	0.066
73	0.070	0.070	0.070	0.070
74	0.070	0.073	0.073	0.073
75	0.074	0.075	0.070	0.070
76	0.071	0.067	0.069	0.069
77	0.074	0.073	0.076	0.074
78	0.078	0.078	0.078	0.078
79	0.080	0.082	0.080	0.081
80	0.083	0.083	0.081	0.082
81	0.082	0.081	0.074	0.072
82	0.073	0.078	0.077	0.072
83	0.071	0.076	0.081	0.067
84	0.076	0.075	0.065	0.062
85	0.062	0.062	0.062	

TABLE A.8.d. MOVING 12-QUARTER VARIANCES OF MANUFACTURING OUTPUT BY SECTOR
(calculated on the basis of quarterly data)

Time	Manufac-turing	Forest industries	Metal and engineering industries	Other manufacturing industries
1964	0.21	3.87	1.28	1.27
1965	0.24	9.27	1.24	2.36
1966	0.15	12.23	0.89	2.94
1967	0.21	12.82	0.72	3.18
1968	0.23	7.06	0.70	2.49
1969	0.61	4.52	1.14	1.98
1970	0.83	1.27	2.10	1.31
1971	1.26	1.27	10.29	1.44
1972	1.75	1.14	19.82	1.41
1973	1.48	0.85	19.60	1.46
1974	0.90	0.93	10.22	1.20
1975	1.06	8.91	0.41	1.01
1976	1.12	9.66	0.69	0.59
1977	0.75	10.23	1.03	0.60
1978	0.55	5.73	0.43	0.55
1979	0.91	2.18	0.98	0.76
1980	0.71	1.56	1.25	0.50
1981	0.48	2.02	0.71	0.31
1982	0.52	2.87	0.86	0.28
1983	0.32	2.15	1.52	0.19
1984	0.18	2.53	1.14	0.14

Another frequently used ex post variable is the moving variance of the time series. When using the moving variance it is implicitly assumed that the time series process generating the data is stationary. The moving variance was calculated for the volume series of sectoral industrial output after the basic series had first been made stationary by taking their logarithms and four-quarter differences. The three-year moving variances calculated for the volume series of industrial output have been placed at the end of the period.

Variables based on ex ante data

An alternative way of measuring uncertainty is to use data which directly reflect companies' views on the near future. If expectations concerning the future differ drastically from one company to another it may either be an indication of changes in divergent developments between sectors or of growing uncertainty. Expectations about the future are also compared with companies subsequent responses on actual developments, in which a time series corresponding to the surprise variable calculated above with the ARIMA models is obtained. Now, however, the "model" is more versatile because the expectations of the information set of corporate managers is certainly larger than the history of one time series.

The data used are the one-quarter sectoral output expectations and output realizations obtained in the survey by the Confederation of Finnish Industries. The variance of expectations was calculated by quantifying the weighted sign disturbances (Appendix 4) and by calculating the variance according to the formula (Carlson and Parkin (1975) and Jalas (1981))

$$\sigma = \frac{l_1 - l_2}{k^- - k^+},$$

where $k^- - k^+ \neq 0$ and k^- and k^+ are weighted sign disturbances (+ and - signs) and $l_1 - l_2$ describes the indifference interval. Similarly, the surprise variable was calculated by subtracting the actual figure for each quarter from the expectation for the quarter after first quantifying the weighted sign disturbances.

TABLE A.8.e. VARIANCE OF OUTPUT EXPECTATIONS BY SECTORS OF SECTOR (CFI survey)

Time	Manufacturing	Forest industries	Metal and engineering industries	Other manufacturing industries
67	1.15		3.29	1.92
68	1.23		2.76	1.98
69	1.09		4.51	2.05
70	0.92	3.45	3.69	2.43
71	1.04	2.53	3.82	2.06
72	1.08	4.19	2.71	2.24
73	1.14	3.47	3.40	2.00
74	1.10	3.56	4.15	1.92
75	1.08	2.21	3.13	2.01
76	1.29	1.65	2.72	2.00
77	1.42	1.83	1.96	2.05
78	1.25	2.42	2.05	2.20
79	1.14	2.44	2.67	2.00
80	1.04	2.86	2.77	2.23
81	1.18	2.18	2.92	1.99
82	1.23	1.41	2.86	2.10
83	0.95	2.24	3.33	2.60
84	0.98	2.62	3.14	2.46

TABLE A.8.f. DEVIATION OF OUTPUT EXPECTATIONS FROM REALIZATIONS (CFI survey)

Time	Manufacturing	Forest industries	Metal and engineering industries	Other manufacturing industries
67	4.29		-2.95	
68	3.50		-3.61	
69	2.67		-4.91	
70	2.19		-4.20	
71	4.14	13.19	-0.93	-20.33
72	2.57	9.51	-1.48	-21.99
73	2.68	7.53	-1.04	-16.91
74	2.78	4.47	-0.11	-8.96
75	3.93	-1.16	1.37	-3.06
76	4.05	-0.01	2.78	-2.08
77	4.65	2.31	2.39	2.80
78	4.80	5.77	1.19	4.47
79	1.20	2.55	-0.86	0.92
80	0.34	-0.38	-0.60	-0.08
81	0.02	-1.80	-0.08	1.97
82	0.53	-4.75	0.07	6.91
83	0.00	-6.16	-0.36	6.07
84	1.90	-6.16	-1.86	1.63

APPENDIX 9

THE TIME SERIES NATURE OF SHOCK AND UNCERTAINTY VARIABLES

The time series nature of variables is examined by applying ARIMA models. For this reason, their stochasticity is first tested by means of the Box-Pierce Portmanteau test statistic. The following table shows the Box-Pierce test statistics of time series calculated from quarterly data for the period 1970Q1 - 1984Q4.

TABLE A.9.1.

Confederation of Finnish Industries Variance of output expectations	Box-Pierce 12 degrees of freedom	$\chi^2_{0.95}(12) = 21.03$
Manufacturing	23.85	
Forest industries	19.98	
Metal and engineering industries	27.43	
Other manufacturing industries	5.60	
Confederation of Finnish Industries Deviation from output expectations		
Manufacturing	196.30	
Forest industries	182.12	
Metal and engineering industries	138.25	
Other manufacturing industries	336.94	

Industrial output Moving volume index 12-quarter variance	Box-Pierce 12 degrees of freedom	$\chi^2_{0.95}(12) = 21.03$
Manufacturing	174.91	
Forest industries	193.29	
Metal and engineering industries	215.31	
Other manufacturing industries	290.46	
Standard deviation of the 4-quarter moving AR(1) forecast		
Manufacturing	38.50	

The table shows that two of the time series tested are stochastic in terms of the test employed. The respective series are both variances of output expectations in the survey data of the Confederation of Finnish Industries concerning the forest industries and other manufacturing industries. ARIMA models are applied to other time series.

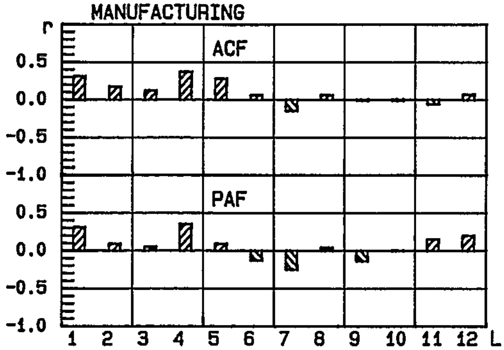
The figures below show the autocorrelation and partial autocorrelation functions of variables and are followed by the time series models best suited to the data. These series are by nature stationary, because they have been deflated to eliminate the impact of inflation and because they describe variances and deviations from expectations. The trend factor has been eliminated from the moving variances series before the formation of the variance. Attempts are made to adjust for seasonal variation in connection with the time series models to be estimated.

CHART A.9.a. UNCERTAINTY CONCERNING DEMAND

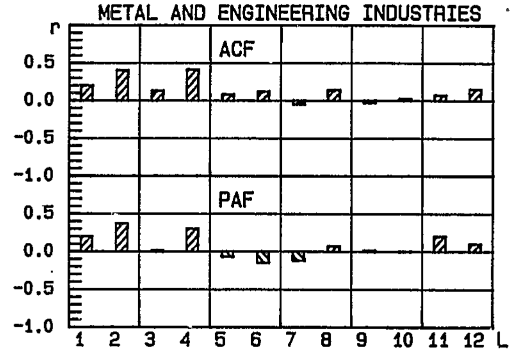
AUTOCORRELATION AND PARTIAL AUTOCORRELATION FUNCTIONS

UC1 CFI, VARIANCE OF OUTPUT EXPECTATIONS

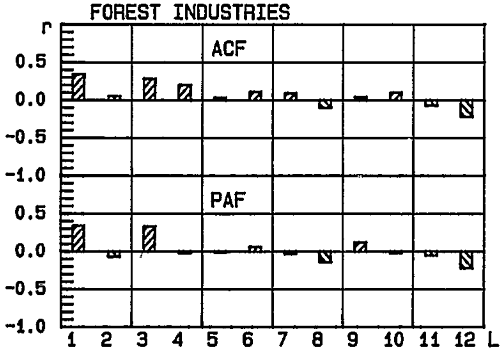
MANUFACTURING



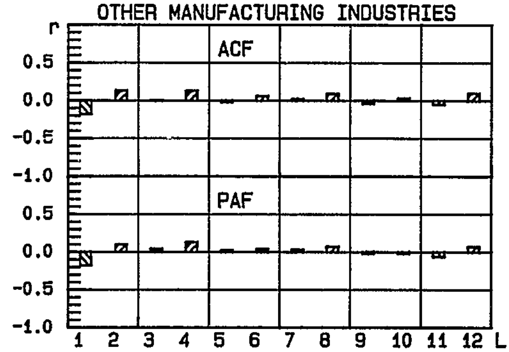
METAL AND ENGINEERING INDUSTRIES



FOREST INDUSTRIES

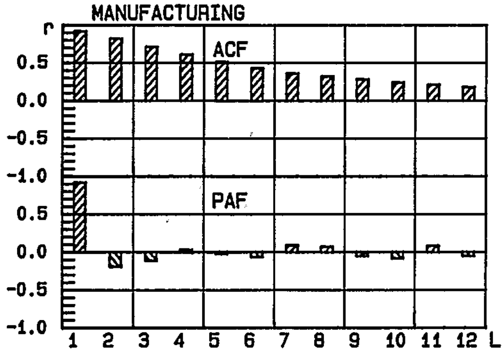


OTHER MANUFACTURING INDUSTRIES

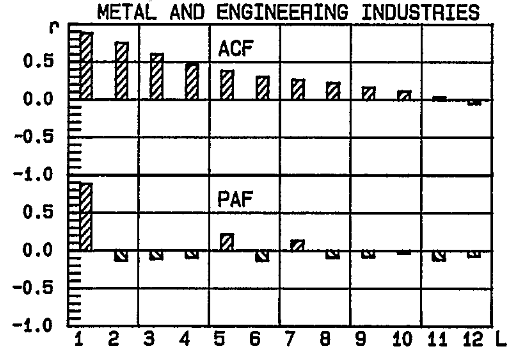


UC2 CFI, DEVIATION OF OUTPUT EXPECTATIONS

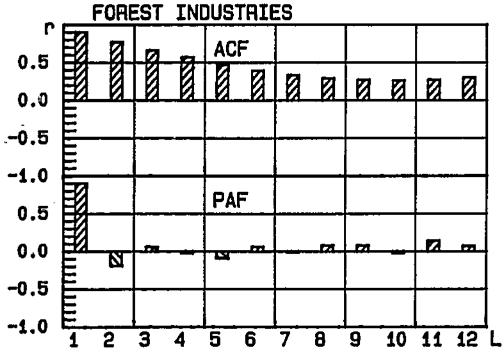
MANUFACTURING



METAL AND ENGINEERING INDUSTRIES



FOREST INDUSTRIES



OTHER MANUFACTURING INDUSTRIES

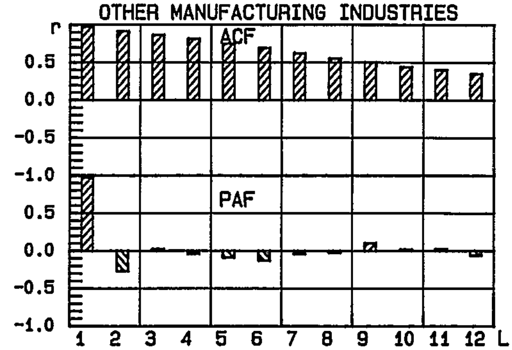
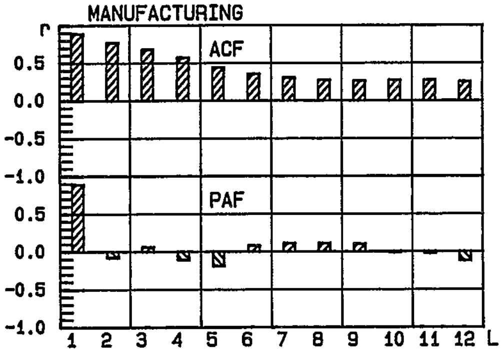


