

# The stock market and investment in the small and open Norwegian economy<sup>1</sup>

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**Abstract.** The relationship between the stock market and investment is analyzed by utilizing a multivariate vector autoregressive model, which also includes fundamentals represented by production and the bank interest rate. Two important results appear on the basis of data from the small, open economy of Norway. The financial market has no lead effect on real activity, as neither the stock market nor the credit market can predict future investment or production. On the contrary, current stock returns correlate negatively with lagged growth in investment, and positively with current growth in production. In addition, changes in the bank interest rate have a positive effect on future stock returns, production leads investment positively, and both production and the bank interest rate become exogenous variables in our model.

**Key words:** Stock market; investment; fundamentals

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## 1. Introduction

This paper analyzes the relationship between the stock market and investment, focusing on the manufacturing sector in Norway. We introduce a multivariate vector autoregressive (VAR) model to establish dynamic interactions among stock returns, growth rates of investment, growth rates of gross pro-

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duction, and changes in the bank interest rate on loans, all adjusted for inflation. Two important results appear. The financial market in Norway has no lead effect on real activity, as neither the stock market nor the credit market can predict future investment or production, i.e. the financial market has no causal effect on real activity. On the contrary, current stock returns correlate negatively with lagged growth in investment, and positively with current growth in production. In addition, changes in the bank interest rate have a positive effect on future stock market returns, production leads investment positively, and both production and the bank interest rate become exogenous variables in our model. These results are documented by causality analyses based on the estimated VAR model, by a decomposition of forecasting error variances, as well as by an innovation accounting approach.

A number of theoretical and empirical contributions support the view that the stock market to some extent influences investment. Morck, Shleifer and Vishny (1990) present four hypotheses on why stock prices and subsequent investment should be correlated. First, according to the passive informant hypothesis, the stock market may reflect information about investment strategies, but without influencing the managers' investment decisions. In this way, the stock market is a "sideshow". The observed correlation is a consequence of the stock market revealing what managers already know or believe, and is thus only a passive predictor of future activity rather than a causal determinant of investment.

Second, according to the active informant hypothesis, managers rely on the stock market as a source of information when making investment decisions. If market signals are accurate (the accurate informant hypothesis), the market helps predict investment as it correctly predicts the future state of the economy. But even if the market sends inaccurate signals (the faulty informant hypothesis), due to investor sentiment or the inherent unpredictability of the future, the noisy information provided by the market may be used. Hence, the stock market may influence investment decisions even though the signals are inaccurate, see Morck et al. (1990, p. 165).

Third, the stock market may affect investment through its influence on the cost of external financing, cf. Fischer and Merton (1984) and Blanchard, Rhee and Summers (1993). The implication of the financing hypothesis, which concerns both equity and debt financing, is that the key channel of the stock market's influence on investment is through the issuance of new securities. High stock prices, for instance, may imply that the cost of issuing new equity is low, which in turn promotes investment.

Fourth, the stock market pressure hypothesis claims that the market exerts pressure on investment quite aside from its informational and financing role. For instance, management compensation plans that link stock prices and wage payments, may influence the managers' investment decisions so that long-term investments may be dropped in favor of short-term ones, cf. the myopic behavior of investors found in Stein (1988) and Shleifer and Vishny (1990).

Several studies based on aggregate data, hypothesize and document a positive relationship between growth rates of investment and current and lagged stock returns. Examples from the U.S. are Bosworth (1975), Fama (1981), Barro (1990), Blanchard, Rhee and Summers (1993) and Galeotti and Schiantarelli (1994). This result is replicated by Fazzari, Hubbard and Peterson (1988), using investment levels, and by Morck, Shleifer and Vishny

(1990), both based on cross-sectional, firm-specific determinants of investment. See also Hubbard (1998) for a survey. As pointed out in a number of these studies, the demonstrated positive correlation between stock returns and growth rates may simply be that the stock market anticipates movements in the underlying variables that really determine capital expenditures. Controlling for fundamentals, represented by e.g. cash flows, sales, private consumption and production, clearly reduces the explanatory power of stock returns. These findings are consistent with the view that the positive relationship between the stock market and investment is a proxy for a positive relationship between underlying economic factors and investment, and hence that the stock market is a "sideshow".

An examination of the determinants of investment in several countries is provided by Tease (1993) and Welch (1995). Tease (1993) reports that the stock market seems to render more leading information on investment in the U.S. than in continental European countries. Welch (1995) finds that the investment of Japanese and continental European firms may respond less to stock returns than the investment of large U.S. firms, whereas the investment of Canadian and British firms may respond more to stock returns than the investment of large U.S. firms. These results indicate that the stock market is a more useful leading indicator in economies with large, mature stock markets than in countries where financial intermediaries, e.g. banks, are more important sources of finance.

Our study advances the literature in two ways. First, our data sample covers the period 1952–1995 in Norway. Several characteristics of the Norwegian economy underscore that it may be an interesting test subject for analyzing the relationship between financial variables and real investment. Norway represents a small, open economy in Europe, and it is sensitive to the world market prices of its natural resources. The industry structure, characterized by processing intermediate products rather than final goods, increases this commodity price risk dependency. The fact that a number of international investors find Norwegian investments attractive has partly been explained by the opportunity to invest in commodity price sensitive securities.

Furthermore, equity and bond markets have historically played a minor role in Norway relative to banks. In general, a small stock market may be accompanied by opportunities that do not exist in more mature markets, and may increase the likelihood of the market reacting inadequately to new information. Short selling of stocks, which implies that negative information may be less effectively incorporated into stock prices, has been prohibited in Norway, like in the majority of European stock markets. Compared to larger equity markets, the volatility of Norwegian stock prices is high, and both economic and market structure phenomena may contribute to explaining this observation.

