

PRODUCTIVITY AND STOCK RETURNS: 1951 - 2002

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Abstract

There is considerable concern whether the decline in stock market returns will eventually exert negative changes in the productivity data. This paper examines the long run, or the equilibrium, relationship between productivity and stock returns for the 1951-2002 period. It introduces the notion of equilibrium as represented by the co-movements of economic variables in the long run. This notion is viewed to be broader than the economic theory definition of equilibrium that usually means market clearance. Acknowledging that structural changes in economic time series are hard to detect, an alternative approach employing pair-wise and multifactor cointegration along with VAR modeling is employed. Within this framework, the relationships among productivity, stock prices (returns), investment, and corporate cash flows are pair-wise and jointly investigated. The results indicate that productivity and stock prices share a common trend; so do the stock prices and corporate net cash flows. The long-run common trend between investment and stock prices on the other hand is not so clear. The implications of these results for investors and policy-makers are discussed.

1. Introduction

During the latter half of the 1990s, productivity in the U.S. economy grew at an unprecedented rate, almost twice the pace of the preceding ten years. Widely attributed to developments in the information technology sector, this surge coincided with the rise in stock returns as measured by such indices as, for example, the Standard and Poor 500 as well as the broadly based Wilshire 5000. During the same period, U.S. firms made massive investments in information technology, which included computer hardware and software and telecommunication equipment.

The encouraging positive trends in the above variables, however, began to slow down and even reverse direction early in 2000. Starting in March 2000, productivity started to show some declines. The stock market lost more than fifty percent of its value within two years thereafter. The reduction in real gross private domestic investment was equally sharp, exhibiting even negative growth over several quarters. Indeed, beginning in the third quarter of 2000, gross investment growth was heavily negative and stayed that way over the following six consecutive quarters. The decline in investment spending sharpened further in the first quarter of 2001 and continued at double-digit rates into the remaining three quarters.

While the decline in productivity in the above-cited instances has not been as sharp as the decline in stock returns and in investment, there is, nevertheless, considerable concern whether the decline in stock returns and investment will eventually show up in the productivity data.

The purpose of this paper is to examine the long run, or the equilibrium, relationship between productivity and stock returns for the period of 1951-2002. Section II reviews the literature with particular attention as to whether productivity gains are temporary or permanent. It also elaborates on the links between investment and the stock market. Section III presents the methodology, and sets the groundwork for establishing a testable hypothesis by introducing the notion of equilibrium as represented by the co-movements of economic variables in the long run. This notion is viewed to be broader than the economic theory definition of equilibrium that usually means market clearance. Section IV then takes to task a set of pair-wise and multi-factor cointegration along with vector auto-regression modeling that link stock returns to a host of variables, including productivity, gross domestic investment, and corporate net cash flows. These models are estimated and implications of their results are discussed. The last section includes summary and concluding remarks.

2. Related Research

There are two important issues pertaining to the analysis of the relationship between productivity and stock returns. First, the relationship between these two variables is not independent of the movements in a host of other variables, notably, the growth of real GDP, the growth of real business fixed investment, and the profitability of domestic corporations. Second, a consideration of the components of productivity themselves becomes inevitable. This often results in decomposing productivity movements into trend and cyclical components. Though these two issues are often inter-

mingled, we start this section by addressing the first one in light of the Q theory (see, for example, Palley, 2001), and then we move onto the second issue.

The transmission mechanism between the financial and real sectors of the economy is often provided by investment spending. Conventionally, interest rate, which is determined in the financial sector, determines investment spending, which in turn transmits into output in the real sector. The Q theoretical approach departs from focusing on interest rate, and instead considers equity prices. Following Palley's presentation, the conventional and the Q theory approaches may be summarized, respectively, as:

$$I = I(r, MEK, \dots) \quad (1)$$

$$I = I(Q) \quad (2)$$

where I , r , and MEK are, respectively, investment spending, real interest rate, and marginal efficiency of capital. And Q , in its simple interpretation¹, is the ratio of the stock market valuation of the corporate sector to the current replacement cost of its physical capital, (Palley, p. 658). Relationship (2) suggests that a change in equity prices causes changes in the numerator of Q , and Q in turn changes the level of investment spending. Hence, r in the conventional theory is now replaced by equity prices through the employment of the Q theoretic approach.

A value of Q above 1 indicates that newly-produced physical assets may be purchased more cheaply than the existing assets. Such a situation may induce businesses to purchase newly-produced physical assets instead of acquiring existing assets; alternatively, it may induce financial investors to reduce the prices they will offer for financial assets. Likewise, a value of Q below 1 indicates that claims to existing assets may be acquired more cheaply than newly-produced assets.