CHART A.9.b. UNCERTAINTY CONCERNING DEMAND

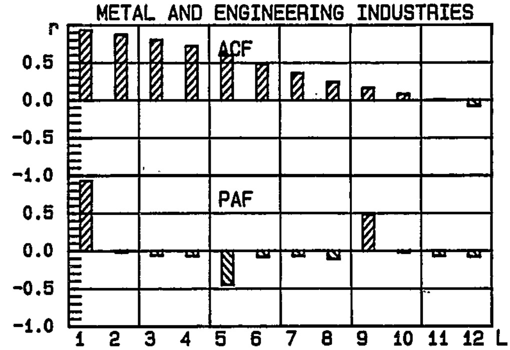
AUTOCORRELATION AND PARTIAL AUTOCORRELATION FUNCTIONS

UC3 MOVING VARIANCE OF INDUSTRIAL PRODUCTION

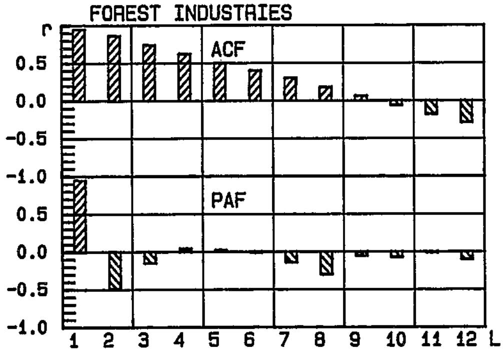
MANUFACTURING



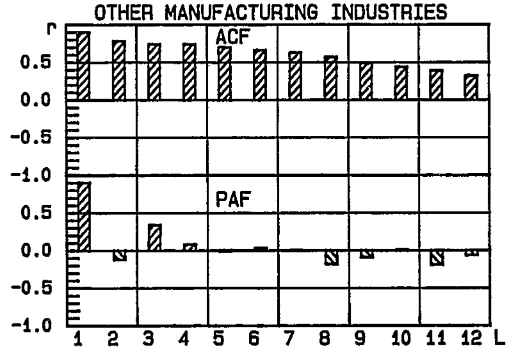
METAL AND ENGINEERING INDUSTRIES



FOREST INDUSTRIES

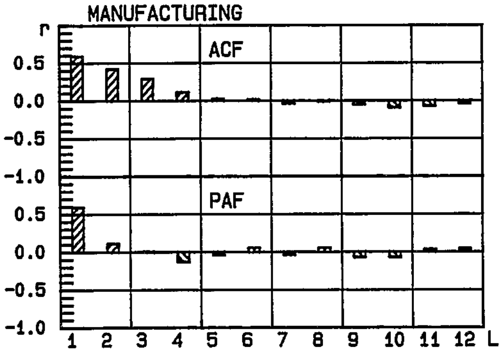


OTHER MANUFACTURING INDUSTRIES



UC4 AR (1) FORECAST ERROR

MANUFACTURING



The variance of output expectations (for one quarter) in the survey data of the Confederation of Finnish Industries

Manufacturing

$$(1 - \underset{(34.69)}{0.963}L)UC1 = (1 - \underset{(3.28)}{0.369}L^4)\varepsilon_t$$

$Q(10) = 18.72 \qquad \chi^2_{0.95}(10) = 18.31$

Forest industries

Stochastic according to the Box-Pierce test criteria

Metal and engineering industries

$$(1 - 0.967L)UC1 = (1 + 0.499L)\varepsilon_t$$

$Q(10) = 26.65 \qquad \chi^2_{0.95}(10) = 18.31$

Other manufacturing industries

Stochastic according to the Box-Pierce test criteria

Deviation of output expectations of the CFI

Manufacturing

$$(1 - \underset{(10.77)}{1.321}L + \underset{(2.95)}{0.358}L^2)UC2 = \varepsilon_t$$

$Q(10) = 10.41 \qquad \chi^2_{0.95}(10) = 18.31$

Forest industries

$$(1 - \underset{(56.92)}{0.949}L)UC2 = \varepsilon_t$$

$Q(10) = 9.41 \qquad \chi^2_{0.95}(10) = 18.31$

Metal and engineering industries

$$\underset{(46.89)}{(1 - 0.939L)}UC2 = \varepsilon_t$$

$Q(10) = 7.59$ $\qquad\qquad \chi^2_{0.95}(10) = 18.31$

Other manufacturing industries

$$(1 - \underset{(11.48)}{1.372L} + \underset{(3.48)}{.408L^2})UC2 = \varepsilon_t$$

$Q(10) = 5.91$ $\qquad\qquad \chi^2_{0.95}(10) = 18.31$

Moving variance of manufacturing output

Manufacturing

$$(1 - \underset{(48.09)}{0.974L})UC3 = \varepsilon_t$$

$Q(10) = 12.41$ $\qquad\qquad \chi^2_{0.95}(10) = 18.31$

Forest industries

$$(1 - \underset{(12.18)}{1.415L} + \underset{(4.22)}{0.488L^2})UC3 = \varepsilon_t$$

$Q(10) = 11.98$ $\qquad\qquad \chi^2_{0.95}(10) = 18.31$

Metal and engineering industries

$$(1 - \underset{(50.82)}{0.960L})UC3 = (1 + \underset{(6.10)}{0.560L^4})\varepsilon_t$$

$Q(10) = 29.19$ $\qquad\qquad \chi^2_{0.95}(10) = 18.31$

Other manufacturing industries

$$(1 - \underset{(93.49)}{0.952L})UC3 = (1 + \underset{(4.16)}{0.425L^2})\varepsilon_t$$

$Q(10) = 10.44$ $\qquad\qquad \chi^2_{0.95}(10) = 18.31$

Standard deviation of the ARIMA forecast

$$\underset{(148.58)}{(1 - 0.947L)}UC4 = \varepsilon_t$$

$Q(11) = 8.99$ $\qquad\qquad$ $\chi^2_{0.95}(11) = 19.67$

In the estimation results, Q(10) denotes the Box-Pierce test statistic with 10 degrees of freedom. t-values are shown in parentheses beneath each parameter estimate. The results show that a AR process can be observed in all the time series, and that in addition a MA(q) process can be observed in the variance variables. The white noise hypothesis of the residual had to be rejected in three cases. However, this is not particularly important in the present context. What is of importance is the fact that the time series constructed give a very different picture of the uncertainty about demand at each time.

APPENDIX 10

REALIZATION FUNCTIONS AND UNCERTAINTY ABOUT DEMAND

Table A.10.a. REALIZATION FUNCTIONS AND UNCERTAINTY ABOUT DEMAND; "UNCERTAINTY" VARIABLE = VARIANCE OF OUTPUT EXPECTATIONS

Constrained systems estimation (parameters for demand and unit wages restricted so that they are equal in all sectors)

Dependent variables: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year

Independent variables: demand, prices of factors of production and "uncertainty" about demand

Variables in real terms

Estimation period: 1972 - 1984

Estimation method: SURE

	Estimated equations					
	A)			B)		
Surprise and "uncertainty" variables	${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$			${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$		
	(1)	(2)	(3)	(1)	(2)	(3)
Demand (CFIQ)	75.63	R	R	-5.614	R	R
	(6.78)			(0.72)		
User cost	-167.8	10.63	-2.200	-106.1	-23.41	5.496
	(4.12)	(0.82)	(0.06)	(3.57)	(1.42)	(0.17)
Wages	-26.36	R	R	10.28	R	R
	(3.64)			(3.03)		
Uncertainty	-2.723	0.896	2.792	3.492	0.228	-12.89
	(1.53)	(1.55)	(0.49)	(6.01)	(0.68)	(2.61)
Constant	571.0	233.4	341.6	343.4	14.11	187.0
	(3.68)	(3.53)	(2.36)	(2.79)	(0.20)	(1.45)
R^2	0.676	0.859	0.470	0.316	0.025	0.172
SEE	1365.0	344.5	1181.0	1111.0	572.1	1085.0
LF	-100.1	-82.23	-98.25	-97.45	-88.82	-97.14

Total model

	A)	B)
R^2	0.643	0.266
SEE	491.2	442.3
LF	-290.6	-286.5

(1) = forest industries
(2) = metal and engineering industries
(3) = other manufacturing industries

TABLE A.10.b REALIZATION FUNCTIONS AND UNCERTAINTY ABOUT DEMAND, "UNCERTAINTY" VARIABLE = DEVIATION OF OUTPUT EXPECTATIONS

Constrained systems estimation (parameters for demand and unit wages restricted so that they are equal in all sectors)

Dependent variables:	A) final investments less plans made in the spring of the previous year B) final investments less plans made in the autumn of the previous year
Independent variables:	demand, prices of factors of production and "uncertainty" about demand
Estimation period:	1972 - 1984
Variables in real terms	
Estimation method:	SURE

Estimated equations

Surprise and "uncertainty" variables	A) $_{t}IRQ^{s}_{t+1} - {}_{t}IPF^{s}_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i}-X_{t-2,i})$			B) $_{t}IRQ^{a}_{t+1} - {}_{t}IPF^{a}_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i}-X_{t-2,i})$		
	(1)	(2)	(3)	(1)	(2)	(3)
Demand (CFIQ)	63.97	R	R	21.90	R	R
	(6.26)			(4.09)		
User cost	-149.5	9.192	6.386	-93.33	-3.201	48.39
	(3.15)	(0.54)	(0.11)	(4.55)	(0.25)	(1.30)
Wages	-8.124	R	R	3.565	R	R
	(1.33)			(1.43)		
Uncertainty	2.167	24.89	-1.447	7.472	121.2	-10.34
	(0.24)	(0.82)	(0.20)	(2.33)	(6.28)	(2.18)
Constant	499.9	110.2	247.3	225.0	-67.32	78.09
	(2.67)	(1.39)	(1.40)	(2.69)	(1.25)	(0.63)
R^2	0.613	0.745	0.408	0.677	0.444	0.383
SEE	1531.0	522.8	1232.0	703.2	429.9	915.0
LF	-101.6	-87.65	-98.80	-91.50	-85.11	-94.93

Total model

	A)	B)
R^2	0.580	0.557
SEE	543.5	329.1
LF	-294.5	-274.9

(1) = forest industries
(2) = metal and engineering industries
(3) = other manufacturing industries

TABLE A.10.c REALIZATION FUNCTIONS AND UNCERTAINTY ABOUT DEMAND; "UNCERTAINTY" VARIABLES = MOVING VARIANCE OF OUTPUT

Constrained systems estimation (parameters for demand and unit wages restricted so that they are equal in all sectors)

Dependent variables: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: demand, prices of factors of production and "uncertainty" about demand
Estimation period: 1972 - 1984
Variables in real terms
Estimation method: SURE

	Estimated equations					
	A)			B)		
Surprise and "uncertainty" variables	${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$			${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i} - X_{t-2,i})$		
	(1)	(2)	(3)	(1)	(2)	(3)
Demand (CFIQ)	66.61	R	R	-2.812	R	R
	(9.13)			(0.46)		
User cost	-113.8	15.68	-29.84	-103.0	-16.79	-38.00
	(2.48)	(1.42)	(1.23)	(4.15)	(1.36)	(1.40)
Wages	-19.48	R	R	-6.072	R	R
	(3.17)			(1.55)		
Uncertainty	0.077	-0.011	1.919	0.017	-0.018	1.657
	(2.07)	(3.21)	(4.85)	(0.89)	(6.33)	(4.57)
Constant	531.6	181.7	716.5	388.5	87.13	573.8
	(3.20)	(2.98)	(5.47)	(4.40)	(1.58)	(4.32)
R^2	0.636	0.891	0.758	0.608	0.506	0.415
SEE	1491.0	347.3	808.5	338.6	406.1	905.1
LF	-101.3	-82.33	-93.32	-92.98	-84.37	-94.78

Total model

	A)	B)
R^2	0.684	0.545
SEE	462.7	338.6
LF	-288.2	-276.0

(1) = forest industries
(2) = metal and engineering industries
(3) = other manufacturing industries

TABLE A.10.d REALIZATION FUNCTIONS AND UNCERTAINTY ABOUT DEMAND, "UNCERTAINTY" VARIABLES = STANDARD DEVIATION OF ARIMA FORECAST

Constrained systems estimation (parameters for demand and unit wages restricted so that they are equal in all sectors)

Dependent variables: A) final investments less plans made in the spring of the previous year
B) final investments less plans made in the autumn of the previous year
Independent variables: demand, prices of factors of production and "uncertainty" about demand
Estimation period: 1972 - 1984
Variables in real terms
Estimation method: SURE

	Estimated equations					
	A)			B)		
Surprise and "uncertainty" variables	${}_tIRQ^s_{t+1} - {}_tIPF^s_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i}-X_{t-2,i})$			${}_tIRQ^a_{t+1} - {}_tIPF^a_{t-1} = a_1 + \sum_{i=2}^{n} a_i(X_{t,i}-X_{t-2,i})$		
	(1)	(2)	(3)	(1)	(2)	(3)
Demand (CFIQ)	71.08	R	R	17.34	R	R
	(7.86)			(2.43)		
User cost	-169.0	6.988	3.805	-119.4	-24.10	-17.54
	(3.96)	(0.52)	(0.10)	(5.39)	(1.72)	(0.56)
Wages	-17.74	R	R	2.372	R	R
	(2.40)			(0.51)		
Uncertainty	-7.983	20.61	-12.92	16.65	30.36	21.22
	(0.15)	(1.51)	(0.31)	(0.56)	(2.05)	(0.61)
Constant	557.4	181.4	301.2	314.4	-0.020	121.0
	(3.43)	(2.45)	(2.04)	(3.76)	(0.01)	(0.99)
R^2	0.641	0.844	0.450	0.654	0.431	0.366
SEE	1438.0	392.4	1193.0	727.5	432.2	1013.0
LF	-100.8	-83.92	-98.38	-91.94	-85.18	-96.24

Total model

	A)	B)
R^2	0.616	0.492
SEE	510.3	352.7
LF	-292.0	-277.6

(1) = forest industries
(2) = metal and engineering industries
(3) = other manufacturing industries

APPENDIX 11

REALIZATION FUNCTIONS OF INVESTMENT PLANS BY MANUFACTURING SECTOR
Estimation results of the adjustment and innovation parameters (equation (98))

Dependent variable: final investments
Independent variables: A) investment plans made in the spring of the previous year
B) investment plans made in the autumn of the previous year and demand, user cost, wages (surprise $X_t - X_{t-2}$)
Variables in real terms, logarithmic form
Estimation period: 1972 - 1984
Estimation method: OLS

Estimated equations

A) $_tIRQ^s_{t+1} = a_1 + a_2\ {}_tIPF^s_{t-1} + \sum_{i=3}^{5} a_i(X_{t,i} - X_{t-2,i})$

B) $_tIRQ^a_{t+1} = a_1 + a_2\ {}_tIPF^a_{t-1} + \sum_{i=3}^{5} a_i(X_{t,i} - X_{t-2,i})$