Although the institutional framework underscores that we would expect e.g. the Norwegian stock market to render less leading information on investment than those of larger, more mature stock markets, the above characteristics of the Norwegian economy are found in other small countries as well. Consequently, this study provides both country specific evidence and evidence of more general interest on the relationship between the financial and real sector in small, open economies.

Second, in recent studies the ability of the stock market to predict investment has been obtained from two regression equations. An upper bound for

the incremental explanatory power of stock market returns is the change in the adjusted  $R^2$  from regressing investment on both fundamentals and stock returns as compared to regressing investment on fundamentals only. Realizing that investment, financing, and fundamentals are all determined simultaneously, this paper is explicitly concerned with the intertemporal relationships among financial and fundamental variables. We therefore utilize a multivariate vector autoregressive model. This technique treats all variables in the system without imposing a priori restrictions on the relationships among them, and, hence, allows for a variety of potential endogenous relationships.

The remainder of our paper is organized as follows. In Section 2, we outline how tests for Granger causality and how forecasting error variances are decomposed within the VAR framework. The variables are defined and the data set is described in Section 3. In Section 4, the results are presented. A summary of important results and some conclusions are offered in Section 5.

## 2. Framework of analysis

The multivariate vector autoregression modelling technique is a useful alternative to the conventional structural modelling procedure. VAR analysis works with unrestricted reduced forms, treating all variables as potentially endogenous. The results of causality tests within a multivariate VAR system are considerably more general and reliable as compared to bivariate test results. The VAR technique provides an unbiased test for Granger causality and can detect feedback relations among the series. We give a brief presentation of the VAR analysis, for a more rigorous discussion, see e.g. Sims (1980).

A VAR process can be described as follows:

$$\Phi(\mathbf{B})\mathbf{Z}_t = \mathbf{e}_t \quad (1)$$

where  $\mathbf{Z}_t = (Z_{1t}, Z_{2t}, \dots, Z_{kt})$  represents a stationary  $(k \times 1)$ -vector of  $k$  time series containing  $n$  observations and where  $\mathbf{e}_t = (e_{1t}, e_{2t}, \dots, e_{kt})$  is a  $(k \times 1)$ -vector of random shocks, which are independently, identically, and normally distributed with mean zero and covariance  $\Sigma$ .  $\Phi(\mathbf{B})$  is a  $(k \times k)$ -matrix of full rank, containing autoregressive parameters and having finite polynomial elements in the lag operator  $B$ , defined as  $B^j Z_{i,t} = Z_{i,t-j}$ . In Equation (1),  $\mathbf{Z}_t$  may be interpreted as the response to a stochastic input  $\mathbf{e}_t$ , while the matrix  $\Phi(\mathbf{B})$  represents the adjustment pattern to these shocks. The stationarity characteristics of the individual time series will be controlled for by an augmented Dickey and Fuller (1979, 1981) test, in which both deterministic and stochastic trends, as well as residual autocorrelations are considered.

An essential part of the analysis is to determine the appropriate lag structure in the VAR system. Lagged dependent variables may often provide a good approximation of the autoregressive process in the error terms. An intuitive guide to establishing the best VAR model is to choose a lag structure such that the estimated model residuals have no significant autocorrelation. However, we start out by performing more formal tests. We employ various lag order selection criteria; the Schwarz, the Hannan-Quinn and the Akaike's Information, respectively, as well as likelihood ratio tests for reduction in the number of lags in the VAR model. We will inspect the model with respect to its error term structure.

A general problem in time series analyses is the possible existence of shifts in the mean and in the trend of the variables. The consequences of that problem are well documented for univariate series, cf. Perron (1989). To test for the significance of intertemporal changes among the variables in the system, we implement a stepwise estimation procedure.

In addition to the VAR model itself, we carry out a variance decomposition by estimating the proportion of a variable's forecasting errors that can be attributed to the influence of the other variables in the system. The VAR model in Equation (1) underscores the fact that the various values of the variables are responses to shocks related to the error terms  $e_t$ .

Although the error terms may be serially uncorrelated, they may be contemporaneously correlated. Then, the simulation of a shock  $Z_{jt}$ , holding all other components at zero, may not be what occurred historically. To circumvent this difficulty the model is transformed, such that the innovations become orthogonal to each other. This is done by using a standard method, see e.g. Hamilton (1994, p. 322). The orthogonalized representation is not neutral with respect to the ordering of the variables, and we will briefly discuss this issue in the Empirical results Section 4.3.

Next, we utilize the identified VAR system  $Z_t$  for  $k$  variables in calculating the variance of  $t$ -year forecasting errors of variable  $i$  explained by innovations in variable  $j$  as follows:

$$\sum_{s=0}^{t-1} c_{ij}(s)^2 \Big/ \sum_{j=1}^k \sum_{s=0}^{t-1} c_{ij}(s)^2 \quad (2)$$

where  $c_{ij}(s)$  is the  $(i, j)$  component of the  $(k \times k)$ -matrix  $C(s)$  and represents the dynamic response of each endogenous variable  $Z_i$  to a shock,  $u_j(t-s)$ , after  $s$  periods. The basis for the calculation of  $c_{ij}(s)$  is an orthogonalized moving average representation of  $Z_t$ :

$$Z_t = \sum_{s=0}^{\infty} C(s)u(t-s) \quad (3)$$

The coefficients of  $C(s)$  represent responses to shocks in particular variables after the orthogonalizing process, while  $u(t-s)$  contains orthogonalized errors.