In practice, different measures of Q are calculated to reflect the investment side of the economy. The Bureau of Economic Analysis of the Department of Commerce (see, for example, Survey of Current Business, September 2001) calculates three Q-type ratios ($Q1$, $Q2$, and $Q3$) for domestic nonfinancial corporations. $Q1$ is calculated as the market value of outstanding equity divided by the net stock of produced assets. $Q2$ adds the book value of corporate bonds to the numerator. The inclusion of bonds makes $Q2$ a better representative measure of the invested capital. $Q3$ further adds net liquid assets to the numerator. In addition, an estimate of land is subtracted from the numerator because land is not included in the denominator.

All three ratios exhibit similar patterns over time. All three dropped sharply in 2000 after reaching record high levels in 1999, but all three have still remained considerably above 1. (The ratios moved above 1 in the mid-1990s). The decreases in 2000 reflected an 18.9 percent drop in the market value of equities, followed by another drop of 15.0 percent in 2001.

While the Q theory of investment has found a great deal of applications at the firm as well as in macro levels, an increasing number of recent literature tends to question the relationship between the stock market and business fixed investment. The hypotheses on stock returns and investments abound. Morck, et al (1990), suggest that the stock market is a passive predictor of future activity. In this context, managers do not necessarily rely on the market in making investment decisions, though they do consider the stock market as a source of information that may or may not be correct about the fundamentals. A more established view is that the stock market affects investment through its influence on the cost of funds and external finance. Hypotheses involving agency theory and managerial perspectives are also equally forwarded. For example, managers are encouraged to pay attention to the stock market in their investment decisions because a low stock price exposes management to the potential of takeovers, etc. Overall, the general score is that both the fundamentals as well as the non-fundamentals affect the stock market, which in turn, will affect investment, (see, for example, Galeotti and Schiantarelli, 1994).

Parallel to the number of hypotheses that are advanced, the level of sophistication in the analysis of stock returns and investment is also rich, and mixed. At the theoretical level, there are increasing suggestions that the stock market is not driven solely by such fundamentals as investments. A variety of theoretical work has called the simple-present value model of stock prices into question (DeLong and Summers, 1988; Blanchard, et al. 1993; and Allen and Gale, 1992). On a different but related front, expected dividends are emphasized by some (Boehme and Sorescu, 2002; Holder, et al. 1998; Naranjo, et al. 1998; Shiller, 1989; Debondt and Thaler, 1989; Cutler, et al. 1989; and Lakonishok and Lev, 1987); and bubbles and/or the illusionary expectations are considered to be the most significant factor by others (Chirinko and Schaller, 1996).

We now turn to the second issue we raised at the beginning of this section, i.e. productivity and its components. It is worthwhile to first examine some real data. Table 1 provides summary information on the productivity and profitability of domestic non-financial corporations for the year preceding March 2000. It is interesting to note that both the rate of return and productivity track each other very well. Both moved up in the 1990s, but were below the levels posted in the high-productivity-growth years of the 1960s.

Table 1
Output productivity and profitability of domestic non-financial corporations

Year corporations	Average Rate of Return Domestic non-financial	Productivity Measured in output per hour
1960 - 1969	11.1	2.87
1970 - 1979	8.3	2.07
1980 - 1989	7.4	1.5
1990 - 1999	8.3	2.1

Sources: Survey of Current Business, September 2000, p.19; and Bureau of Labor Statistics, 2001 and 2002 issues. The rate of return is the ratio of property income to produced assets. Property income is profits of domestic nonfinancial corporations with inventory valuation and capital adjustments net of interest. Produced assets are the current-cost value for domestic nonfinancial corporations of the net stock of equipment and software and of structures and replacement-cost value of inventories.

Since both the rate of return and productivity exhibit pro-cyclical movements together (Table 1), and since stock returns and real fixed investment have declined from their highs in late 1999, the question is still open whether such changes in investment spending, in productivity, and in stock prices are temporary or permanent in ushering the new economy. Many observers have linked the rise in productivity as well as the rise in the stock market in the 1990s to the explosive growth of the information technology. Others challenge such an interpretation, arguing that there is little evidence of the new economy outside the information technology sector.