Investment plans	A) (1)	A) (2)	A) (3)	A) (4)	B) (1)	B) (2)	B) (3)	B) (4)
$_tIPF^s_{t-1}$	0.793	0.542	1.030	0.652				
	(5.15)	(2.45)	(11.80)	(3.41)				
	(6.30)	(2.98)	(19.29)	(5.45)				
$_tIPF^a_{t-1}$					0.826	0.816	0.950	0.822
					(11.60)	(6.14)	(6.84)	(6.16)
					(17.03)	(6.38)	(7.87)	(9.53)
Surprise variables								
CFIQ	2.889	0.893	4.726	2.326	1.454	0.742	1.246	1.784
	(3.77)	(0.59)	(8.43)	(2.94)	(4.51)	(0.92)	(1.63)	(3.33)
	(4.19)	(0.72)	(20.84)	(3.78)	(6.80)	(1.23)	(2.25)	(5.11)
C	-0.042	-0.290	0.122	-0.005	-0.060	-0.239	-0.007	0.006
	(0.84)	(2.21)	(3.13)	(0.09)	(2.66)	(3.29)	(0.15)	(0.15)
	(1.39)	(2.67)	(4.38)	(0.17)	(3.95)	(4.02)	(0.25)	(0.14)
W	-0.661	-0.178	-1.830	-1.405	-0.062	0.219	-0.733	-0.864
	(1.34)	(0.46)	(5.25)	(1.06)	(0.26)	(1.06)	(1.35)	(0.95)
	(2.48)	(0.66)	(7.28)	(1.11)	(0.37)	(1.30)	(2.90)	(1.23)
Constant	1.941	3.820	-0.108	2.956	1.585	1.543	0.427	1.494
	(1.39)	(2.19)	(0.16)	(1.91)	(2.44)	(1.45)	(0.39)	(1.37)
	(1.68)	(2.61)	(0.26)	(3.08)	(3.58)	(1.47)	(0.46)	(2.11)
R^2C	0.801	0.414	0.966	0.596	0.948	0.810	0.922	0.809
SEE	0.096	0.194	0.056	0.142	0.048	0.115	0.084	0.098
DW	1.364	1.825	2.333	1.423	2.788	1.939	1.249	1.854
LM	0.068	1.330	2.525	0.081	1.206	3.616	0.028	0.118

$\chi^2_{0.95}(1) = 3.84$

1 = manufacturing
2 = forest industries
3 = metal and engineering industries
4 = other manufacturing industries

t-ratios are in parentheses immediately below the coefficient estimates, below them are White's t-ratios adjusted for heteroscedasticity

APPENDIX 12

FORMING THE QUARTERLY DATA BY MANUFACTURING SECTOR FOR EULER EQUATION ESTIMATIONS

Most of the quarterly data are approximated by using suitable reference series for annual data. Where suitable reference series could not be found, the annual data were converted to quarterly data by disaggregating it using a mechanical procedure which took care of original annual changes. There are only two such series and the disaggregated series are almost constants.

The net capital stock series of manufacturing and the main manufacturing sector were converted to quarterly level by using quarterly gross investments as a reference series. The reference series, quarterly gross investment, was obtained by weighting together quarterly indices of investments in machinery and equipment in the economy and the net value added series of industrial construction using the shares of machinery and equipment investment and construction investment in total industrial investment as weights. The weights were calculated by manufacturing sector.

The reference series for the quarterly price index of industrial investment goods was obtained by weighting together the wholesale price index of machinery and equipment and the construction cost index with the share of these goods in total manufacturing investment. The annual changes correspond to the deflator of manufacturing investments published in the official statistics. The total manufacturing series are also used in the sectoral models.

The producer price index was used as a reference series in forming the quarterly industrial production price index.

The wage concept used here is total labour costs per hour, including employers' contributions to social security schemes. Manufacturing earnings serve as a quarterly reference series for the annual series. The total industrial earnings index are used as a reference series for sectoral wages.

The tax depreciation and corporate sector average tax rate series were converted to quarterly series mechanically. These series have been very stationary in the past. (Appendix 16)

TABLE A.12. QUARTERLY DATA USED IN ESTIMATIONS OF THE EULER EQUATION. NET CAPITAL STOCK. VOLUME INDEX 1985 = 100

Manufacturing

	I	II	III	IV
1970	57.6	58.5	59.5	60.9
1971	61.8	62.9	64.1	65.5
1972	66.4	67.4	68.2	69.1
1973	69.7	70.1	70.8	71.6
1974	72.4	73.6	84.9	76.5
1975	77.7	79.0	80.0	81.2
1976	82.1	82.9	83.6	84.3
1977	84.9	85.4	85.6	85.8
1978	85.8	85.8	85.7	85.5
1979	85.5	85.5	85.6	86.0
1980	86.4	87.0	87.7	88.5
1981	89.2	89.9	90.6	91.5
1982	92.2	92.9	93.5	94.3
1983	94.9	95.4	95.9	96.4
1984	96.9	97.4	97.9	98.5
1985	99.1	99.7	100.2	101.0
1986	101.6	102.2	102.7	103.4

Forest industries

	I	II	III	IV
1970	69.9	70.8	71.7	73.1
1971	74.0	75.4	76.5	77.9
1972	78.7	79.3	79.7	80.1
1973	80.3	80.5	80.6	80.7
1974	80.9	81.1	81.5	82.2
1975	83.0	83.9	84.7	85.7
1976	86.4	87.1	88.0	89.2
1977	90.6	91.9	92.4	92.4
1978	91.9	91.2	90.7	90.0
1979	89.4	89.1	89.1	89.3
1980	89.7	90.3	90.8	91.5
1981	92.2	92.9	93.7	94.6
1982	95.3	95.9	96.4	96.8
1983	97.1	97.2	97.3	97.4
1984	97.5	97.7	98.0	98.5
1985	99.1	99.7	100.2	101.0
1986	101.6	102.0	102.3	102.6

Metal and engineering industries

	I	II	III	IV
1970	47.0	48.2	49.4	51.0
1971	52.0	53.3	54.5	55.9
1972	56.9	57.9	58.7	59.5
1973	60.1	60.6	61.3	62.4
1974	63.7	65.6	67.8	70.6
1975	72.7	74.9	77.1	79.8
1976	82.1	83.9	85.6	86.8
1977	87.4	87.6	87.7	87.6
1978	87.6	87.5	87.3	87.1
1979	86.8	86.6	86.5	86.5
1980	86.7	87.2	88.0	88.8
1981	89.5	90.1	90.6	91.2
1982	91.8	92.3	92.9	93.7
1983	94.3	94.8	95.2	95.7
1984	96.2	96.7	97.2	97.9
1985	98.7	99.5	100.3	101.5
1986	102.4	103.1	103.9	104.7

Other manufacturing industries

	I	II	III	IV
1970	55.1	56.0	56.9	58.1
1971	58.8	59.8	60.9	62.3
1972	63.3	64.5	65.6	66.9
1973	67.8	68.6	69.5	70.6
1974	71.7	73.0	74.4	75.9
1975	77.0	77.8	78.3	78.7
1976	78.9	79.0	79.0	79.0
1977	79.1	79.2	79.3	79.6
1978	80.0	80.3	80.7	81.2
1979	81.7	82.1	82.5	83.1
1980	83.8	84.4	85.2	86.0
1981	86.8	87.5	88.4	89.3
1982	90.2	91.0	91.8	92.8
1983	93.7	94.5	95.2	96.1
1984	97.0	97.6	98.2	98.8
1985	99.4	99.8	100.2	100.7
1986	101.2	101.7	102.3	103.2

Price index of industrial production

Manufacturing

	I	II	III	IV
1970	25.3	25.4	25.6	25.7
1971	26.3	26.4	26.8	27.3
1972	28.0	28.6	28.8	29.2
1973	30.3	31.9	34.5	37.1
1974	40.4	43.3	45.7	47.0
1975	49.1	49.2	49.3	50.3
1976	52.2	54.3	56.2	56.7
1977	57.6	58.9	59.8	60.9
1978	62.2	64.1	65.9	67.5
1979	69.1	70.4	71.7	72.2
1980	74.8	76.2	76.4	76.4
1981	78.2	79.8	81.4	82.6
1982	84.3	85.2	85.6	87.4
1983	89.1	90.7	92.6	94.4
1984	96.3	98.3	99.4	99.7
1985	100.0	100.6	100.1	99.2
1986	99.3	98.7	99.8	101.4

Forest industries

	I	II	III	IV
1970	27.6	27.5	27.2	26.4
1971	26.0	25.2	24.8	24.7
1972	25.3	25.8	26.3	27.2
1973	28.9	31.4	35.4	39.5
1974	44.4	48.5	51.3	52.3
1975	53.3	51.2	48.8	47.2
1976	46.7	47.2	48.6	49.8
1977	52.1	55.0	57.4	59.6
1978	61.6	64.2	67.0	69.9
1979	73.2	76.5	79.8	82.2
1980	86.8	89.4	89.9	89.4
1981	90.1	89.7	88.6	86.7
1982	85.3	83.6	82.5	83.9
1983	86.4	89.9	94.3	99.0
1984	103.4	106.8	107.6	106.1
1985	103.5	101.3	98.6	96.6
1986	96.7	96.7	98.6	101.2

Metal and engineering industries

	I	II	III	IV
1970	27.9	28.2	28.7	29.2
1971	30.4	31.0	31.6	32.0
1972	32.6	33.0	33.0	33.4
1973	34.6	36.3	39.0	41.2
1974	43.9	46.2	48.0	49.1
1975	51.4	52.2	53.5	56.0
1976	59.2	62.0	63.6	62.5
1977	61.3	61.0	61.0	62.6
1978	65.0	68.0	70.4	71.8
1979	72.6	72.7	72.7	72.0
1980	73.7	74.1	73.4	72.7
1981	73.9	75.6	77.9	80.6
1982	83.9	86.2	87.4	89.2
1983	90.4	91.0	91.9	92.8
1984	94.1	96.0	97.4	98.4
1985	99.4	100.7	100.4	99.5
1986	99.0	97.8	98.0	98.9

Other manufacturing industries

	I	II	III	IV
1970	22.6	22.8	23.1	23.3
1971	24.1	24.6	25.2	25.9
1972	26.8	27.4	27.4	27.7
1973	28.3	29.3	31.4	33.4
1974	36.2	38.8	41.2	42.9
1975	45.6	46.2	46.5	47.5
1976	49.3	51.4	53.8	55.2
1977	57.0	59.0	59.9	60.4
1978	60.7	61.3	62.3	63.3
1979	64.7	66.0	67.1	67.5
1980	69.8	71.3	72.0	73.0
1981	75.9	78.5	80.8	82.4
1982	84.1	84.9	85.4	87.4
1983	89.4	90.9	92.5	93.6
1984	94.8	96.2	97.1	97.8
1985	98.8	100.3	100.6	100.3
1986	100.8	100.5	101.8	103.7

Price index of investment goods

Manufacturing

	I	II	III	IV
1970	22.7	23.1	23.3	24.2
1971	24.9	25.6	26.3	27.3
1972	28.5	29.5	30.3	30.9
1973	32.0	33.7	36.1	37.4
1974	39.7	42.0	43.3	44.7
1975	47.1	47.8	49.2	50.7
1976	52.1	53.1	54.5	55.6
1977	58.3	59.2	60.0	60.3
1978	61.0	61.5	62.3	62.8
1979	63.8	65.6	66.8	68.3
1980	70.5	73.0	75.1	76.8
1981	78.5	79.8	81.5	83.6
1982	85.4	87.4	87.5	88.0
1983	87.7	87.8	88.6	89.6
1984	91.5	93.7	95.4	97.0
1985	98.8	99.9	100.4	100.9
1986	101.7	102.4	103.1	103.7

Tax depreciation coefficient

Manufacturing

	I	II	III	IV
1970	0.21	0.21	0.21	0.21
1971	0.21	0.21	0.21	0.21
1972	0.22	0.21	0.21	0.21
1973	0.21	0.21	0.21	0.22
1974	0.22	0.22	0.21	0.20
1975	0.19	0.20	0.21	0.24
1976	0.28	0.31	0.34	0.35
1977	0.35	0.34	0.32	0.31
1978	0.29	0.28	0.29	0.30
1979	0.32	0.34	0.36	0.37
1980	0.37	0.35	0.31	0.26
1981	0.22	0.19	0.20	0.23
1982	0.29	0.34	0.38	0.39
1983	0.39	0.37	0.34	0.31
1984	0.28	0.26	0.25	0.25
1985	0.25	0.26	0.26	0.27
1986	0.26	0.26	0.26	0.25

Forest industries

	I	II	III	IV
1970	0.23	0.23	0.23	0.23
1971	0.23	0.23	0.23	0.24
1972	0.24	0.24	0.23	0.23
1973	0.23	0.23	0.23	0.24
1974	0.24	0.24	0.23	0.22
1975	0.22	0.22	0.23	0.26
1976	0.28	0.31	0.34	0.35
1977	0.35	0.34	0.32	0.31
1978	0.29	0.28	0.29	0.30
1979	0.32	0.34	0.36	0.37
1980	0.37	0.35	0.31	0.26
1981	0.22	0.19	0.20	0.23
1982	0.29	0.34	0.38	0.39
1983	0.39	0.37	0.34	0.31
1984	0.28	0.26	0.25	0.25
1985	0.25	0.26	0.26	0.27
1986	0.26	0.26	0.26	0.25

Metal and engineering industries

	I	II	III	IV
1970	0.20	0.20	0.20	0.20
1971	0.20	0.20	0.20	0.20
1972	0.20	0.20	0.20	0.20
1973	0.20	0.20	0.20	0.21
1974	0.21	0.21	0.20	0.19
1975	0.18	0.18	0.20	0.24
1976	0.28	0.31	0.34	0.35
1977	0.35	0.34	0.32	0.31
1978	0.29	0.28	0.29	0.30
1979	0.32	0.34	0.36	0.37
1980	0.37	0.35	0.31	0.26
1981	0.21	0.18	0.19	0.23
1982	0.28	0.34	0.38	0.40
1983	0.39	0.37	0.34	0.31
1984	0.28	0.26	0.25	0.25
1985	0.25	0.26	0.26	0.27
1986	0.26	0.26	0.26	0.25