### 3. Data

Although we do not directly rely on structural models, see Chirinko (1993) for a survey of formal investment models like the accelerator, the neoclassical or the Tobin's  $q$ -model, the selection of variables are motivated on economic grounds. The literature surveyed in Section 1 illustrates that researchers typically hypothesize and document a positive relationship between changes in investment and stock market returns. Regressions are run on changes (or growth rates) rather than on levels, because levels have residuals that are serially correlated, cf. Morck, Schleifer and Vishny (1990, p. 170). The "fixed effect" is the dominant influence in level regressions and yields little informa-

tion about what drives year-to-year growth rates. We have followed the change regression approach and use real stock returns as the key financial variable, and growth rates of real investment as the key real variable. Since our focus is on the ability of the stock market per se to predict investment, market valuation is measured by stock returns rather than growth rates of Tobin's  $q$ . We recognize that a change in the  $q$ -value may be strongly related to changes in the stock price, but reliable  $q$ -estimates are difficult to obtain for Norwegian firms over the whole period. In addition, Barro (1990, pp. 118–122) found that the growth rate of the real stock market price outperformed the growth rate of Tobin's  $q$ . This finding has later been confirmed by Blanchard, Rhee and Summers (1993, p. 127).

As pointed out in the Introduction, the demonstrated positive correlation between stock returns and the growth rates of investment may simply be that the stock market anticipates movements in underlying variables that are the real determinants of capital expenditures. In the literature, economic fundamentals are represented by e.g. cash flows, sales, private consumption and production, and including such fundamentals clearly reduces the explanatory power of a regression of investment on stock market performance. Including firm-specific fundamental variables like corporate profits, cash flows and sales, would have been interesting. Unfortunately, there are no easily available statistics for these figures before 1977. Consequently, we use real gross production in the manufacturing sector as a fundamental economic variable, and the real interest rate as a fundamental financial variable. Yearly national account numbers for the period 1952–1995 are obtained from the Statistics Norway. Quarterly or monthly data are not available in Norway over the whole period.

The variables used in the VAR analysis are defined as follows: 1) Logarithmic stock returns (year  $t$  relative to  $t - 1$ ),  $SR_t = \log(P_t + DIV_t) - \log(P_{t-1})$ , where  $P_t$  is the value-weighted stock price index of manufacturing for year  $t$  and  $DIV_t$  is the dividend payout. The inflation rate for the consumer price index (year  $t$  relative to year  $t - 1$ ),  $INF_t$ , is subtracted to compute real stock returns,  $SRR_t$ . 2) The logarithmic growth rate of real gross investment (year  $t$  relative to year  $t - 1$ ) in manufacturing,  $DIR_t$ . 3) The logarithmic growth rate of real gross production (year  $t$  relative to year  $t - 1$ ) in manufacturing,  $DPR_t$ . 4) The average real interest rate on loans from commercial and savings banks,  $BRR_t$ , found by deducting inflation  $INF_t$  and differentiating, i.e.  $BRR_t = \log(1 + R_t - INF_t) - \log(1 + R_{t-1} - INF_{t-1})$ , where  $R_t$  is the nominal interest rate.

## 4. Empirical results

### 4.1. Stationarity of the time series and the number of lags in the VAR model

Rejecting the null hypothesis of the Dickey and Fuller test indicates satisfactory stationarity properties for all time series. Based on the values from MacKinnon (1991), we learn from Table 1 that all values are below the critical ones. Thus, we may conclude that the stationarity requirements are met for all time series.

Based on VAR (5) to VAR (1) specifications, the information criteria of Schwarz, Hannan-Quinn and Akaike, as well as likelihood ratio tests for the reduction of lags, all indicate that the number of lags can be reduced to one.

**Table 1.** Augmented Dickey-Fuller tests for stationarity of the individual time series of real stock returns (SRR) in the manufacturing sector, changes in real investment (DIR) in the manufacturing sector, changes in real production (DPR) in the manufacturing sector, and changes in real bank interest rates on loans (BRR)

	No Constant No Trend	Constant No Trend	Constant Trend	Number of lags
SRR	-3.71**	-3.68**	-4.09*	2
SRR	-5.36**	-5.31**	-5.70**	1
SRR	-5.55**	-5.49**	-5.72**	0
DIR	-3.88**	-3.92**	-4.14*	2
DIR	-6.29**	-6.32**	-6.56**	1
DIR	-5.54**	-5.53**	-5.58**	0
DPR	-2.98**	-3.63**	-3.65*	2
DPR	-4.06**	-4.77**	-4.79**	1
DPR	-4.38**	-4.87**	-4.77**	0
BRR	-6.72**	-6.85**	-6.65**	2
BRR	-8.73**	-8.83**	-8.81**	1
BRR	-10.04**	-10.12**	-10.19**	0

\* Significant at the 5%-level.

\*\* Significant at the 1%-level.

Critical values: 5% = -1.948 1% = -2.616.

Critical values: 5% = -2.929 1% = -3.585; constant included.

Critical values: 5% = -3.514 1% = -4.178; constant and trend included.

In addition, we execute diagnostic controls for autocorrelation, heteroscedasticity, and normality in residuals. To check for autocorrelation, a  $t$ -test for the regression of current residuals on lagged ones is performed, see Harvey (1981). Any heteroscedasticity is revealed by an  $F$ -test of the regression of squared residuals on values and squared lagged values, see White (1980). The normality property is tested by the procedure of Bera and Jarque (1980), in which deviations in both skewness and kurtosis are examined. The diagnostic controls indicate autocorrelation problems for the VAR (1) specification. Otherwise, there are no significant residual problems in any individual equation or any VAR model. We therefore conclude that the VAR (2) model is the most suitable specification in our study.