Gordon (2000), for example, argues that despite the growing use of computers and other information technology, the long-term growth rate (or the trend) of average labor productivity outside the durable goods manufacturing sector has not accelerated significantly in recent years. He calculates average labor productivity for 1972-1995 and 1995-1999 periods and found the difference between the two periods to be 1.35%. Gordon disaggregates this difference in productivity growth into four components. He attributes 0.5 percent of it to the acceleration of growth that occurs when an economy is in a business cycle upswing. About 0.2 percent is attributed to improvement in labor quality and changes in the measurement of prices, and about 0.3 is

attributed to capital deepening, which is an increase in the capital to labor ratio. The remaining 0.3 percent increase in the trend is attributed to the multi-factor productivity also known as the Solow residual.

Defenders of the new economy, for example, Oliner and Schel (2000), find that labor productivity growth has been 1.04 percent faster in the late 1990s than in the early 1990s. They attribute about half of this increase to the increased use of information technology throughout the economy, including computer hardware and software, and telecommunication equipment. About 0.37 percent is attributed to multi-factor productivity. Increased efficiency outside the information technology-producing sector and in the "other" sectors together account for the remaining 0.2 percentage points. Stiroh (2001) reaches similar results using statistics at the industry-level. These results, however, are not fully in tune with those provided by Jorgenson (2001) who offers a mixed conclusion about productivity growth outside the information technology sector.

Baker (2002) argues that it is true that the new economy, as measured by computers and software, accounted for the increase in productivity, but he also argues that computers and software become obsolete very quickly. As a result, the portion of output that must be devoted to replacing such equipment rises rapidly, as the share of investment going to these items increases. He finds that net domestic product (NDP) actually grew slightly less rapidly than GDP. The gap increased in the 1980s, as computers and high-technology items took an increasing economic importance. GDP grew at an average of 3.0 percent annually over this period, while NDP grew by 2.8 percent, a difference of 0.2 percentage points. In the years from the fourth quarter of 1995 to the fourth quarter of 2000, GDP growth averaged 4.1 percent, while NDP growth averaged 3.7 percent. The gap of 0.4 percentage point in the annual growth rates corresponds to the increase in the share of depreciation in output.

Table 2 exhibits productivity data from the Bureau of Labor Statistics as compared with Baker's estimates. Whether we go by published data or use the net measures of productivity growth — arguably a better measure of the rate at which living standards are improving through time — it is clear that even at the height of the boom years the new economy does not compare favorably with productivity achieved in the early postwar period.

Well, is the published 2.5 percent, or Baker's 2.1 percent, productivity estimates permanent? Researchers have been rigorous in decomposing the movements of output into trend and cyclical components. They have long sought to answer the question of what differentiates the trend from the cycle (Chocrane, 1994; Burke and Kouparitsas, 1998; Nelson and Plosser,

1982; Watson, 1986; Prescott and Hodrick, 1997; and Baxter and King, 1999). They also have been investigating the existence of shifts, if any, in these movements (Hansen, 2001). Burke and Kouparistas, for example, conclude, "...the high growth rates of U.S. output in the 1990s have not been due to an increase in the underlying growth rate but rather to temporary unobservable factors that have permanently raised the level of trend output." (p. 3)

Table 2
Average annual rates of productivity growth (in per cent)

	Published Data	Estimated Net Measure
1949-59	2.8	2.8
1959-69	2.8	2.8
1969-79	1.9	1.9
1979-89	1.4	1.2
1989-2000	1.9	1.7
1995-2000	2.5	2.1

Source: Baker, *Is the New Economy Wearing Out?*, p. 120.

The above conclusion, however, is somewhat in contrast with those obtained by other researchers who have been investigating the existence of shifts, if any, in productivity series. For example, Hansen (2001) focuses on dating productivity breaks in the U. S. labor productivity for the period 1947 through 2000. He finds strong evidence of a structural shift some time between 1992 and 1996. To provide further detail, he disaggregates the manufacturing/durables sector by two-digit SIC codes into ten industry groups. He finds that there is evidence of "regression function" structural change for seven of the ten industry groups, but only two—industrial machinery and electronic equipment—show evidence of structural break in the "mean" growth rates. Hansen leaves the reader with a strong bent on accepting the shift(s), but as to whether the shifts are permanent or transitory, and under the cautionary evidences offered, the outcome could still remain mixed.

In hindsight, a philosophical view of 'permanency' may pose itself: what length of time in one's horizon is to be considered permanent? Avoiding further complexities, we consider the trend and the cyclical movements in a variable as permanent and transitory components, respectively. Others have followed the same path (see, for example, Cochrane, 1994).