Other manufacturing industries

	I	II	III	IV
1970	0.20	0.20	0.20	0.20
1971	0.20	0.20	0.20	0.20
1972	0.20	0.20	0.20	0.20
1973	0.20	0.20	0.21	0.21
1974	0.21	0.21	0.20	0.19
1975	0.19	0.19	0.21	0.24
1976	0.28	0.31	0.34	0.35
1977	0.35	0.34	0.32	0.31
1978	0.29	0.28	0.29	0.30
1979	0.32	0.34	0.36	0.37
1980	0.37	0.35	0.31	0.26
1981	0.22	0.19	0.20	0.23
1982	0.29	0.34	0.38	0.39
1983	0.39	0.37	0.34	0.31
1984	0.28	0.26	0.25	0.25
1985	0.25	0.26	0.26	0.27
1986	0.26	0.26	0.26	0.25

APPENDIX 13

ESTIMATION RESULTS OF THE EULER-EQUATION (Equation 101), quarterly data

Manufacturing and main manufacturing sector

Dependent variable: capital stock (t+1), volume index 1985 = 100 from the official statistics
Independent variables: capital stock (t, t-1) at 1985 prices, price index of capital goods (t+1, t), price index of production (t).
Estimation period: 1971:2 - 1986:3
Variables in logarithmic difference form
Estimation method: nonlinear instrumental variable method
Instruments: prices of capital and labour, value added at fixed prices (lags t-2, ..., t-5)

	(1)	(2)	(3)	(4)
Capital stock (t)	1.154	1.159	1.344	1.635
	(10.16)	(12.25)	(6.69)	(10.50)
(t-1)	-1.054	-0.925	-1.011	-1.009
	(7.17)	(7.30)	(5.37)	(6.84)
Prices of capital goods (t+1)	-0.050	0.023	-0.069	-0.067
	(0.50)	(0.30)	(0.49)	(0.61)
(t)	0.239	0.047	0.401	0.231
	(2.11)	(0.59)	(2.44)	(1.88)
Price of production (t)	-0.017	-0.002	-0.009	-0.025
	(0.78)	(0.15)	(0.29)	(0.10)
Standard error of estimate	0.01	0.004	0.06	0.01
R^2	0.98	0.99	0.96	0.98
LF	244.0	258.7	224.0	237.8

1 = manufacturing
2 = forest industries
3 = metal and engineering industries
4 = other manufacturing industries

APPENDIX 14

ESTIMATION RESULTS OF THE EULER EQUATION

Annual data pooling by manufacturing sector

TABLE A.14.a. UNCONSTRAINED AND CONSTRAINED ESTIMATION (equation (101))

Manufacturing and main manufacturing sector

Dependent variable: capital stock (t+1) at 1985 prices from the official statistics
Independent variables: capital stock (t, t-1) at 1985 prices, price index of capital goods (t+1, t), price index of production (t).
Estimation period: 1968 - 1985
Variables in logarithmic form
Estimation method: nonlinear instrumental variable method
Instruments: price index of new capital goods, value added at fixed prices, all by manufacturing sector (lags t-2)

		Unconstrained estimation			All parameters constrained equal by manufacturing sector		
		(1)	(2)	(3)	(1)	(2)	(3)
Capital stock	(t)	0.242	0.808	0.459	0.783		
		(1.75)	(7.24)	(4.15)	(9.83)		
	(t-1)	-0.456	-0.058	-0.078	-0.017		
		(3.62)	(0.49)	(0.99)	(0.24)		
Prices of	(t+1)	0.562	0.836	0.874	0.770		
capital goods		(5.81)	(8.13)	(12.97)	(11.88)	R	
	(t)	-0.333	-0.663	-0.430	-0.658		
		(3.55)	(6.61)	(4.46)	(9.71)		
Price of	(t)	-0.028	-0.056	-0.183	-0.029		
production		(0.61)	(0.63)	(2.89)	(0.74)		
Constant		11.49	1.974	5.256	2.007	1.968	2.063
		(7.64)	(1.65)	(6.16)	(3.96)	(4.01)	(3.99)
R^2		0.836	0.972	0.973	0.846	0.972	0.964
LF		32.69	35.43	40.81	31.15	34.41	38.11
Total model							
R^2		0.981			0.978		
SEE		0.041			0.039		
LF		107.1			102.3		

TABLE A.14.b. CONSTRAINED SYSTEM ESTIMATION OF THE EULER EQUATION (equation (101))

Manufacturing and main manufacturing sector

Dependent variable: capital stock (t+1) at 1985 prices
A) estimate of the spring survey of the previous year
B) estimate of the autumn survey of the previous year

Independent variables: capital stock (t, t-1) at 1985 prices, price index of capital goods (t+1, t), price index of production (t).

Estimation period: 1968 - 1985

Variables in logarithmic form

Estimation method: nonlinear instrumental variable method

Instruments: price index of new capital goods, value added at fixed prices, all by manufacturing sector (lags t-2)

		A) (1)	A) (2)	A) (3)	B) (1)	B) (2)	B) (3)
Capital stock	(t)	0.826			0.809		
		(8.98)			(8.65)		
	(t-1)	-0.039			-0.066		
		(0.47)			(0.78)		
Prices of	(t+1)	0.708			0.738		
capital goods		(8.95)	R		(9.22)	R	
	(t)	-0.634			-0.658		
		(7.86)			(8.21)		
Price of	(t)	0.011			0.012		
production		(0.27)			(0.31)		
Constant		1.811	1.769	1.853	2.231	2.178	2.283
		(3.39)	(3.42)	(3.41)	(4.02)	(4.06)	(4.04)
R^2		0.782	0.956	0.967	0.828	0.957	0.962
LF		27.42	30.93	36.90	29.45	30.99	36.51
Total model							
R^2		0.969			0.972		
SEE		0.047			0.045		
LF		92.85			95.54		

TABLE A.14.c. CONSTRAINED SYSTEM ESTIMATION OF THE EULER EQUATION (equation (101))

Manufacturing and main manufacturing sector

Dependent variable: capital stock (t+1) at 1985 prices
A) estimate of the spring survey of the current year
B) estimate of the autumn survey of the current year
Independent variables: capital stock (t, t-1) at 1985 prices, price index of capital goods (t+1, t), price index of production (t).
Estimation period: 1968 - 1985
Variables in logarithmic form
Estimation method: nonlinear instrumental variable method
Instruments: price index of new capital goods, value added at fixed prices, all by manufacturing sector (lags t-2)

		A) (1)	A) (2)	A) (3)	B) (1)	B) (2)	B) (3)
Capital stock	(t)	0.798			0.779		
		(8.27)			(8.36)		
	(t-1)	-0.059			-0.016		
		(0.66)			(0.19)		
Prices of	(t+1)	0.752			0.782		
capital goods		(9.08)	R		(10.02)	R	
	(t)	-0.693			-0.691		
		(8.36)			(8.66)		
Price of	(t)	0.016			-0.017		
production		(0.395)			(0.41)		
Constant		2.341	2.286	2.394	2.095	2.039	2.136
		(4.38)	(4.42)	(4.40)	(3.86)		
R^2		0.816	0.944	0.960	0.805	0.954	0.961
LF		29.98	29.81	35.83	29.59	30.80	36.87
Total model							
R^2		0.969			0.971		
SEE		0.046			0.045		
LF		94.41			95.71		

APPENDIX 15

THE DATA OF THE BANK OF FINLAND'S INVESTMENT INQUIRY

TABLE A.15.a. DATA AGGREGATED BY MANUFACTURING SECTOR, MILLION MARKKAA, CURRENT PRICES

Explanations of codes:

IPV ... = investment plans in current prices
IV ... = realized investments according to the survey
... EK.. = investment plans asked in the spring of the previous year
... ES.. = investment plans asked in the autumn of the previous year
... KK.. = investment plans asked in the spring of the current year
... KS.. = investment plans asked in the autumn of the current year
... TK.. = realized investments according to the survey in the spring of the following year
... TS.. = realized investments according to the survey in the autumn of the following year

The letter code is followed by the sector code

01-13:

01 = Manufacturing

02 = Forest industries
03 = Metal and engineering industries
04 = Other manufacturing industries

05 = Manufacture of food, beverages and tobacco
06 = Textile, wearing apparel and leather industries
07 = Manuf. of chemic., petr., rubber and plast. products
08 = Manufacture of non-metallic mineral products
09 = Other manufacturing industries and printing, publishing and allied industries
10 = Manufacture of wood
11 = Manufacture of paper and products
12 = Manufacturing investment: machinery and equipment
13 = Manufacturing investment: construction

Time	IPVEK01	IPVEK02	IPVEK03	IPVEK04	IPVEK12	IPVEK13
1969	1231.00	395.00	380.00	457.00	819.00	412.00
1970	2065.00	703.00	635.00	729.00	1436.00	629.00
1971	3031.00	1110.00	836.00	1083.00	2038.00	993.00
1972	2628.00	821.00	785.00	1023.00	1850.00	778.00
1973	2576.00	628.00	709.00	1239.00	1672.00	904.00
1974	4074.00	910.00	1136.00	2029.00	2803.00	1271.00
1975	6634.00	1924.00	2258.00	2452.00	4463.00	2171.00
1976	7250.00	2595.00	2056.00	2599.00	4930.00	2320.00
1977	6550.00	3344.00	1584.00	1622.00	4944.00	1606.00
1978	4705.00	1329.00	1361.00	2015.00	3526.00	1179.00
1979	4790.00	1488.00	1090.00	2212.00	3577.00	1213.00
1980	6389.00	2233.00	1594.00	2562.00	5003.00	1388.00
1981	11088.00	4563.00	2416.00	4109.00	8529.00	2559.00
1982	11276.00	4403.00	2799.00	4074.00	8625.00	2650.00
1983	10989.00	3555.00	2820.00	4614.00	8340.00	2651.00
1984	10772.00	2822.00	3108.00	4842.00	8338.00	2434.00
1985	13573.00	4575.00	3890.00	5108.00	10862.00	2711.00
1986	14537.00	4035.00	4382.00	6129.00	11658.00	2890.00

Time	IPVES01	IPVES02	IPVES03	IPVES04	IPVES12	IPVES13
1964	1063.00	354.00	273.00	436.00	642.00	421.00
1965	1136.00	361.00	283.00	491.00	691.00	445.00
1966	1261.00	329.00	407.00	525.00	818.00	443.00
1967	1217.00	283.00	379.00	556.00	755.00	462.00
1968	1380.50	402.60	338.50	656.40	974.50	412.00
1969	1546.00	390.00	445.00	710.00	1019.00	527.00
1970	2431.00	872.00	726.00	833.00	1684.00	747.00
1971	3248.00	1195.00	850.00	1203.00	2218.00	1030.00
1972	2852.00	755.00	844.00	1253.00	1923.00	929.00
1973	3267.00	883.00	923.00	1461.00	2150.00	1117.00
1974	4731.00	1390.00	1435.00	1907.00	3047.00	1684.00
1975	7282.00	2337.00	2361.00	2584.00	4777.00	2506.00
1976	6148.00	2179.00	1791.00	2178.00	4177.00	1971.00
1977	5854.00	2773.00	1257.00	1824.00	4430.00	1424.00
1978	4532.00	1370.00	1215.00	1947.00	3427.00	1105.00
1979	6265.00	2117.00	1430.00	2718.00	4723.00	1542.00
1980	8474.00	3090.00	2053.00	3331.00	6592.00	1883.00
1981	11058.00	4377.00	2638.00	4043.00	8335.00	2722.00
1982	11947.00	4018.00	2964.00	4965.00	8939.00	3007.00
1983	11588.00	3319.00	2984.00	5285.00	8571.00	3017.00
1984	13469.00	4368.00	3703.00	5398.00	10315.00	3154.00
1985	14793.00	4727.00	4405.00	5661.00	11446.00	3347.00
1986	15790.00	4372.00	5115.00	6304.00	12544.00	3246.00

Time	IPVKK01	IPVKK02	IPVKK03	IPVKK04	IPVKK12	IPVKK13
1964	1180.00	428.00	290.00	462.00	743.00	437.00
1965	1235.00	367.00	308.00	559.00	758.00	477.00
1966	1446.00	411.00	437.00	598.00	951.00	495.00
1967	1197.00	308.00	381.00	509.00	766.00	431.00
1968	1529.00	482.00	355.00	693.00	1010.00	519.00
1969	2007.00	650.00	557.00	799.00	1313.00	694.00
1970	3058.00	1045.00	1050.00	963.00	2044.00	1014.00
1971	3312.00	1234.00	829.00	1246.00	2310.00	1002.00
1972	3131.00	851.00	791.00	1490.00	2030.00	1101.00
1973	3621.00	1133.00	924.00	1564.00	2343.00	1278.00
1974	5970.00	1879.00	1787.00	2304.00	3725.00	2245.00
1975	7177.00	2730.00	1882.00	2565.00	4518.00	2659.00
1976	6371.00	2286.00	2035.00	2050.00	4445.00	1926.00
1977	5260.00	2115.00	1277.00	1868.00	3852.00	1408.00
1978	5013.00	1410.00	1265.00	2338.00	3568.00	1445.00
1979	6615.00	2345.00	1460.00	2810.00	4979.00	1636.00
1980	9481.00	3399.00	2247.00	3835.00	7476.00	2004.00
1981	11372.00	4329.00	2832.00	4211.00	8714.00	2659.00
1982	11824.00	4021.00	3019.00	4784.00	8823.00	3002.00
1983	12009.00	3381.00	3179.00	5449.00	9071.00	2938.00
1984	14021.00	4296.00	4044.00	5681.00	10506.00	3515.00
1985	14448.00	4925.00	4375.00	6249.00	11924.00	3625.00
1986	16431.00	4409.00	5049.00	6973.00	13164.00	3267.00