To obtain information about the stability over time in the VAR system, we implement a stepwise Chow test described in Rao (1973) and Anderson (1984). The  $F$ -test statistic is estimated on an increasing number of observations over time. First, we initialize the test procedure by estimating the test statistic on the set of observations from 1952 to 1964. Then, the estimation period is widened by cumulating observations to the initial observation set, i.e. the second test statistic is estimated over the period from 1952 to 1965, the third test statistic is estimated over the period from 1952 to 1966 and so on to the last test statistic, which is estimated over the period from 1952 to 1995. The test compares the residuals of the VAR system estimated on  $t$  against  $t - 1$  observations ( $M \leq t \leq T$ , where  $M$  is the number of observations in the initializing sample and  $T$  is the total number of observations). In Figure 1, we plot the estimated test statistic for the 1 and 5 per cent level, respectively, along with the normalized critical level (the  $F$ -test statistic divided by the critical value of  $F$ ). Consequently, Figure 1 clearly illustrates the intertemporal structure among the variables in the VAR system.

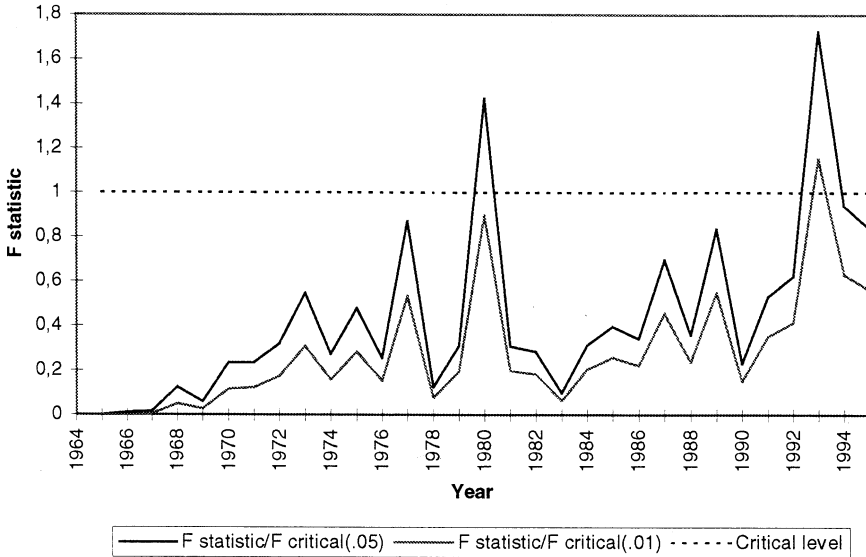


Fig. 1. Stability test of the VAR system.

We see that Figure 1 yields no evidence of structural shifts in the data. However, as the null hypothesis of constant parameters is rejected at the 5% level both for 1980 ( $p$ -value 0.021) and 1993 ( $p$ -value 0.008), we include two impulse dummy variables in our model. Both dummies may be explained on economic grounds. The dramatic worsening of the competitiveness of the (exposed) Norwegian manufacturing industries was striking during the end of the seventies, see e.g. Thøgersen (1994) for further elaboration. The dummy for 1980 may be explained by the significant decline ( $-6.3\%$ ) in real production that year after a sharp increase ( $10.6\%$ ) in 1979. Furthermore, during the autumn of 1992, the turbulence in both the domestic and the international interest rate market led to an increase in the interest rates. The dummy for 1993 may be explained by the significant interest rate decline ( $-4.7\%$ ) that year.

#### 4.2. VAR model results

Before we discuss the results of our VAR estimations, we briefly summarize the empirical relationships based on cross correlations, both for contemporaneous observations and for one lag. The cross correlation matrix is presented in Panel A of Table 2.

Both the correlation coefficient between stock returns and lagged growth rates of investment and the coefficient between growth rates of investment and lagged stock returns are highly significant, and equal  $-0.623$  and  $0.492$ , respectively. Thus, the bivariate results indicate a feedback relation between the stock market and real investment. The stock market seems to provide positive leading information about future investment, and investment seems to provide negative information about future stock market performance. Furthermore,

**Table 2-A.** Cross correlations among individual time series of real stock returns (SRR) in the manufacturing sector, changes in real investment (DIR) in the manufacturing sector, changes in real production (DPR) in the manufacturing sector, and changes in real bank interest rates on loans (BRR)

	SRR <sub>t</sub>	SRR <sub>t-1</sub>	DIR <sub>t</sub>	DIR <sub>t-1</sub>	DPR <sub>t</sub>	DPR <sub>t-1</sub>	BRR <sub>t</sub>	BRR <sub>t-1</sub>
SRR <sub>t</sub>	1.000	0.162		-0.623*		-0.094		0.196
DIR <sub>t</sub>	-0.175	0.492*	1.000	0.110		0.537*		0.013
DPR <sub>t</sub>	0.290	0.129	0.154	-0.053	1.000	0.287		0.108
BRR <sub>t</sub>	-0.013	-0.242	-0.180	0.012	-0.181	-0.309	1.000	-0.131

\* Significant at the 5%-level.

**Table 2-B.** Coefficient estimates from regression equations of changes in real investment (DIR) in the manufacturing sector on changes in real production (DPR) in the manufacturing sector, real bank interest rates on loans (BR) and real stock returns (SRR) in the manufacturing sector

Model Estimates <sup>a</sup>	Adjusted R <sup>2</sup>
(a) DIR <sub>t</sub> : +1.618 DPR <sub>t-1</sub> (0.000)	0.255
(b) DIR <sub>t</sub> : +1.067 DPR <sub>t-1</sub> + 0.352 SRR <sub>t-1</sub> (0.012) (0.001)	0.411
(c) DIR <sub>t</sub> : +1.563 DPR <sub>t-1</sub> - 0.434 DIR <sub>t-2</sub> (0.000) (0.002)	0.397
(d) DIR <sub>t</sub> : +1.226 DPR <sub>t-1</sub> (0.005)	0.422