3. Methodology

While most research has been focusing on the market model and its offsprings, this paper shifts its attention away from the interest rate and the return on the market (R_m) towards the underlying fundamentals in the equity market. To this end, this section brings together a few strands of the theoretical positions on Q theory, productivity, stock returns, and investments that were briefly discussed in the prior section. It aims at establishing a theoretical relationship that could be cast into a testable hypothesis on productivity and stock returns.

Palley (2001) provides the theoretical aspects of the links that Q provides between equity markets and investment. Thus, while revisiting relationship (2), we also resort to Lettau and Ludvigson's (2002) recent research on Q theory. They derive a loglinear Q model that posits both log of stock prices and log of Q to have a common determining variable, namely, expected returns. Drawing upon Abel and Blanchard (1986), Lettau and Ludvigson obtain the following expressions:

$$q_t \approx E_t \left[\sum_{j=0}^{\infty} \rho_q^j [(1-\rho_q)m_{t+j} - r_{t+j} + \Phi_{t+j}] \right] \quad (3)$$

where:

E_t = expectation operator

q_t = $\ln(Q_t)$

$\rho_q = 1/(1 + \exp(\overline{m-q}))$

$m_t = \ln(M_t) = \ln[(1-\delta) \partial \pi_t / k_t]$

π_t = net cash flows = $\pi_t(K_t, I_t)$

K_t = physical capital stock = $(1-\delta) K_{t-1} + I_t$

I_t = gross investment

r_t = investment returns, and

Φ = linearization constant.

A simple interpretation of relationship (3) is that q_t is determined by two components: expected marginal profits (m_t), and expected future investment returns (r_t).

Lettau and Ludvigson also present an expression similar to relationship (3) for the stock prices:

$$q_t \approx E_t \left[\sum_{j=0}^{\infty} \rho_p^j [(1-\rho_p)d_{t+j} - r_{t+j} + \Phi_{t+j}] \right] \quad (4)$$

where

$$\begin{aligned}
 p_t &= \ln (P_t) = \log \text{ of stock price } P_t \\
 d_t &= \ln (D_t) = \log \text{ of dividend } D_t \\
 r_{st+1} &= \ln (P_{t+1} + D_{t+1}) - \ln P_t = \text{ stock returns, and} \\
 \rho_p &= 1/(1 + \exp(\bar{d} - p))
 \end{aligned}$$

Similarities between relationships (3) and (4) are noteworthy. Both q_t and p_t depend on expected returns but in the former it is expected “*investment*” return and in the latter it is expected “*stock*” return. Are these two returns closely related? Cochrane (1991) as well as Lettau and Ludvigson posit that, under simplifying assumptions, the equilibrium r_t and r_{st} are indeed the same. “Intuitively, firms will remove arbitrage opportunities between asset returns and investment returns until the two are equal ex post, in every state of nature.” (Lettau and Ludvigson, p. 37). Under these assumptions, then both q_t and p_t have a common determining factor, namely, expected future stock returns, $r_{st} = r_t$.

We now turn to conjecture, based on relationships (2) through (4), and attempt to establish an econometric methodology that could yield a testable hypothesis to examine the relationship between productivity and stock returns.

To start, we view ‘permanency’ as a long run equilibrium phenomenon and ‘transitory’ as cyclical movements. The notion of equilibrium here refers to a state in which there is no inherent tendency for variables to change; and the notion of equilibrium relationship between two variables describes a relationship exhibiting ‘*tatannment*’ movements with a tendency towards convergence over time. This is consistent with the equilibrium assumption that brought the equality of r_{st} and r_t in the first place. In statistical terms, the notion of co-integration, if it exists, formalizes this concept. It is simply an inquiry into the existence of long-run relationship(s) between a set of integrated variables.

As discussed in the previous section, an analysis of the relationship between stock returns and productivity necessitates consideration of a host of variables that are related to, or pose as the underlying determinants of, these two variables. Considering the loglinear q-model (relationships 3 and 4) and the other points of views that were discussed in the last section, we now need to narrow down on the number of potential proxies that could link stock returns and productivity. In general, and in light of the vast and rich body of the literature on stock market and its relationship with other variables, the researchers may simply opt to minimize, rather than to completely

overcome, the risk arising from the omission of such determining variables. Acknowledging this point, we hypothesize that stock returns are related not only to productivity measures, but also to a few other major determining factors, including investment and corporate cash flows. We consider corporate cash flows as a good proxy for either m or d in relationships (3) and (4), respectively. Productivity per se could be viewed as a proxy for investment returns in relationship (3) or stock returns in relationship (4). Investment spending captures the backbone of the Q theory as expressed in relationship (2) or (3).