Time	IPVKS01	IPVKS02	IPVKS03	IPVKS04	IPVKS12	IPVKS13
1964	1175.00	420.00	287.00	468.00	739.00	436.00
1965	1384.00	419.00	364.00	600.00	866.00	518.00
1966	1425.00	410.00	440.00	575.00	960.00	465.00
1967	1275.10	286.50	418.50	576.10	913.70	448.10
1968	1451.00	425.00	328.00	692.00	995.00	452.00
1969	2021.00	682.00	534.00	805.00	1339.00	682.00
1970	2890.00	1087.00	792.00	1014.00	1902.00	988.00
1971	3272.00	1181.00	773.00	1318.00	2235.00	1037.00
1972	3316.00	1027.00	832.00	1458.00	2207.00	1109.00
1973	3660.00	1125.00	878.00	1656.00	2470.00	1190.00
1974	6005.00	2062.00	1620.00	2323.00	3899.00	2105.00
1975	7493.00	2642.00	2370.00	2481.00	4721.00	2772.00
1976	5893.00	2154.00	1850.00	1889.00	4239.00	1654.00
1977	5596.00	2501.00	1259.00	1836.00	4009.00	1587.00
1978	5108.00	1428.00	1291.00	2389.00	3687.00	1421.00
1979	6424.00	2236.00	1349.00	2839.00	4896.00	1529.00
1980	10022.00	3650.00	2275.00	4097.00	7538.00	2484.00
1981	10805.00	3863.00	2714.00	4228.00	8301.00	2504.00
1982	10850.00	3742.00	2724.00	4384.00	8180.00	2669.00
1983	12359.00	3807.00	3254.00	5298.00	9127.00	3231.00
1984	13259.00	4238.00	3663.00	5358.00	9899.00	3360.00
1985	14845.00	5019.00	4160.00	5666.00	11356.00	3488.00
1986	15417.00	4543.00	4825.00	6049.00	12225.00	3192.00

Time	IVTK01	IVTK02	IVTK03	IVTK04	IVTK12	IVTK13
1964	1187.00	458.00	296.00	432.00	752.00	435.00
1965	1423.00	441.00	364.00	618.00	874.00	549.00
1966	1524.00	445.00	461.00	618.00	1045.00	479.00
1967	1393.00	317.00	476.00	601.00	892.00	501.00
1968	1594.00	486.00	364.00	744.00	1133.00	461.00
1969	2241.00	711.00	696.00	834.00	1513.00	728.00
1970	3025.00	1145.00	850.00	1033.00	1947.00	1078.00
1971	3327.00	1026.00	847.00	1454.00	2271.00	1056.00
1972	3345.00	1082.00	801.00	1462.00	2263.00	1082.00
1973	3802.00	1121.00	864.00	1817.00	2528.00	1275.00
1974	6076.00	2081.00	1536.00	2459.00	3875.00	2201.00
1975	8417.00	3053.00	2796.00	2568.00	5496.00	2921.00
1976	6551.00	2575.00	2064.00	1912.00	4736.00	1815.00
1977	5686.00	2615.00	1266.00	1805.00	4159.00	1527.00
1978	4622.00	1382.00	1109.00	2131.00	3343.00	1279.00
1979	6298.00	2152.00	1462.00	2684.00	4733.00	1563.00
1980	9562.00	3424.00	2163.00	3975.00	6749.00	2813.00
1981	10464.00	3891.00	2642.00	3931.00	7918.00	2548.00
1982	11162.00	3705.00	2806.00	4651.00	8296.00	2866.00
1983	11656.00	3514.00	3031.00	5111.00	8369.00	3287.00
1984	13006.00	4359.00	3345.00	5302.00	9464.00	3542.00
1985	14660.00	4785.00	4056.00	5820.00	11407.00	3254.00
1986	14967.00	4457.00	4619.00	5891.00	11458.00	3508.00

Time	IVTS01	IVTS02	IVTS03	IVTS04	IVTS12	IVTS13
1964	1187.00	465.00	299.00	422.00	752.00	435.00
1965	1441.00	428.00	365.00	649.00	902.00	539.00
1966	1505.50	440.50	443.30	623.20	1029.70	474.20
1967	1324.00	299.00	427.00	597.00	862.00	462.00
1968	1584.00	489.00	362.00	732.00	1118.00	466.00
1969	2077.00	711.00	503.00	863.00	1377.00	700.00
1970	2870.00	967.00	739.00	1165.00	1809.00	1061.00
1971	3550.00	1211.00	861.00	1478.00	2425.00	1125.00
1972	3301.00	1018.00	787.00	1497.00	2227.00	1074.00
1973	3925.00	1179.00	885.00	1861.00	2618.00	1306.00
1974	6159.00	2011.00	1697.00	2451.00	3824.00	2335.00
1975	7890.00	3022.00	2550.00	2318.00	5115.00	2775.00
1976	6446.00	2492.00	2040.00	1914.00	4640.00	1806.00
1977	5583.00	2592.00	1234.00	1757.00	4169.00	1414.00
1978	4563.00	1291.00	1069.00	2203.00	3356.00	1204.00
1979	6464.00	2162.00	1485.00	2817.00	4787.00	1676.00
1980	9611.00	3452.00	2197.00	3962.00	6971.00	2641.00
1981	10548.00	3974.00	2526.00	4048.00	7879.00	2669.00
1982	11437.00	3781.00	2838.00	4819.00	8391.00	3046.00
1983	11582.00	3473.00	2961.00	5148.00	8316.00	3266.00
1984	13006.00	4359.00	3345.00	5302.00	9464.00	3542.00
1985	14201.00	4771.00	3887.00	5543.00	10956.00	3244.00
1986	14947.00	4482.00	4605.00	5860.00	11397.00	3550.00

Time	IPVEK05	IPVEK06	IPVEK07	IPVEK08	IPVEK09	IPVEK10	IPVEK11
1977	653.00	176.00	540.00	68.00	185.00	1318.00	2026.00
1978	748.00	145.00	736.00	153.00	233.00	496.00	833.00
1979	719.00	246.00	797.00	118.00	332.00	395.00	1093.00
1980	741.00	290.00	885.00	332.00	314.00	627.00	1606.00
1981	1093.00	580.00	1736.00	379.00	321.00	952.00	3611.00
1982	1228.00	364.00	1814.00	274.00	409.00	940.00	3461.00
1983	1163.00	445.00	2008.00	342.00	656.00	647.00	2908.00
1984	1451.00	679.00	1590.00	351.00	771.00	723.00	2098.00
1985	1397.00	545.00	1875.00	391.00	900.00	773.00	3801.00
1986	1752.00	601.00	2233.00	703.00	841.00	670.00	3365.00

Time	IPVES05	IPVES06	IPVES07	IPVES08	IPVES09	IPVES10	IPVES11
1976	817.00	197.00	650.00	248.00	266.00	691.00	1488.00
1977	745.00	213.00	496.00	146.00	224.00	1051.00	1722.00
1978	678.00	175.00	692.00	152.00	250.00	354.00	1016.00
1979	774.00	247.00	974.00	241.00	482.00	493.00	1624.00
1980	1000.00	364.00	1325.00	217.00	425.00	782.00	2308.00
1981	1039.00	316.00	1999.00	280.00	417.00	782.00	3601.00
1982	1180.00	638.00	2268.00	361.00	518.00	864.00	3154.00
1983	1551.00	453.00	2092.00	388.00	801.00	628.00	2692.00
1984	1563.00	562.00	1769.00	434.00	1070.00	743.00	3625.00
1985	1531.00	559.00	1894.00	498.00	1178.00	852.00	3876.00
1986	1583.00	685.00	2310.00	712.00	1013.00	797.00	3575.00

Time	IPVKK05	IPVKK06	IPVKK07	IPVKK08	IPVKK09	IPVKK10	IPVKK11
1976	684.00	234.00	686.00	196.00	250.00	877.00	1409.00
1977	728.00	211.00	516.00	171.00	242.00	508.00	1607.00
1978	827.00	223.00	770.00	150.00	368.00	453.00	957.00
1979	792.00	337.00	1111.00	200.00	370.00	772.00	1573.00
1980	961.00	578.00	1593.00	326.00	377.00	951.00	2448.00
1981	1219.00	362.00	1772.00	448.00	416.00	766.00	3530.00
1982	1266.00	671.00	1997.00	387.00	463.00	847.00	3174.00
1983	1563.00	644.00	1823.00	505.00	915.00	876.00	2504.00
1984	1396.00	637.00	1964.00	550.00	1133.00	716.00	3579.00
1985	1595.00	598.00	2331.00	523.00	1202.00	853.00	4071.00
1986	1658.00	746.00	2580.00	887.00	1102.00	707.00	3702.00

Time	IPVKS05	IPVKS06	IPVKS07	IPVKS08	IPVKS09	IPVKS10	IPVKS11
1975	803.00	208.00	1008.00	319.00	143.00	743.00	1899.00
1976	732.00	261.00	501.00	135.00	260.00	826.00	1328.00
1977	715.00	226.00	441.00	158.00	296.00	896.00	1605.00
1978	815.00	274.00	740.00	184.00	376.00	464.00	964.00
1979	914.00	352.00	1021.00	236.00	316.00	698.00	1538.00
1980	1032.00	387.00	1625.00	644.00	439.00	1307.00	2353.00
1981	1025.00	365.00	1959.00	468.00	411.00	833.00	3030.00
1982	1276.00	622.00	1681.00	390.00	414.00	691.00	3051.00
1983	1551.00	657.00	1767.00	452.00	871.00	643.00	3164.00
1984	1430.00	676.00	1707.00	517.00	1028.00	739.00	3499.00
1985	1268.00	687.00	2027.00	535.00	1149.00	995.00	4024.00
1986	1608.00	611.00	2104.00	662.00	1063.00	921.00	3621.00

Time	IVTK05	IVTK06	IVTK07	IVTK08	IVTK09	IVTK10	IVTK11
1975	889.00	226.00	1053.00	250.00	150.00	972.00	2081.00
1976	756.00	245.00	501.00	157.00	253.00	1146.00	1429.00
1977	678.00	259.00	464.00	97.00	307.00	902.00	1713.00
1978	664.00	222.00	663.00	205.00	377.00	544.00	838.00
1979	926.00	444.00	792.00	238.00	284.00	688.00	1464.00
1980	1059.00	398.00	1485.00	645.00	402.00	1249.00	2218.00
1981	1131.00	445.00	1546.00	400.00	409.00	742.00	3149.00
1982	1414.00	691.00	1578.00	478.00	490.00	726.00	2979.00
1983	1521.00	645.00	1554.00	409.00	982.00	642.00	2872.00
1984	1360.00	681.00	1738.00	537.00	987.00	664.00	3695.00
1985	1304.00	703.00	2010.00	530.00	1271.00	1007.00	3777.00
1986	1518.00	683.00	2037.00	609.00	1044.00	817.00	3640.00

Time	IVTS05	IVTS06	IVTS07	IVTS08	IVTS09	IVTS10	IVTS11
1974	646.00	266.00	842.00	453.00	244.00	594.00	1417.00
1975	906.00	245.00	816.00	207.00	144.00	1056.00	1966.00
1976	756.00	263.00	476.00	154.00	265.00	1060.00	1432.00
1977	685.00	227.00	462.00	103.00	280.00	807.00	1785.00
1978	720.00	219.00	698.00	209.00	357.00	455.00	836.00
1979	912.00	317.00	1011.00	218.00	363.00	665.00	1504.00
1980	991.00	403.00	1526.00	688.00	354.00	1209.00	2243.00
1981	1147.00	540.00	1473.00	374.00	514.00	840.00	3134.00
1982	1564.00	678.00	1565.00	503.00	509.00	697.00	3084.00
1983	1511.00	706.00	1585.00	388.00	958.00	618.00	2855.00
1984	1304.00	733.00	1769.00	403.00	957.00	705.00	3622.00
1985	1369.00	646.00	1846.00	488.00	1194.00	1088.00	3683.00
1986	1661.00	684.00	2055.00	549.00	911.00	764.00	3719.00

TABLE A.15.b. DATA OF THE INVESTMENT INQUIRY OF THE BANK OF FINLAND AGGREGATED BY MANUFACTURING SECTOR, MILLION MARKKAA, AT 1980 PRICES
(deflated by actual prices of investment goods in manufacturing)

Explanations of codes:
IPF ... = investment plans at 1980 prices
IF ... = realized investments according to the survey at 1980 prices
other codes as before

Time	IPFEK01	IPFEK02	IPFEK03	IPFEK04	IPFEK12	IPFEK13
1969	4549.07	1459.69	1404.26	1688.81	3005.47	1549.02
1970	6904.61	2350.58	2123.21	2437.51	4744.97	2157.74
1971	9007.26	3298.60	2484.35	3218.37	5953.93	3075.32
1972	6930.45	2165.11	2070.17	2697.81	4747.86	2207.56
1973	5863.25	1429.39	1613.76	2820.10	3742.13	2148.58
1974	7542.18	1684.68	2103.07	3756.28	5211.68	2335.66
1975	10676.32	3096.36	3633.88	3946.09	7165.37	3508.34
1976	10562.41	3780.61	2995.35	3786.44	7129.57	3443.85
1977	8341.94	4258.85	2017.35	2065.74	6192.75	2121.45
1978	5971.43	1686.72	1727.34	2557.37	4369.08	1583.71
1979	5698.71	1770.29	1296.78	2631.64	4135.59	1558.77
1980	6389.00	2233.00	1594.00	2562.00	5003.00	1388.00
1981	10731.40	4416.25	2338.30	3976.85	8224.79	2506.68
1982	10110.48	3947.89	2509.69	3652.90	7758.87	2355.75
1983	9831.93	3180.68	2523.07	4128.18	7674.20	2195.03
1984	9088.70	2381.02	2622.33	4085.36	7259.90	1859.95