Eq(a):  $DIR_t = \alpha_0 + \alpha_1 DPR_{t-1} + \alpha_2 DPR_{t-2} + \beta_1 BR_{t-1} + \beta_2 BR_{t-2} + \varepsilon_t$   
 Eq(b):  $DIR_t = \alpha_0 + \alpha_1 DPR_{t-1} + \alpha_2 DPR_{t-2} + \beta_1 BR_{t-1} + \beta_2 BR_{t-2} + \gamma_1 SRR_{t-1} + \gamma_2 SRR_{t-2} + \varepsilon_t$   
 Eq(c):  $DIR_t = \alpha_0 + \alpha_1 DPR_{t-1} + \alpha_2 DPR_{t-2} + \beta_1 BR_{t-1} + \beta_2 BR_{t-2} + \lambda_1 DIR_{t-1} + \lambda_2 DIR_{t-2} + \varepsilon_t$   
 Eq(d):  $DIR_t = \alpha_0 + \alpha_1 DPR_{t-1} + \alpha_2 DPR_{t-2} + \beta_1 BR_{t-1} + \beta_2 BR_{t-2} + \lambda_1 DIR_{t-1} + \lambda_2 DIR_{t-2} + \gamma_1 SRR_{t-1} + \gamma_2 SRR_{t-2} + \varepsilon_t$

<sup>a</sup> *p*-values are in parentheses. Only estimates with a *p*-value less than 5% are reported

there is a strong positive correlation of 0.537 between growth rates of investment and lagged production, indicating that investment seems to be substantially influenced by production.

To learn more about the relationship between the stock market and real investment, Panel B of Table 2 contains the results of four regression equations close to those found in Tease (1993, p. 54). We have yearly (not quarterly) data, somewhat different variable definitions and a longer period of time. Tease includes US, Japan, Germany, France, Italy, UK and Canada in his study and reports only insignificant changes in the explanatory power when stock returns are added to production and real interest variables, i.e. going from Equation (a) to Equation (b) in Table 2-B. In Norway, this seems to be different, as the increase in the adjusted R<sup>2</sup> is about 0.15, as opposed to the average of about 0.02 found by Tease. Apparently, stock returns have a significant influence on investment. However, by including lagged investment

**Table 3-A.** VAR estimates of causal relations among real stock returns (SRR) in the manufacturing sector, changes in real investment (DIR) in the manufacturing sector, changes in real production (DPR) in the manufacturing sector and changes in real bank interest rates on loans (BRR)

Model Estimates <sup>a</sup>	F-value <sup>b</sup>
(a) SRR <sub>t</sub> : -1.036 DIR <sub>t-1</sub> + 1.806 BRR <sub>t-2</sub> (0.000) (0.017)	DIR 11.17 (0.000) BRR 3.45 (0.044)
(b) DIR <sub>t</sub> : +1.527 DPR <sub>t-1</sub> (0.002)	DPR 7.70 (0.002)
(c) DPR <sub>t</sub> : +1.910 + 0.466 DPR <sub>t-1</sub> - 16.446 D <sub>1980</sub> (0.011) (0.005) (0.001)	DPR 4.75 (0.015)
(d) BRR <sub>t</sub> : +1.144 - 0.374 BRR <sub>t-1</sub> - 0.259 BRR <sub>t-2</sub> - 6.282D <sub>1993</sub> (0.015) (0.005) (0.035) (0.023)	BRR 5.84 (0.007)

<sup>a</sup> VAR (2) Model. *p*-values are in parentheses. Only estimates with a *p*-value less than 5% are reported.

<sup>b</sup> Corresponding *F*-value for the set of all lagged variables. *p*-values are in parentheses.

**Table 3-B.** Correlation of unrestricted reduced form errors

	SRR	DIR	DPR	BRR
SRR	1.00			
DIR	-0.158	1.00		
DPR	0.479*	0.011	1.00	
BRR	0.349*	-0.040	0.022	1.00

\* Significant at the 5%-level.

variables, cf. Equation (d) versus Equation (c) of Table 2-B, the stock market return becomes insignificant. With this specification, the increase in the adjusted *R*<sup>2</sup> is only 0.02. Hence, the stock market cannot significantly contribute to understanding future investment, which is consistent with Tease’s findings.

Table 3 presents the results of our VAR (2) model. In Panel A, we learn from Equation (b) that the Norwegian stock market does not seem to lead investment. Thus, the significant correlation coefficient between lagged stock returns and growth rates of investment of 0.492, reported in Table 2-A, measures a spurious effect, cf. the results of Table 2-B, and does not imply a causal influence from the stock market to investment. This finding is in line with Carlsen and Spjøtvoll (1993), who utilize the procedure of Morck, Shleifer and Vishny (1990) by using Norwegian data from a period of very active stock trading in Norway (1980–1989). This lack of impact may be justified on two grounds. First, with different approaches, methodologies and data sets, empirical studies document a positive relationship between the importance of the stock market and its function as a leading indicator. That is, the stock market’s ability to predict real activity is an increasing function of the stock market’s importance relative to the bank sector, cf. Section 1. Second, empirical studies also report that market valuation plays a limited role in the determination of investment decisions when fundamentals are

included in the analysis. Our result is thus in accordance with previous findings.

In Norway, as in the majority of small European countries, the importance of stock and bond markets as a source of financing relative to banks has been minor. E.g. Steigum (1975) documents that the supply of credit provided by banks had a significant influence on investment. We find that neither the stock market nor the interest rate is able to explain investment, as Equation (b) also yields no significant causal effect from the bank interest rate on investment. Our result is consistent with the well-established time series evidence that interest rates generally have limited additional explanatory power, cf. Bernanke and Gertler (1995) and Chirinko, Fazzari and Meyer (1999).