Using a general representation, the above hypothesis may be cast into:

$$SR = f (PR, IN, CF, \dots) \quad (5)$$

where SR is stock returns and PR , IN , and CF are, respectively, real fixed gross investment, and real corporate cash flows.

Theoretically, several issues pertaining to the modeling of stock returns as presented in relationship (5) need to be resolved. These are: the ergogeneity of the variables, cointegration or the existence of a long-run relationship between integrated variables, and single-equation versus system modeling.

If the conditioning variables are weakly exogenous, efficient inference then can be based on a conditional model (Engle, et al. 1983; Ericsson, 1992). Analyzing conditional stock returns and productivity equations without at the same time analyzing the marginal model of the investment leads to a loss of generality. For productivity to be treated as weakly exogenous, and thus justifying the analysis of the conditional model, two important conditions must hold. First, the parameter of interest to the researcher must only be a function of the conditional model. Second, the parameters of the conditional and the marginal models must be variation-free.

On the second theoretical issue, it is well established that cointegration in a set of integrated series implies that a linear combination of them is of lower order of integration. Under an $I(1)$ series, there may still exist a stationary combination. When variables are cointegrated, the cointegrating relationship appears in general in the marginal of all variables, and as result it can not be assumed that one particular variable in the system is weakly exogenous for the parameters of the other equations, and in particular for the cointegration vector. In other words, weak exogeneity must be established.

Finally, on the single-equation versus system modeling, there are several reasons for starting the analysis of the economic series from their joint

density function (Hedry and Doornik, 1994; Hendry, 1995). First, the economy is a system, and as such all variables are potentially endogenous. Second, testing the weak exogeneity of a subset of variables may pose an alternative that warrants investigating. Third, the absence of weak exogeneity of the conditioning variables for the parameters of interest in a conditional model can lead to serious problems of bias and efficiency in finite sample.

Considering the above, we have augmented our empirical methodology with error correction modeling (ECM), and have also opted for a VAR model that contains all the variables as endogenous. We will examine these models and their subsets in detail in the next section.

4. Empirical Application

Quarterly data on S&P 500 index (SR), productivity (PR), real fixed private domestic investment (IN), and corporate net cash flows (CF) were compiled for the period of 1951:1 to 2002:1 from FRED Economic Database. The latter three variables are seasonally adjusted; productivity is the index of non-farm business sector output per hour of all persons (1992=100); and investments are in 1996 dollars.

We first tested for stationarity of each variable. Both the augmented Dicky-Fuller and the Phillips-Perron tests indicated nonstationary of the variables in their levels, but stationarity in their first differences.

We then ran a series of tests on the four variables -- SR, PR, IN, and CF -- using Granger causality, ECM, and VAR. The causality test results indicated, for the most part, lack of feedback among the variables. To scrutinize these results further, we extended Granger's approach into an ECM framework. Then, the outcome indicated the existence of uni- or bi-directional feedback among the variables. The results for the productivity and stock returns are presented in Table 3. A strong bi-feedback relationship from PR to SR (and vice versa) is captured by the coefficient of the residual variable in the ECM specification. This variable is highly statistically significant (see the t or the probability values in Table 3).

Considering all variables as endogenous, we tested a VAR system with four lags². The estimated coefficients for the entire model reflected at least one or more statistically significant coefficients in each of the non-autoregressive explanatory variables, thus supporting, in general, the endogeneity among the four variables. The stock return variable contained the least number of significant variables among the non-autoregressive explanatory variables. Only the productivity variable and the intercept were significant in the SR equation. Corporate net cash flows (CF) contained the

most number of significant variables (a total of six — two in each of the non-autoregressive explanatory variables). Similar numbers on the counts of the statistically significant non-autoregressive explanatory variables for the productivity (PR) and investment (IN) equations were three and four, respectively. Finally, the impulse response functions of the four variables indicated convergence, arising from Cholesky shocks, to near zero point after about twelve quarters.

Table 3
Productivity and stock returns feedback mechanism
(EMC approach)

Causality From	Coefficient of Residual Variable in ECM	Probability of t-statistic
SR PR	-1.092 (-6.646)*	0.000
PR SR	-1.101 (-6.486)*	0.000

* = Significant at the probability in the last column.

As a further test between stock returns and the other three variables, i.e. productivity, investments, and corporate net cash flows, we ran OLS with SR as the dependent variable. Except for the productivity variable (PR), the results (not reported) did not indicate the presence of robust relationships between stock returns and the other two (IN and CF) variables.