Time	IPFES01	IPFES02	IPFES03	IPFES04	IPFES12	IPFES13
1964	5329.68	1774.89	1368.77	2186.02	3226.76	2099.74
1965	5317.54	1689.82	1324.71	2298.34	3211.37	2111.65
1966	5796.61	1512.36	1870.91	2413.34	3761.94	2033.99
1967	5373.79	1249.62	1673.51	2455.08	3356.47	2008.58
1968	5296.34	1544.59	1298.67	2518.30	3700.32	1627.96
1969	5713.12	1441.21	1644.46	2623.75	3739.40	1981.39
1970	8128.38	2915.65	2427.48	2785.25	5564.44	2562.53
1971	9652.13	3551.20	2525.96	3574.97	6479.80	3189.91
1972	7521.17	1991.05	2225.76	3304.36	4935.21	2636.02
1973	7436.04	2009.80	2100.85	3325.39	4811.95	2654.83
1974	8758.48	2573.30	2656.61	3530.42	5665.35	3094.61
1975	11719.17	3761.01	3799.64	4158.52	7669.50	4049.71
1976	8956.92	3174.55	2609.28	3173.09	6040.61	2925.79
1977	7455.53	3531.63	1600.89	2323.01	5548.93	1881.04
1978	5751.87	1738.76	1542.04	2471.07	4246.41	1484.30
1979	7453.53	2518.61	1701.28	3233.63	5460.55	1981.56
1980	8474.00	3090.00	2053.00	3331.00	6592.00	1883.00
1981	10702.36	4236.23	2553.16	3912.97	8037.71	2666.35
1982	10712.13	3602.69	2657.63	4451.81	8041.34	2673.11
1983	10367.86	2969.53	2669.81	4728.53	7886.76	2498.08
1984	11364.25	3685.43	3124.35	4554.48	8981.27	2410.14

Time	IPFKK01	IPFKK02	IPFKK03	IPFKK04	IPFKK12	IPFKK13
1964	5916.30	2145.91	1454.01	2316.38	3734.40	2179.54
1965	5780.96	1717.90	1441.73	2616.64	3522.74	2263.50
1966	6647.02	1889.30	2008.82	2748.91	4373.60	2272.74
1967	5285.48	1360.01	1682.35	2247.54	3405.37	1873.81
1968	5866.07	1849.21	1361.97	2658.72	3835.12	2050.75
1969	7416.71	2402.02	2058.35	2952.64	4818.29	2609.27
1970	10224.84	3494.10	3510.82	3219.92	6753.98	3478.46
1971	9842.32	3667.09	2463.55	3702.76	6748.57	3103.19
1972	8256.94	2244.22	2085.99	3929.36	5209.82	3124.07
1973	8241.78	2578.83	2103.12	3559.83	5243.90	3037.49
1974	11052.23	3478.58	3308.26	4265.38	6925.97	4125.53
1975	11550.19	4393.48	3028.77	4127.94	7253.67	4296.95
1976	9281.81	3330.44	2964.76	2986.61	6428.18	2858.99
1977	6699.02	2693.62	1626.36	2379.04	4824.94	1859.90
1978	6362.34	1789.53	1605.50	2967.31	4421.13	1941.01
1979	7869.92	2789.87	1736.98	3343.08	5756.53	2102.35
1980	9481.00	3399.00	2247.00	3835.00	7476.00	2004.00
1981	11006.26	4189.77	2740.92	4075.57	8403.19	2604.64
1982	10601.84	3605.38	2706.95	4289.51	7936.99	2668.67
1983	10744.53	3025.00	2844.27	4875.26	8346.84	2432.67
1984	11830.00	3624.68	3412.06	4793.25	9147.58	2686.00

Time	IPFKS01	IPFKS02	IPFKS03	IPFKS04	IPFKS12	IPFKS13
1964	5891.23	2105.80	1438.96	2346.46	3714.30	2174.55
1965	6478.42	1961.31	1703.86	2808.56	4024.67	2458.06
1966	6550.49	1884.70	2022.61	2643.18	4414.99	2135.00
1967	5630.34	1265.07	1847.93	2543.83	4061.99	1948.15
1968	5566.82	1630.53	1258.38	2654.88	3778.16	1786.01
1969	7468.45	2520.28	1973.36	2974.82	4913.70	2564.15
1970	9663.11	3634.53	2648.16	3390.45	6284.77	3389.26
1971	9723.45	3509.59	2297.13	3916.72	6529.46	3211.59
1972	8744.81	2708.36	2194.11	3844.98	5664.07	3146.77
1973	8330.55	2560.62	1998.42	3769.23	5528.14	2828.33
1974	11117.03	3817.37	2999.10	4300.56	7249.49	3868.26
1975	12058.74	4251.86	3814.12	3992.76	7579.59	4479.56
1976	8585.42	3138.13	2695.24	2752.05	6130.27	2455.23
1977	7126.95	3185.22	1603.44	2338.29	5021.59	2096.35
1978	6482.91	1812.37	1638.50	3032.04	4568.58	1908.78
1979	7642.69	2660.19	1604.92	3377.58	5660.57	1964.85
1980	10022.00	3650.00	2275.00	4097.00	7538.00	2484.00
1981	10457.50	3738.76	2626.71	4092.02	8004.92	2452.81
1982	9728.52	3355.22	2442.44	3930.86	7358.56	2372.64
1983	11057.68	3406.15	2911.38	4740.16	8398.37	2675.27
1984	11187.07	3575.75	3090.60	4520.73	8619.06	2567.56

Time	IFTK01	IFTK02	IFTK03	IFTK04	IFTK12	IFTK13
1964	5951.40	2296.33	1484.09	2165.97	3779.63	2169.56
1965	6660.97	2064.29	1703.86	2892.82	4061.85	2605.16
1966	7005.58	2045.59	2119.14	2840.84	4805.91	2199.28
1967	6150.94	1399.75	2101.83	2653.78	3965.52	2178.14
1968	6115.44	1864.56	1396.50	2854.38	4302.17	1821.57
1969	8281.44	2627.45	2572.01	3081.98	5552.23	2737.10
1970	10114.50	3828.46	2842.09	3453.98	6433.47	3698.00
1971	9886.89	3048.98	2517.04	4320.87	6634.63	3270.43
1972	8821.29	2853.40	2112.36	3855.52	5807.79	3070.16
1973	8653.76	2551.52	1966.56	4135.68	5657.95	3030.36
1974	11248.47	3852.55	2843.59	4552.33	7204.87	4044.67
1975	13545.76	4913.30	4499.70	4132.77	8823.85	4720.35
1976	9544.05	3751.48	3007.01	2785.56	6849.02	2694.22
1977	7241.57	3330.41	1612.35	2298.81	5209.48	2017.10
1978	5866.09	1753.99	1407.51	2704.60	4142.33	1718.03
1979	7492.79	2560.25	1739.35	3193.18	5472.11	2008.54
1980	9562.00	3424.00	2163.00	3975.00	6749.00	2813.00
1981	10127.47	3765.86	2557.03	3804.57	7635.58	2495.91
1982	10008.27	3322.04	2515.96	4170.26	7462.91	2547.77
1983	10428.70	3144.00	2711.86	4572.85	7700.89	2721.64
1984	10973.61	3677.84	2822.29	4473.48	8240.31	2706.63

Time	IFTS01	IFTS02	IFTS03	IFTS04	IFTS12	IFTS13
1964	5951.40	2331.42	1499.13	2115.83	3779.63	2169.56
1965	6745.23	2003.44	1708.54	3037.93	4191.97	2557.71
1966	6920.54	2024.91	2037.78	2864.75	4735.54	2177.24
1967	5846.26	1320.27	1885.46	2636.12	3832.15	2008.58
1968	6077.08	1876.07	1388.83	2808.35	4245.21	1841.33
1969	7675.39	2627.45	1858.80	3189.15	5053.15	2631.83
1970	9596.24	3233.30	2470.95	3895.34	5977.47	3639.69
1971	10549.58	3598.75	2558.65	4392.19	7084.54	3484.12
1972	8705.26	2684.63	2075.44	3947.82	5715.40	3047.46
1973	8933.72	2683.53	2014.35	4235.83	5859.38	3104.03
1974	11402.13	3722.95	3141.65	4537.52	7110.04	4290.92
1975	12697.64	4863.41	4103.80	3730.44	8212.16	4484.41
1976	9391.08	3630.56	2972.04	2788.48	6710.19	2680.86
1977	7110.39	3301.12	1571.60	2237.68	5222.01	1867.83
1978	5791.21	1638.50	1356.74	2795.98	4158.44	1617.29
1979	7690.28	2572.15	1766.72	3351.41	5534.55	2153.75
1980	9611.00	3452.00	2197.00	3962.00	6971.00	2641.00
1981	10208.76	3846.19	2444.76	3917.81	7597.97	2614.44
1982	10254.84	3390.19	2544.66	4320.90	7548.37	2707.78
1983	10362.49	3107.32	2649.23	4605.95	7652.12	2704.25
1984	10973.61	3677.84	2822.29	4473.48	8240.31	2706.63

TABLE A.15.c. DATA OF THE INVESTMENT INQUIRY OF THE BANK OF FINLAND AGGREGATED BY MANUFACTURING SECTOR, MILLION MARKKAA, AT 1980 PRICES
(the deflator of the plans concerning investments in the following year calculated by the ARIMA; see appendix 2)

Explanations of codes:
IPA = investment plans deflated by ARIMA forecast
other codes as before

Time	IPAEK01	IPAEK02	IPAEK03	IPAEK04	IPAEK12	IPAEK13
1969	4004.89	1285.08	1236.28	1486.79	2704.71	1279.09
1970	6474.81	2204.26	1991.04	2285.78	4583.22	1857.83
1971	8541.61	3128.07	2355.92	3051.99	5821.43	2671.72
1972	6571.17	2052.87	1962.85	2557.96	4674.88	1881.08
1973	5730.89	1397.13	1577.33	2756.43	3713.49	2012.41
1974	7712.73	1722.77	2150.63	3841.22	5395.65	2318.04
1975	10224.91	2965.44	3480.23	3779.24	7120.84	3088.30
1976	9813.04	3512.39	2782.84	3517.81	6829.50	2936.60
1977	8058.84	4114.31	1948.89	1995.64	6208.12	1858.72
1978	5052.80	1427.24	1461.61	2163.95	3815.01	1225.60
1979	5219.25	1621.35	1187.68	2410.23	3889.25	1292.33
1980	6389.00	2233.00	1594.00	2562.00	5003.00	1388.00
1981	9281.95	3819.77	2022.47	3439.71	7366.35	1976.40
1982	9350.03	3650.96	2320.92	3378.15	7280.43	2060.34
1983	8324.62	2693.06	2136.27	3495.30	6515.93	1838.64
1984	8276.81	2168.32	2388.07	3720.41	6751.34	1585.82

Time	IPAES01	IPAES02	IPAES03	IPAES04	IPAES12	IPAES13
1964	4799.77	1598.42	1232.68	1968.68	2937.94	1785.74
1965	4825.36	1533.41	1202.09	2085.61	3019.07	1741.21
1966	5012.54	1307.79	1617.85	2086.90	3307.11	1654.66
1967	4803.97	1117.11	1496.06	2194.75	3054.02	1674.25
1968	5122.77	1493.97	1256.11	2435.77	3734.20	1404.44
1969	5029.69	1268.81	1447.75	2309.89	3365.20	1636.11
1970	7622.40	2734.16	2276.37	2611.87	5374.75	2206.36
1971	9153.14	3367.61	2395.37	3390.16	6335.59	2771.27
1972	7131.27	1887.84	2110.38	3133.06	4859.35	2246.18
1973	7268.18	1964.43	2053.42	3250.32	4775.12	2486.57
1974	8956.54	2631.49	2716.68	3610.25	5865.34	3071.26
1975	11223.67	3601.99	3638.98	3982.69	7621.83	3564.84
1976	8321.46	2949.33	2424.16	2947.97	5786.37	2494.84
1977	7202.51	3411.78	1546.56	2244.17	5562.70	1648.08
1978	4867.02	1471.27	1304.82	2090.93	3707.89	1148.67
1979	6826.43	2306.71	1558.15	2961.57	5135.29	1642.85
1980	8474.00	3090.00	2053.00	3331.00	6592.00	1883.00
1981	9256.84	3664.06	2208.31	3384.46	7198.80	2102.29
1982	9906.42	3331.72	2457.74	4116.97	7545.48	2337.91
1983	8778.39	2514.28	2260.50	4003.61	6696.41	2092.49
1984	10349.08	3356.21	2845.25	4147.62	8352.13	2054.92

TABLE A.15.d. DATA OF THE INVESTMENT INQUIRY OF THE BANK OF FINLAND AGGREGATED BY SIZE OF FIRM, MILLION MARKKAA, AT 1980 PRICES (deflated by actual prices)

Explanations of codes:

IPFS = investment plans, large firms (500 employees and over)
IPFK = investment plans, medium-sized firms (100 - 499 employees)
IPFP = investment plans, small firms (20 - 99 employees)
IFS = realized investments of large firms according to the survey
IFK = realized investments of medium-sized firms according to the survey
IFP = realized investments of small firms according to the survey

other codes as before

Time	IPFSEK01	IPFKEK01	IPFPEK01	IPFSES01	IPFKES01	IPFPES01
1979	4104.38	1291.56	616.28	5393.43	1664.35	805.81
1980	5598.13	1220.89	739.40	7210.61	1775.74	1038.71
1981	8215.00	1841.00	1032.00	8290.00	1899.00	869.00
1982	8192.22	1957.83	789.73	8535.66	1940.36	1113.77
1983	7223.32	1782.87	889.63	6831.63	2191.67	1410.09

Time	IPFSKK01	IPFKKK01	IPFPKK01	IPFSKS01	IPFKKS01	IPFPKS01
1978	4033.41	1599.15	729.77	4075.30	1557.27	850.34
1979	5485.75	1477.62	906.56	5119.32	1563.28	960.10
1980	6432.00	1916.00	1133.00	6851.00	2101.00	1070.00
1981	8323.41	1754.69	928.16	7461.07	2006.33	990.10
1982	7737.98	1674.92	1189.84	6810.86	1828.24	1089.41
1983	7078.92	2231.40	1433.32	7129.92	2370.08	1556.79
1984	8660.09	1929.62	1241.13	8197.72	1780.28	1209.07