However, Equation (b) shows that production has a significant causal influence on investment. There is a positive relationship between underlying production and future investment in the manufacturing sector, cf. the acceleration model of investment. This may simply express the view that an increase (decrease) in production taking place in the expansion (recession) phase of the business cycle, is a signal of increased (decreased) future profitability/cash flows from new investments. The lagged effect may be related to the fact that decisions about new investments take time and will only be carried out after existing slack has been eliminated.

Equation (c) indicates a positive serial correlation in production, and that the constant term as well as the dummy coefficient for 1980 is significant, cf. Section 4.1. However, the equation identifies no causal effect from any other variable on production. This suggests that production is an exogenous variable in our system. A number of studies on U.S. data, e.g. Fama (1981), Geske and Roll (1983), James, Koreisha and Partch (1985), Kaul (1987), Fama (1990), Schwert (1990) and Lee (1992), conclude that the stock market rationally signals growth in production. We find no evidence that the Norwegian stock market reflects expectations of this kind. A relatively immature stock market together with banks as the primary source of finance over the period of analysis may at least partly explain this result.

Moreover, Equation (a) demonstrates the reverse relationship; there is a lagged and negative response in the stock market to changes in investment. International evidence suggests that firms which undertake long-term investments are rewarded by the stock market. In particular, Chan, Martin and Kensinger (1990) find that the stock market is able to distinguish between good and poor investment projects, and only firms that make good investments are rewarded. If these results are valid also for the Norwegian stock market, the negative market response to investment activities may be attributed to manufacturing companies lacking the ability to meet the cost of capital required by the capital market. However, we are reluctant to conclude that the manufacturing industry on average has invested in unprofitable projects over a long period of time. Other explanations of the identified stock market – investment puzzle are more likely.

First, the negative relationship between investment and the stock market could be caused by rationalization prior to decreases in the stock market. As rationalization increases investment, stock prices are falling, not because of increased rationalization, but because of less demand during the forthcoming recession. Second, the stock exchange listed manufacturing companies in Norway are mainly large, export-oriented companies, while the investment index also contains a significant group of small, domestic-oriented companies.

The subperiod 1989–1991 is a good illustration of this segmentation. The export-oriented manufacturing firms faced a boom in their major export markets and therefore increased their investment activity significantly, whereas the domestic-oriented manufacturing firms faced a national recession which led to a substantial decrease in their investment activity. At the same time, the stock price index of manufacturing companies listed on the Oslo Stock Exchange increased significantly, suggesting a positive relationship between growth rates of investment and stock returns. However, because we are analyzing the relationship between stock returns and growth rates of total investment in the manufacturing industry, i.e. the investment of export- as well as of domestic-oriented firms, we find a negative relationship between the two due to the weight of small, domestic-oriented firms. Unfortunately, our data do not allow us to separate listed from non-listed manufacturing companies.

Equation (a) also indicates that changes in the bank interest rate have a significant positive effect on future stock market performance. Conventionally, real stock returns are supposed to be negatively influenced by real interest changes in the short run, since increasing interest rates will increase the required rate of return on investment upwards. On the other hand, it is argued that high interest rates may also be associated with the expansion phase of a business cycle, and thereby be associated with improved cash flows for firms, which in turn will increase stock prices in the long run. We find little support for this explanation in our data, since no significant interest rate – production relationship is observed in our VAR analysis. This lack of significance is consistent with the fact that the real interest rate has not always been procyclical in Norway. It was decreasing during the strong expansion in the 1970s due to the interest rate regulation and high inflation. It was increasing when the inflation rate was decreasing during the recession in 1989–1990, and it has been decreasing during a recent boom, due to the policy of fixing exchange rates.

Finally, as can be seen from Equation (d), no variable has a causal effect on the bank interest rate. It is thus an exogenous financial variable in the VAR system. However, a negative serial correlation is identified and the constant term as well as the dummy variable for 1993 is significant. The dummy variable captures the effect of the substantial real interest rate decline (–4.7%) that year.

The error covariance matrix accounts for contemporaneous correlation among the four variables. In Panel B of Table 3, two significant correlation coefficients appear, a positive correlation of 0.479 and 0.349, respectively, between stock returns and growth rates of production and between stock returns and changes in interest rates. Although we cannot observe the direction of causalities, we are inclined to interpret this result as an immediate response by the stock market to production changes, and not as a reaction from the stock market to production, and as an immediate response by interest rate changes on stock returns. This conclusion is intuitive both with respect to the results in the lagged equations as well as to the evidence in our variance decomposition analyses reported below.

#### *4.3. Variance decomposition and innovation accounting results*

We start our decomposition of the forecast error variances by eliminating contemporaneous correlations revealed by the error covariance matrix of the

**Table 4.** Variance decomposition: Percentage of the forecast error variance explained by innovations in real stock returns (SRR) in the manufacturing sector, changes in real investment (DIR) in the manufacturing sector, changes in real production (DPR) in the manufacturing sector and changes in real bank interest rates on loans (BRR)

Variable explained	Horizon (in years)	By innovations in			
		DPR	BRR	DIR	SRR
DPR	0	100.00	0.00	0.00	0.00
	1	94.39	4.16	0.05	1.41
	2	93.91	4.14	0.34	1.61
	3	91.69	4.31	2.04	1.95
	4	91.40	4.51	2.15	1.95
BRR	0	0.05	99.95	0.00	0.00
	1	6.85	90.70	1.39	1.06
	2	8.50	87.97	1.33	2.20
	3	10.06	86.33	1.34	2.27
	4	10.94	85.09	1.65	2.32
DIR	0	0.01	0.16	99.83	0.00
	1	28.46	2.77	65.84	2.93
	2	32.90	2.67	62.04	2.39
	3	34.49	2.60	60.18	2.73
	4	35.67	2.71	58.94	2.68
SRR	0	22.99	11.44	2.23	63.33
	1	13.44	9.87	39.04	37.65
	2	23.06	9.62	34.32	33.00
	3	26.14	9.36	34.47	30.03
	4	26.71	9.24	34.35	29.69