Tests for cointegration between the variables and in the entire system were the next step. These tests were done both pair wise and in total, i.e., between the stock index and each of the other variables, and between the stock index and the other variables as a group. These tests were performed using the Johansen test procedure on both the log and the actual values of the variables. To achieve some degree of stabilization (smoothness) in the means and variances of the series, all variables were also converted to log values.

Table 4 presents the results for the variables in their log values. The results using the actual values of the variables are roughly the same; hence they are not reported in Table 4. The test results indicate the presence of:

- one cointegrating equation between stock index and productivity (see Panel A in Table 3)
- one cointegrating equation between stock index and net corporate cash flows (Panel B), and

- no cointegrating equation between stock index and real fixed gross investment (Panel C).

Table 4
Unrestricted cointegration rank tests

(r 1)	Trace ¹	5% CV	1% CV	Max-Eigen ¹	5% CV	1% CV
Panel A: Stock prices and productivity						
0	33.69*	19.96	24.60	32.23*	15.67	20.20
1	1.46	9.24	12.96	1.36	9.24	12.97
Panel B: Stock prices and corporate net cash flows						
0	33.74*	19.96	24.60	32.28*	15.67	20.20
1	1.46	9.24	12.96	1.46	9.24	12.97
Panel C: Stock prices and investments						
0	15.82	19.96	24.60	13.43	15.67	20.20
1	2.39	9.24	12.96	2.39	9.24	12.97
Panel D: Stock returns, productivity, corporate net cash flows, and investments						
0	99.40*	53.12	60.18	56.73*	28.14	33.24
1	42.67*	34.91	41.07	21.74	22.00	26.81
2	20.93**	19.96	24.60	12.55	15.67	20.20
3	8.38	9.24	12.97	8.38	9.24	12.97

¹ For the trace test, the null hypothesis is that the number of cointegrating vectors is less than or equal to r , against the alternative of higher than r . For the maximum eigen value test, the null hypothesis is that number of cointegrating vectors is r , against the alternative of $r+1$ cointegrating vectors. Hence, the sign of λ_1 in the first column of this table needs to be interpreted with caution (see Johansen and Juselius, 1990).

* (or **) = Significant at the 1 (= *) or 5 (= **) percent or below.

Clearly, the relationship between stock index and productivity and stock index and cash flows suggests that there may be a unique pair-wise relation between these variables. This, of course, does not exclude that these three variables may be part of a larger system. In contrast, there is no cointegrating relation between stock index and real fixed investment. Though intuitively implausible, recent literature suggests that the correlation (or causality) may be from consumption to stock prices rather than from investment

(see Lettau and Ludvigson, 2001). It could also plausibly be argued that there may exist one or more “other” relationships that may establish the link, if any, between these two variables.

The test for cointegration between stock index and the other three variables indicates the existence of one to three cointegrating equations (see Panel D of Table 4). The ambiguity in the number of cointegrating equations rests on the choice of the critical value and the statistical criterion employed. Using the trace statistic and the 5 percent critical value, the test indicates three cointegrating equations. At the other extreme, max-eigen statistic under one percent critical value indicates the existence of only one cointegrating equation.

For the pair-wise cointegration, the Johansen procedure yields three normalized equations for Panels A, B, and C of Table 4, respectively. These are presented in Panel A of Table 5. Panel B of this table reports the one and the three normalized equations corresponding to the cointegration test of SR on PR, CF, and IN as a group.

Clearly, all the coefficients in the first two equations of Panel A (Table 5) are highly significant and carry the a-priori expected signs. In contrast, in the SR - IN equation, the IN coefficient, though not statistically significant, has the wrong sign. As stated above, no cointegrating equation for SR - IN was identified.

The results in Panel B of Table 5 are somewhat interesting. In the case of one integrating equation, CF and IN are significant, though IN has the wrong sign. Thus IN still behaves counter to one’s intuition. However, under the three cointegrating equations, all coefficients are significant and carry the a-priori expected signs. In particular, as a system, the model yields a robust cointegrating relationship between SR and IN, which is in contrast with our results under the pair-wise, and the system single cointegrating equation, cases. As a system, IN thus yields mixed results. On the one hand, it has the wrong sign in one equation. On the other hand, a cointegrating relationship between SR and IN does appear to exist. This latter point, in turn, may be attributed to the system that captures the SR - IN relationship through the other variables. This conclusion however is not conclusive.

Since volatility of stock prices is known to be counter cyclical, the above parameter estimates indicate different relationships between stock prices and each of the three variables. It should be noted that within the system productivity appears to link with stock prices through investment.