Time	IFSTK01	IFKKK01	IFPTK01	IFSTS01	IFKTS01	IFPTS01
1977	4839.60	1705.32	696.65	4788.66	1712.96	608.77
1978	3920.46	1236.17	708.20	3780.85	1293.28	717.08
1979	4824.27	1616.81	1051.70	5119.32	1723.89	845.88
1980	6310.00	2177.00	1075.00	6325.00	2218.00	1069.00
1981	7380.74	1707.27	1039.46	7169.75	2016.98	1022.04
1982	7038.60	1902.66	1067.90	7108.54	2047.02	1100.17
1983	6993.03	1918.25	1517.42	7013.61	1873.52	1475.37
1984	7694.01	1827.53	1366.01	7694.01	1827.53	1366.01

APPENDIX 16

OTHER DATA USED IN ESTIMATIONS

Value added, million markkaa, at 1980 prices

Manufacturing

Time	Q1	Q2	Q3	Q4
1950	1953.71	1986.27	1686.70	1901.61
1951	2240.25	2435.62	2240.25	2383.53
1952	2305.38	2136.06	1888.59	2259.79
1953	2090.47	2123.03	2090.47	2435.62
1954	2344.45	2448.65	2396.55	2650.53
1955	2858.93	2884.98	2852.42	3073.84
1956	2468.19	3230.13	3093.37	3353.87
1957	3780.88	3576.51	3310.82	3474.32
1958	3443.66	3310.82	3188.20	3596.94
1959	3413.01	3729.78	3566.29	4005.69
1960	4179.03	4185.61	3961.22	4453.14
1961	4590.60	4541.96	4301.83	4767.60
1962	4885.09	4718.00	4409.66	4940.26
1963	4875.94	4911.69	4678.29	5248.09
1964	5150.86	5265.62	5038.08	5618.44
1965	5651.41	5538.70	5283.83	5805.07
1966	5832.97	5774.74	5451.87	6329.42
1967	6124.03	6083.49	5539.52	6297.95
1968	6561.38	6265.22	5771.06	6789.34
1969	7150.77	7087.43	6666.15	7744.64
1970	7869.01	8143.24	7396.97	8374.77
1971	7487.44	8337.21	7662.75	8822.60
1972	9226.15	9000.19	8063.94	9671.72
1973	10067.67	9330.36	8643.68	10240.29
1974	10675.36	10055.64	8960.65	10294.35
1975	10062.35	9893.30	8205.80	9775.55
1976	10029.91	9865.69	8414.97	10457.43
1977	9908.16	9726.03	8451.01	10347.80
1978	10091.42	10368.04	8817.60	11011.95
1979	11407.17	11281.76	10090.12	12011.95
1980	12164.14	12157.72	11192.71	12893.43
1981	12506.51	12629.69	11417.69	13186.11
1982	12890.36	12952.09	11161.24	13146.30
1983	13086.47	13516.88	11681.32	13579.33
1984	13671.16	13988.67	12201.24	14544.92

Forest industries

Time	Q1	Q2	Q3	Q4
1962	1461.24	1326.70	1381.44	1476.62
1963	1573.38	1540.48	1499.57	1467.58
1964	1364.87	1430.10	1673.41	2129.61
1965	1804.55	1721.07	1737.46	1700.92
1966	2161.47	1785.14	1595.91	1630.48
1967	1736.10	1772.25	1816.61	1855.04
1968	2037.75	1854.98	1819.57	1916.71
1969	2122.74	2064.67	2128.11	2236.48
1970	2311.79	2252.33	2251.34	2270.54
1971	2396.54	2227.23	2179.41	2366.82
1972	2611.70	2420.66	2344.94	2650.70
1973	2889.38	2576.68	2630.84	2886.10
1974	3103.51	2630.40	2566.47	2634.62
1975	2256.08	2058.28	1979.90	2018.75
1976	2202.86	2096.34	2027.93	2438.87
1977	2277.36	2209.13	2049.25	2306.26
1978	2440.81	2511.30	2246.60	2696.29
1979	2879.50	2806.04	2734.26	3001.19
1980	3132.59	3005.04	3055.50	3126.87
1981	3083.66	2945.76	2900.51	3054.07
1982	2639.77	2917.76	2822.18	2914.30
1983	2914.44	3198.17	2986.99	3179.40
1984	3261.41	3296.08	3207.40	3396.12

Metal and engineering industries

Time	Q1	Q2	Q3	Q4
1962	1399.02	1323.03	1141.37	1391.58
1963	1365.18	1278.50	1107.66	1350.67
1964	1373.48	1338.67	1194.54	1502.31
1965	1525.77	1460.86	1270.27	1562.10
1966	1582.53	1448.03	1248.03	1659.41
1967	1662.65	1588.21	1238.92	1613.22
1968	1797.27	1580.21	1306.85	1760.67
1969	1826.04	1762.73	1545.66	2066.57
1970	2125.76	2181.07	1800.64	2291.53
1971	1422.39	2385.28	2048.05	2551.28
1972	2636.53	2512.91	2030.65	2708.90
1973	2888.15	2729.28	2171.89	2891.68
1974	3163.35	3078.78	2474.03	3201.84
1975	3313.20	3385.16	2614.75	3400.89
1976	3441.32	3379.87	2539.71	3449.10
1977	3305.20	3287.00	2551.69	3378.10
1978	3273.38	3282.67	2587.88	3461.07
1979	3663.63	3559.47	2921.00	3787.89
1980	3912.02	3988.31	3434.35	4321.32
1981	4129.44	4369.10	3640.90	4612.56
1982	4715.30	4889.35	3474.07	4675.28
1983	4566.47	4978.96	3638.79	4710.79
1984	4755.56	5250.41	3829.61	5214.42

Other manufacturing industries

Time	Q1	Q2	Q3	Q4
1962	2041.67	2041.68	1879.48	2089.18
1963	2000.53	2104.41	2052.04	2374.02
1964	2347.10	2411.52	2161.78	2145.60
1965	2353.94	2355.28	2263.03	2523.75
1966	2257.92	2534.93	2528.37	2956.77
1967	2732.29	2723.83	2477.63	2828.25
1968	2812.73	2818.87	2609.28	3072.12
1969	3185.95	3217.63	2997.82	3494.60
1970	3527.67	3733.12	3322.57	3715.64
1971	3408.27	3640.17	3477.25	4207.30
1972	3811.25	4044.62	3746.04	4443.09
1973	4413.66	4057.44	3757.74	4389.16
1974	4414.39	4340.14	3896.50	4481.97
1975	4497.48	4449.33	3602.16	4361.03
1976	4408.86	4397.84	3797.72	4587.58
1977	4346.22	4257.77	3810.47	4654.54
1978	4379.07	4569.27	3993.26	4847.40
1979	4889.37	4900.21	4461.47	5186.94
1980	5129.38	5132.88	4758.63	5411.11
1981	5288.02	5321.27	4860.42	5534.29
1982	5502.98	5223.54	4830.19	5545.30
1983	5574.99	5427.93	5009.59	5677.49
1984	5651.91	5517.12	5113.84	5912.13

Gross value of manufacturing output, million markkaa, at 1980 prices

Time	Manufacturing	Forest industries	Metal and engineering industries	Other manufacturing industries
1970	95115.16	26798.20	21810.10	47122.46
1971	97809.28	31357.06	19938.11	48387.79
1972	107209.78	33847.45	23503.56	51807.80
1973	111619.44	33284.90	25822.43	53658.01
1974	119936.03	34114.76	28899.96	57872.75
1975	114357.56	30526.66	29565.49	56118.45
1976	116681.50	35198.24	28424.58	57077.06
1977	116582.38	32656.03	29987.14	55477.57
1978	118813.78	31823.95	29310.15	58686.86
1979	133833.85	34210.60	34493.64	65559.64
1980	152230.00	37056.00	41193.00	74081.00
1981	159632.14	39719.82	43360.97	76078.22
1982	157639.15	39807.31	44043.38	74374.45
1983	159391.60	40355.47	43991.78	75056.28
1984	163535.30	41007.05	46081.11	76056.48

Time	Gross domestic product at 1980 prices	Total domestic demand at 1980 prices
1962	93458.00	96679.00
1963	96528.00	98652.00
1964	101585.00	107211.00
1965	106972.00	113644.00
1966	109510.00	115754.00
1967	111885.00	116569.00
1968	114462.00	115331.00
1969	125443.00	128098.00
1970	134957.00	142024.00
1971	137742.00	145006.00
1972	148210.00	152088.00
1973	157993.00	164737.00
1974	162850.00	173284.00
1975	164591.00	181464.00
1976	165139.00	176118.00
1977	165461.00	168794.00
1978	169719.00	166800.00
1979	182303.00	183919.00
1980	192556.00	194186.00
1981	196028.00	191286.00
1982	201831.00	199419.00
1983	207752.00	205200.00
1984	214044.00	208248.00

Exports, million markkaa, at 1980 prices

Time	Manufacturing	Metal and engineering industries	Forest industries	Other manufacturing industries
1964	18242.91	13613.04	3119.26	1510.60
1965	19266.77	13771.03	3786.31	1709.43
1966	20117.71	14264.61	3848.10	2005.01
1967	20871.55	13919.92	4594.64	2356.99
1968	23801.02	15250.73	5848.21	2702.08
1969	27942.55	17098.47	7201.81	3642.27
1970	29714.35	17524.87	7761.78	4427.70
1971	28671.73	16741.85	7071.21	4858.66
1972	32767.08	18487.74	8702.61	5576.73
1973	35263.37	19941.03	9753.51	5568.83
1974	36043.31	18505.09	11032.59	6505.63
1975	30086.59	13172.59	11146.09	5767.91
1976	35198.21	15484.73	12900.80	6812.69
1977	38871.80	16581.91	14129.35	8160.54
1978	42314.25	19297.87	14120.93	8895.45
1979	46055.01	21984.47	14904.72	9165.83
1980	50258.00	23493.00	15099.00	11666.00
1981	51337.15	21828.99	16666.67	12841.49
1982	50000.93	20698.02	17948.79	11354.12
1983	52250.49	21927.42	18379.33	11943.74
1984	57105.50	23357.75	20670.23	13077.52

Explanations of numbers:

1 = Imports of the five countries most important for Finnish exports weighted with Finnish export weights, at 1980 prices in common currency, index 1969S2 = 100
2 = Countries and market areas most important for Finnish exports weighted with Finnish export weights, at 1980 prices in common currency, index 1969S2 = 100
3 = Total domestic demand of countries most important for Finnish exports, at 1980 prices in common currency, index 1969S2 = 100
4 = Contribution of stockbuilding to GDP, countries most important for Finnish exports, at 1980 prices in common currency, index 1969S2 = 100
5 = GDP of countries most important for Finnish exports, at 1980 prices in common currency, index 1969S2 = 100
6 = World trade, at 1980 prices in common currency, index 1969S = 100

Time	(1)	(2)	(3)	(4)	(5)	(6)
1970	107.65	107.26	102.50	99.93	102.22	106.56
1971	111.49	111.16	106.05	99.22	105.90	112.36
1972	120.26	120.87	112.64	99.35	112.16	123.82
1973	130.17	138.73	119.29	100.03	119.10	145.60
1974	135.67	150.19	117.51	99.79	118.51	161.27
1975	129.69	146.06	116.66	98.13	118.22	160.46
1976	143.54	162.41	123.82	99.38	125.83	179.41
1977	144.72	167.87	128.83	99.44	131.30	189.16
1978	147.84	172.56	134.67	99.35	137.08	200.79
1979	163.78	189.36	140.00	99.57	142.03	217.58
1980	164.86	192.05	139.78	98.98	143.50	223.52
1981	161.36	192.68	141.70	98.88	146.43	232.84
1982	165.65	195.59	142.49	98.62	146.54	233.76
1983	171.10	199.56	146.89	98.69	150.68	237.63
1984	184.39	213.12	154.40	99.73	158.24	256.31

Total compensation per hour, volume index 1980 = 100
(deflated by the price index of production)

Time	Manufac-turing	Forest industries	Metal and engineering industries	Other manufac-turing industries
1962	42.87	57.99	42.22	36.32
1963	44.69	59.45	42.46	39.01
1964	48.47	64.55	45.72	42.36
1965	52.67	71.82	49.30	45.71
1966	56.75	81.57	51.23	49.21
1967	60.31	86.57	55.03	52.31
1968	60.01	81.17	54.45	53.76
1969	59.16	67.89	52.83	58.10
1970	65.22	74.38	58.91	64.25
1971	72.44	93.72	63.05	68.48
1972	78.54	106.07	68.10	73.02
1973	80.70	99.04	70.73	78.21
1974	76.97	87.50	70.70	76.02
1975	84.50	100.46	77.16	82.89
1976	90.25	122.46	78.50	87.59
1977	93.77	114.61	89.45	88.26
1978	93.06	104.07	87.56	91.58
1979	94.87	99.01	91.80	94.69
1980	100.00	100.00	100.00	100.00
1981	107.50	110.74	108.69	104.65
1982	111.42	125.29	107.48	107.77
1983	113.10	122.06	110.48	110.06
1984	115.42	115.29	114.97	115.09

Average price of oil in OPEC's long-term contracts, dollars per barrel, at 1980 prices, deflated by the price index of industrial production in Finland

Gross cash flow, million markkaa, at 1980 prices, deflated by the price index of production

Time	Price of oil	Manufacturing	Forest industries	Metal and engineering industries	Other manufacturing industries
1962	7.08	4856.94	1120.84	1207.76	2659.48
1963	6.82	5320.09	1436.20	1210.63	2883.01
1964	6.13	5357.05	1574.72	1129.79	2938.84
1965	6.01	5004.42	1326.63	972.40	2964.21
1966	5.92	4799.90	866.69	917.35	3163.15
1967	4.89	4739.83	749.02	848.23	3309.26
1968	4.37	6299.72	1601.81	1193.90	3852.25
1969	3.95	8928.26	3375.98	1850.83	4371.25
1970	3.80	9150.55	3374.32	1955.53	4536.08
1971	4.47	7033.78	1797.94	1639.88	4387.07
1972	4.68	7736.26	1778.65	1854.18	4964.83
1973	5.40	7448.19	2443.40	1854.08	4416.18
1974	16.67	10442.09	3227.70	2647.32	4787.27
1975	16.73	5943.68	-66.85	2329.30	3625.25
1976	16.46	4808.79	-1747.84	2372.83	3495.40
1977	16.12	4566.87	-1119.14	1302.49	4028.65
1978	14.92	7209.52	844.61	1807.15	4625.14
1979	19.79	10179.19	2597.14	2217.85	5581.13
1980	31.14	10157.60	3201.30	1850.19	5296.21
1981	32.56	8077.72	1726.43	1365.61	5113.85
1982	29.26	8106.26	67.51	2683.27	5239.77
1983	23.89	11639.81	2305.30	2764.63	6607.84
1984	21.52	13333.40	3752.10	3229.70	6504.72