VAR (2) model. By carrying out an orthogonalizing transformation of error terms, inferences about causality can be drawn in a straightforward manner. As regards the ordering of the variables, we have put last those not expected to have any predictive value for other variables. Therefore, exogenous variables, as identified in the VAR estimations, are ordered first. As pointed out, the orthogonalized representation is not neutral with respect to the ordering of the variables. Hence, we have also tried alternative orders of factorization to analyze the sensitivity of the results, and it turns out that the results are very robust.

Table 4 presents the results of the decomposition procedure by reporting the percentage of 0- to 4-year forecast error variance, respectively, accounted for by innovations in each of the four variables in the system.

There is little evidence of a bidirectional causality or feedback between the variables, while unidirectional causalities are apparent on a number of occasions. Based on the 4-year forecasting horizon, we see that 91.4% of the forecast error variance for the production variable are accounted for by its own innovations, leaving only negligible impulses from the other variables. On the other hand, production explains 10.9%, 35.7% and 26.7% of the movements in bank interest rates, investment, and stock returns, respectively.

The empirical evidence underscore our impression of the passive role played by the financial market. Clearly, the results illustrate that innovations in stock returns only marginally influence the other time series variables. For instance, based on 4-year forecasting, innovations in stock returns account for less than 3% and 2% of the variance of growth rates of investment and pro-

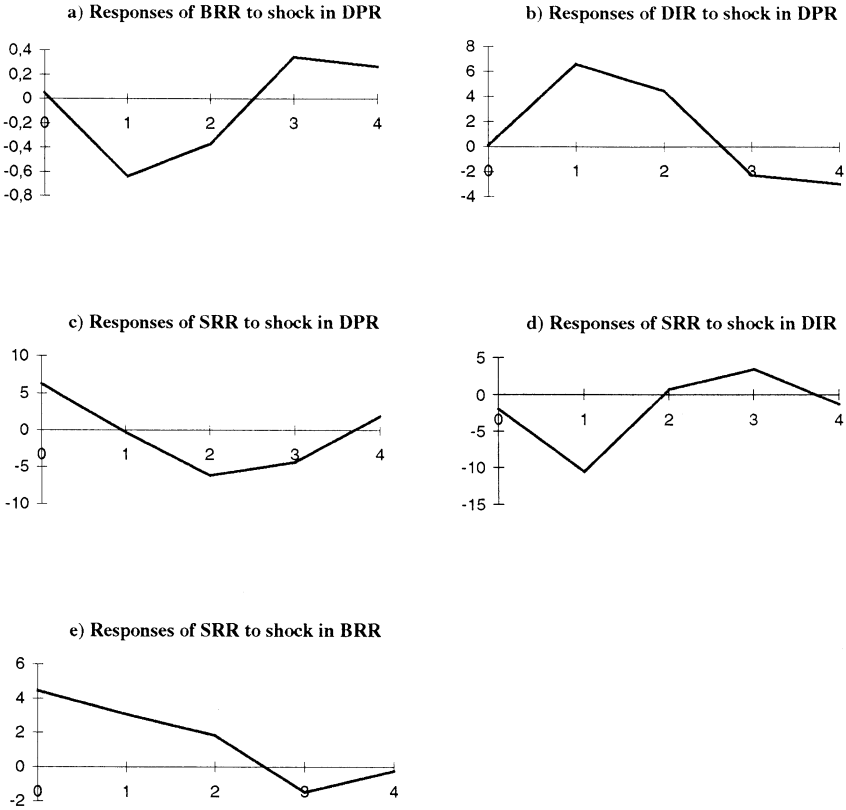


Fig. 2. Impulse responses of each endogenous variable to shocks in each variable.

duction, respectively, while 26.7% and 34.4% of the stock market performance may be attributed to shocks in the production and the investment variable, respectively. Furthermore, interest rates seem to explain 9.2% of the stock market performance.

To illustrate the dynamic responses and the transmission mechanism of information among the time series, we plot the normalized impulse-response function. Figure 2 depicts the simulated effect of an innovation in one variable on future values of another variable in the system (only scores beyond 10% are visualized). The most distinct impulse response patterns are found in Figures 2b), 2d) and 2e). They demonstrate clearly that production has a negative impact on the stock market, and that interest rates changes have a positive effect on the stock market performance. The graphs of Figures 2a) and 2c) are more unclear. Both substantial positive and negative responses occur, such that the direction of the net effect is not obvious.

### 5. Concluding remarks

First, by using aggregated data from the Norwegian manufacturing sector over the period 1952–1995, this study reveals that financial variables repre-

sented by stock returns and bank interest rates have had no significant influence on neither future investment nor future production. A stock market that lacks the ability to predict changes in real activity is consistent with previous findings, especially when, like in this study, fundamental variables are included as explanatory variables. With a different methodology, based on the multivariate vector autoregressive model, and a different data set, our results on these issues fit nicely into the pattern established by previous research.

Second, current stock market returns correlate negatively with lagged growth rates of investment and positively with current growth rates of production. The negative market response to investment activities may be attributed to manufacturing companies lacking the ability to meet the cost of capital required by the market. More likely explanations are: i) The negative relationship between investment and stock market returns may be caused by rationalization prior to decreases in the stock market. ii) Since the available index of investment activity contains a broader group of companies than our stock market index, the negative relationship may stem from export and home industries following different investment cycles.