Considering the above results -- including our extensions into Granger causality, ECM, and VAR -- there are ample indications that the linkages between the four variables we have considered are complex, and that they may not easily be captured by simple specifications.

Table 5
Pair-Wise and system normalized cointegrating coefficients
(standard errors are in parenthesis)

Panel A: Pair-Wise			
SR	=	-17.662	+ 4.703 PR
		(-3.911)*	(0.892)*
SR	=	3.531	+ 0.816 PR
		(1.592)*	(0.301)*
SR	=	-94.128	- 18.790 IN
		(-509.385)	(-80.857)
Panel B: System			
One Cointegrating Equation			
SR	=	28.977	- 3.354 PR + 5.557 CF - 6.799 IN
		(23.999)	(-9.445) (2.273)* (-4.871)*
Three Cointegrating Equations			
SR	=	-6.211	+ 1.837 IN
		(-1.259)*	(0.192)*
PR	=	1.319	+ 0.482 IN
		(-0.127)*	(0.019)*
CF	=	-5.535	+ 1.845 IN
		(-0.918)*	(0.140)*

* = Significant at the 5 percent or below.

5. Conclusion

During the latter half of the 1990s, productivity grew at almost twice the pace of the preceding ten years. The surge in productivity was accompanied by a double-digit increase in stock returns. For some observers, the productivity surge and the stock market boom were the twin manifestations of the new economy. This period is in sharp contrast with the decade starting in the early 70s. Then, productivity growth slowed sharply and stayed low for nearly two decades; and the stock market exhibited similar declines. It thus appears

that both the stock market and productivity either respond to each other, or reflect changes in “other” economic variables. These episodes also raise the question of what impact, if any, changes in productivity exert on stock returns.

In this paper, we reviewed the long-run relationship between productivity and stock prices (returns) for the period of 1951:1-2002:1. We addressed whether changes in productivity are cyclical or permanent. The results are mixed. Whereas some researchers conclude that the trend growth rate of U.S. output has not increased in the 1990s, others show the presence of structural breaks in the underlying economic time series. In hindsight, we tend to bridge these two positions in light of a philosophical question on ‘permanency’: what length of time in one’s horizon is to be considered permanent?

Our pair-wise and system (multi-vector) cointegration tests confirmed some of the above views, yielding zero to one cointegrating vectors in the pair-wise cases, and three cointegrating vectors in the system case. Overall, our results also suggest that the relationship between productivity and stock returns needs to be modeled as part of a larger system that includes investment, corporate net cash flows, and other variables.

Within our experiments, we tend to conclude that productivity and stock prices share a common trend *directly* within a *pair-wise* context. Within a system, however, the results for these two variables are mixed. The link appears to be indirect and is captured (overshadowed) by other variables. Stock prices and corporate net cash flows also share a common trend, but in this case both in a pair-wise and within a system environment. Empirically, the pair-wise and the system results are very consistent with regards to SR and CF. In contrast to the case of SR and PR, stock prices and investments do not seem to show a common trend directly, but do appear to do so indirectly through other variables in the system. This reflects our mixed results as to whether these two variables are or are not cointegrated in the long run. It also reflects a position currently reached by other researchers. Palley (2001), for example, while acknowledging that the relationship between investment and stock return is ultimately an empirical matter, suggests that in an investment decision, after controlling for cyclical economic conditions, the stock market is a sideshow. Others, for example Morck, et al (1990) and Blanchard et al (1993), find statistically significant relationship, though of small size, between investment and stock return. Further research in this area is warranted.

Endnotes

1. There are different interpretations of Q: strong Q (Brainard and Tobin, 1977), weak Q (Minsky, 1986), and neoclassical Q (Hayashi, 1982). For further details see Palley (2001).
2. Akaike and Schwarz's criteria indicated optimal lag structure of length four to six.

References

- Abel, A. B., & Olivier, J. B. (1986). The present value of profits and cyclical movements in investments. *Econometrica*, 54(2), 249-274.
- Allen, F., & Douglas, G. (1992). Stock-price manipulation. *Review of Financial Studies*, 5(3), 503-529.
- Bauer, P., Jensen, J., & Schweitzer, M. (2001). Productivity gains, how permanent? *Economic Commentary: Federal Reserve Bank of Cleveland*.
- Baxter, M., & Robert, G. K. (1999). Measuring business cycles: Approximate band-pass filters for economic time series. *Review of Economics and Statistics*, 81, 575-593.
- Blanchard, O., Rhee, C., & Summers, L. (1993). The stock market, profit and investment. *Quarterly Journal of Economics*, 98(1), 115-136.
- Boehme, R., & Sorin, S. (2002). The long run performance following dividend initiations and resumptions: Underreaction or product of chance. *Journal of Finance*, 57(2), 871-900.
- Brainard, W. T. J. (1977). Asset markets and the cost of capital, in Bellassa, B. and Nelson, R. (eds.). *Economic progress, private values, and public policy: Essays in honor of William Fellner*. New York: North Holland.
- Burke, M. K., & Kouparistas, M. A. (1998). A new paradigm for the U.S. economy. *Chicago Fed Letter*, 134, 1-4.