Net cash flow, million markkaa, at 1980 prices, deflated by the price index of production

Time	Manufacturing	Forest industries	Metal and engineering industries	Other manufacturing industries
1962	1609.99	-719.46	856.45	1336.85
1963	2018.26	-296.80	856.06	1437.40
1964	1902.45	-49.28	718.14	1335.35
1965	1437.77	-414.64	546.87	1341.88
1966	1125.71	-874.23	508.73	1372.37
1967	1080.37	-888.09	199.52	1705.51
1968	2496.94	-183.69	505.76	2280.94
1969	3640.51	1473.10	891.13	1827.27
1970	3414.34	913.39	735.51	2367.34
1971	2142.31	-98.14	788.88	2051.45
1972	2931.84	-47.50	1064.81	2569.44
1973	1826.84	447.97	607.91	1926.30
1974	3182.29	981.37	1007.76	1544.19
1975	314.32	-1752.88	1036.58	996.90
1976	-570.16	-3267.78	1089.59	929.77
1977	-668.91	-2641.96	26.17	1653.60
1978	1596.45	-658.45	307.16	2107.20
1979	2916.57	150.60	500.09	2563.61
1980	2784.39	773.71	86.90	2265.87
1981	750.08	-524.99	-443.28	2011.70
1982	1761.98	-1733.50	1089.17	2364.35
1983	5328.10	282.52	999.24	4113.55
1984	6377.74	1492.55	1170.00	3949.04

Time	Net capital stock, million markkaa, at 1980 prices				Marginal interest rate on banks' central bank debt, deflated by the price index of production
	Manufac-turing	Forest industries	Metal and engineering industries	Other manufac-turing industries	
1962	38672.60	16502.50	7712.80	14457.30	13.78
1963	40636.90	17217.70	8277.70	15141.50	8.31
1964	43026.50	18221.70	8796.20	16008.60	7.43
1965	45564.90	18766.60	9247.80	17550.50	6.66
1966	48190.90	19186.10	10361.50	18643.30	18.13
1967	49722.60	19025.50	11195.40	19501.70	2.06
1968	51064.00	19284.30	11454.40	20325.30	-4.53
1969	53326.80	19853.60	11893.00	21580.20	-3.05
1970	57367.70	21049.60	13194.60	23123.50	10.68
1971	61701.30	22425.50	14511.40	24764.40	3.90
1972	65246.50	23082.40	15452.50	26711.60	0.51
1973	67764.80	23320.10	16199.60	28245.10	-2.42
1974	72483.30	23804.90	18279.60	30398.80	-10.08
1975	77053.10	24810.10	20693.10	31549.90	8.98
1976	80079.90	25845.90	22557.20	31676.80	7.96
1977	81214.70	26737.70	22660.10	31816.90	11.22
1978	80951.20	26073.00	22473.40	32404.80	3.86
1979	81347.00	25926.30	22275.70	33145.00	0.67
1980	83255.60	26466.40	22691.40	34097.80	7.23
1981	86092.40	27364.50	23303.50	35424.40	7.55
1982	88762.40	28093.80	23902.50	36766.10	6.51
1983	90872.70	28338.40	24460.10	38074.20	7.06
1984	93262.40	28804.70	25200.50	39257.20	7.73

Euro-dollar rate (3 months), in real terms, deflated by the price index of production

Time	
1966	5.35
1967	1.39
1968	-4.71
1969	0.65
1970	2.61
1971	1.00
1972	-1.33
1973	-5.59
1974	-16.50
1975	-5.82
1976	-4.96
1977	-0.21
1978	2.64
1979	5.32
1980	9.72
1981	6.20
1982	1.87
1983	1.98
1984	0.56

Banks' average lending rate

Time	Q1	Q2	Q3	Q4
1962	7.02	7.03	7.04	7.04
1963	7.13	7.14	7.15	7.15
1964	7.24	7.25	7.26	7.26
1965	7.46	7.47	7.48	7.48
1966	7.52	7.53	7.54	7.54
1967	7.55	7.56	7.57	7.57
1968	7.69	7.70	7.71	7.71
1969	7.70	7.71	7.72	7.72
1970	7.75	7.76	7.77	7.77
1971	8.73	8.74	8.75	8.75
1972	8.16	8.16	8.17	8.17
1973	8.19	8.23	9.66	9.75
1974	9.75	9.79	9.88	9.91
1975	9.96	10.00	10.04	10.08
1976	10.10	10.13	10.14	10.17
1977	10.19	10.22	10.25	9.29
1978	9.24	8.30	8.25	8.24
1979	8.20	8.21	8.21	9.41
1980	10.16	10.17	10.17	10.17
1981	10.19	10.21	10.17	10.19
1982	10.15	9.42	9.38	9.36
1983	9.35	9.37	10.39	10.39
1984	10.47	10.53	10.61	10.67

The rate of interest on total liabilities of manufacturing firms

Time	Manufac-turing	Forest industries	Metal and engineering industries	Other manufac-turing industries
1962	0.04	0.05	0.03	0.04
1963	0.04	0.05	0.04	0.04
1964	0.05	0.05	0.04	0.04
1965	0.05	0.06	0.04	0.04
1966	0.05	0.06	0.04	0.05
1967	0.05	0.06	0.04	0.05
1968	0.05	0.06	0.05	0.05
1969	0.05	0.06	0.05	0.05
1970	0.05	0.06	0.04	0.05
1971	0.05	0.06	0.04	0.05
1972	0.05	0.06	0.05	0.05
1973	0.05	0.06	0.05	0.05
1974	0.05	0.06	0.05	0.05
1975	0.05	0.06	0.05	0.06
1976	0.06	0.06	0.05	0.06
1977	0.06	0.07	0.06	0.06
1978	0.06	0.07	0.06	0.06
1979	0.06	0.07	0.06	0.06
1980	0.06	0.07	0.06	0.06
1981	0.07	0.08	0.07	0.07
1982	0.07	0.08	0.06	0.07
1983	0.07	0.08	0.07	0.06
1984	0.07	0.08	0.07	0.07

Economic rate of depreciation of the capital stock

Time	Manufacturing	Forest industries	Metal and engineering industries	Other manufacturing industries
1962	0.07	0.07	0.08	0.07
1963	0.07	0.07	0.08	0.07
1964	0.07	0.07	0.08	0.07
1965	0.07	0.07	0.08	0.07
1966	0.07	0.07	0.08	0.07
1967	0.07	0.08	0.08	0.07
1968	0.08	0.07	0.08	0.08
1969	0.08	0.08	0.08	0.07
1970	0.07	0.08	0.08	0.07
1971	0.07	0.08	0.08	0.07
1972	0.08	0.08	0.08	0.07
1973	0.08	0.08	0.08	0.07
1974	0.08	0.08	0.07	0.07
1975	0.08	0.08	0.07	0.07
1976	0.08	0.09	0.07	0.07
1977	0.08	0.09	0.08	0.07
1978	0.08	0.09	0.08	0.07
1979	0.08	0.08	0.08	0.08
1980	0.08	0.08	0.08	0.08
1981	0.08	0.08	0.08	0.08
1982	0.08	0.08	0.08	0.08
1983	0.08	0.08	0.08	0.08
1984	0.08	0.08	0.08	0.08

Tax depreciation rate of the capital stock

Time	Manufacturing	Forest industries	Metal and engineering industries	Other manufacturing industries	Corporate tax rate
1962	0.21	0.23	0.19	0.19	0.55
1963	0.21	0.23	0.20	0.19	0.50
1964	0.21	0.23	0.20	0.20	0.57
1965	0.21	0.23	0.20	0.20	0.60
1966	0.21	0.23	0.20	0.20	0.61
1967	0.21	0.23	0.20	0.22	0.62
1968	0.21	0.23	0.20	0.20	0.72
1969	0.21	0.23	0.20	0.20	0.63
1970	0.21	0.23	0.20	0.20	0.61
1971	0.21	0.23	0.20	0.20	0.58
1972	0.21	0.23	0.20	0.20	0.58
1973	0.21	0.23	0.20	0.20	0.58
1974	0.21	0.23	0.20	0.21	0.58
1975	0.21	0.23	0.20	0.21	0.59
1976	0.32	0.32	0.32	0.32	0.59
1977	0.33	0.33	0.33	0.33	0.59
1978	0.29	0.29	0.29	0.29	0.59
1979	0.35	0.35	0.35	0.35	0.59
1980	0.32	0.32	0.32	0.32	0.59
1981	0.21	0.21	0.20	0.21	0.59
1982	0.35	0.35	0.35	0.35	0.59
1983	0.35	0.35	0.35	0.35	0.59
1984	0.26	0.26	0.26	0.26	0.59

Price index of investment goods, 1980 = 100

Time	Manufacturing	Manufacturing investment: machinery and equipment	Manufacturing investment: construction
1962	18.57	18.88	17.64
1963	19.03	19.21	18.61
1964	19.94	19.90	20.05
1965	21.36	21.52	21.07
1966	21.75	21.74	21.78
1967	22.65	22.49	23.00
1968	26.07	26.34	25.31
1969	27.06	27.25	26.60
1970	29.91	30.26	29.15
1971	33.65	34.23	32.29
1972	37.92	38.96	35.24
1973	43.93	44.68	42.07
1974	54.02	53.78	54.42
1975	62.14	62.29	61.88
1976	68.64	69.15	67.37
1977	78.52	79.84	75.70
1978	78.79	80.70	74.45
1979	84.05	86.49	77.82
1980	100.00	100.00	100.00
1981	103.32	103.70	102.09
1982	111.53	111.16	112.49
1983	111.77	108.68	120.77
1984	118.52	114.85	130.86

Price index of industrial production, 1980 = 100

Time	Manufacturing	Forest industries	Metal and engineering industries	Other manufacturing industries
1962	22.61	17.22	24.80	24.98
1963	23.45	17.94	26.50	25.55
1964	24.48	18.63	27.86	26.73
1965	24.94	18.45	28.41	27.58
1966	25.33	17.52	29.98	28.10
1967	26.56	18.12	31.64	29.31
1968	29.77	21.41	35.27	32.27
1969	32.89	28.36	39.24	32.34
1970	34.20	30.88	39.56	33.16
1971	35.82	28.59	43.40	36.00
1972	38.45	29.71	45.82	39.37
1973	44.88	38.40	52.44	44.30
1974	59.18	55.81	64.97	57.29
1975	66.42	56.95	73.96	65.40
1976	73.38	54.38	86.07	73.60
1977	78.78	63.16	84.38	82.75
1978	85.77	74.15	93.58	86.69
1979	93.30	87.79	98.41	92.87
1980	100.00	100.00	100.00	100.00
1981	106.69	100.80	105.03	111.38
1982	114.35	97.19	117.97	120.50
1983	123.28	107.97	125.18	130.37
1984	133.31	126.57	132.04	138.41

Principal components (all variables, significant at 99 per cent level of confidence)
Data used in the estimations in Table 14

Time	PC_2	PC_3
1978	57169.6	-8082.9
1968	59978.2	-7036.8
1969	67155.9	-6032.8
1970	72366.0	-6908.7
1971	72693.6	-8979.1
1972	79369.1	-9506.0
1973	84526.2	-10770.5
1974	87847.3	-8885.9
1975	84578.1	-12851.4
1976	86641.9	-13695.2
1977	87894.5	-13791.3
1978	91919.7	-12039.7
1979	100057.2	-10987.0
1980	106520.8	-12078.9
1981	108151.6	-14149.1
1982	109905.0	-14792.2
1983	114254.0	-12522.9
1984	119543.1	-11737.4

Principal components (all variables, significant at 99 per cent level of confidence)
Logarithmic difference transformation

Time	P_1	P_2	P_3
1968	0.22	0.06	-0.10
1969	0.32	-0.01	-0.15
1970	0.14	-0.09	0.07
1971	-0.10	-0.24	0.13
1972	0.16	-0.23	-0.12
1973	0.11	-0.01	0.18
1974	0.09	-1.16	-0.90
1975	-0.35	-0.23	0.41
1976	0.05	0.22	0.36
1977	-0.03	-0.15	-0.06
1978	0.28	0.49	0.10
1979	0.32	0.09	-0.03
1980	0.10	-0.27	-0.08
1981	-0.07	0.03	0.27
1982	-0.01	-0.01	0.07
1983	0.18	0.18	-0.06
1984	0.15	0.09	0.04

Logarithmic difference transformation transformed back to levels
Data used in the estimations in Table A.6.b

Time	P_1	P_2	P_3
1968	3.38	2.88	2.46
1969	4.67	2.87	2.11
1970	5.38	2.63	2.25
1971	4.85	2.08	2.57
1972	5.71	1.65	2.28
1973	6.38	1.64	2.72
1974	6.98	0.52	1.10
1975	4.91	0.41	1.65
1976	5.15	0.51	2.38
1977	5.02	0.44	2.23
1978	6.66	0.72	2.46
1979	9.18	0.79	2.37
1980	10.11	0.60	2.18
1981	9.45	0.62	2.85
1982	9.32	0.62	3.05
1983	11.14	0.73	2.86
1984	12.92	0.81	2.98

Principal component (demand variables)
Data used in the basic model estimation in Tables 15.a - 15.d

Time	PC_1
1970	71302.4
1971	72230.8
1972	77996.9
1973	83376.4
1974	84875.1
1975	82147.5
1976	83601.8
1977	84255.3
1978	87788.1
1979	95199.5
1980	100783.5
1981	101440.3
1982	103199.4
1983	106790.2
1984	110589.6

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