In addition to these two major results, we find that changes in interest rates have a positive effect on future stock returns. Although high interest rates are often associated with the growth phase of a business cycle, we find little support for this explanation in our data. Furthermore, we find that production leads investment positively, indicating that companies base their expectations of future cash flows in part on their observations of the past. When production capacity is fully utilized, this is a signal to invest. Finally, both production and the real interest rate become exogenous variables in our model. The exogenous bank interest rate may be a consequence of the fact that interest rates have historically been regulated, either directly or indirectly through monetary policy, by Norwegian authorities.

Our results confirm that real variables have not been affected by financial variables in Norway. Although we have not directly analyzed the efficiency of the Norwegian stock market, we may conclude that the stock market has had an insignificant impact on investment decisions in the manufacturing sector. Consequently, if stock prices have been influenced by false signals, e.g. in terms of liquidity driven booms and bursts, they have not substantially infected the real sector.

## 6. References

- Anderson TW (1984) An introduction to multivariate statistical analysis. John Wiley & Sons, New York
- Barro RB (1990) The stock market and investment. *The Review of Financial Studies* 3:115–131
- Bera AK, Jarque CM (1980) Efficient tests for normality, homoscedasticity and serial independence of regression residuals. *Economics Letters* 6:255–259
- Bernanke BS, Gertler M (1995) Inside the black box – The credit channel of monetary-policy transmission. *Journal of Economic Perspectives* 9:27–48
- Blanchard O, Rhee C, Summers L (1993) The stock market, profit, and investment. *Quarterly Journal of Economics* 108:115–136
- Bosworth B (1975) The stock market and the economy. *Brookings Papers on Economic Activity* 2:257–300
- Carlsen F, Spjøtvoll E (1993) The stock market and real investment. *Norsk Økonomisk Tidsskrift* 107:233–253 (in Norwegian)

- Chan SH, Martin JD, Kensinger JW (1990) Corporate research and development expenditures and share value. *Journal of Financial Economics* 26:255–276
- Chirinko RS (1993) Business fixed investment spending: A critical survey of modelling strategies, empirical results, and policy implications. *Journal of Economic Literature* 31:1875–1911
- Chirinko RS, Fazzari SM, Meyer AP (1999) How responsive is business capital formation to its user cost? An exploration with micro data. *Journal of Public Economics* 74:53–80
- Dickey DA, Fuller WA (1979) Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association* 74:427–431
- Dickey DA, Fuller WA (1981) Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica* 49:1057–1072
- Fama EF (1981) Stock returns, real activity, inflation and money. *American Economic Review* 71:545–565
- Fama EF (1990) Stock returns, expected returns, and real activity. *Journal of Finance* 45:1089–1108
- Fazzari S, Hubbard RG, Peterson B (1988) Financing constraints and corporate investment. *Brookings Papers on Economic Activity* 1:141–195
- Fischer S, Merton RC (1984) Macroeconomics and finance: The role of the stock market. *Carnegie Rochester Conference Series on Public Policy* 21:57–108
- Galeotti M, Schiantarelli F (1994) Stock market volatility and investment: Do only fundamentals matter? *Economica* 61:147–165
- Geske R, Roll R (1983) The monetary and fiscal linkage between stock returns and inflation. *Journal of Finance* 38:1–33
- Hamilton JD (1994) *Time series analysis*. Princeton University Press, Princeton, New Jersey
- Harvey AC (1981) *The econometric analysis of time series*. Halsted Press, New York
- Hubbard RG (1998) Capital market imperfections and investment. *Journal of Economic Literature* 36:193–225
- James C, Koreisha S, Partch M (1985) A VARMA analysis of the causal relations among stock returns, real output, and nominal interest rates. *Journal of Finance* 40:1375–1384
- Kaul G (1987) Stock returns and inflation: The role of the monetary sector. *Journal of Financial Economics* 18:253–276
- Lee B-S (1992) Causal relations among stock returns, interest rates, real activity, and inflation. *Journal of Finance* 47:1591–1603
- MacKinnon JG (1991) Critical values for co-integration tests. In Engle RF, Granger CWJ (eds.) *Long Run Economic Relationships*, Oxford University Press, Oxford: 267–276
- Morck R, Shleifer A, Vishny RW (1990) The stock market and investment: Is the market a side-show? *Brookings Paper on Economic Activity* 2:157–215
- Perron P (1989) The great crash, the oil price shock, and the unit root hypothesis. *Econometrica* 57:1361–1401
- Rao CR (1973) *Linear statistical inference and its applications*. John Wiley & Sons, New York
- Schwert GW (1990) Stock returns and real activity: A century of evidence. *Journal of Finance* 45:1237–1257
- Shleifer A, Vishny RW (1990) Equilibrium short horizons of investor and firms. *American Economic Review* 80:148–153
- Sims CA (1980) Macroeconomics and reality. *Econometrica* 48:1–49
- Steigum E (1975) Bank credit and real investment – an empirical test. *Statsøkonomisk Tidsskrift* 89:1–14 (in Norwegian)
- Stein JC (1988) Takeover threats and managerial myopia. *Journal of Political Economy* 96:61–80
- Tease W (1993) The stock market and investment. *OECD Economic Studies* no. 20:41–63
- Thøgersen Ø (1994) Economic policy, macroeconomic performance and the Norwegian petroleum wealth – a survey. Working Paper no. 21, Institute of Economics, Norwegian School of Economics and Business Administration, Bergen
- Welch I (1995) The cross-sectional determinants of corporate capital expenditures: A multinational comparison. Working Paper University of California, Los Angeles
- White H (1980) A heteroscedasticity-consistent covariance matrix estimator and a direct test for heteroscedasticity. *Econometrica* 48:817–838