- Chirinko, R. (1993). Business fixed investment spending: Modeling strategies, empirical results and policy implication. *Journal of Economic Literature*, 31, 1875-1911.
- Chirinko, R., S. & Huntley, S. (1996). Bubbles, fundamentals, and investment: A multiple equation testing strategy. *Journal of Monetary Economics*, 38, 47-76.
- Cochrane, J. H. (1994). Permanent and transitory components of GNP and stock prices. *The Quarterly Journal of Economics*, 109(1), 241-265.
- Cutler, D. M., James, M. P., & Lawrence, H. S. (1989). What moves stock prices? *Journal of Portfolio Management*, 15(3), 4-12.
- DeBondt, W. F. M., & Richard, H. T. (1989). Anomalies: A mean-reverting walk down wall street. *Journal of Economic Perspectives*, 3(1), 189-202.
- DeLong, J. B., & Lawrence, H. S. (1988). How does macroeconomics policy affect output? *Brookings Papers*, 19(2), 433-480.
- Galeotti, M., & Fabio, S. (1994). Stock market volatility and investment: Do only fundamentals matter? *Economica*, 61(242), 147-166.
- Gordon, R. (2000). Does the new economy measure up to the great inventions of the past? *Journal of Economic Perspective*, 14 (4), 49-74.
- Hayashi, F. (1982). Tobin's marginal q and average q: A neoclassical interpretation. *Econometrica*, 50(1), 213-224.
- Hodrick, R., & Prescott, E. (1997). Post-war U.S. business cycle: An empirical investigation. *Journal of Money, Credit and Banking*, 29(1), 1-16.
- Holder, M. E., Frederick, W. L., & Hexter, L. J. (1998). Dividend policy determinants: An investigation of the influences of stakeholder theory. *Financial Management*, 27 (3), 73-82.
- Jorgenson, D. (2001). Information technology and the U.S. Economy. *American Economic Review*, 91, 1-32.
- King, R. G., Charles, I. P., James, H. S., & Mark, W. W. (1991). Stochastic trends and economic fluctuations. *American Economic Review*, 81(4), 819-840.

- Lakonishok, J., & Baruch, L. (1987). Stock splits and stock dividends: Why, who, and when. *Journal of Finance*, 42 (4), 913-932.
- Lettau, M., & Sydney, L. (2001). Consumption, aggregate wealth, and expected stock returns. *Journal of Finance*, 56(3), 815-849.
- Lettau, M., & Sydney, L. (2002). Time-varying risk premia and the cost of capital: An alternative implication of the theory of investment. *Journal of Monetary Economics*, 49, 31-66.
- Minsky, H. (1986). *Stabilizing an unstable economy*. New Haven: Yale University Press.
- Morck, R., Shleifer, A., & Vishny, R. W. (1990). The stock market and investment: Is the market a sideshow? *Brooking Papers on Economic Activity*, (21)2, 157-215.
- Naranjo, A., Nimalendran, M., & Mike, R. (1998). Stock returns, dividend yields, and taxes. *Journal of Finance*, 53(6), 2029-2057.
- Nelson, C. R., & Plosser, C. I. (1982). Trends and random walks in macroeconomic time series: Some evidence and implications. *Journal of Monetary Economics*, 10(2), 139-162.
- Oliner, S., & Sichel, D. (2000). The resurgence of growth in the late 1990s: Is the information technology the story? *Journal of Economic Perspective*, 14 (4), 2-22.
- Palley, T.I. (2001). The stock market and investment: Another look at the micro-foundations of q theory. *Cambridge Journal of Economics*, 25, 657-667.
- Shiller, R. J. (1989). Comovements in stock prices and comovements in dividends. *Journal of Finance*, 44(3), 719-730.
- Stock, J. H., & Watson, M. W. (2001). Vector autoregression. *Journal of Economic Perspective*, 15 (4), 101-115.
- Watson, M. W. (1986). Univariate detrending methods with stochastic trends. *Journal of Monetary Economics*, 18(1), 49-76.